No. 724,180. PATENTED MAR. 31, 1903.

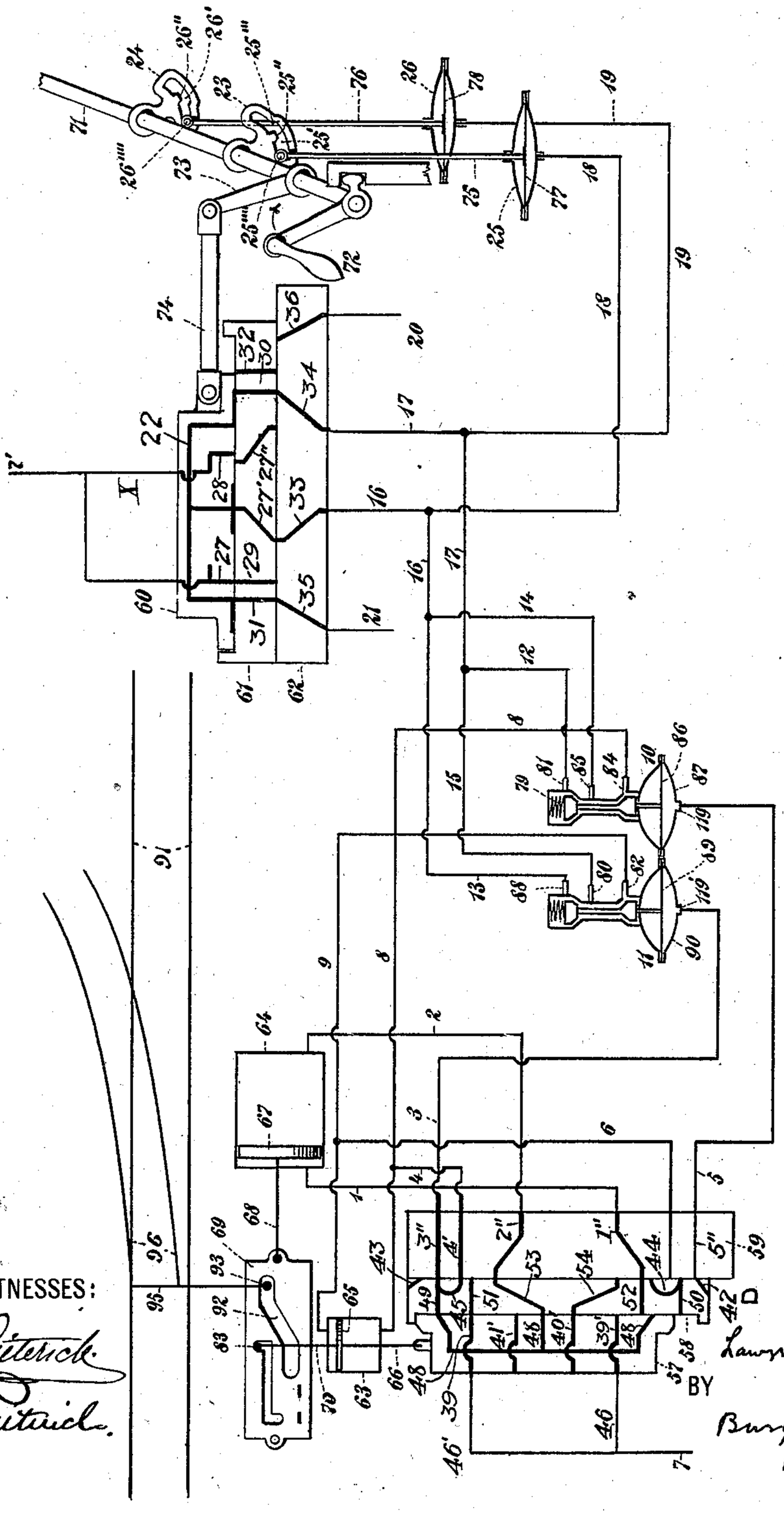
L. GRIFFITH.

PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

APPLICATION FILED APR. 18, 1902.

NO MODEL. 13 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

Ge. Dieterich.

C. H. Dieterich.

INVENTOR

Lawrence Griffith

BY

Burgess & Philip

ATTORNEYS

No. 724,180. PATENTED MAR. 31, 1903.

L. GRIFFITH.

PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

NO MODEL. APPLICATION FILED APR. 18, 1902.

13 SHEETS—SHEET 2.

Fig. 2.

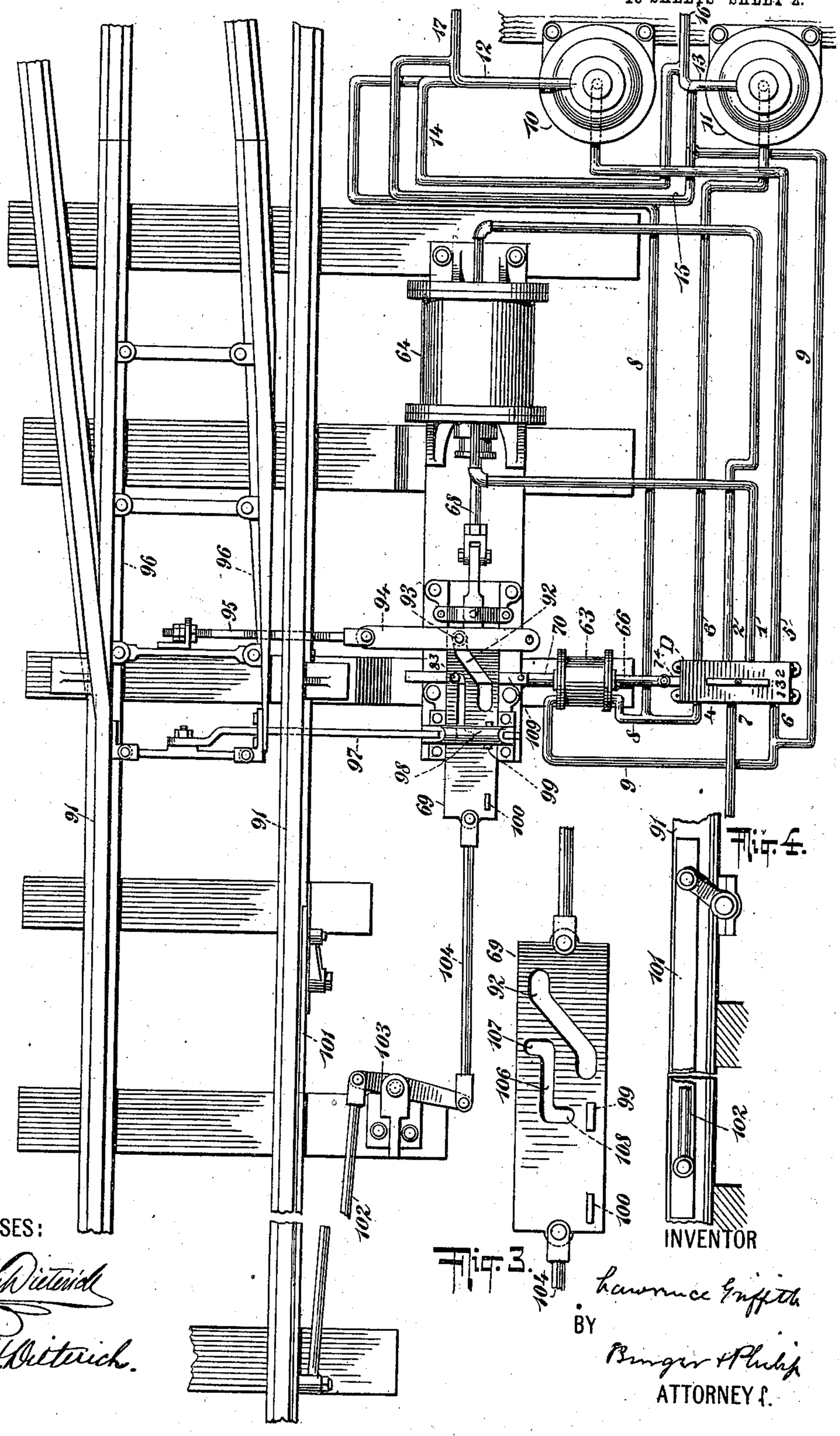


Fig. 4.

Fig. 3.

WITNESSES:

Gustave Dietrich

Edwin N. Dietrich.

INVENTOR

Lawrence Griffith

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Burger & Phelps

ATTORNEYS.

No. 724,180. PATENTED MAR. 31, 1903.

L. GRIFFITH.

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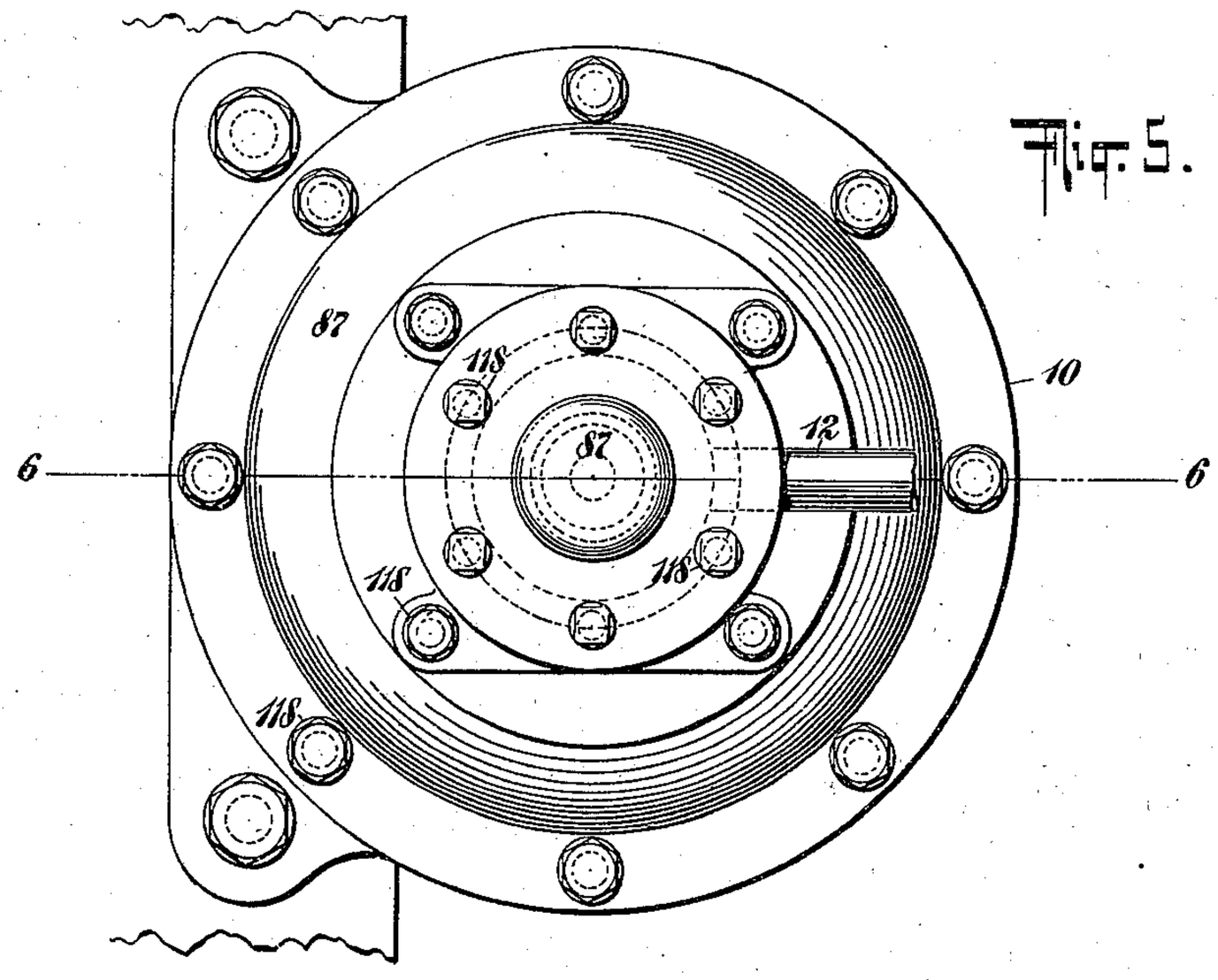
APPLICATION FILED APR. 18, 1902.

NO MODEL. 13 SHEETS—SHEET 3.

Fig. 5.



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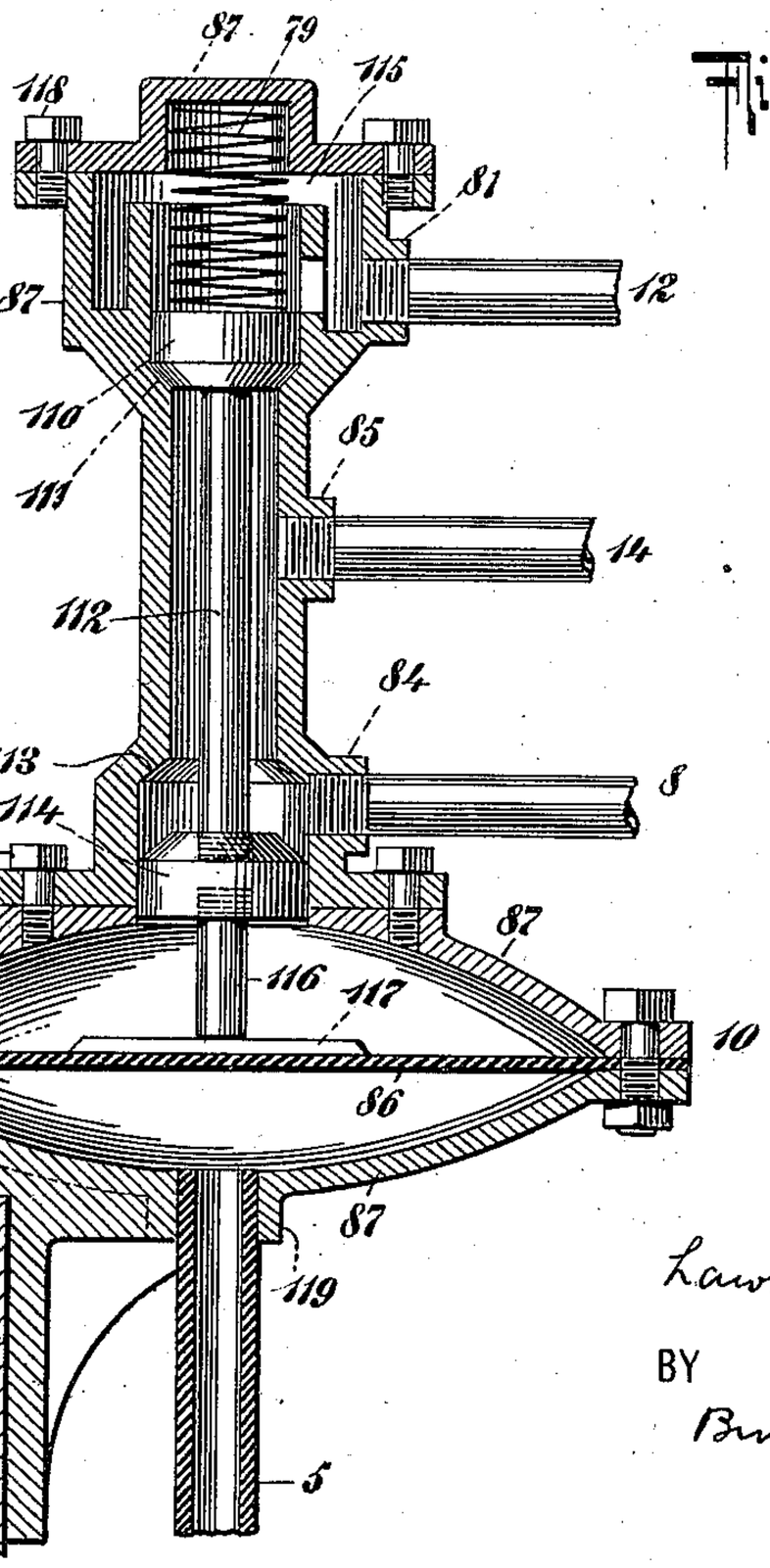

WITNESSES:

Gustave Dieterich.

Edwin H. Dieterich.

INVENTOR

Lawrence Griffith

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Burgess & Pauly

ATTORNEYS

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L. GRIFFITH.

