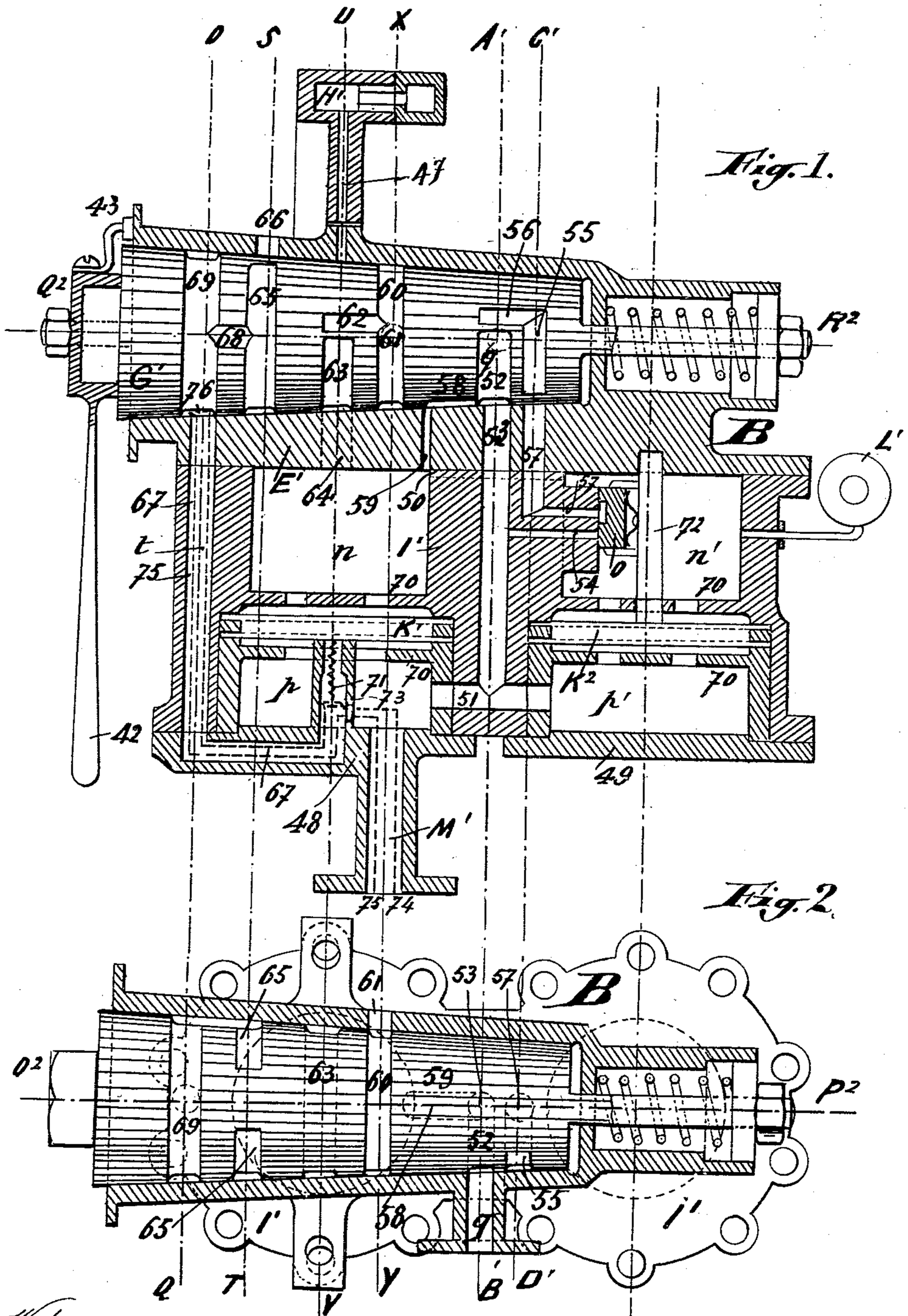
No. 664,812. Patented Dec. 25, 1900.

C. LUYERS.

RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

(No Model.) 11 Sheets—Sheet 1.



Witnesses
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Ad Sturm

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per Lidius & Co
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No. 664,812. Patented Dec. 25, 1900.

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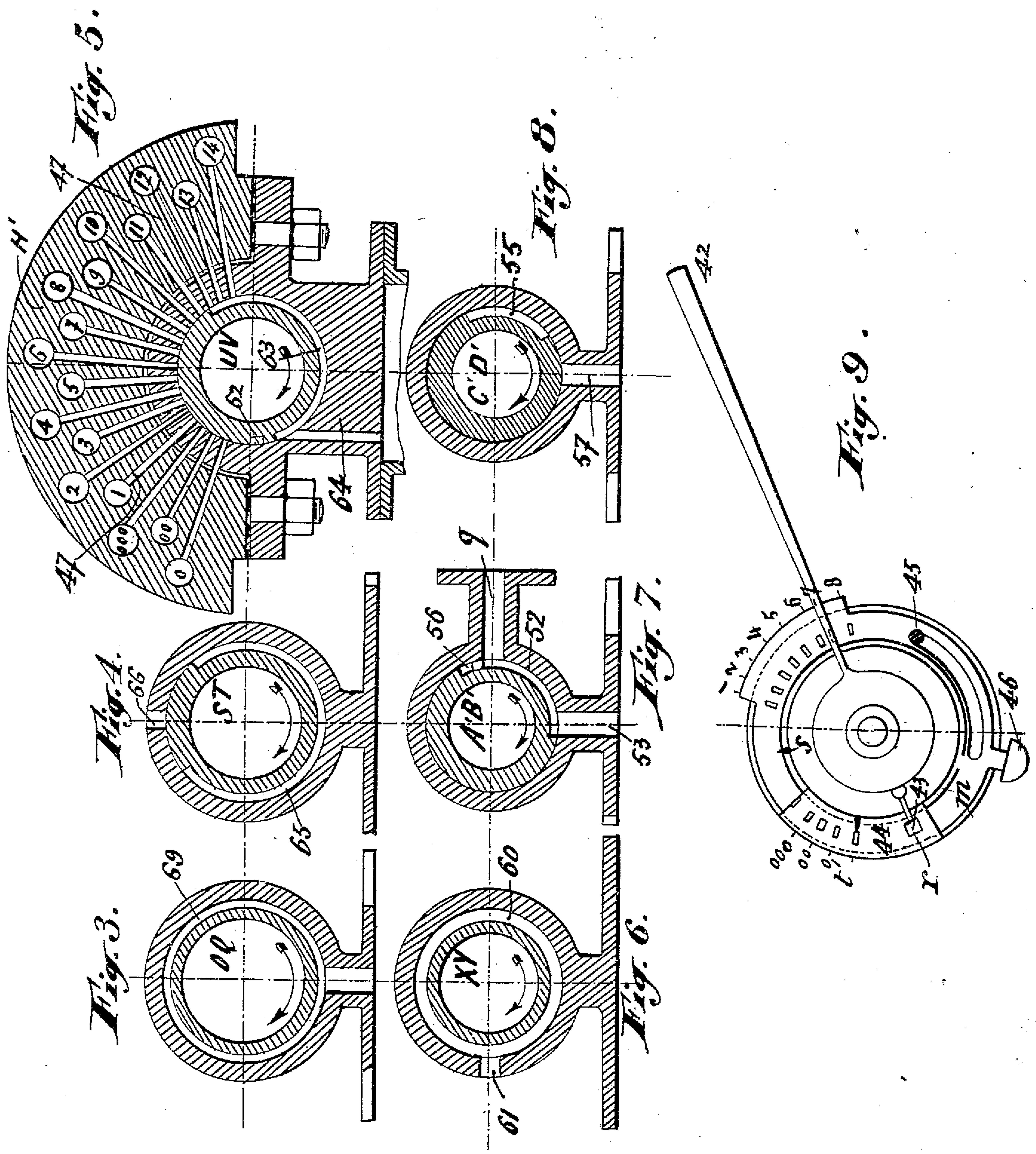
RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

(No Model.) 11 Sheets—Sheet 2.



Witnesses

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 664,812. Patented Dec. 25, 1900.

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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

(No Model.) 11 Sheets—Sheet 3.

Fig. 12.

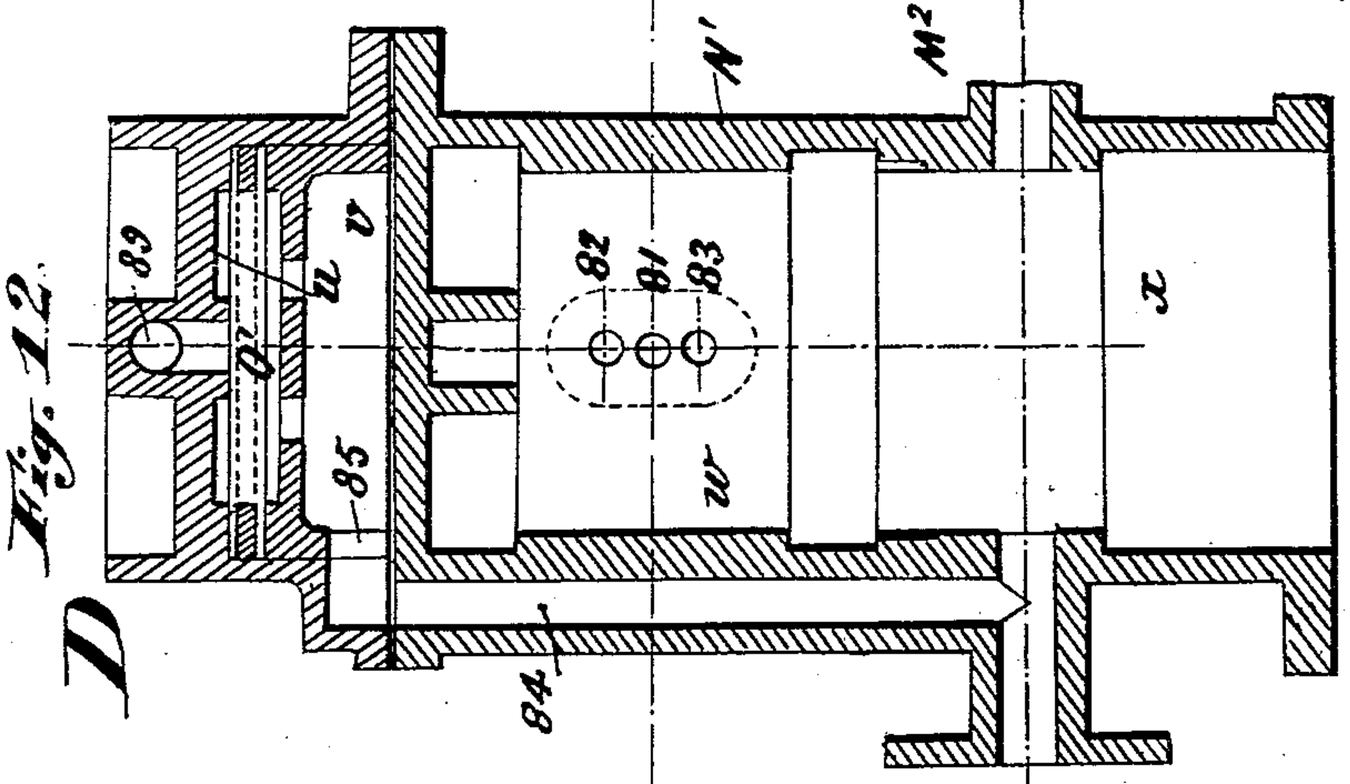


Fig. 10.

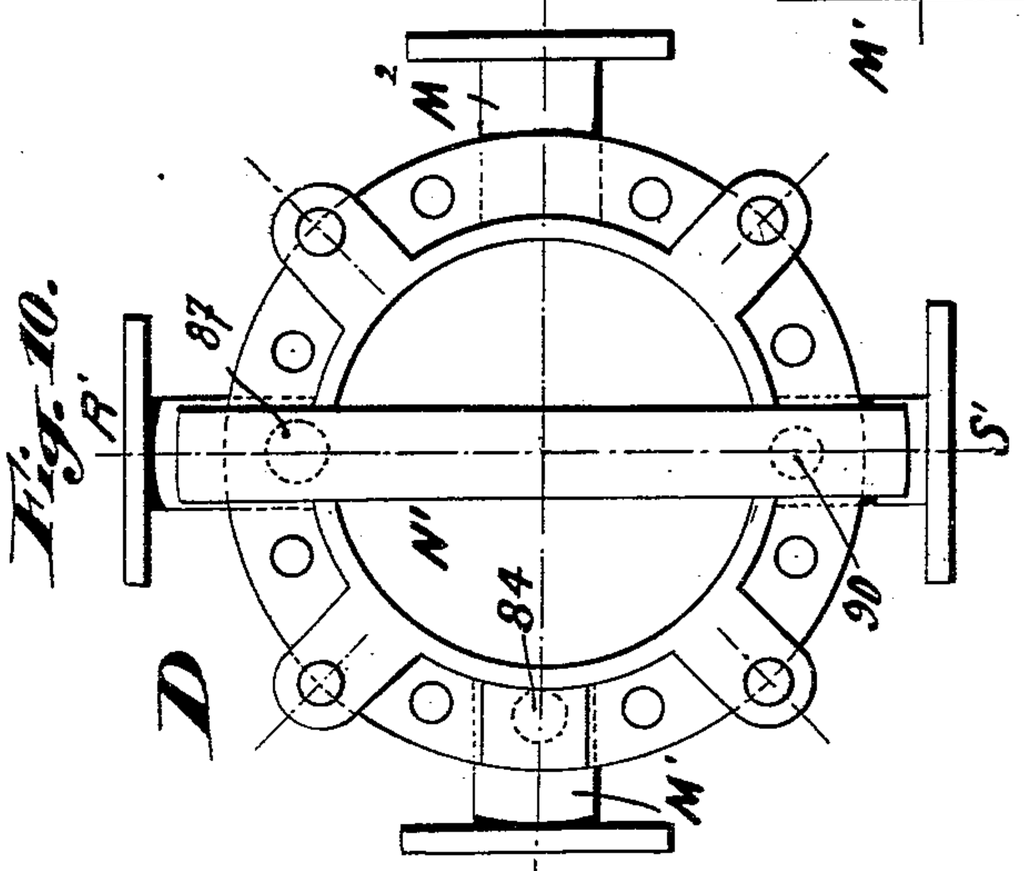
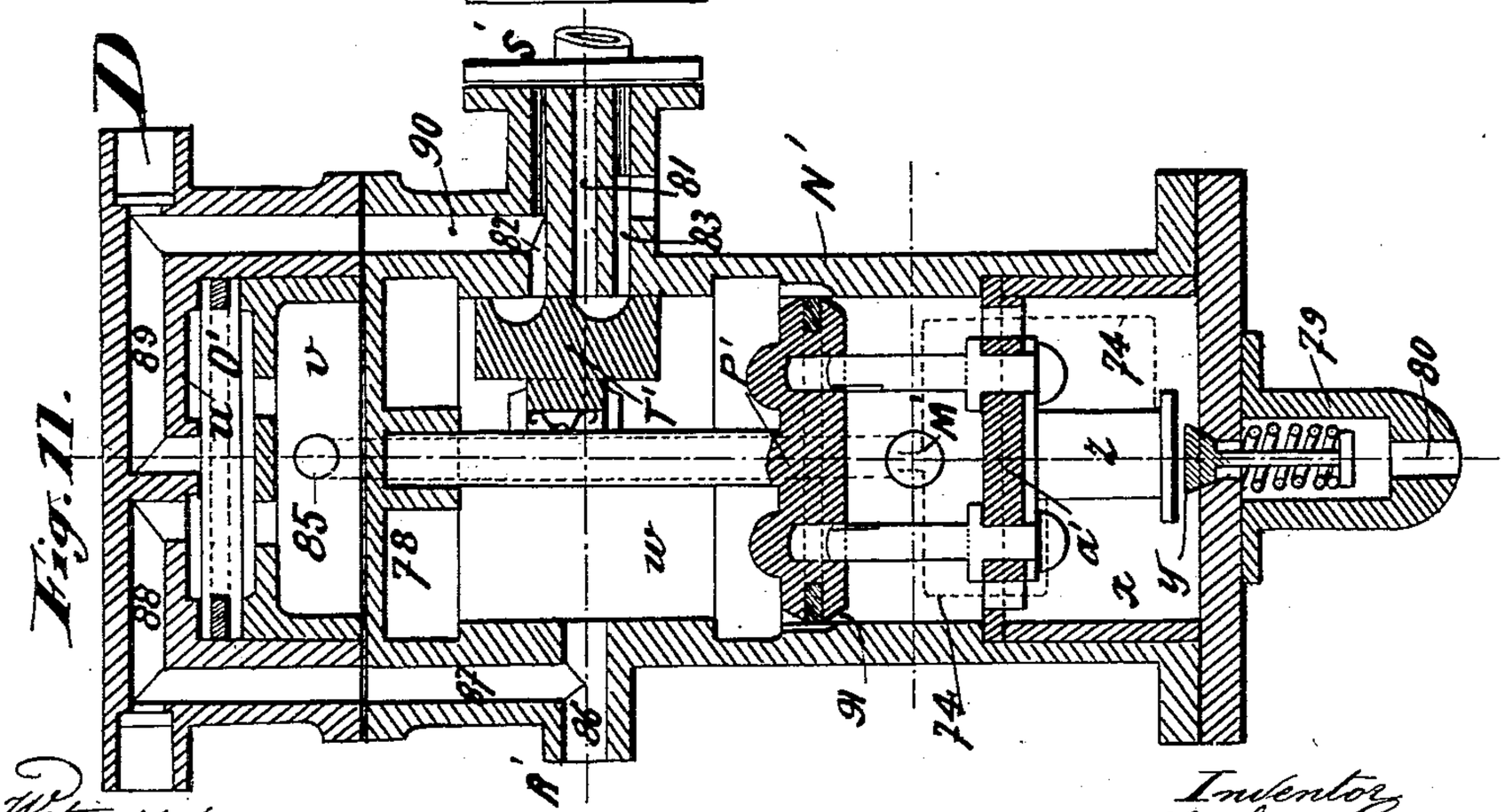