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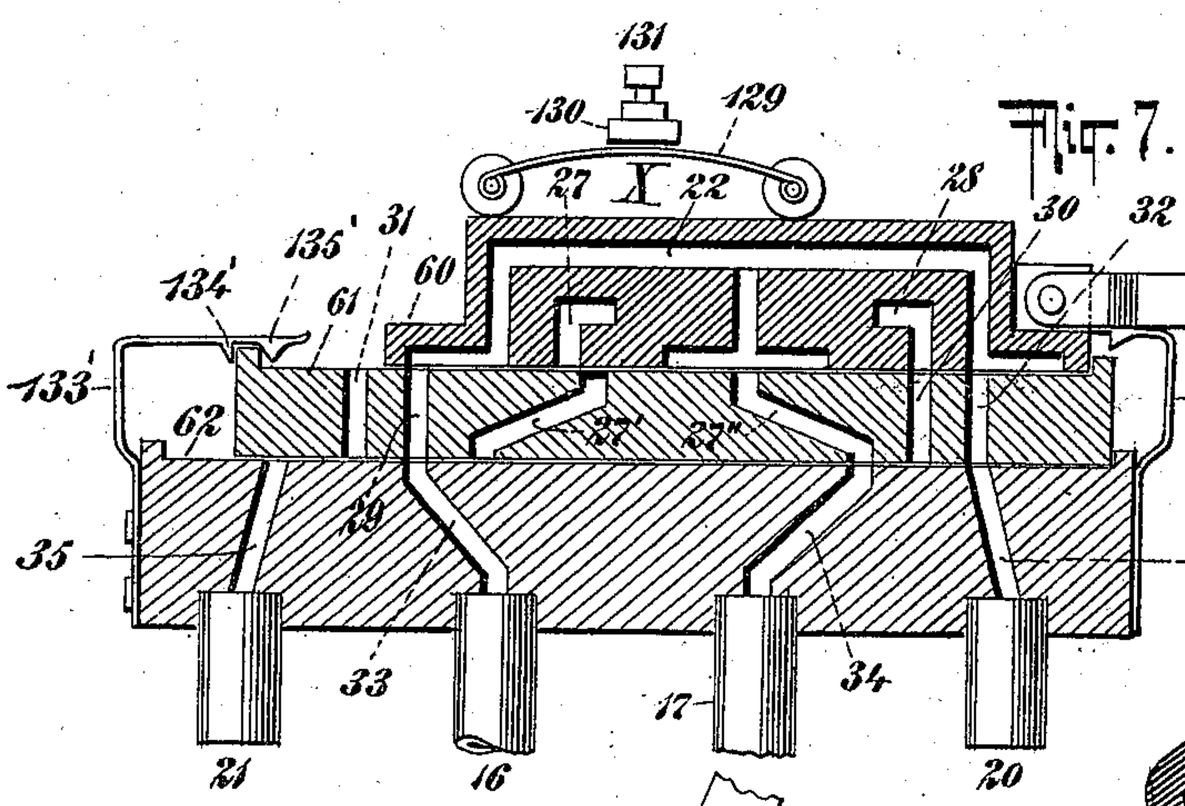
NO MODEL. 13 SHEETS—SHEET 4.

Fig. 7.



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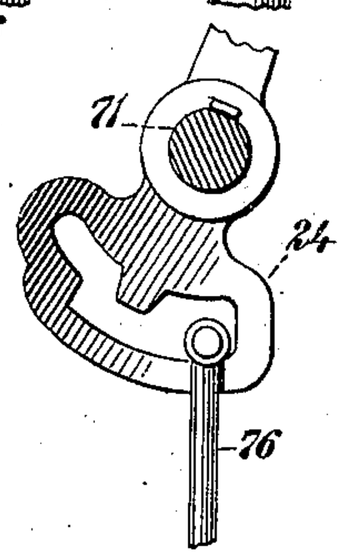

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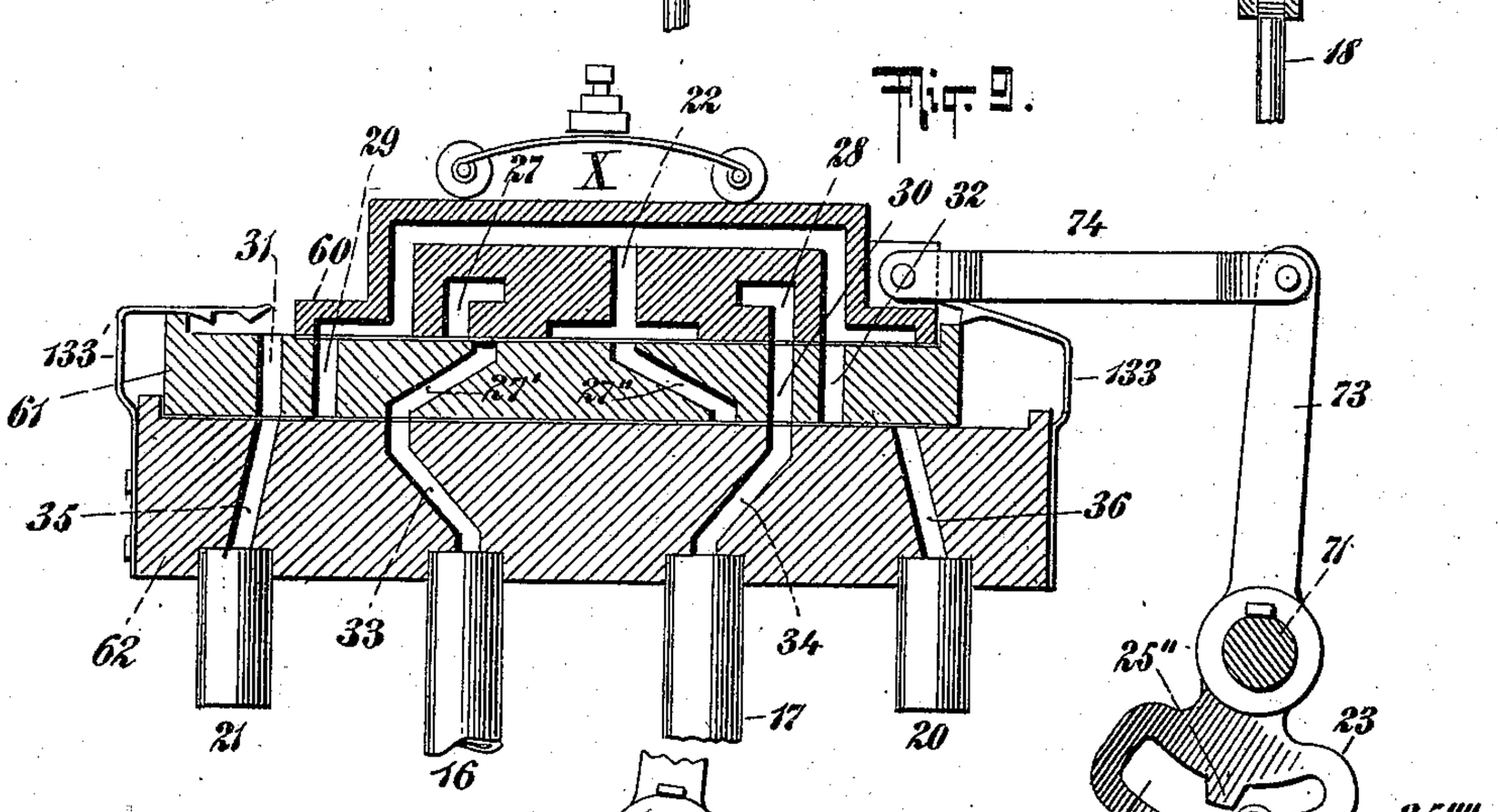

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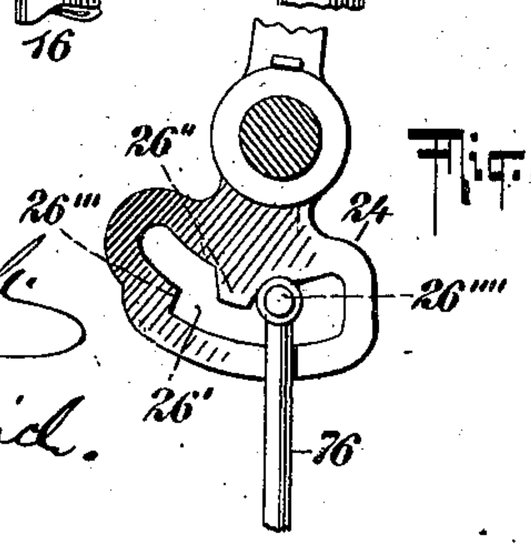

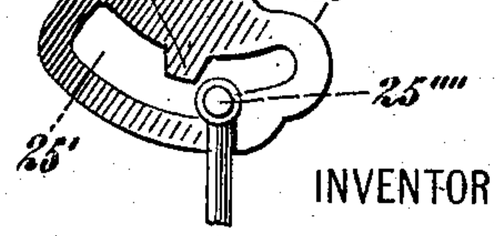

WITNESSES:

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ATTORNEYS.

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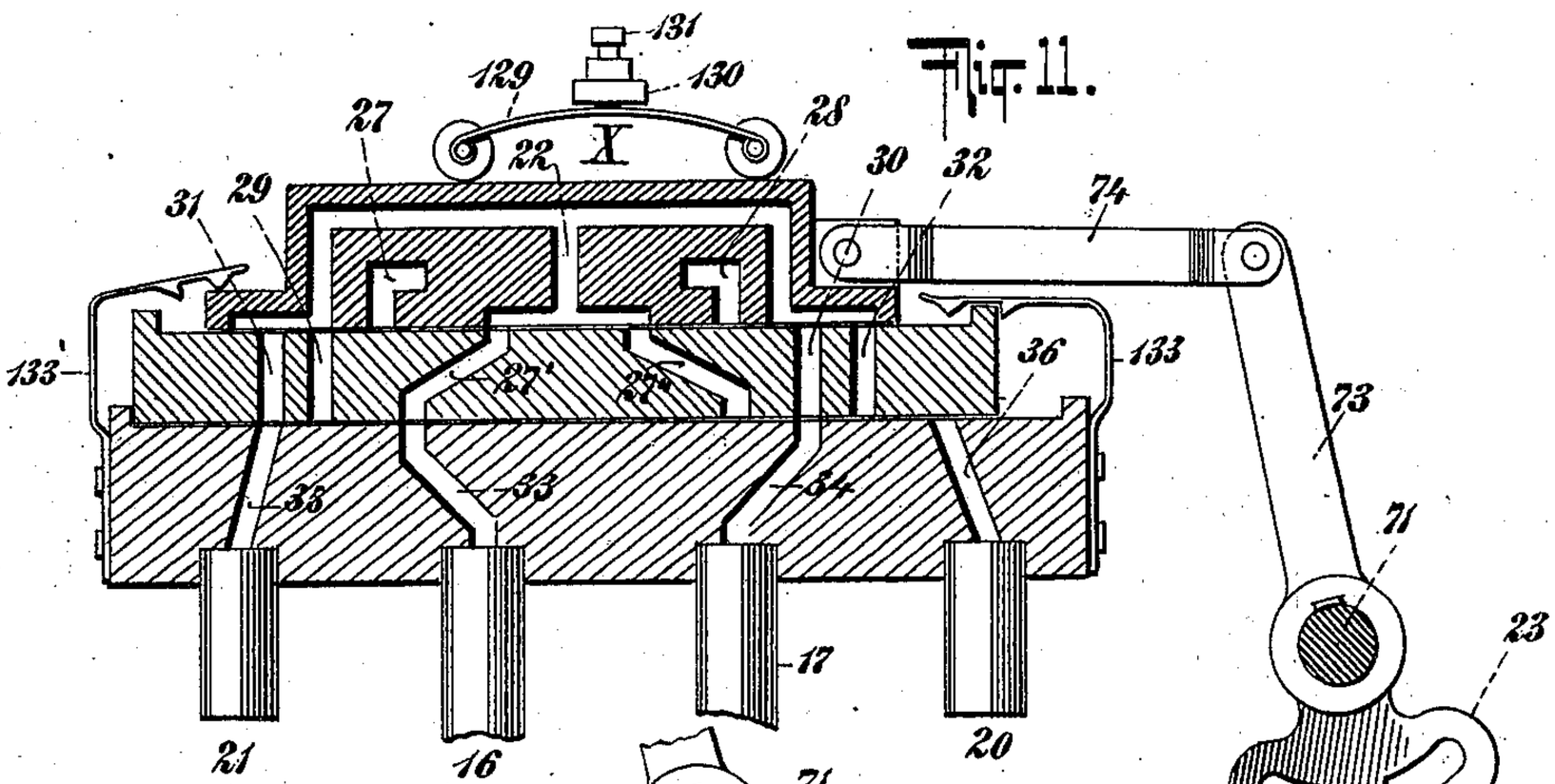
NO MODEL. 13 SHEETS—SHEET 5.

Fig. 11.



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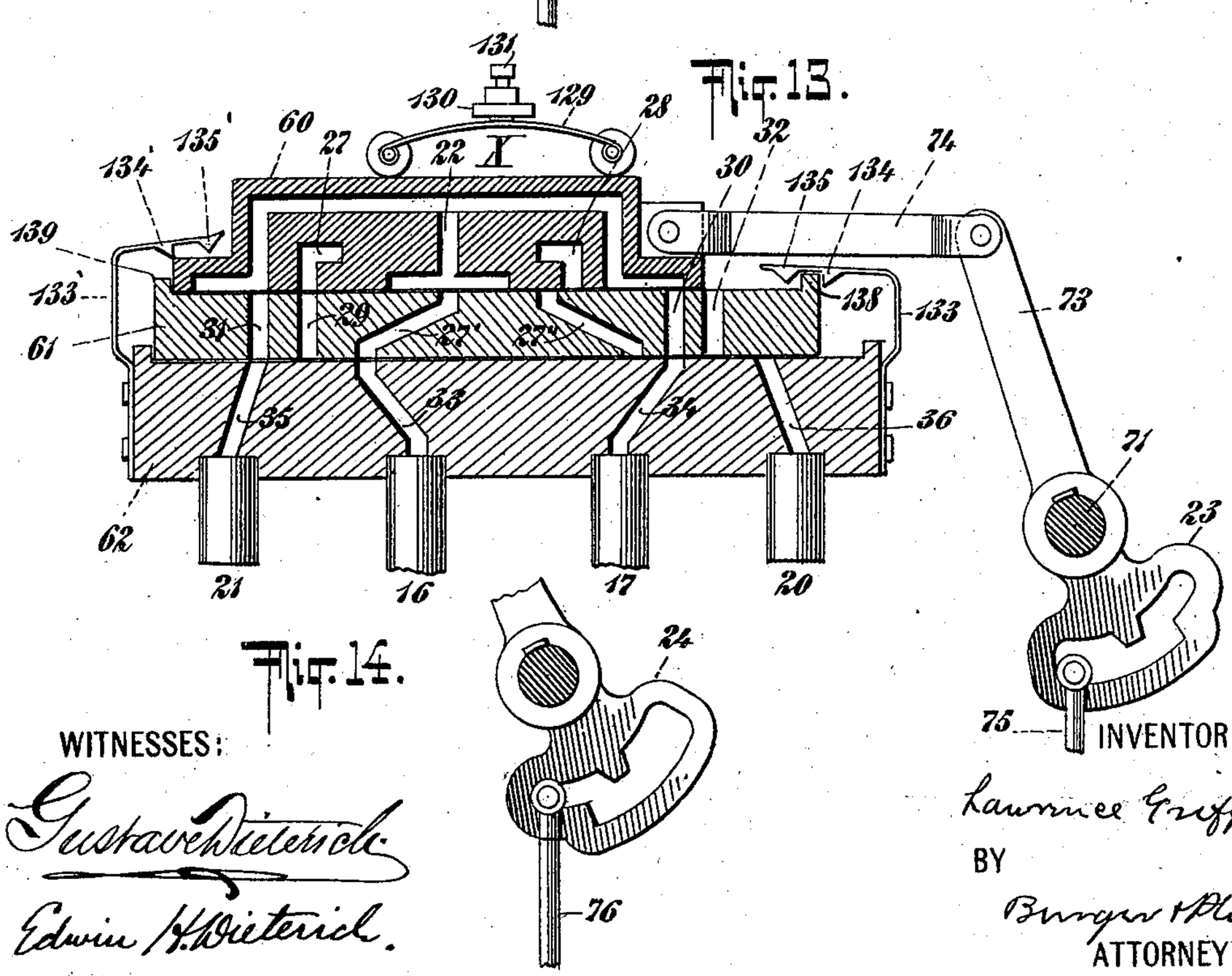

Fig. 13.

Fig. 14.

WITNESSES:

Gustave Dieterich.

Edwin H. Dieterich.

INVENTOR

Lawrence Griffith

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No. 724,180. PATENTED MAR. 31, 1903.

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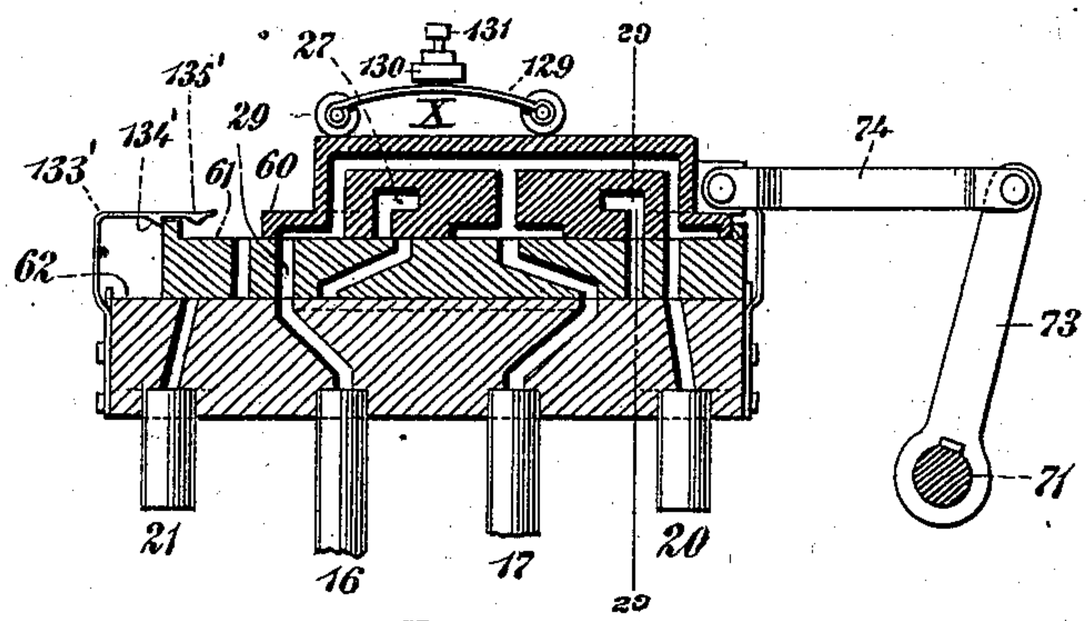
NO MODEL. 13 SHEETS—SHEET 6.