Fig. 11.



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No. 664,812. Patented Dec. 25, 1900.

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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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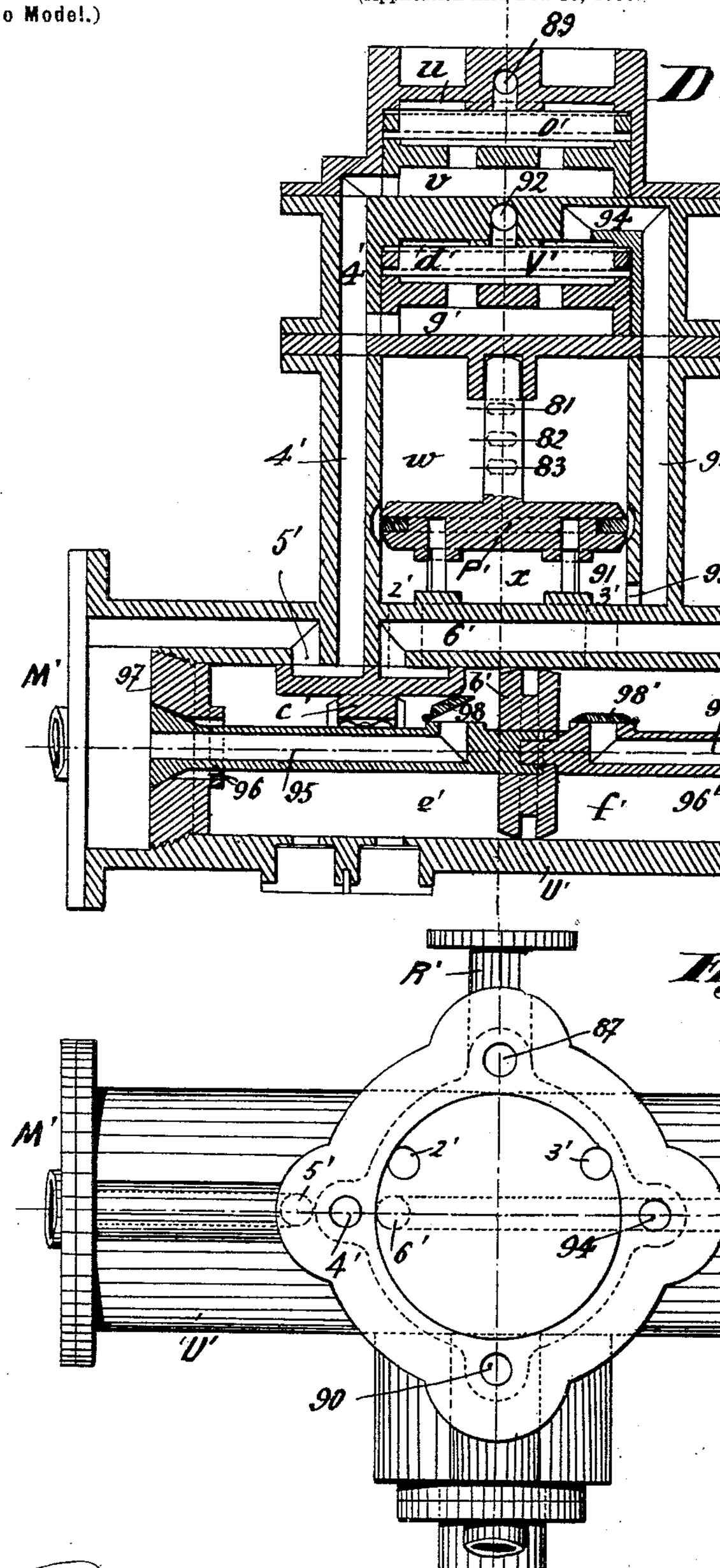

Fig. 14.

Fig. 13.

D

Witnesses.
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No. 664,812. Patented Dec. 25, 1900.

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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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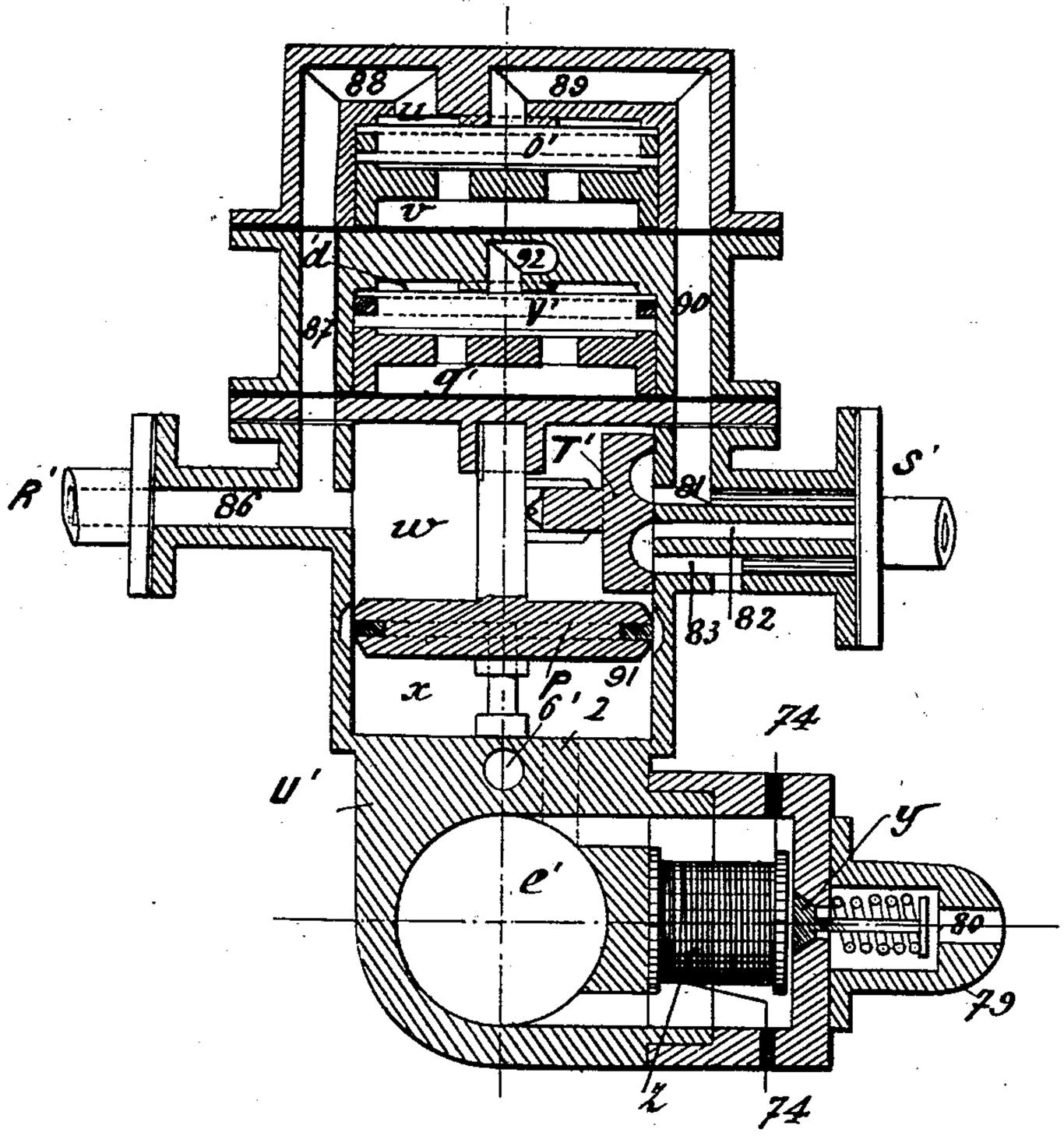
Fig. 15.



Witnesses.
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(Application filed Dec. 30, 1897.)

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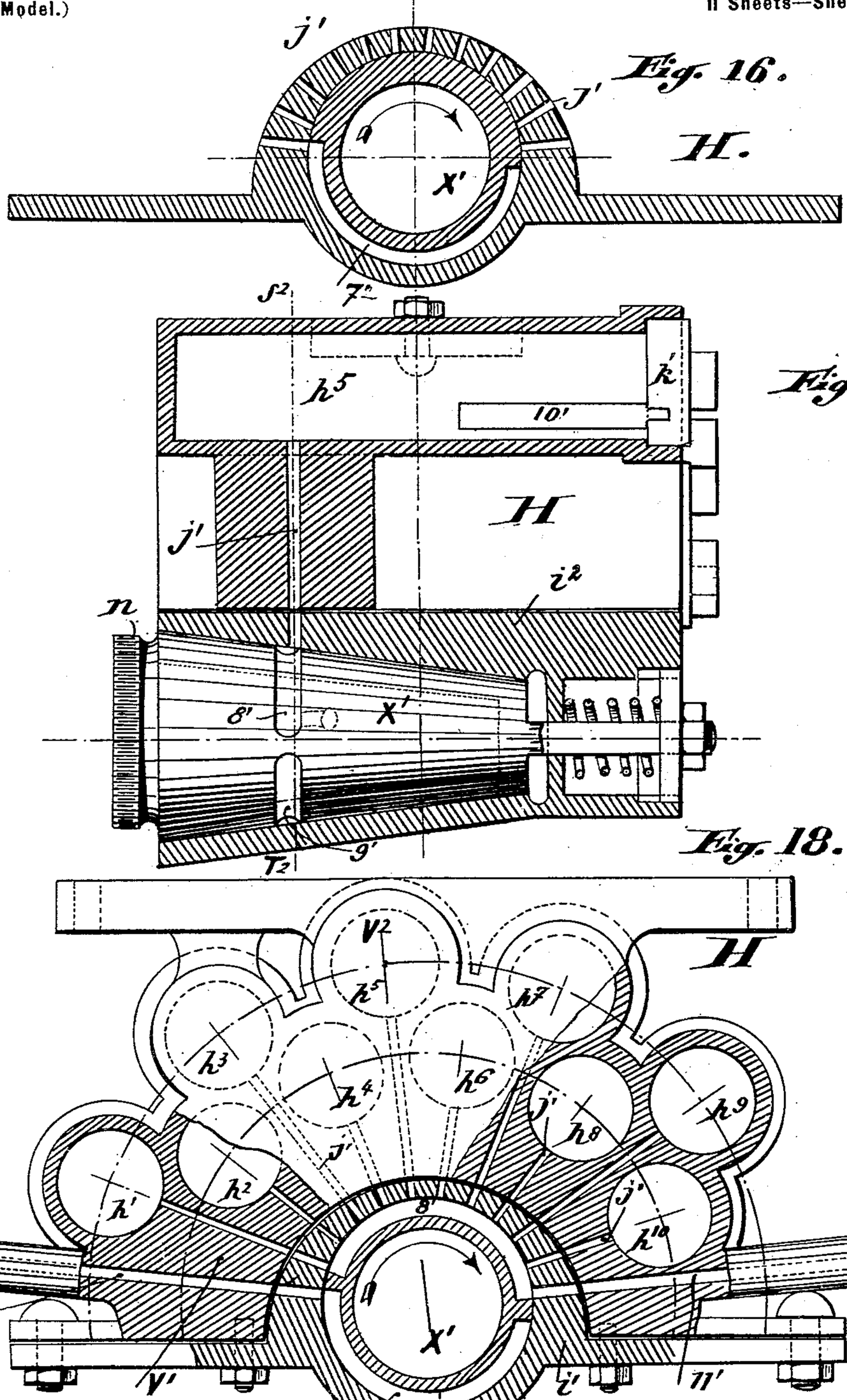

Witnesses
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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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Fig. 19.

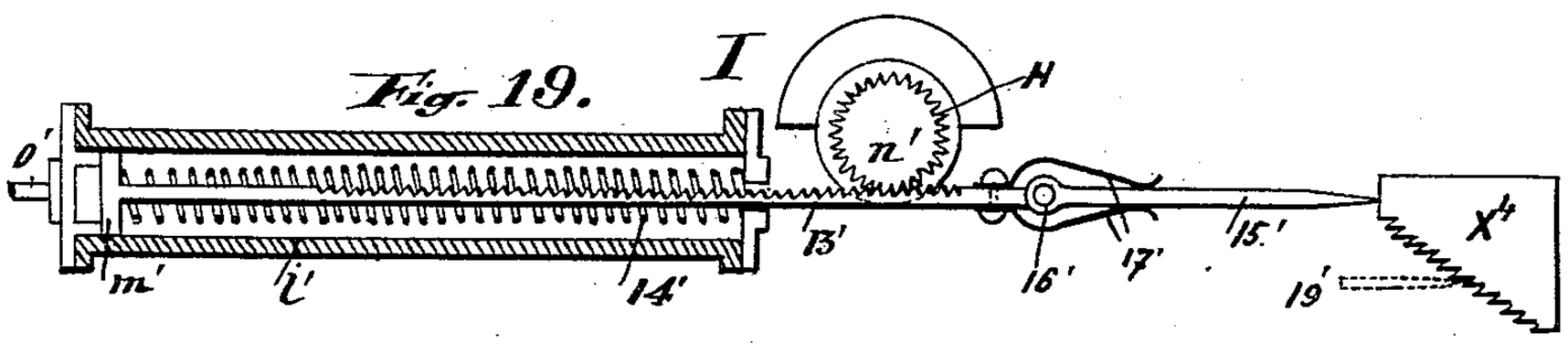


Fig. 21.