Fig. 15.



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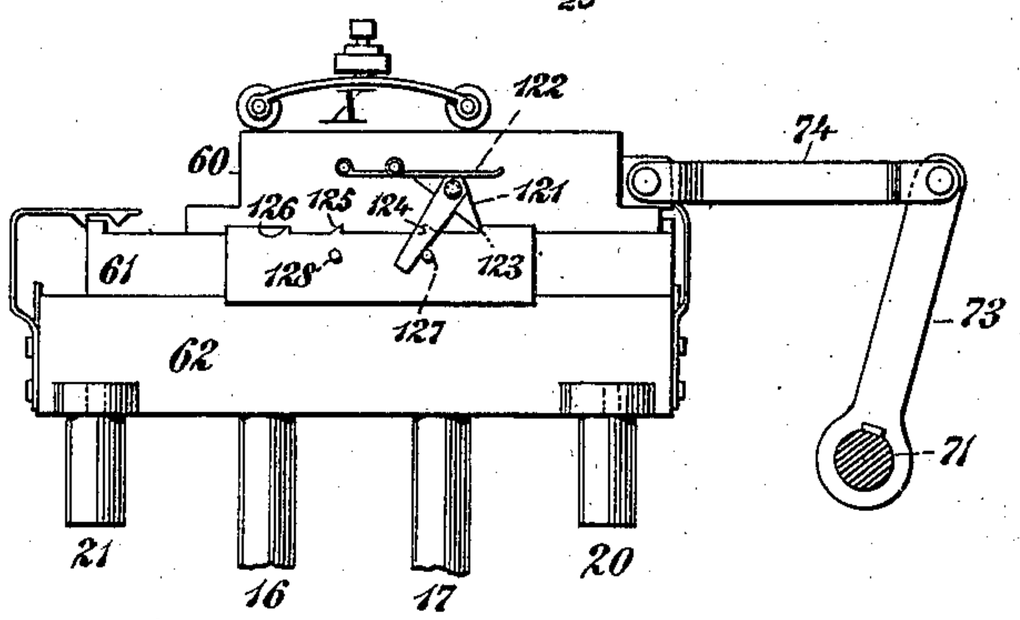

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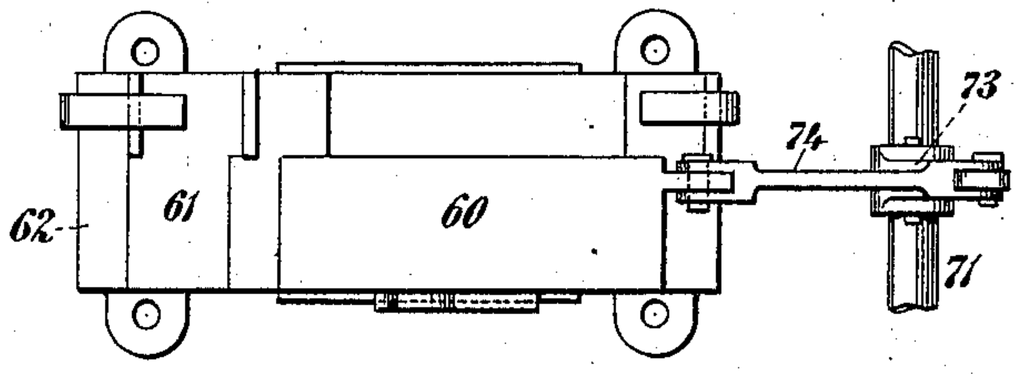

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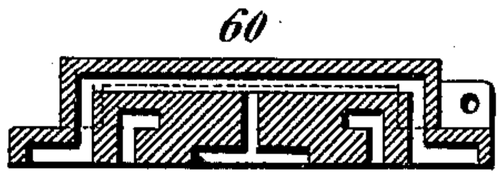

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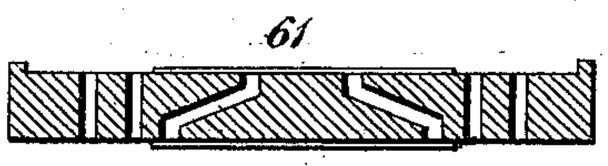

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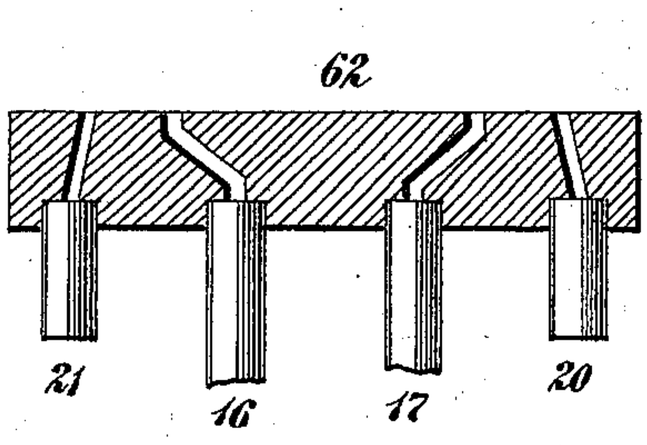

WITNESSES:

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Edwin H. Dieterich.

INVENTOR

Lawrence Griffith

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ATTORNEYS.

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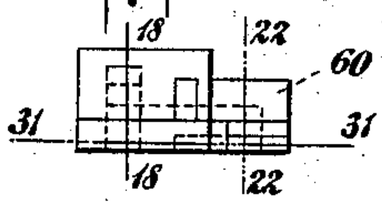
Fig. 21.



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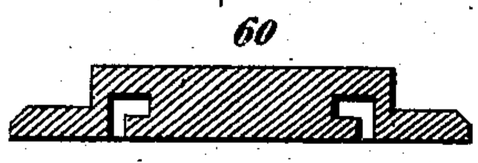

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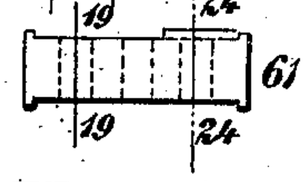

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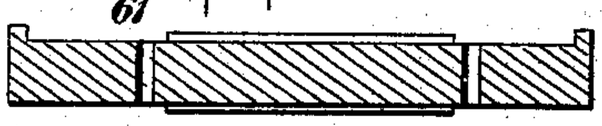

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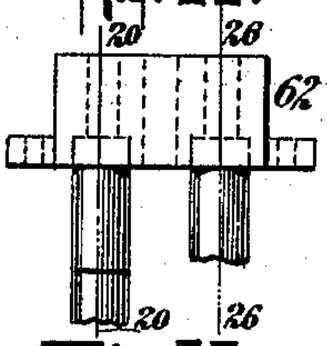

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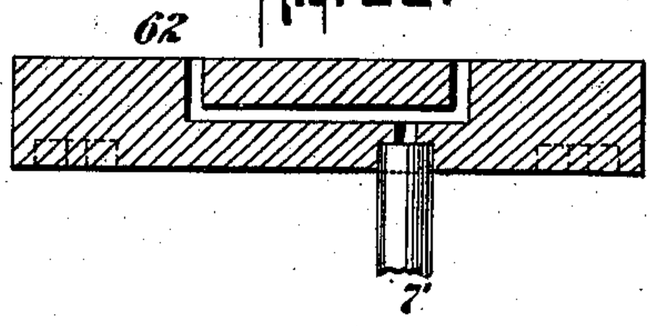

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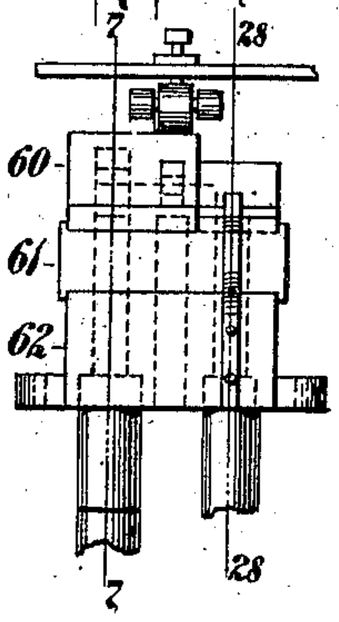

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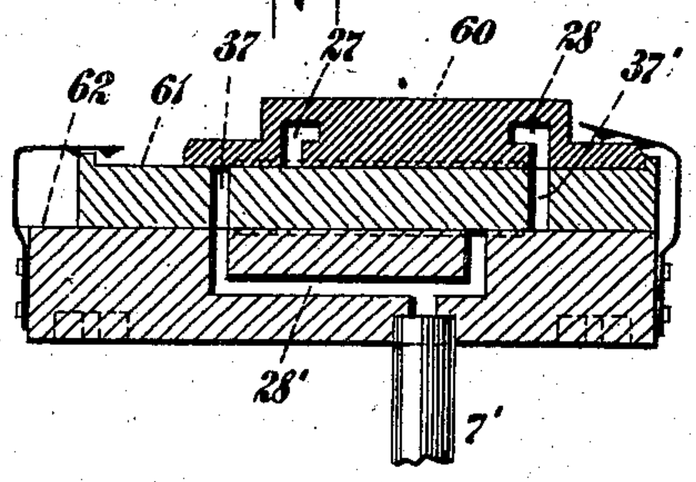

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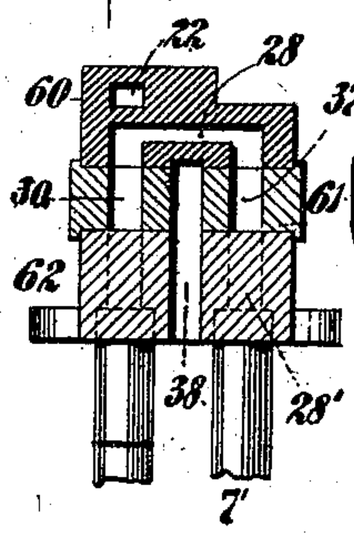

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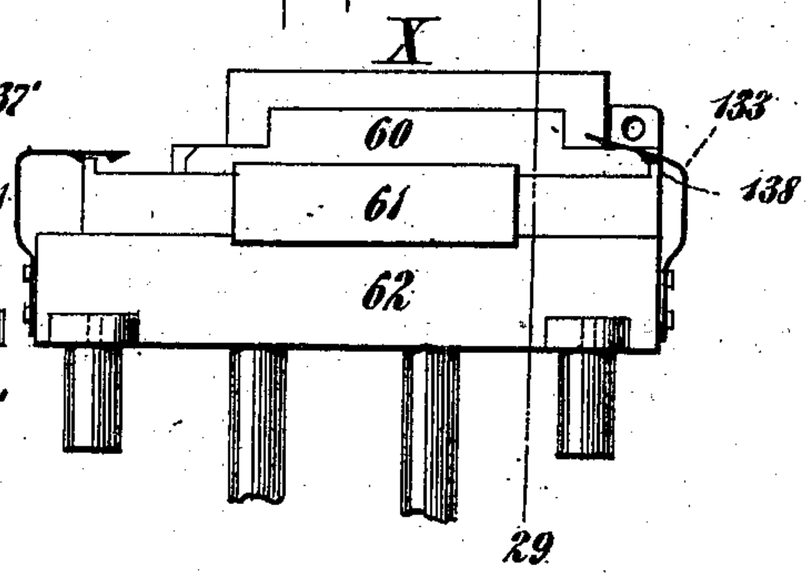

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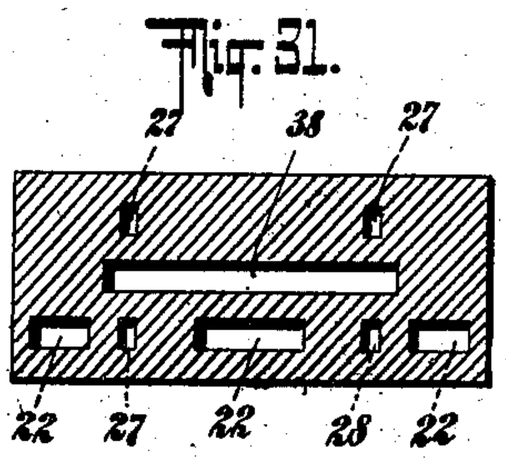

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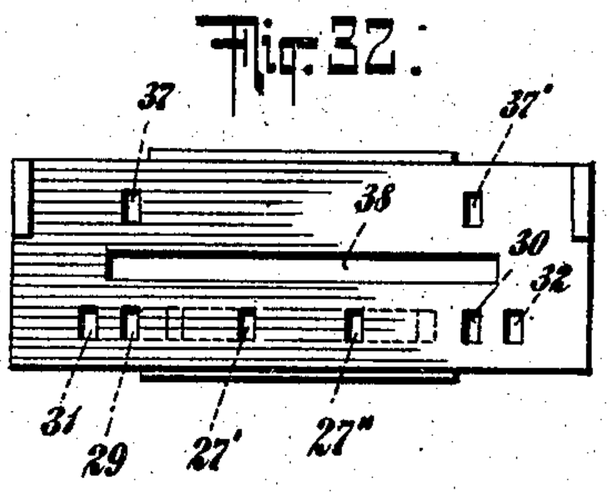

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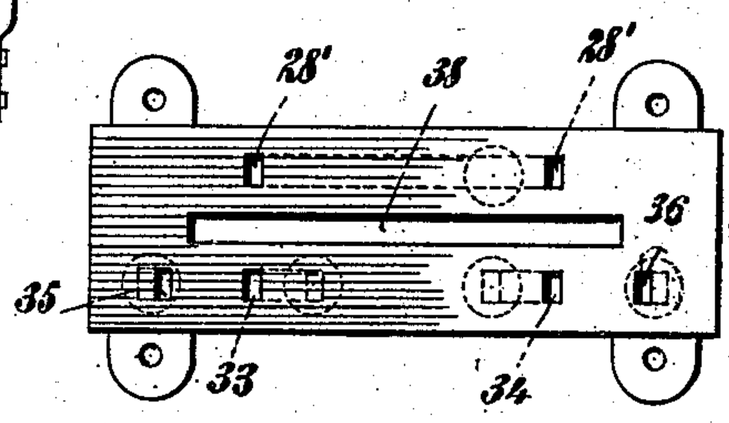


WITNESSES:

Gustave Dieterich.

Edwin H. Dieterich

INVENTOR

Lawrence Griffith

BY

Burgess & Phelps

ATTORNEYS

No. 724,180. PATENTED MAR. 31, 1903.

L. GRIFFITH.

PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

APPLICATION FILED APR. 18, 1902.

NO MODEL. 13 SHEETS—SHEET 8.

Fig. 34.

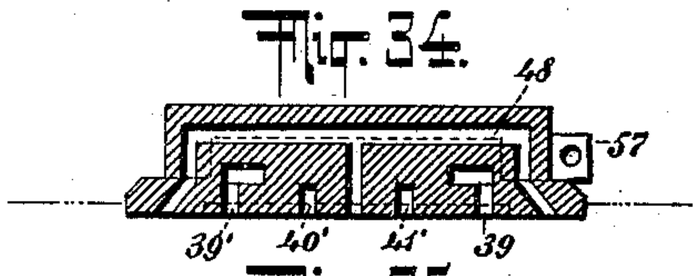
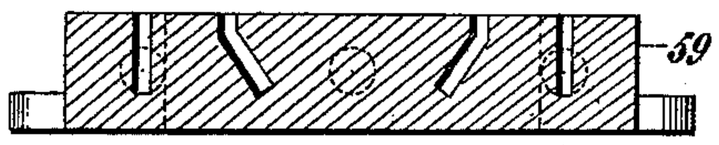


Fig. 35.

Fig. 36.



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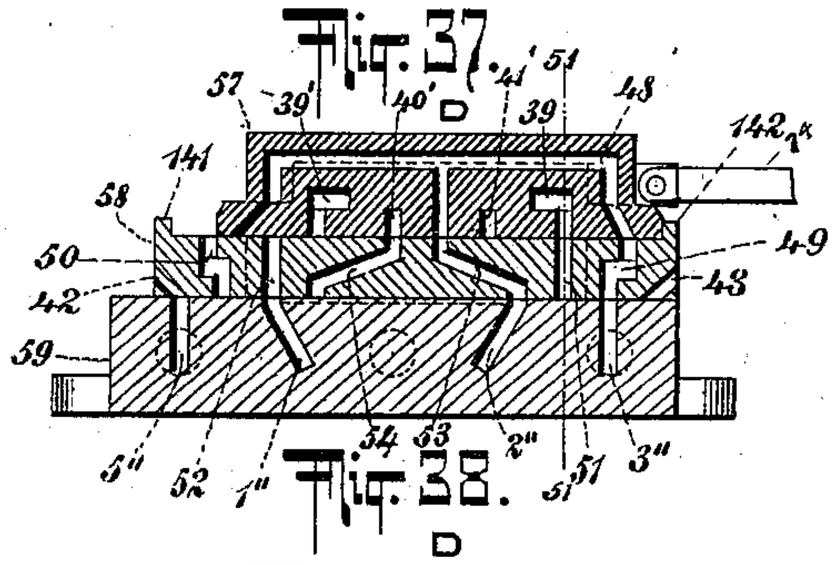
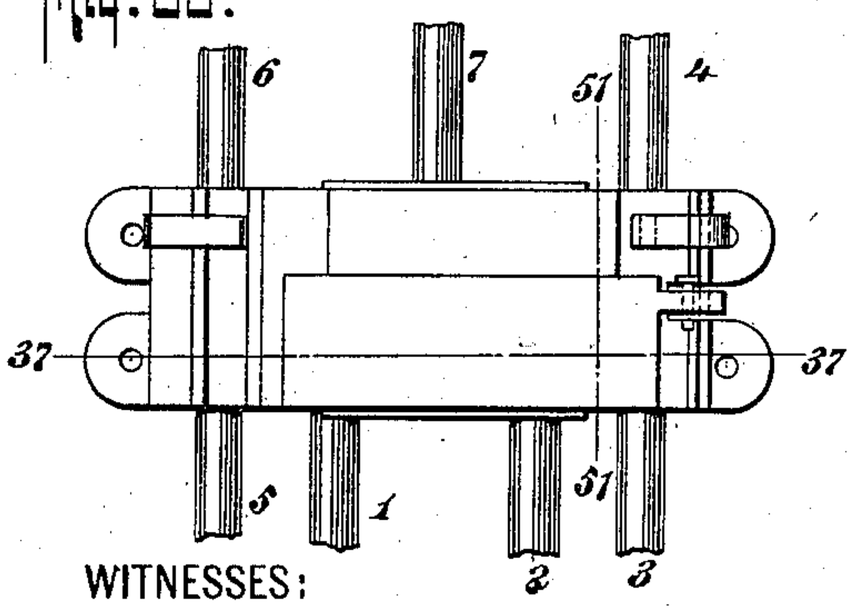


Fig. 38.