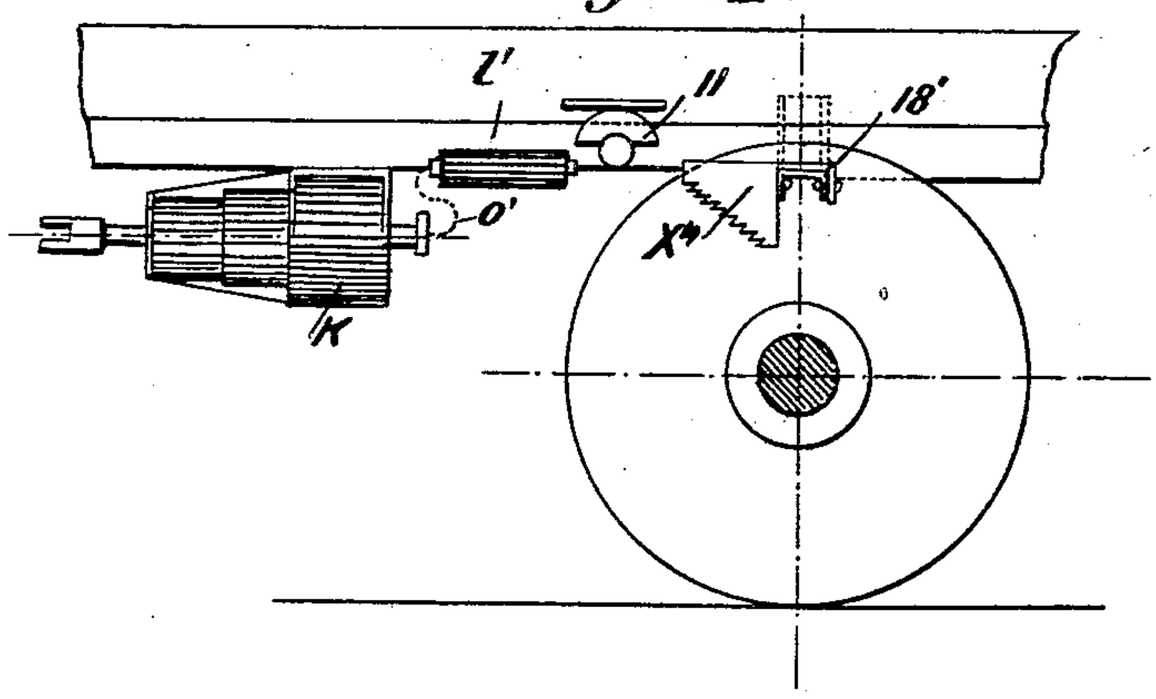
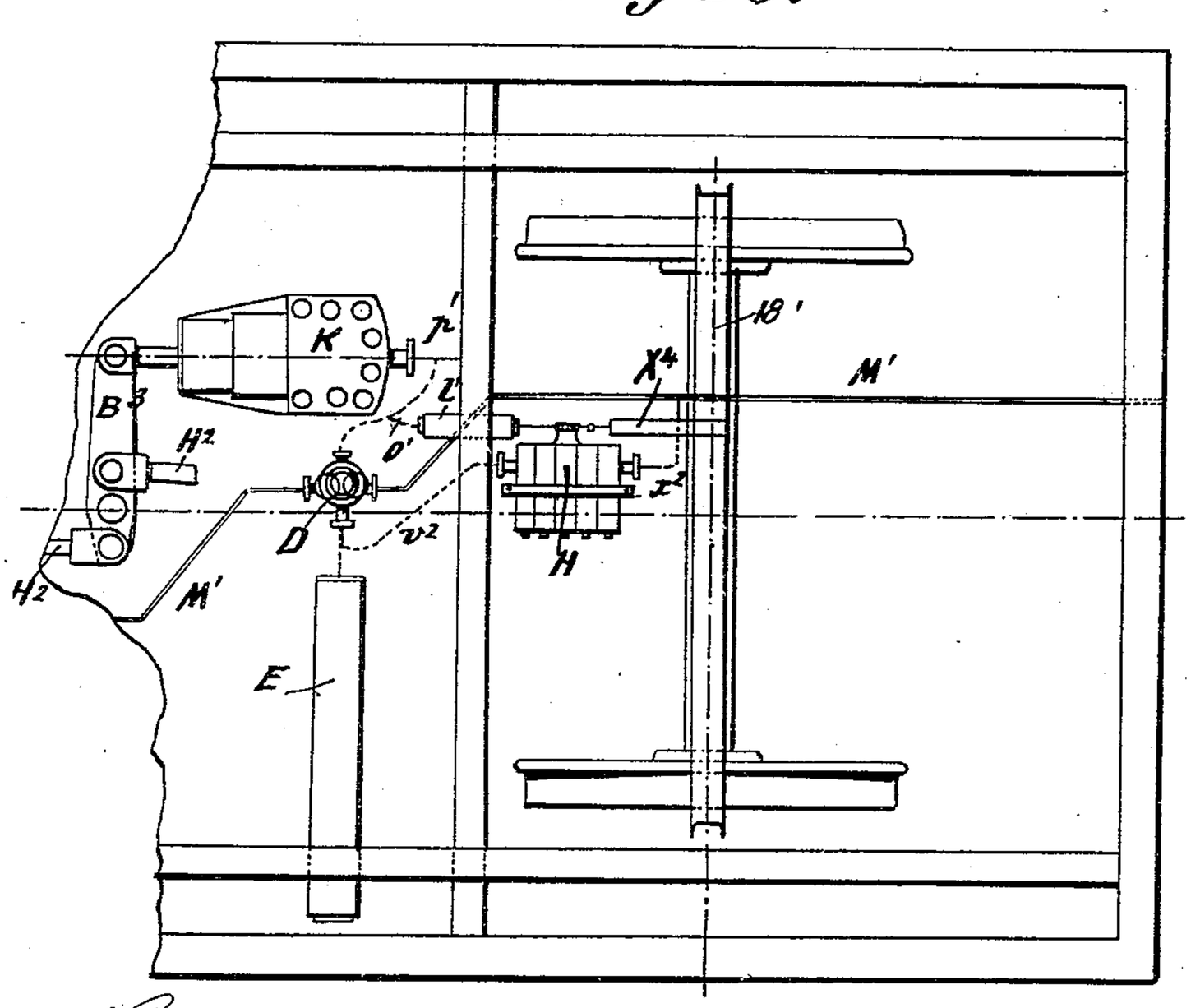


Fig. 20.



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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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Fig. 23b

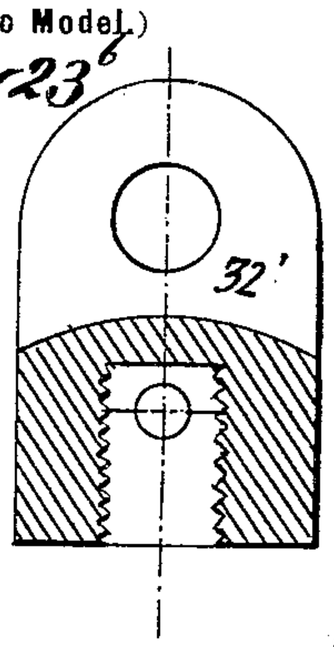

Fig. 22.

Fig. 23.

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No. 664,812. Patented Dec. 25, 1900.

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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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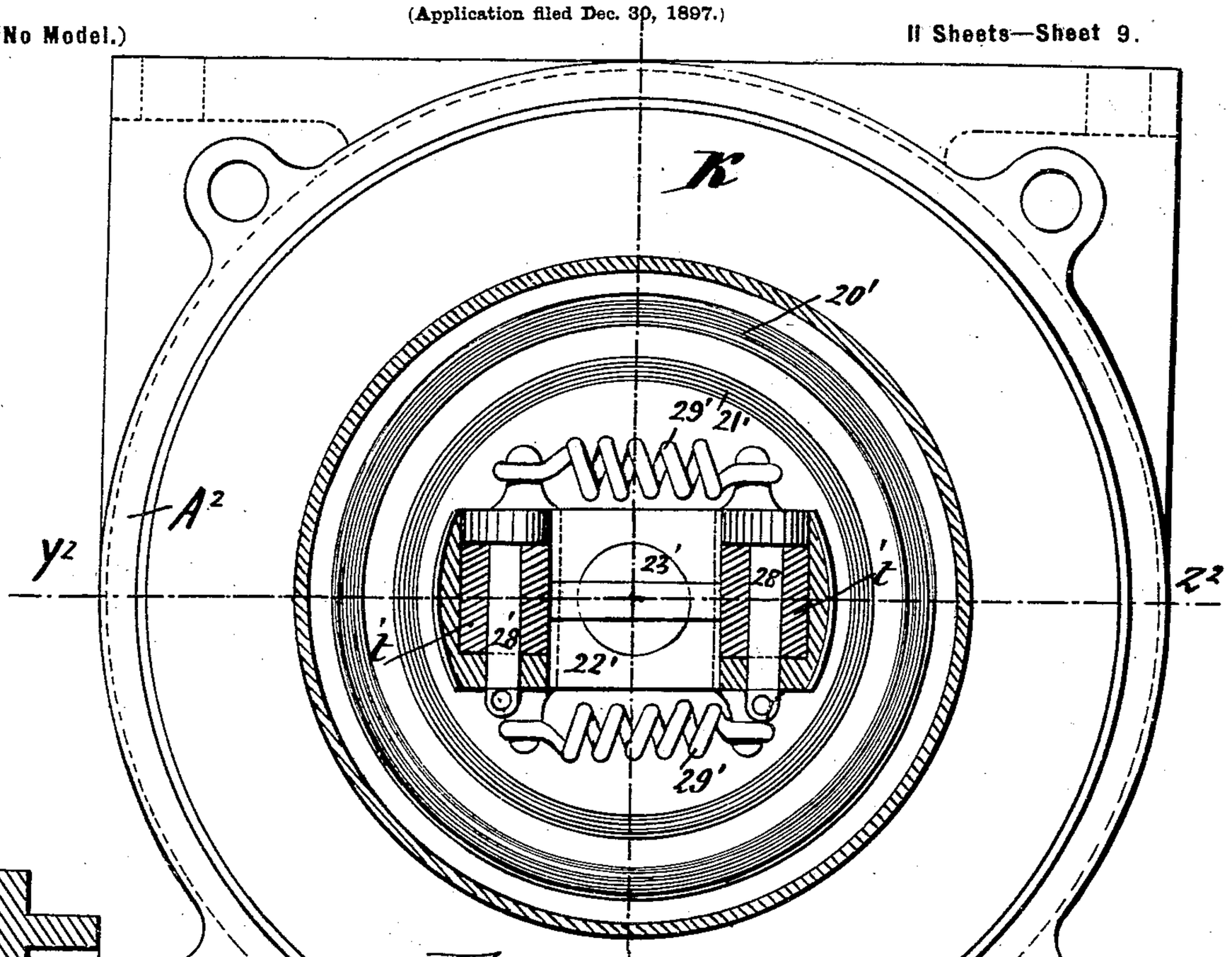

Fig. 24.

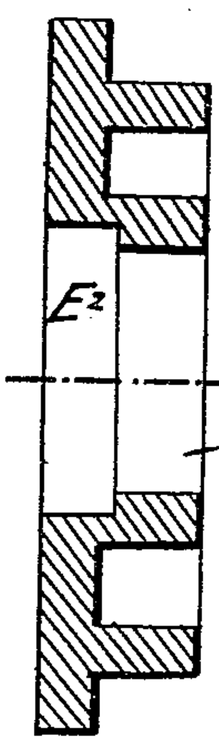

Fig. 26.

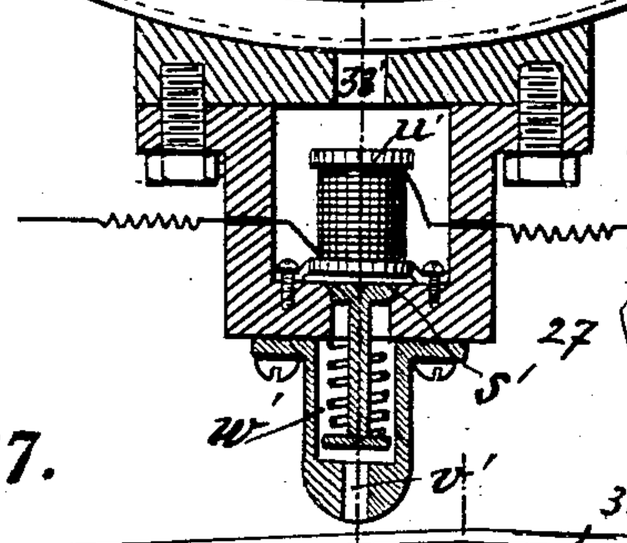

Fig. 27.

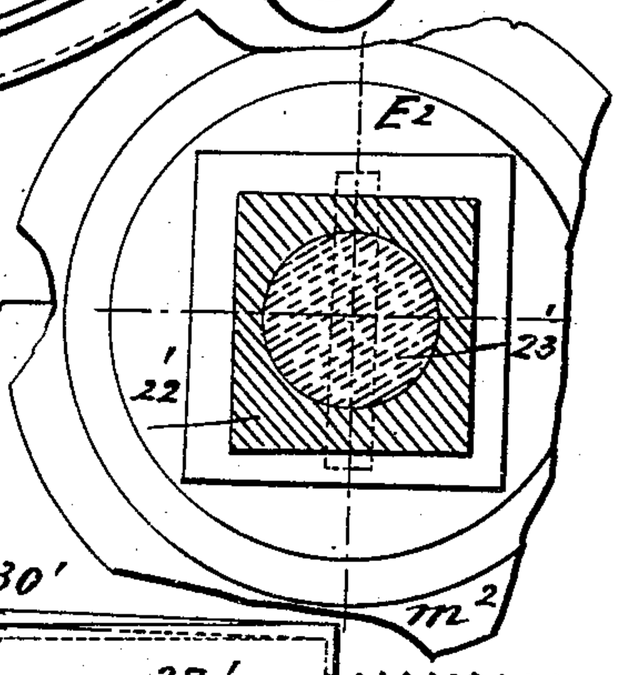

Fig. 25.

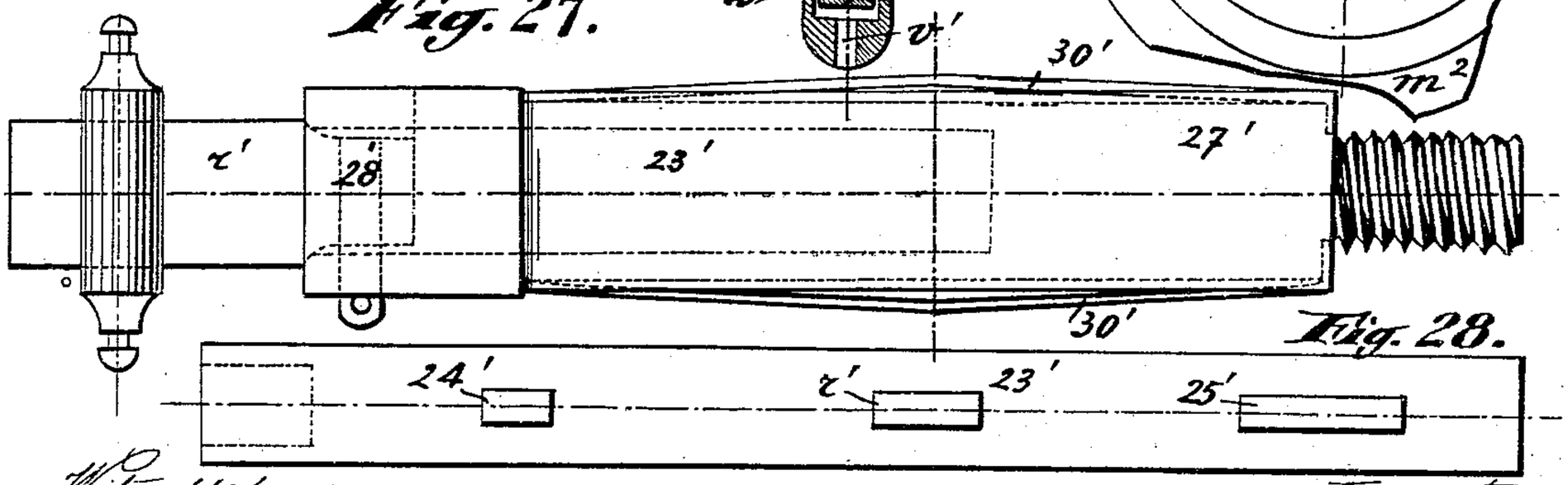

Fig. 28.

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No. 664,812. Patented Dec. 25, 1900.

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RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