Fig. 39.



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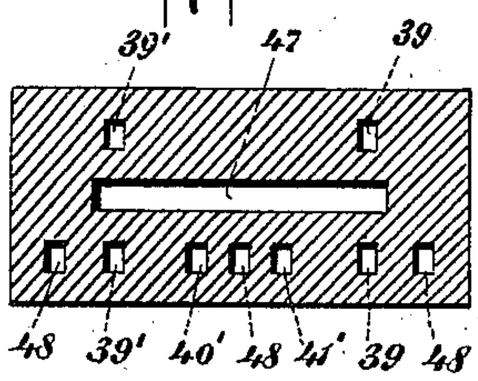

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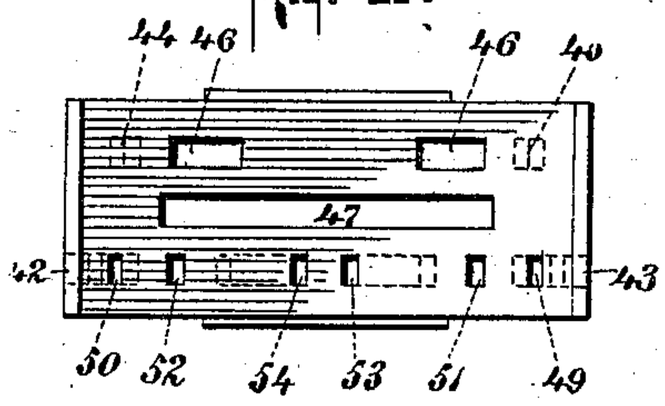

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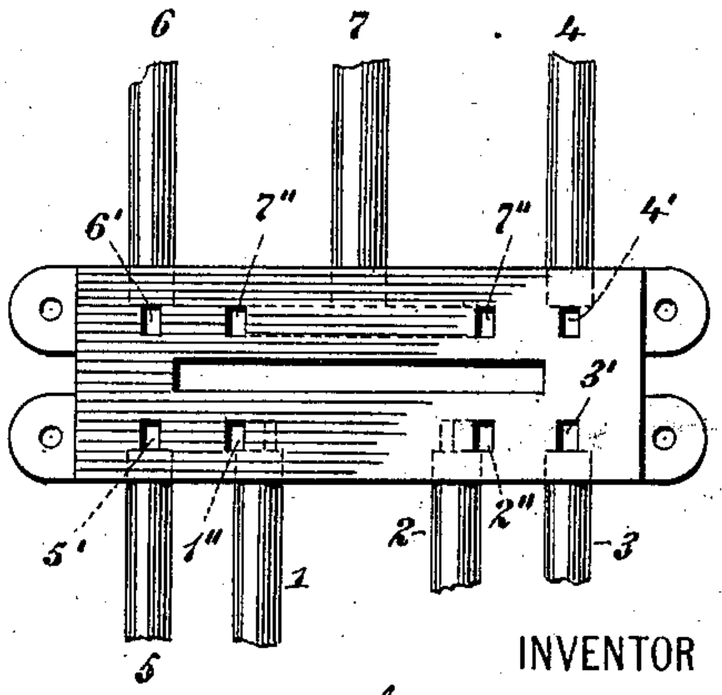

WITNESSES:

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Edwin H. Dietrich.

INVENTOR

Lawrence Griffith

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ATTORNEYS.

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L. GRIFFITH.

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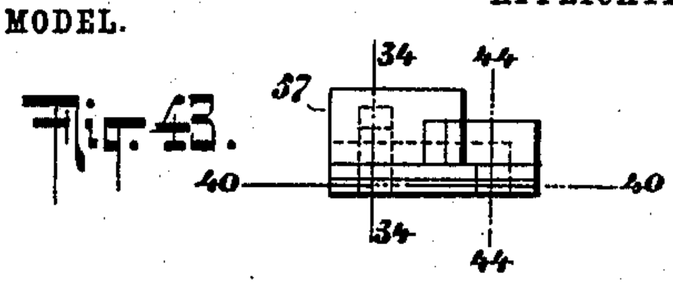
NO MODEL. 13 SHEETS—SHEET 9.

Fig. 43.



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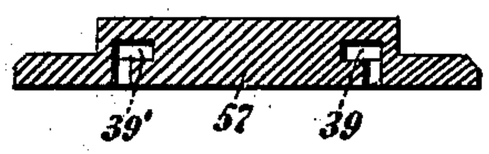

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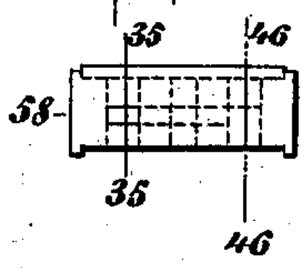

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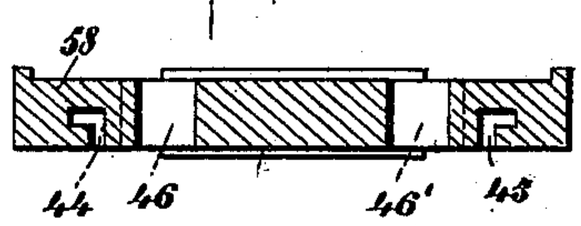

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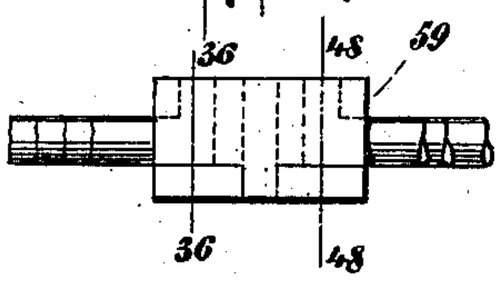

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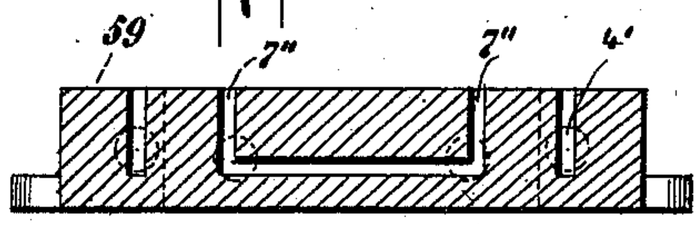

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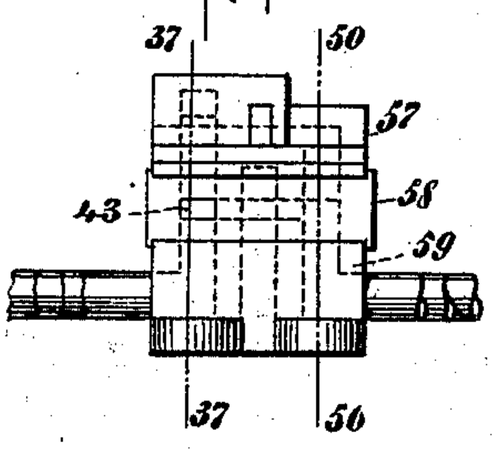

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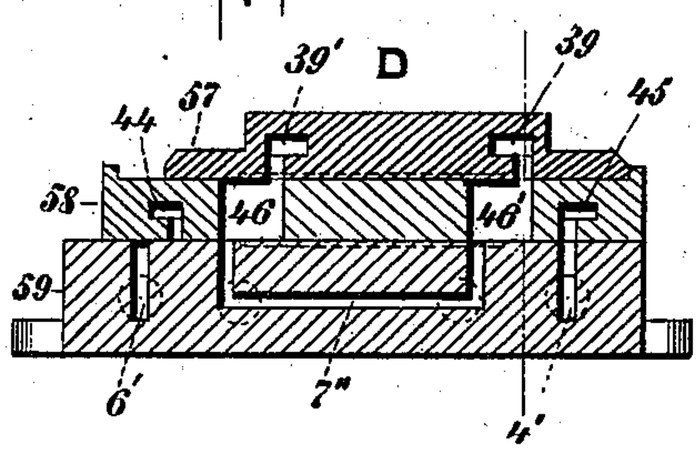

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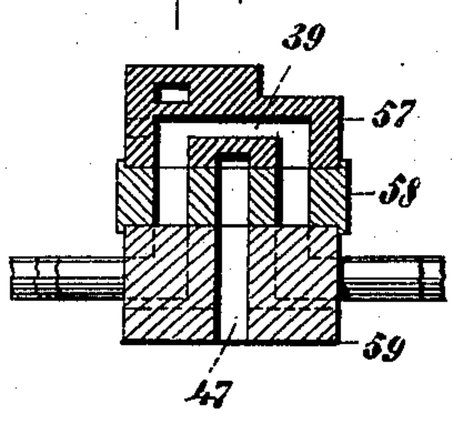

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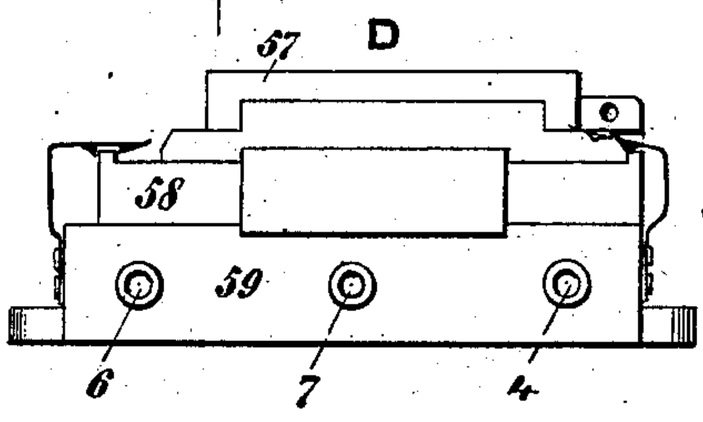

WITNESSES:

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Edwin H. Dieterich.

INVENTOR

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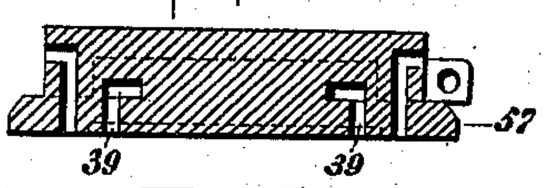
NO MODEL. 18 SHEETS—SHEET 10.

Fig. 53.



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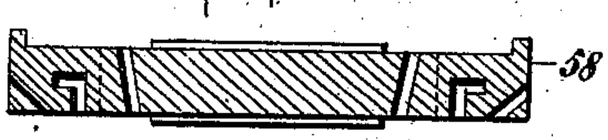

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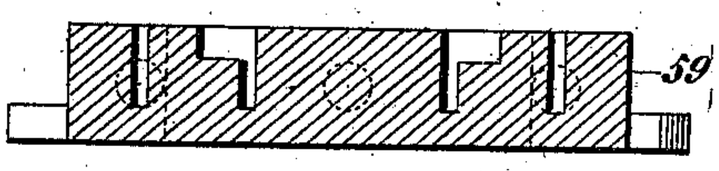

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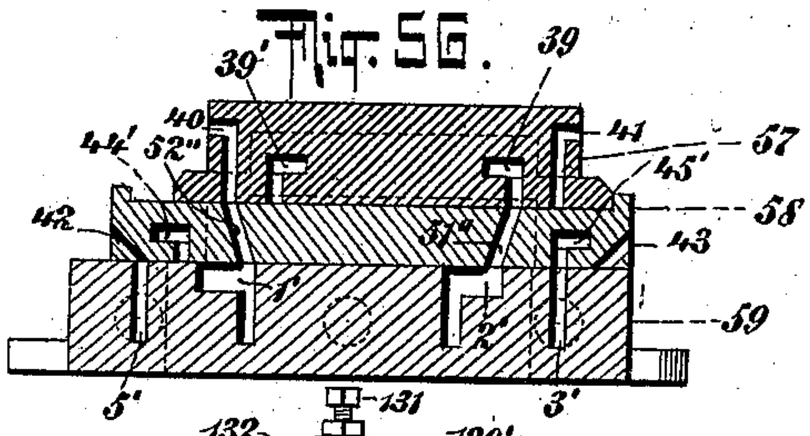


Fig. 57.

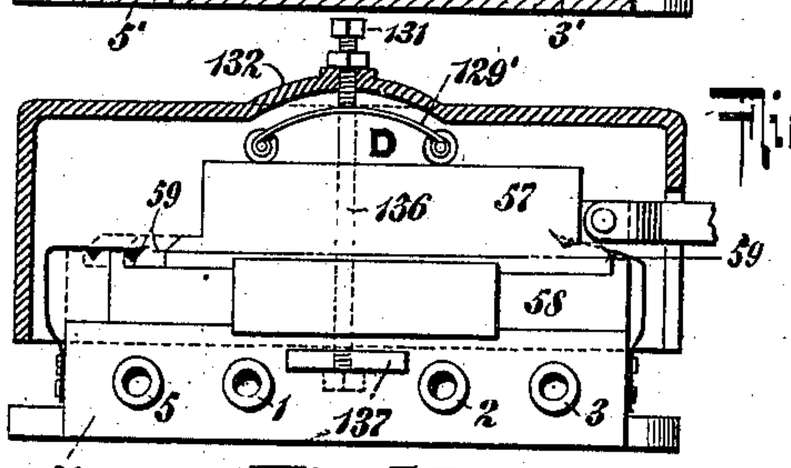


Fig. 58.

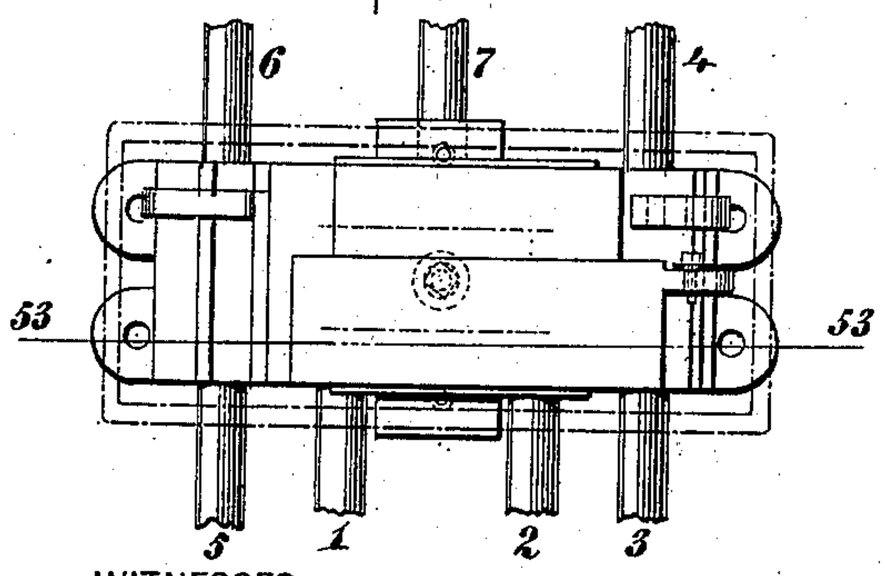


Fig. 59.

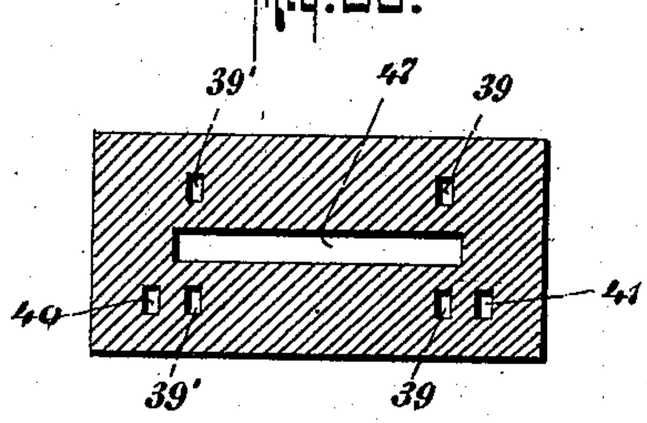


Fig. 60.