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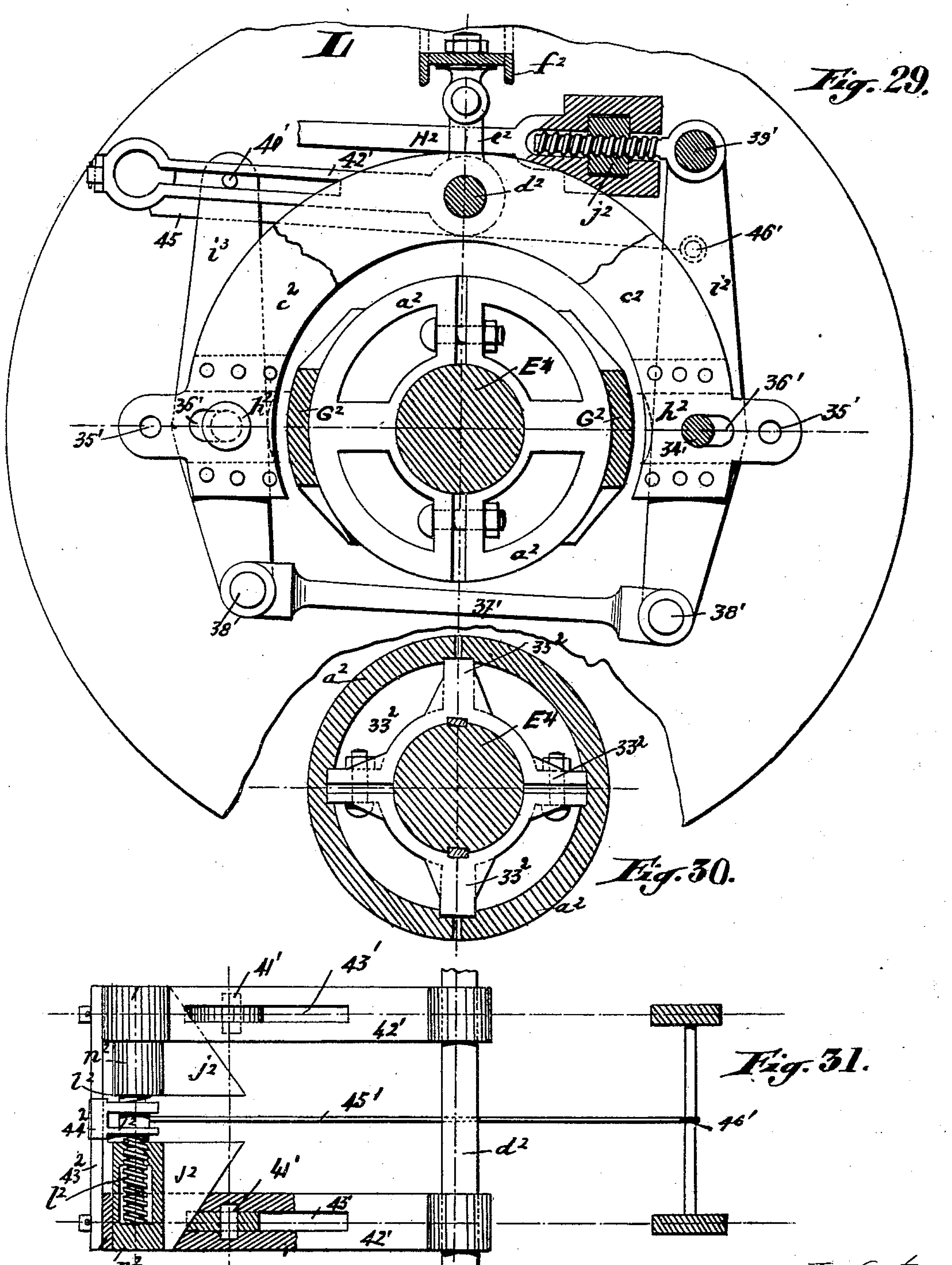

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per [signature]
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No. 664,812. Patented Dec. 25, 1900.

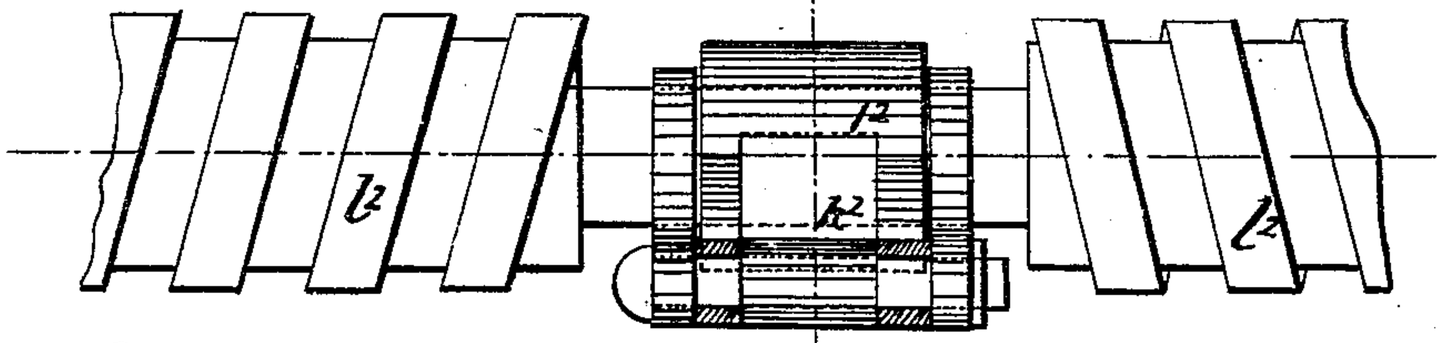
C. LUYERS.

RAILWAY AERO-ELECTRIC BRAKE.

(Application filed Dec. 30, 1897.)

(No Model.) 11 Sheets—Sheet 11.

Fig. 33



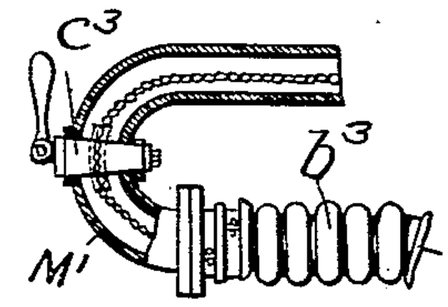


Fig. 35.

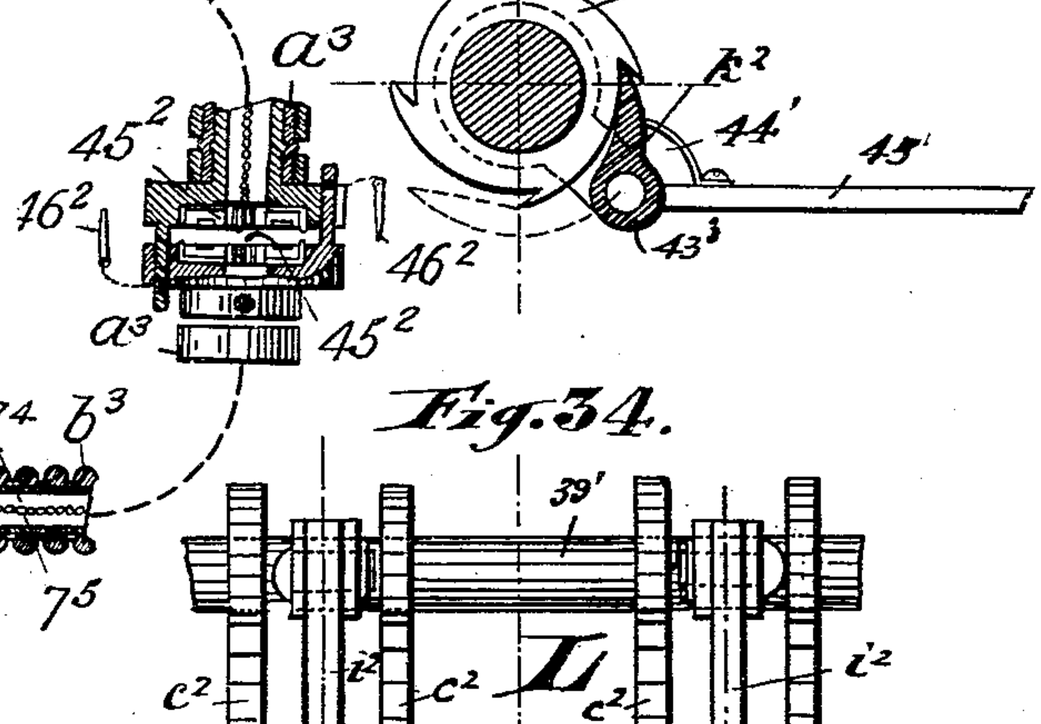
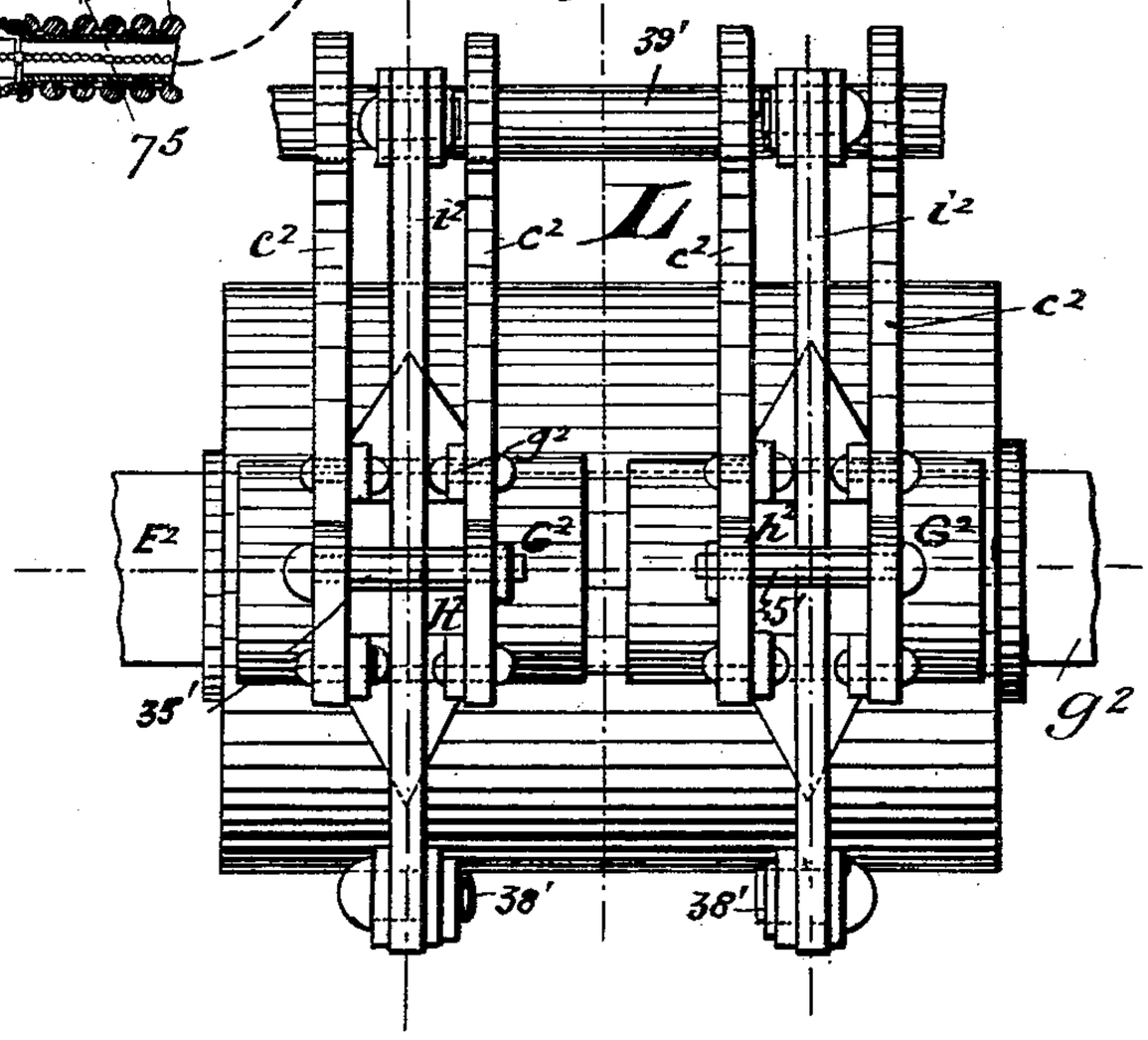