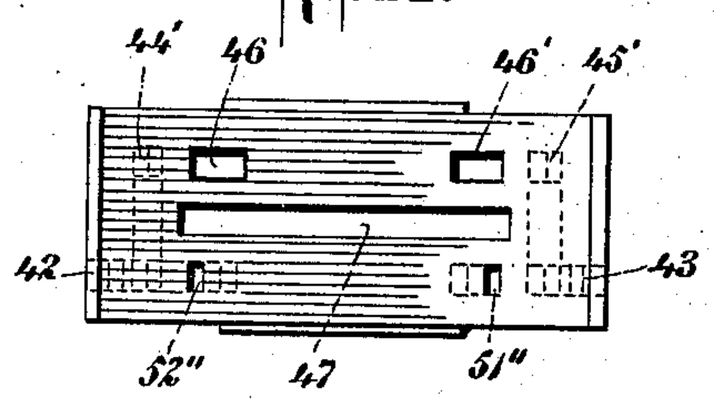
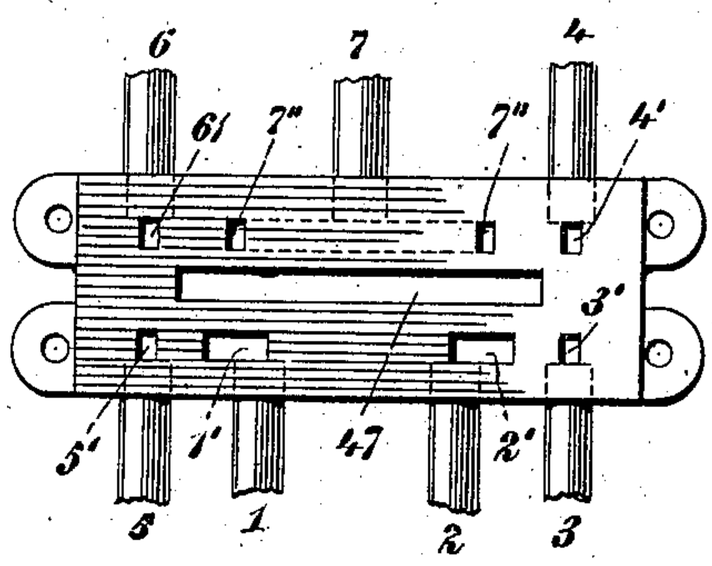


Fig. 61.



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No. 724,180. PATENTED MAR. 31, 1903.

L. GRIFFITH.

PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

APPLICATION FILED APR. 18, 1902.

NO MODEL. 13 SHEETS—SHEET 11.

Fig. 63.

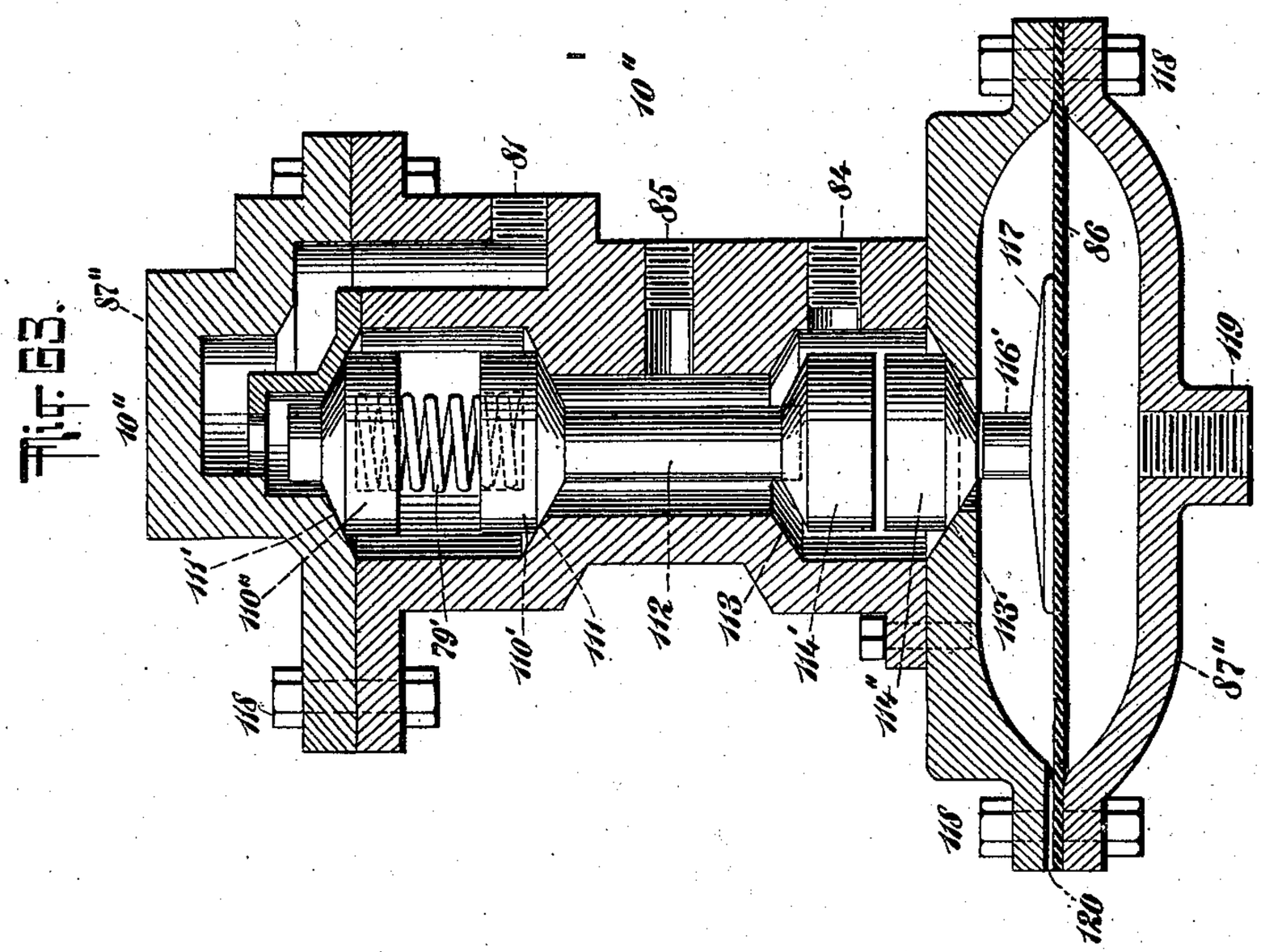
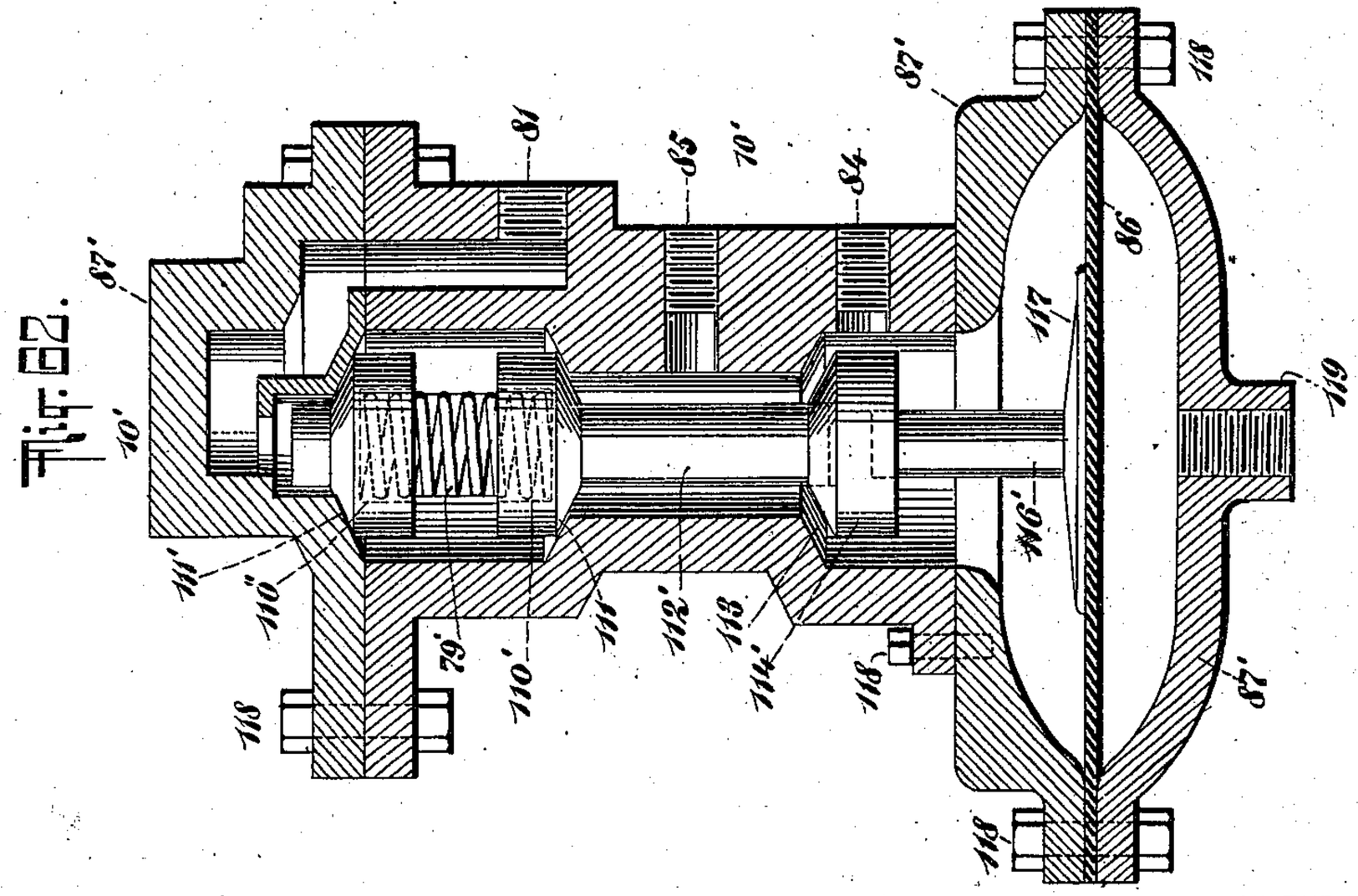


Fig. 62.



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NO MODEL. 13 SHEETS—SHEET 12.

Fig. 64.

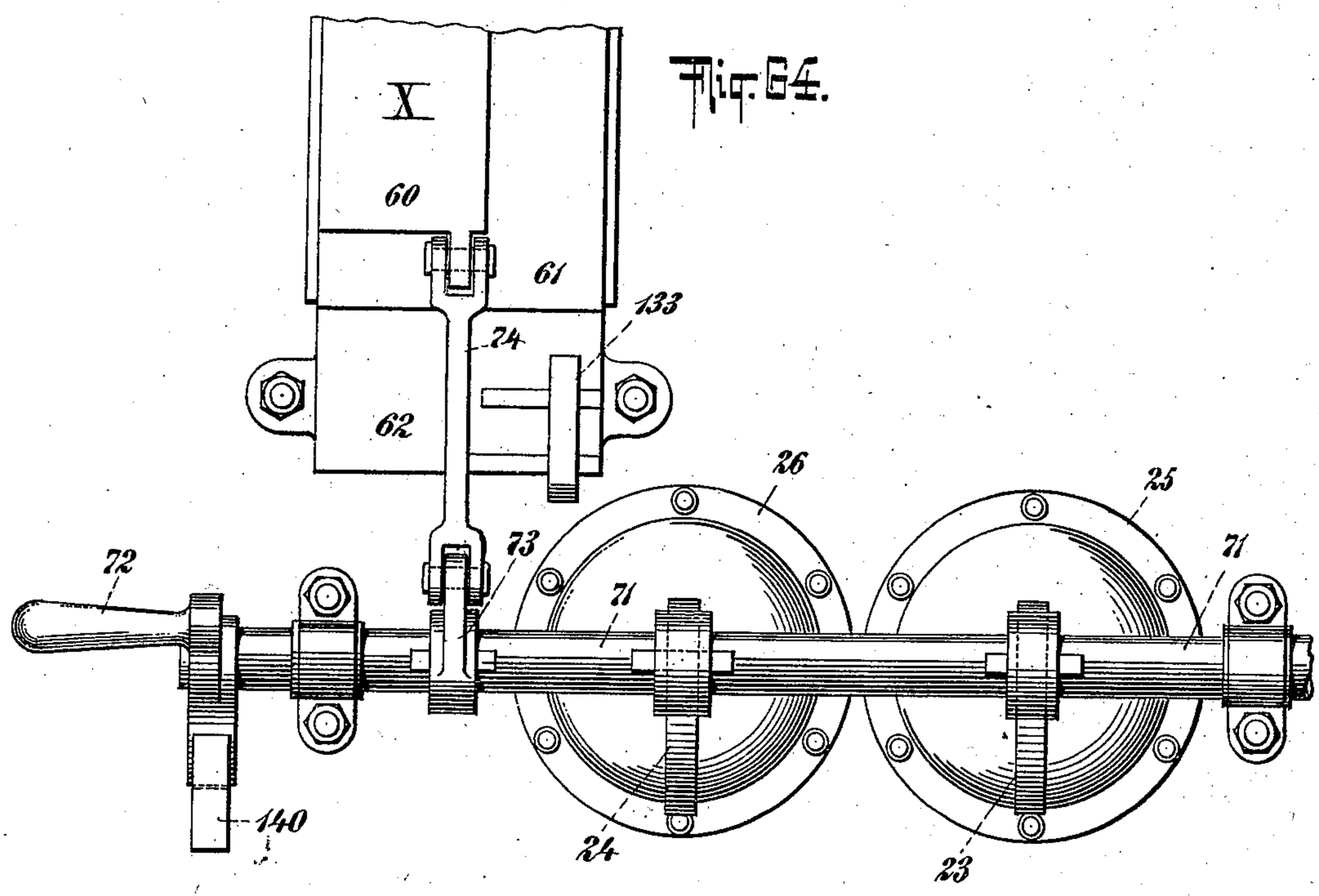
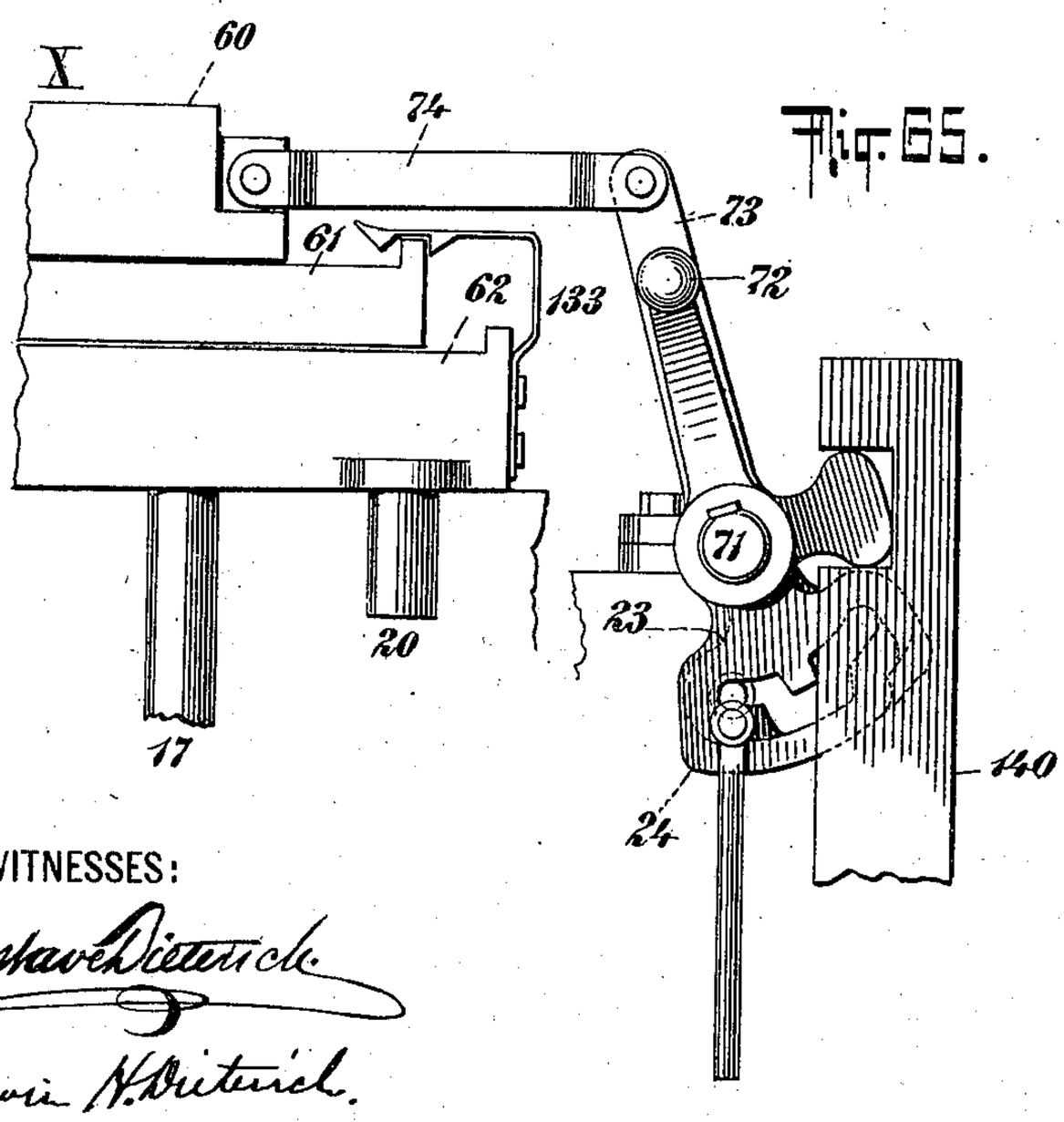


Fig. 65.



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PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

NO MODEL. APPLICATION FILED APR. 18, 1902. 13 SHEETS—SHEET 13.

Fig. 66.

Fig. 67.

Fig. 68.

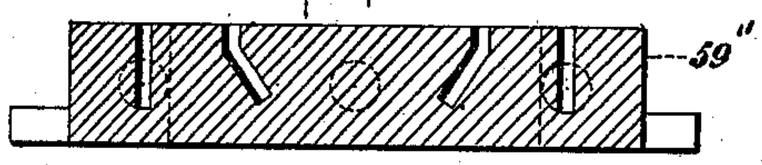
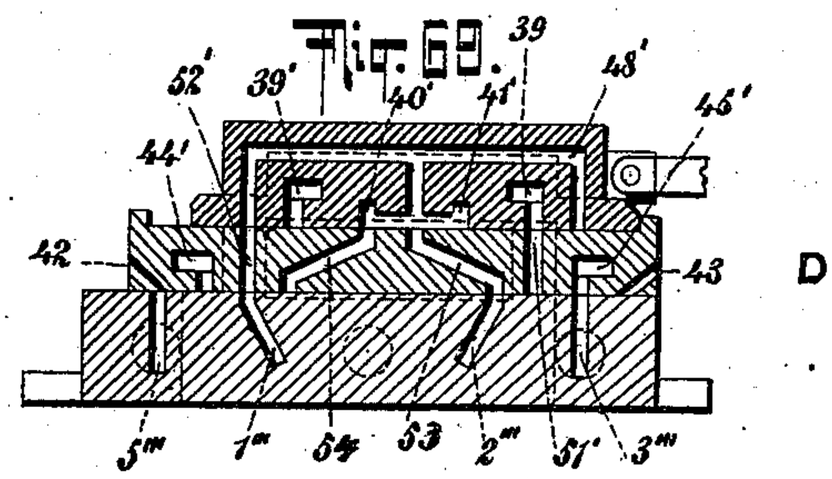


Fig. 69.



D

Fig. 70.

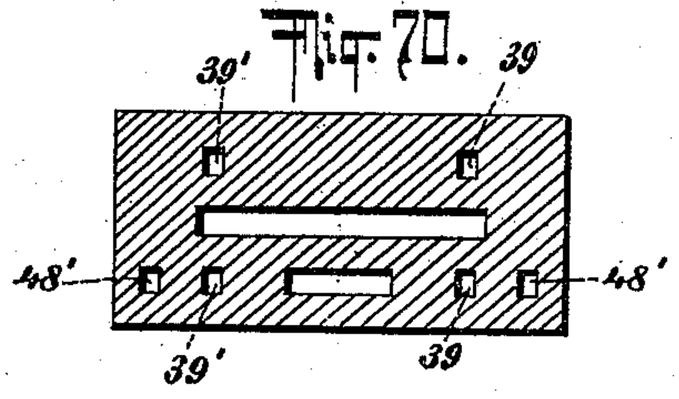
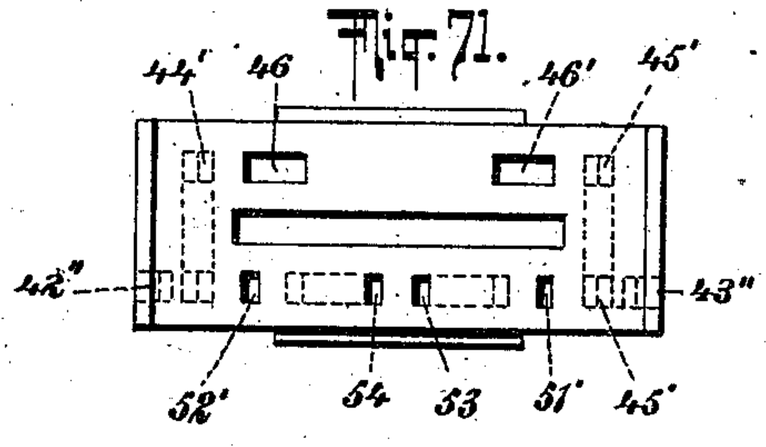


Fig. 71.



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UNITED STATES PATENT OFFICE.

LAWRENCE GRIFFITH, OF YONKERS, NEW YORK.

PNEUMATIC SWITCH APPARATUS AND VALVE THEREFOR.

SPECIFICATION forming part of Letters Patent No. 724,180, dated March 31, 1903.

Application filed April 18, 1902. Serial No. 103,523. (No model.)

To all whom it may concern:

Be it known that I, LAWRENCE GRIFFITH, a citizen of the United States of America, residing in the city of Yonkers, county of Westchester, State of New York, have invented certain new and useful Improvements in Pneumatic Switch Apparatus and Valve Therefor, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to apparatus for operating switches and signals of a railway by means of air under pressure. Its objects are to provide an apparatus or system in which less piping may be used than has heretofore been accomplished, to allow air under pressure to enter the pipes of the system only when the operating handle or lever is in proper position, and to provide means for locking the operating handle or lever in its operative position until the switch has been set and for unlocking the same when the switch has been set, but only to allow it to be moved to full reverse or normal position.

To these ends my invention consists of a valve comprising a stationary part or seat and two coöperating movable parts or slides, all of said parts being provided with suitable ports adapted to register at certain predetermined relative positions of said parts, a combination of two of said valves with the piping and mechanism of a pneumatic switch apparatus, and of certain details of construction in the apparatus.

I hereinafter describe my invention and point out the particular features in the claims, having reference to the accompanying drawings, in which similar letters and numerals of reference indicate similar parts throughout the various views, of which—

Figure 1 represents a general diagram of the apparatus. Fig. 2 represents a general plan view of the apparatus at or near the switch. Fig. 3 is a detail plan view of the motion-plate. Fig. 4 is a detail side view of a rail and detector-bar. Fig. 5 is a plan view of one of the diaphragm-operated seat-valves. Fig. 6 is a vertical section on the line 6 6 of Fig. 5. Fig. 7 is a longitudinal section on the line 7 7 of Fig. 27 of valve X, shown in reverse position, showing also position of reverse quadrant. Fig. 8 is a detail view of normal quadrant in reverse position. Fig. 9 is a longitudinal section on line 7 7 of Fig. 27 of valve X, shown at two-thirds stroke from normal, showing also position of reverse quadrant at same stroke. Fig. 10 is a detail view of normal quadrant at two-thirds stroke from normal. Fig. 11 is a longitudinal section on line 7 7 of Fig. 27 of valve X, shown at one-third stroke from normal, also showing position of reverse quadrant at same stroke. Fig. 12 is a detail view of normal quarant at one-third stroke from normal. Fig. 13 is a longitudinal section on line 7 7 of Fig. 27 of valve X, shown at normal position, also showing position of reverse quadrant at normal position. Fig. 14 is a detail view of normal quadrant at normal position. Fig. 15 is a longitudinal section on line 7 7 of Fig. 27 of valve X. Fig. 16 is a side view of valve X. Fig. 17 is a top plan view of valve X. Fig. 18 is a detail longitudinal section on line 18 18 of Fig. 21 of top slide of valve X. Fig. 19 is a detail longitudinal section of under slide of valve X on line 19 19 of Fig. 23. Fig. 20 is a detail longitudinal section of valve-seat of valve X on line 20 20 of Fig. 25. Figs. 21 and 22 show, respectively, detail front and section views of top slide of valve X, the section being taken on line 22 22 of Fig. 21. Figs. 23 and 24 show detail front and section views of under slide of valve X, the section being taken on line 24 24 of Fig. 23. Figs. 25 and 26 show detail front and section views of valve-seat of valve X, the section being taken on the line 26 26 of Fig. 25. Figs. 27 and 28 show front and section views of valve X, the section being taken on the line 28 28 of Fig. 27. Figs. 29 and 30 show section and side views of valve X, the section being taken on the line 29 29 of Figs. 30 and 15. Fig. 31 is a detail horizontal section of top slide of valve X on line 31 31 of Fig. 21. Fig. 32 is a detail plan view of the under slide of valve X. Fig. 33 is a detail plan view of valve-seat of valve X. Figs. 34 to 52, both inclusive, show valve D. Fig. 34 is a longitudinal section of top slide of valve D on line 34 34 of Fig. 43. Fig. 35 is a longitudinal section of valve D on line 35 35 of Fig. 45. Fig. 36 is a longitudinal section of valve-seat of valve D on line 36 36 of Fig. 47. Fig. 37 is a longitudinal section of

valve D on line 37 37 of Fig. 49. Fig. 38 is a side view of valve D. Fig. 39 is a top plan view of valve D. Fig. 40 is a horizontal section on line 40 40 of Fig. 43. Fig. 41 is a plan view of under slide of valve D. Fig. 42 is a plan view of valve-seat of valve D. Figs. 43 and 44 are end and longitudinal section views of top slide of valve D, the section being taken on the line 44 44 of Fig. 43. Figs. 45 and 46 are end and longitudinal section views of under slide of valve D, the section being taken on line 46 46 of Fig. 45. Figs. 47 and 48 are end and longitudinal section views of the valve-seat of valve D, the section being taken on the line 48 48 of Fig. 47. Figs. 49 and 50 are end and longitudinal section views of valve D, the sectional view being taken on the line 50 50 of Fig. 49. Fig. 51 is a cross-section view of valve D on line 51 51 of Figs. 39 and 37. Fig. 52 is a side view of the other side of valve D. Fig. 53 is a longitudinal section view of top slide of a modification of valve D on line 53 53 of Fig. 58. Fig. 54 is a longitudinal section view of under slide of said modification of valve D on line 53 53 of Fig. 58. Fig. 55 is a longitudinal section view of valve-seat of said modification of valve D on line 53 53 of Fig. 58. Fig. 56 is a longitudinal section view of said modification of valve D on line 53 53 of Fig. 58. Fig. 57 is a side view of said modification of valve D and longitudinal section view of the cover of valve D. Fig. 58 is a plan view of said modification of valve D. Fig. 59 is a longitudinal section view of top slide of said modification of valve D on line 59 59 of Fig. 57. Fig. 60 is a top plan view of under slide of said modification of valve D. Fig. 61 is a top plan view of valve-seat of said modification of valve D. Figs. 62 and 63 are vertical section views of modified forms of diaphragm-operated seat-valves. Fig. 64 is a plan view of valve X and diaphragms 25 and 26. Fig. 65 is a side view of valve X, its lever, quadrant, and tappet. Fig. 66 is a longitudinal section view of top slide of another modification of valve D on line 34 34 of Fig. 43. Fig. 67 is a longitudinal section view of the under slide of said modification of valve D on line 35 35 of Fig. 45. Fig. 68 is a longitudinal section view on the line 36 36 of Fig. 47 of valve-seat of said modification of valve D. Fig. 69 is a longitudinal section view of said modification of valve D on line 37 37 of Fig. 49. Fig. 70 is a longitudinal section view of top slide of said modification of valve D on line 70 70 of Fig. 66. Fig. 71 is a top plan view of the under slide of said modification of valve D.

71 is an operating-shaft suitably journaled in a frame in the tower or operator's station. 72 is a handle for turning said shaft. Rigidly attached to said shaft are two quadrants 23 and 24. Also rigidly attached to said shaft is an arm 73, which at its other end, by connecting-rod 74, is connected with the top slide 60 of valve X, which will be more fully described hereinafter.

Referring to Fig. 1, quadrant 23 will be called the "reverse" quadrant and quadrant 24 the "normal" quadrant. Each of these quadrants is provided with a locking-slot 25′ and 26′, respectively, and within each of said slots are lugs 25″ and 26″, respectively. Also within said slots 25′ and 26′ of said quadrants and adapted to coöperate therewith are rollers 25‴ and 26‴, respectively, borne by rods 75 and 76, respectively. Each of the lugs 25″ and 26″ have two stopping-surfaces, and they are so arranged with reference to shoulders 25‴ and 26‴, respectively, Figs. 7 and 10, that in the movement of the quadrants from normal to reverse or in the direction of arrow, Fig. 7, the travel of the roller in the normal quadrant to its corresponding lug is longer than the travel of the other roller in its corresponding slot to the lug therein. It will be understood that the opposite is true in the movement from reverse to normal. Said rods 75 and 76 are borne upon flexible diaphragms 77 and 78 within diaphragm-casings 25 and 26, respectively, so as to be raised by said diaphragms when air under pressure is introduced within said casings underneath said diaphragms. Of course it will be understood that said rods 75 and 76 are supported by suitable guides in the framework in said tower. Leading from said valve X and adapted by the operation of said valve, to be hereinafter described, to be connected with a source of air under pressure 7′ are two air-pipes leading to the piping and mechanism at the switch, 17 being the pipe into which air under pressure is introduced from source 7′ when the shaft 71 is moved by its handle from normal position toward reverse and 16 being the pipe into which air under pressure is introduced when said shaft 71 is moved by its handle from reverse position toward normal. Said pipe 17 leads, by means of pipe 12, to opening 81 in diaphragm-operated seat-valve 10. Said diaphragm-operated seat-valve, (shown in Fig. 1,) together with its counterpart valve 11, is more particularly illustrated in Figs. 5 and 6. Said pipe 17 before reaching said valve 10 tees off through pipe 19 to diaphragm-casing 26, so that air under pressure therein may operate upon the under side of diaphragm 78. Said valve 10, into which said pipe 17 through pipe 12 leads, is closed to air under pressure in said pipe 17, as will be more particularly described hereinafter when said valves 10 and 11 are described. Also before reaching said valve 10 said pipe 17 tees off through pipe 15 to opening 80 in said valve 11 and communicates, through the chamber of said valve 11 and opening 82 with pipe 9, which leads to one end of a cylinder 63. Before reaching said cylinder said pipe 9 tees off, by means of pipe 6, to valve D. From said valve D, which valve is also suitably connected with a source of air under pressure 7, as will be hereinafter described, is pipe 1, leading to operating-cylinder 64. From the other end of said cylin-

der 64 pipe 2 leads back to said valve D. Piston 65 of said cylinder 63 bears rod 66, connected with the top slide 57 of valve D by bar 74′, so as to operate the same in the same manner as rod 74 operates the top slide of valve X. Said piston 65 also bears rod 70, operatively connected with roller 83. Leading from valve D is pipe 5, communicating with under side of diaphragm 86 within casing 87 of said valve 10. Said pipe 16 leads, by means of pipe 13, to opening 88 in said valve 11, normally closed thereto. Before reaching said valve 11 said pipe 16 tees off by pipe 18 to the bottom of diaphragm 77 within casing 25. Also before reaching said valve 11 said pipe 16 tees off, by means of pipe 14, to opening 85 in said valve 10 and communicating through the chamber of said valve 10 and opening 84 with pipe 8, which leads to cylinder 63 at the opposite end from that at which said pipe 9 enters the same. Before reaching said cylinder 63 said pipe 8 tees off through pipe 4 to said valve D. From said valve D pipe 3 leads to the under side of diaphragm 89 within casing 90 of said valve 11. Also leading from said valve D is pipe 2, leading to cylinder 64 at the opposite end thereof from that at which pipe 1 enters the same. Within said cylinder 64 is a piston 67, bearing rod 68, operatively connected with the motion-plate 69, referring now to Figs. 2, 3, and 4. Said motion-plate 69 is mounted in the usual way, so as to slide longitudinally of the rails 91. Said motion-plate 69 has a cam-groove 92 therein of the well-known form, in which groove works roller 93, borne on bar 94, which at its other end is operatively connected with rod 95, carrying the movable switch-points 96 in the well-known manner. Said switch-points also bear with them as they move lock-rod 97, crossing said motion-plate 69 through casing 98. Said lock-rod has therein two notches (not shown) coöperating in the usual manner with two lugs 99 and 100 on said motion-plate 69, so as to mechanically lock the switch-points in their normal or reverse positions.

101 is a detector-bar of the usual form, connected, by means of rod 102, lever 103, and rod 104, with said motion-plate 69, so as to lock the motion-plate and switch when a wheel of a car rests upon that portion of one of the rails 91 along which said detector-bar 101 extends.

I now proceed to describe means of pneumatically locking the switch-points in their normal or reverse positions, means of pneumatically locking the operator's handle or lever during the movement of said switch-points until they have reached their limit of stroke in either the one direction or the other, and means of pneumatically releasing the lock of said handle when the switch-points have completed their movement in the one direction or the other, and thereby notifying the operator that said points have completed their movement and allowing him to complete the movement of the operating handle or lever to the full limit of the stroke. Said motion-plate 69 also has a slot 106 cut therein in parallel with its line of movement and at each end thereof a recess 107 and 108. Said rod 70 is operatively connected with a bar 109, bearing pin or roller 83. Said pin or roller 83 works in said slot 106 and is adapted to be inserted in or withdrawn from its recess 107 or 108, as the case may be, so as to hold or release said motion-plate, and thereby the switch-points.

Referring now to valve X, Figs. 7, 9, 11, 13, and 15 to 33, inclusive, air under pressure is admitted to valve X by means of pipe 7′ through opening 28′ in the seat 62. (See Figs. 28 and 29.) When the slides of the valve are in the normal position, Fig. 13, or reverse position, Figs. 7, 15, and 28, said air under pressure is cut off from the apparatus by said valve, the under slide 61 stopping one of the outlets of port 28′ in the seat 62 and the top slide 60 stopping the other of the outlets of said port 28′, which in reverse position is registering with the port 37 in said under slide and in normal position is registering with port 37′ in said under slide. As appears by Figs. 7, 9, 11, and 13, the pipes 16 and 17 are exhausting any air under pressure which may have remained in the apparatus after the last movement of the switch-points through ports 33 and 34 in valve-seat 62, ports 27′ and 30 in under slide 61, port 22 in top slide 60, and ports 31 and 35, respectively, in the under slide 61 and seat 62, or through ports 32 and 36, respectively, in said under slide 61 and valve-seat 62, ports 29 and 27″ in under slide, port 22 in top slide, ports 32 and 36 in under slide and seat, respectively, as the parts of said valve may be in the normal or reverse positions. It will be understood that the exhaust through ports 35 and 36 in seat 62 may be led away through pipes 21 and 20, respectively. Fig. 11 shows the position of the parts when the operating-lever has been moved about one-third of its stroke from normal position. It will be observed that at this point any air under pressure in pipes 16 and 17 is still exhausting through the same ports, as just above described, in the normal position shown in Fig. 13 and that supply-ports 27 and 28 in top slide 60 are still cut off by the surface of under slide 61. It will hereinafter be described how if there is still any air under pressure in either pipe 16 or pipe 17 the parts of said valve will be locked at said one-third stroke until all of said air under pressure has been exhausted. Said air under pressure having been exhausted and said lever having been moved farther in the same direction and until it has reached a point two-thirds of its stroke, where it is locked, as will be hereinafter described, air under pressure from pipe 7′ will be admitted through ports 28′ in valve-seat 62, 37 in under slide 61 to port 28 in top slide 60. (The position of said slides at said two-thirds stroke

showing the ports last mentioned is not shown; but by referring to Fig. 28 it will be readily understood the position of said ports will be such as to allow of the communication referred to.) From said port 28 in top slide 60 air under pressure will be admitted to pipe 17 through ports 30 and 34 in under slide 61 and seat 62, respectively, and pipe 16 will be cut from the atmosphere, as the surface of top slide 60 has shut off communication therewith, as shown in said Fig. 9. Upon the release of said lever from its lock, as will be hereinafter described, the parts of said valve may be moved into the position shown in Figs. 7 and 28, thereby again shutting off the air under pressure from pipe 7′ and again allowing the air under pressure in the apparatus to exhaust from pipes 16 and 17 through valve X, as above described. 38 (shown in Figs. 29, 31, 32, and 33) is a medial port through each of the three parts of said valve, which being open to the atmosphere prevents any air under pressure should it leak from pipe 7′ from finding its way into the pipes of the apparatus.

Referring now to valve D, which is located at or near the switch, air under pressure is admitted to port 7″ of seat 59 of valve D through pipe 7, and in the normal or reverse position of said valve, the normal position only being shown in Figs. 50 and 37, said air under pressure is admitted to ports 39 and 39′ of top slide of said valve through ports 46 and 46′ in under slide 58 of the same and is shut off from the atmosphere and the pipes of the apparatus by the surface of under slide 58 and surface of valve-seat 59, which surface it reaches through port 51 in said under slide or port 52 in said slide, as the case may be. In normal position pipe 2, connecting said valve D with the end of operating-cylinder 64 last charged, communicates with port 2″ in seat 59 of said valve, thence with port 3″ in said seat through ports 53 in under slide 58, port 48 in top slide of the same, and port 49 in said under slide. At the same time air under pressure is admitted to port 4′ of said valve-seat from pipe 4, also communicating with said port 3″ through ports 45 and 49 in under slide of said valve. Pipe 5 at this position of the valve communicates with the atmosphere through ports 5″ and 42 in valve-seat 59 and under slide 58, respectively. The stroke of this valve is divided into two parts. The first part of the stroke from normal, it will readily be understood after the description of valve X and referring to Figs. 37 and 50, will place the ports thereof so that air under pressure in port 39′ will be admitted to pipe 1 through ports 52 and 1″ in under slide 58 and valve-seat 59, respectively, and pipe 2 will be allowed to communicate with the atmosphere through ports 2″, 53, and 41′ in valve-seat, under slide, and top slide, respectively, as shown in Figs. 37 and 38. Upon the completion of the stroke it will be understood that pipe 5 will be closed to the atmosphere through ports 5″ and 50, respectively, in seat and under slide, said port 50 being closed by the surface of top slide, and pipe 5 is put into communication with pipe 1 through ports 1″ in the seat, 54 in under slide, 48 in top slide, 50 in under slide, and 5″ in seat, and said pipe 5 is put into communication with pipe 6 through ports 6′ in seat and ports 44 and 50 in under slide, and in said reverse position pipe 2 is cut off from the atmosphere by the surface of top slide 57 closing the ports 2″ and 51 of valve-seat and under slide, respectively, with which ports said pipe 2 then communicates.

It will be understood that in the movement of the parts of valve D from reverse position back to normal position the necessary communication between the several pipes of the system will in the two positions of the parts of the valve be properly established by the ports thereof to effect the movement of the switch-points and the unlocking of the operator's lever at the tower in accordance with the description of the operation of the parts hereinafter contained.

In valve D last described, as will be shown when the operation of the system is described, the ports are so arranged that upon the completion of the stroke of piston 67 in cylinder 64 and upon the movement of the parts of said valve D to their complete reverse or normal positions the air under pressure in the end of the cylinder last charged is led into the system of piping which is adapted to carry air under pressure to valves 10 and 11 to operate the same for the purpose of indicating that the switch-points have been completely moved and of unlocking the operating handle or lever. In some cases it may be desirable to provide in said valve D a system of ports whereby when piston 67 in said cylinder has completed its stroke in either direction and the parts of said valve D have been placed in full normal or reverse position to maintain the air under pressure in the end of the cylinder 64 last charged until the next movement of said piston 67 in the other direction. Figs 53 to 61, both inclusive, illustrate the necessary changes in ports of said valve D to effect this result. Port 48, Fig. 37, in top slide of valve D is omitted in this modified form thereof. Port 49 of under slide 50 of said valve D is omitted and port 45′, Fig. 56, substituted therefor, and, similarly, on the other end of said under slide 58 port 50 is omitted and port 44′, Fig. 56, substituted therefor. In top slide of said valve ports 40′ and 41′ are omitted therefrom and ports 40 and 41, Fig. 56, substituted therefor, and in under slide 58 of said valve ports 52, 54, 53, and 51 are omitted and ports 52″ and 51″ substituted therefor, and in the seat of said valve ports 1″ and 2″ are changed in form so as to become ports 1′ and 2′ in Fig. 56, so that in the position of the parts shown in Fig. 1 that end of cylinder 64, having been last charged, which communicates with pipe

2 and the valve being in normal position said pipe 2 is connected with pipe 7 through ports 2′ in seat, port 51″ in under slide, and port 39 in top slide and port 46′ in under slide and port 7″ in seat. Also in this modified form of the valve the ports thereof are so arranged that when piston 67 has been completely moved the exhaust side of said piston 67 remains open to the atmosphere. In other words, in the position of the parts shown in Fig. 1 pipe 1 is open to the atmosphere (referring to Fig. 56) through ports 1′ in seat, 52″ in under slide, and 40 in top slide thereof. In Figs. 66 to 71, both inclusive, another modification of said valve is shown, in which it is provided that in normal or reverse position both ends of said cylinder 64 are open to the atmosphere through the ports of said valve. To accomplish this result, in the under slide 58 of said valve D port 50 is eliminated and port 44′ substituted therefor and port 49 is eliminated and port 45′ substituted therefor, and in top slide 57 port 48 is eliminated and port 48′ substituted therefor, so that pipe 2 may exhaust to the atmosphere (referring to Fig. 69) through ports 2‴ in the seat, port 53 in under slide, and ports 48′, 40′, and 41′ in top slide, and pipe 1 exhausts to the atmosphere through ports 1‴ of seat, 52′ of under slide, and 48′ and 40′ and 41′ in top slide, and when in reverse position pipe 1 will exhaust through 1‴ in seat, port 54 in under slide, and ports 48′, 40′, and 41′ in top slide, and pipe 2 will exhaust to the atmosphere through ports 2‴ in seat, 51′ in under slide, and ports 48′, 40′, and 41′ in top slide.

In Figs. 5 and 6 valve 10 is shown, the same being similar in construction and mode of operation with valve 11.

In the description of the operation hereinbelow valve 10 is the valve through which air under pressure is to be returned to the tower for the purpose of indicating to the operator that the switch-points have been fully set and to unlock the operating-handle in movement from normal to reverse position, and we will first describe said valve with reference to its functions in that regard and then with reference to its functions as they would be performed were it then valve 11 instead of valve 10 on Fig. 1. 87 is a casing formed to accommodate the several parts within the valve and the four necessary openings therefrom. 118 represents suitable screws or bolts holding said casing together. Air under pressure is admitted to the valve from pipe 12 through opening 81, and during the movement of the switch-points and until their movement has been completed it is necessary to prevent any air under pressure from escaping from opening 85 or 84 into pipes 14 and 8, respectively. To this end said valve-casing 87, immediately below opening 81, is provided with valve-seat 111, and a valve-head 110 is adapted to fit upon said seat 111, preventing any air under pressure from passing into the lower chamber of valve 10 while said head is pressed down upon said seat by air under pressure from pipe 12. Said valve-head 110 is held normally in that position by spring 79. Said valve-head 110 is borne upon top of valve-stem 112, which in turn at its other end is carried by valve-head 114. Said valve-head 114 is connected to bar 116 and is borne thereby. Within said casing 87 is another valve-seat 113. Said valve-seat 113, valve-head 114, and opening 84 are so arranged with reference to each other that when said head is by the action of said bar 116 moved upon its valve-seat 113 communication between the chamber of valve 10 and opening 84 is cut off. It will of course be understood that when the parts are in the position last described communication through the interior of valve 10 has been established between openings 81 and 85. Said bar 116 is carried by a plate 117, borne by diaphragm 86, so that when air under pressure is admitted to valve-casing underneath diaphragm 86 through opening 119 by pipe 5, opening 84 will be closed and communication established between pipes 12 and 14. When the valve is performing the functions of valve 11, (shown in Fig. 1,) communication is established between pipes 13 and 15. In Fig. 62 is shown modification 10′ of said valve 10 last described, by which an easier means of assembling the various parts of the valve are provided. The valve-head 110 is divided into two parts 110′, adapted to rest upon seat 111, and 110″, adapted to rest upon seat 111′. The two parts are normally separated by the action of spring 79′. Valve-stem 112′ fits loosely in valve-head 114′, as does also bar 116′. It will be understood that casing 87′ is also changed in its form to properly accommodate the parts within as changed. Fig. 63 shows another modification 10″ of said valve 10, in which valve-head 114 is divided into two parts 114′ and 114″, and valve-casing 87″ is provided with an additional seat 113′, adapted to receive head 114″, and said casing is also provided above diaphragm 86 with an opening to the atmosphere 120. It will be readily understood that the functions of this valve are the same as those of valve 10 and 10′ and that by means of the additional head 114″ and its corresponding seat 113′ and opening 120 provision is made whereby any moisture which may collect upon the top of diaphragm 86 is allowed to escape.

Referring to Fig. 16, pivoted to top slide 60 of valve X is a trigger 121, controlled by spring 122, coöperating with notches 123, 124, 125, and 126 on under slide 61 and with pins 127 and 128 thereon, so as to prevent after a one-third or two-thirds stroke of the operating-lever in either direction any return movement of the parts of the valve until a complete motion thereof has been made.

The following devices are employed for the purpose of maintaining the several parts of the two valves X and D in proper relative positions with each other: To maintain the

parts of valve X in proper vertical relation with each other, a roller-spring 129 bears upon the top of top slide 60 and is adjustable therewith in relation to the frame of the machine 130 by means of set-screw 131, and in valve D the same result is accomplished by means of roller-spring 129', set-screw 131', and valve-casing 132, said casing 132 being provided for valve D because said valve is exposed to the weather, and it is held upon said valve by means of screw 136, passing through said casing, and lug 137 on the seat of said valve. In order to prevent longitudinal displacement of under slide 61 of valve X during the movement of top slide 60 thereof and in order to cause said under slide to be moved by the movement of top slide at proper time, said under slide is provided with lugs or abutments, one at either end thereof, 138 and 139. Attached to one end of valve-seat 62 is a spring 133' and to the other end thereof a similar spring 133. Said spring 133' bears stop 134' and release-lug 135', and spring 133 bears stop 134 and release-lug 135. The description of the movement of the parts of the valve in one direction in connection with this device fully describes the mechanism in that connection. Referring to Fig. 13, when the top slide 60 has about reached the limit of its two-thirds stroke the end of said top slide 60 will strike releasing-lug 135, and the continued motion of said top slide will operate to release stop 134 from end of under slide 61, so as to allow the end of top slide 60 to abut against abutment 138 on said under slide and move the same upon the further movement of said top slide. It will be understood that similar devices are employed in connection with valve D. Fig. 65 shows a method of operating from the shaft 71 the well-known tappet 140 of an interlocking device.

I now proceed to describe the operation of the system. The parts in Figs. 1, 2, 13, 14, 37, 50, 64, 65 are shown in normal position, and the switch-points are to be thrown to reverse position. Operating-lever 72 is moved in the direction of the arrow, Fig. 1, thereby turning shaft 71 on its journals in the frame of the machine in the tower. Should there be any air under pressure in the system, either or both of diaphragms 77 78 would have raised their respective rods 75 76 so as to lock the further movement of said shaft 71 beyond the point where rollers 25'''' and 26'''', borne, respectively, by said rods 75 76, abut against their respective lugs 25'' and 26''. This locking of shaft 71 is accomplished at approximately one-third of the full stroke of operating-lever, or at a point when pipes 16 and 17 of the system are still exhausting to the atmosphere and before any air under pressure has been let into either of said pipes, as shown in Fig. 11. Should there not have been any air under pressure in said pipes 16 and 17 or when said shaft 71 has been stopped, as just described, and the air from said pipes has been exhausted, said rollers 25'''' and 26'''' will be released from their respective lugs 25'' and 26'', and they will be allowed to drop by gravity into the lower portions of the locking-slots of their respective quadrants 23 and 24, the configuration of said slots being such that roller 25'''' must be allowed to drop before roller 26'''' can pass its lug 26'' in order to prevent a mechanical locking of shaft 71. Upon the further movement of shaft 71 by means of crank 72 in the direction of the arrow the same will be locked when roller 25'''' abuts against shoulder 25''' of quadrant 23. The parts are so adjusted that at this point top slide 60 of valve X has been moved until its end abuts against abutment 138 of under slide 61, which position of the parts of the valve is shown in Fig. 9. Referring to said Fig. 9 and to Figs. 1, 2, and 28, it will appear that air under pressure will be admitted from pipe 7' through ports 28', 37', 28, 30, and 34 into pipe 17, by which said air under pressure is led to bottom of diaphragm 78, and thereby roller 26'''' is raised to the position shown in Fig. 10. Said air under pressure is also carried by pipe 17 teeing off through pipe 12 to opening 81 in diaphragm-operated seat-valve 10, the chamber of which valve is closed to said opening 81. Said air under pressure is also carried by pipe 17 through pipe 15 to opening 80 in diaphragm-operated seat-valve 11, through the chamber of said valve 11 out of opening 82 thereof, and by pipe 9 teeing off through pipe 6 to valve D, which valve is then in the position shown in Fig. 50, said pipe 6 being closed by the surface of under slide 58 of said valve covering port 6' of the seat thereof, into which said pipe 6 leads. From where pipe 6 tees off from said pipe 9 air under pressure is borne by said pipe 9 to cylinder 63 at the end thereof, from which its piston 65 is next to be moved. Said air under pressure operates upon said piston 65 and simultaneously produces the following effects: First, by means of rod 70 and bar 109 roller 83 is withdrawn from recess 107 in the motion-plate 69, thereby allowing longitudinal movement of the same, and, second, through rod 66 and bar 74' top slide 57 of valve D is moved until the end of said top slide abuts against abutment 141 of under slide 58, which is the half-stroke of said valve, as above described. Referring now to Fig. 37 and considering the parts of the valve at the said half-stroke position, air under pressure from pipe 7 will pass into pipe 1 through the following ports of said valve: 7'', 46, 39', 52, and 1'', and thence through said pipe 1 to operating-cylinder 64, whose piston 67 is then at that end of the cylinder. Said piston 67 will thereby be operated and moved to the other end of said cylinder 64, carrying with it by means of rod 68 motion-plate 69, and at this position of valve D pipe 2, leading from the other end of said cylinder 64, will exhaust to the atmosphere through the following ports of

said valve: 2″, 53, and 41′. By means of groove 92 in said motion-plate 69 operating upon roller 93, borne by bar 94, which bar is operatively connected with rod 95, bearing switch-points 96, the said switch-points will be moved to reverse position in the usual way. During said movement of said motion-plate and switch-points roller 83 will run in slot 106, which will hold during said movement the piston 65 against the air under pressure communicated to the cylinder by means of said pipe 9 until the limit of the stroke of said motion-plate has been reached, when said piston will be allowed to operate in obedience to said air under pressure in pipe 9 and pull, by means of said rod 70, roller 83 into recess 108, and thereby pneumatically lock the motion-plate and switch-points. Said motion-plate in this position is also locked by lug 100 thereon being inserted in its corresponding notch in lock-rod 97. The said further movement of said piston 65 through rod 66 completes the stroke of the parts of valve D to reverse position, when the supply from pipe 7 is cut off by the surface of seat 59, to which it is led through ports 39′ of top slide and 52 of under slide of said valve, and air under pressure from the supply from the tower will be admitted to pipe 5 from pipe 6 through ports 6′, 44, 50, and 5″, and also air under pressure will be admitted to said pipe 5 from operating-cylinder 64 through pipe 1 through the following ports of said valve D: 1″, 54, 48, 50, and 5″. At this position of the valve pipe 3 will exhaust to the atmosphere through said valve through ports 3″ and 43, and pipe 4 will be closed to the atmosphere by surface of under slide 58 through port 4′ in the seat, and pipe 2 will be cut from the atmosphere by the surface of top slide 57 through the ports 2″ and 51. The air under pressure admitted to pipe 5, as above described, will be carried thereby through opening 119 in valve-casing 87 of valve 10 to diaphragm 86, thereby raising the same and setting valve-head 114 upon its seat 113, closing opening 84, raising valve-head 110 from its seat 111, making communication through chamber of valve 10 between pipes 12 and 14, and as air under pressure from the tower is then in pipe 12 the same will be carried into pipe 14 and thence through pipes 16 and 18 to the under side of diaphragm 77, raising the same, and thereby through rod 75 raising roller 25′′′′ from its shoulder 25′′′, allowing the operator to complete the movement of handle or lever 72 in the direction of the arrow, Fig. 1, and placing the parts of valve X in reverse position, Fig. 7, when air under pressure from 7′ will be cut off by the surface of the seat 62, which it reaches through ports 28 and 30, and by the surface of under slide 61, which it reaches through port 27, and any air under pressure in the apparatus will be allowed to exhaust from pipes 16 and 17 through the following ports of said valve: 33, 29, 34, 27″, 22, 32, and 36. Referring to Fig. 10, it will be understood that the shaft 71 will be locked when it is at its two-thirds position just described from movement back to normal until the remaining third of the stroke has been made by roller 26′′′′ abutting against lug 26″ in quadrant 24.

In returning the switch-points from reverse to normal position it will be understood that the operation of the mechanical parts of the mechanism, both at the switch and in the tower, is the same as described in connection with the movement from normal to reverse. I therefore will only describe the relative positions of the ports in the two slide-valves as they are operated from reverse to-normal positions. In Fig. 7 the parts of valve X are shown in reverse position. As top slide 60 thereof is moved toward its position at two-thirds of the stroke the shaft 71 will be locked against further movement in that direction at about one-third of the stroke thereof by the action of rollers 25′′′′ and 26′′′′ against lugs 25″ and 26″, respectively, or either of them, as above described, until all air under pressure has escaped from pipes 16 and 17 through ports 33 34 in valve-seat 62, 29 27″ in under slide 61, and 22 in top slide 60, port 32 in under slide 61, and port 36 in seat 62. When the air under pressure has thus been exhausted and the top slide has completed its two-thirds stroke, air under pressure will be admitted from 7′ to pipe 16 through the following ports of valve X: 28′ in the seat, 37 in the under slide, 27 in top slide, 29 in under slide, and 33 in the seat, and at this position of the parts pipe 17 will be cut off from the atmosphere by the surface of top slide 60 shutting ports 27″ in under slide, and 34 in the seat. Said pipe 16 communicates with the under surface of diaphragm 77 through pipe 18 and tees off through pipe 13 to opening 88 of diaphragm-operated seat-valve 11 and also tees off through pipe 14 to opening 85 in diaphragm-operated seat-valve 10, communicating through the chamber of said valve with opening 84 thereof, and pipe 8, which tees off through pipe 4 to valve D and is shut to the atmosphere by the surface of under slide 58 through port 4′. Said pipe 8 also leads to the end of cylinder 63, at which the piston 65 thereof then is, and air under pressure in said pipe 8 will operate said piston and through its rod 70 and bar 109 pushing roller 83 from recess 108, thereby releasing the motion-plate, as above described, and will also through rod 66 and bar 74′ move top slide 57 of valve D to its half-stroke position, when air under pressure from 7 will be admitted to pipe 2 through the following ports of said valve: 7″ in the seat, 46′ in under slide, 39 in top slide, 51 in under slide, and 2″ in seat, and pipe 1, leading from the other end of said cylinder, will be allowed to exhaust to the atmosphere through the following ports of said valve: 1″ in the seat, 54 in under slide, and 40′ in top slide. The piston 67 of cylinder 64 will under the influence

of air under pressure from pipe 2 move to the other end of said cylinder, carrying with it by means of its rod 68 motion-plate 69, which in the ordinary way will move the switch-points 96 to normal position. Roller 83, working in slot 106, holds piston 65 from any further movement until it has reached recess 107, when under the influence of air under pressure from pipe 8 it will complete its stroke, pushing said roller 83 into said slot 107 and again locking the motion-plate 69 and the switch-points and by rod 66 and bar 74′ complete the movement of the parts of valve D to their normal position, when air under pressure from 7 will be cut off by the surface of seat 59 through ports 7″ in seat, 46′ in under slide, 39 in top slide, and 51 in under slide, and air under pressure from pipe 4 from the tower will be admitted to pipe 3 through the following ports of said valve: 4′ in the seat, 45 and 49 in under slide, and 3″ in seat, and air under pressure from pipe 2 will be admitted to said pipe 3 through the following ports of said valve: 2″ in seat, 53 in under slide, 48 in top slide, 49 in under slide, and 3″ in seat, and pipe 5 will communicate to the atmosphere through the following ports of said valve: 5″ in the seat, and 42 in under slide, and pipe 6 will be shut to the atmosphere by the surface of under slide 58 of said valve through port 6′ of the seat thereof, and pipe 1 will be shut to the atmosphere by the surface of top slide 57 through the following ports of said valve: 1″ in the seat, and 52 in under slide. Air under pressure is led by pipe 3 to the under surface of diaphragm 89 through opening 119′ in the bottom of casing 90 of diaphragm-operated seat-valve 11, thereby raising diaphragm 89 thereof, closing opening 82, and establishing communication through the chamber of said valve between opening 88 and opening 80, so that the air under pressure from pipe 13 flows to pipe 17 through pipe 15. Said pipe 17 is shut to the atmosphere by the surface of top slide 60 of valve X through the following ports of said valve: 34 in the seat and 27″ in under slide. Air under pressure is led from said pipe 17 by pipe 19 to diaphragm 78, thereby, as above described with reference to diaphragm 77, releasing shaft 71 from its lock and allowing the operator to complete the movement of valve X to normal position, when any air under pressure from pipes 16 and 17 will be allowed to escape to the atmosphere through the following ports of said valve: from 16 through ports 33 in the seat, 27′ in under slide, 22 in top slide, 31 in under slide, and 35 in seat, and from 17 through ports 34 in the seat, 30 in under slide, 22 in top slide, 31 in under slide, and 35 in the seat, and air under pressure from 7′ will be cut off by the surface of under slide 61 through port 28 and by the surface of top slide through ports 28′ and 37.

The operation of the modification of valve D shown in Figs. 66 to 71, inclusive, is similar to that of valve D already described, except that in the reverse and normal positions thereof air under pressure from pipes 2 and 1 is allowed to escape to the atmosphere through the following ports of said valve: from pipe 2 through port 2‴ in the seat, 53 in under slide, 48′, 40′, and 41′ in top slide, 57″, and from pipe 1 through port 1‴ in seat, 52′ in under slide, 48′, 40′, and 41′ in top slide when the parts of said valve are in normal position, and when the same are in reversed position pipe 2 will exhaust to the atmosphere from the following ports: 2‴ in seat, 51′ in under slide, 48′ 40′ 41′ in top slide, and pipe 1 will exhaust to the atmosphere through the following ports: 1‴ in seat, 54 in under slide, 48′, 40′, and 41′ in top slide, as will appear from Fig. 69.

The operation of the parts of the modification of valve D shown in Figs. 53 to 61, inclusive, is the same as of valve D; but provision is made whereby in the normal and reverse positions of said valve air under pressure is maintained in cylinder 64 upon that side of the piston thereof last acted upon, and the other end of the cylinder is open to the atmosphere, so that when in normal position pipe 2 communicates through said valve with air under pressure in 7 through the following ports of said valve: 2′ in seat, 51″ in under slide, 39 in top slide, and pipe 1 will exhaust to the atmosphere through the following ports: 1′ in seat, 52″ in under slide, 40 in top slide, and in reverse position pipe 1 will communicate with air under pressure through the following ports: 1′ in seat, 52″ in under slide, 39′ in top slide, and pipe 2 will exhaust to the atmosphere through the following ports: 2′ in seat, 51″ in under slide, and 41 in top slide, as will appear by Fig. 56.

It will thus be seen that in admitting air under pressure through either valves X or D or the modifications thereof to the desired pipe of the apparatus no crossing of the opening into another and undesired pipe is made. In many cases it is desirable to cause to be operated by the same handle or lever in the tower two or more sets of switch-points. By the use of my new double-slide valves above described, the one at the tower and the other at the switch, only two of the diaphragm-operated seat-valves are required, no matter how many sets of switch-points are to be operated. For instance, should a second switch be desired to be operated, pipes 5 and 3, Fig. 1, instead of leading to valves 10 and 11, respectively, will lead to and become pipes 9 and 8, respectively, of the system of piping of the second switch, and the corresponding pipes 5 and 3 of the system of piping of the second switch will lead to valves 10 and 11, respectively, and so on, no matter how many sets of switch-points are in the series.

As will be seen from the above, only two pipes are required from the tower or operator's station to the switch-operating point, and by the use of my new valve the same may be accomplished with reference to a sema-

phore or signal which will form the subject of an application for a patent which I am about to file.

Of course I do not limit the use of my double-slide valve to switch and signal apparatus, as it is evident it would be useful in other pneumatic apparatus.

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

1. In a pneumatic apparatus, a slide-valve comprising a seat having inlet and outlet ports, an under slide adapted to slide on said seat and having ports adapted to be put into registry with the ports of said seat, a top slide adapted to slide on said under slide and having ports adapted to be put into registry with the ports of said under slide and therethrough with the ports of said seat, and means for moving the top slide in two directions whereby it must make a complete stroke in either of said directions before commencing the stroke in the other direction, and for carrying with it said under slide for a part only of such complete stroke.

2. In a slide-valve for pneumatic apparatus, the combination of a seat having inlet and outlet ports, with an under slide having ports adapted to be put into registry with the ports of said seat, a top slide having ports adapted to be put into registry with the ports of said under slide and therethrough with the ports of said seat, a spring for maintaining the two slides and seat in operative relation with each other, abutments on the under slide for carrying the same with the top slide during part of its movement in both directions, and means for moving the top slide with reference to the seat in two directions whereby it must make a complete stroke in either of said directions before commencing the stroke in the other direction.

3. In a slide-valve for pneumatic apparatus the combination of a seat having inlet and outlet ports, with an under slide having ports adapted to be put into registry with the ports of said seat, a top slide having ports adapted to be put into registry with the ports of said under slide and therethrough with the ports of said seat, a spring for maintaining the two slides and seat in operative relation with each other, abutments on said under slide for carrying the same with the top slide during part of its movement in both directions, spring-catches coöperating with said abutments to hold the under slide during part of the movement of the top slide in both directions, means for releasing said catches, and means for moving the top slide with reference to the seat in two directions.

4. In a slide-valve for pneumatic apparatus, the combination of a seat with two superimposed slides the said seat and slides having ports those of the under of said slides being adapted to be put into registry both with those of the top slide and the seat, means for moving the top slide in two directions with reference to the seat and for carrying with it the under slide during part of its movement in each direction, and means for locking the top slide against a return movement until its movement in either direction has been completed.

5. In a slide-valve for pneumatic apparatus, the combination of a seat with two superimposed slides the said seat and slides having ports those of the under of said slides being adapted to be put into registry both with those of the top slide and the seat, means for moving the top slide in two directions with reference to the seat and for carrying with it the under slide during part of its movement in each direction, means for automatically locking the top slide in the course of its stroke in each direction, and means for automatically unlocking said top slide so that its stroke may be completed.

6. In a slide-valve for pneumatic apparatus, the combination of a seat with two superimposed slides the said seat and slides having ports those of the under of said slides being adapted to be put into registry both with those of the top slide and the seat, a handle for moving the top slide in two directions with reference to the seat, two quadrants rigidly connected with said handle each having locking-cams therein, locking-rollers one adapted to coöperate with the locking-surfaces of each of said cams, two pipes connecting two of the outlet-ports of the seat of said valve with the pipes of the pneumatic apparatus and with said locking-rollers so as to lock and unlock said handle at certain positions of the slides of said valve and of the parts of the pneumatic apparatus, and means for carrying the under slide with the top slide during part of its movement in each direction.

7. In pneumatic apparatus the combination of the piping and mechanism situate at or near the part to be moved by the apparatus with a slide-valve situate at the operator's station said slide-valve having a seat and two superimposed slides the seat and slides having ports those of the under of said slides being adapted to be put into registry both with the ports of the top slide and the seat the top slide being adapted to be moved in two directions with reference to the seat and to carry the under slide with it during part of its movement in each direction, locking and unlocking devices for said top slide and two pipes connecting the piping at or near said part to be moved with two of the ports of the seat of said valve at the station and with said locking and unlocking devices.

8. In pneumatic apparatus the combination of the piping and mechanism situate at or near the part to be moved by the apparatus, with a slide-valve situate at the operator's station, said slide-valve having a seat and two superimposed slides, the seat and slides having ports, those of the under of said slides being adapted to be put into registry both with the ports of the top slide and the seat,

the top slide being adapted to be moved in two directions with reference to the seat and to carry the under slide with it during part of its movement in each direction, and two pipes connecting the piping at or near said part to be moved with two of the ports of the seat of said valve at the station.

9. In pneumatic apparatus the combination of the piping and mechanism situate at or near the part to be moved by the apparatus with two slide-valves—one connected with said piping and mechanism at or near the part to be moved and the other situate at the operator's station—each of said slide-valves having a seat and two superimposed slides, the seat and slides having ports, those of the under of said slides being adapted to be put into registry both with the ports of the top slide and the seat, the top slide being adapted to be moved in two directions with reference to the seat and to carry the under slide with it during part of its movement in each direction, and two pipes connecting the piping at or near said part to be moved with two of the ports of the seat of said valve at the station.

10. In pneumatic apparatus for switches, the combination of a slide valve at the operator's station said slide-valve having a seat and two superimposed slides the seat and slides having ports those of the under of said slides being adapted to be put into registry both with the ports of the top slide and the seat the top slide being adapted to be moved in two directions with reference to the seat and to carry the under slide with it during part of its movement in each direction with locking and unlocking devices for said top slide, a second of said slide-valves at or near the switch, a cylinder and piston adapted to operate the top slide of said second slide-valve, a cylinder and piston for operating the switch-points, two similar diaphragm-operated valves at or near the switch whose ports are adapted to supply air under pressure from the first-mentioned slide-valve to said locking and unlocking devices or to said first-mentioned cylinder, pipes adapted to suitably connect the parts at the switch and two pipes leading therefrom to the slide-valve at the station and the said locking and unlocking devices.

11. In a pneumatic apparatus for switches having at or near the switch a motion-plate, a valve comprising a seat and two superimposed slides, and means for operating the top slide of said valve and for locking the switch-points consisting of the combination of a cylinder and piston with means for introducing air under pressure to each side of said piston, a rod operatively connected with said piston and said top slide, a groove in the motion-plate having a recess at each end thereof, a roller adapted to ride in said groove as the motion-plate is moved and to be inserted in said recesses, and a rod operatively connected with said roller and said piston.

12. In a valve for pneumatic apparatus, the combination of a suitable casing with a chamber therein, three ports vertically arranged with reference to each other adapted the top port to lead air under pressure to said chamber the middle port to lead air under pressure both to said chamber and away from it and the bottom port to lead air under pressure away from said chamber, two vertically-opposing valve-seats in said chamber in the course of communication therethrough between said top port and said middle port, two valve-heads one coöperating with each of said seats, a spring adapted to hold normally said heads upon their respective seats but to be overcome by air under pressure from said top port, a valve-stem borne by the lower of said valve-heads, a third valve-seat in said chamber, a third valve-head coöperating with said last-mentioned seat to close communication between said middle port and said bottom port and loosely bearing said valve-stem, a bar loosely bearing said last-mentioned head, and a diaphragm bearing said bar and adapted to be raised by air under pressure beneath the same.

13. In a valve for pneumatic apparatus, the combination of a suitable casing with a chamber therein, three ports vertically arranged with reference to each other adapted the top port to lead air under pressure to said chamber the middle port to lead air under pressure both to said chamber and away from it and the bottom port to lead air under pressure away from said chamber, two vertically-opposing valve-seats in said chamber in the course of communication therethrough between said top port and said middle port, two valve-heads one coöperating with each of said seats, a spring adapted to hold normally said heads upon their respective seats but to be overcome by air under pressure from said top port, a valve-stem borne by the lower of said valve-heads, a third valve-seat in said chamber, a third valve-head coöperating with said last-mentioned seat to close communication between said middle port and said bottom port and loosely bearing said valve-stem, a diaphragm bearing a rod and adapted to be raised by air under pressure beneath the same, a fourth valve-head loosely borne by said rod and loosely bearing said third-named valve-head, a fourth valve-seat coöperating with said fourth-named valve-head and therewith adapted to control communication through said chamber between said ports and the top of said diaphragm, and an opening in said casing immediately above said diaphragm.

In witness whereof I hereunto affix my name, in the presence of two witnesses, this 12th day of April, 1902.

LAWRENCE GRIFFITH.

Witnesses:
H. V. N. PHILIP,
J. T. BOUDREAU.