Fig. 32.

Fig. 34.



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Attorney

UNITED STATES PATENT OFFICE.

CHARLES LUYERS, OF BRUSSELS, BELGIUM.

RAILWAY AERO-ELECTRIC BRAKE.

SPECIFICATION forming part of Letters Patent No. 664,812, dated December 25, 1900.

Application filed December 30, 1897. Serial No. 664,657. (No model.)

To all whom it may concern:

Be it known that I, CHARLES LUYERS, a citizen of the Kingdom of Belgium, residing at Brussels, Belgium, have invented certain new and useful Improvements in Railway Aero-Electric Brakes, (for which I have made applications for patent as follows: in Belgium, No. 128,535, filed May 26, 1897, allowed June 15, 1897; in France, No. 241,288, filed September 21, 1897, allowed January 10, 1898; in Spain, No. 21,578, filed October 12, 1897, allowed November 17, 1897; in Italy, No. 46,080, filed October 20, 1897, allowed November 11, 1898; in Austria, No. 3,315/48, filed October 30, 1897, allowed June 16, 1898; in Hungary, No. 13,753, filed November 16, 1897, allowed December 28, 1897; in Canada, No. 65,618, filed September 15, 1898, allowed January 3, 1900, and in England, No. 30,001, filed December 18, 1897, allowed November 26, 1898,) of which the following is a specification.

The present invention relates to improvements in that kind of brakes forming the subject of my prior patent, No. 563,934, dated July 14, 1896, and applicable to passenger and goods trains and whose action upon each carriage or wagon is proportionate with the weight borne by the latter.

In the annexed drawings, Figure 1 shows a vertical and horizontal section of the working cock following line O^2 P^2 of Fig. 2. Fig. 2 is a horizontal section of this cock following line Q^2 R^2 of Fig. 1. Figs. 3, 4, 5, 6, 7, and 8 show vertical transverse sections of the box and plug of the cock following the lines O Q, S T, U V, X Y, A′ B′, and C′ D′ of Fig. 1. Fig. 9 is an elevated view of the movable plate of the cock and of the working lever. Fig. 10 is a plan view of the regulator with electric local-train-pipe exhaust. Fig. 11 is a vertical section of this regulator following line R′ S′ of Fig. 10. Fig. 12 shows a vertical section of the same apparatus following line M′ M^2 of Fig. 10. Fig. 13 represents a view in plan of the regulating-distributer with electric and local train-pipe exhaust. Fig. 14 is a longitudinal vertical section of this apparatus following line M′ M^2 of Fig. 13. Fig. 15 is a vertical transverse section of same apparatus following line R′ S′ of Fig. 13. Fig. 16 is a transverse section of the multiple-way cock regulated with the hand following line S^2 T^2 of Fig. 17. Fig. 17 is a vertical longitudinal section of the multiple-way cock following line V^2 X^2 of Fig. 18. Fig. 18 is a vertical section of same apparatus following line S^2 T^2 of Fig. 17. Fig. 19 represents the automatic regulating arrangement of the multiple-way cock with the cylinder i' in a longitudinal section. Fig. 20 is a view underneath a wagon of the whole apparatus automatically working the brake, according to the load, with multiple-way cock automatically regulated, as shown by full lines, and also adapted to be regulated by hand. Fig. 21 represents an elevated view of the above apparatuses. Fig. 22 shows a horizontal and longitudinal section of the brake-cylinder. Figs. 23 and 23^b are a profile view and a vertical section of the head of piston-rod. Fig. 24 is a transverse view of the brake-cylinder following lines m^2 n^2 o^2 p^2 q^2 r^2 of Fig. 22, the cap of the cylinder being removed. Fig. 25 is a front view of the ring E^2. Fig. 26 is a transversal section of the same ring. Fig. 27 represents the hollow ratchet-axle 27′. Fig. 28 is a view of the shaft 23′ of the small piston. Fig. 29 is an elevated view of the mechanism and of the brake friction-drum. Fig. 30 is a view of the pulley at the fore part of the arms 33′. Fig. 31 represents a plan section of the wearing-compensator. Fig. 32 shows the ratchet-wheel of the wearing-compensator with its pawl. Fig. 33 shows the screws, the ratchet-wheel, and the pawl of the wearing-compensator, showing the jointing of the pawl with the commanding-rod. Fig. 34 is a side view of a friction-pulley fitted with the brake. Fig. 35 represents a coupling arrangement of the air-tube.

This system of continuous brake is composed, essentially, of the following parts, apparatuses, or arrangements: a principal air-reservoir (not shown) fixed underneath the locomotive and feeding the carriage or wagon reservoirs by means of a general conduit M′ which exists along the whole length of the train; then under each carriage or wagon, besides the air-tube M′, an air-regulating distributer D intercalated in the air-tube and communicating with the air-reservoir E of the vehicle and with the brake-cylinder K; an air-feeding reservoir E for the brake-cylin-

der communicating with the regulating-distributer D and with the multiple-way cock H; a multiple-way cock H and auxiliary reservoirs connected on one hand with the general air-pipe M′ and on the other hand with the principal reservoir of the vehicle E and regulated automatically or otherwise to render the action of the brake proportionate with the load; an arrangement I for working the multiple-way cock H automatically and according to the load; a brake-cylinder K, communicating with the regulating-distributer D and working the properly so-called "brake;" a brake L with its friction-drum, its organs, and its wearing-compensator. The principal reservoir of the brake is fixed underneath the engine and is fed by the compression-pump A, which is automatically worked by a regulator, so as to maintain and limit the air-pressure of the principal reservoir to the atmospheric pressure desired.

The air in the principal reservoir is driven into the air-conduit by means of a working cock B, placed near the driver. This working cock (shown in Figs. 1, 2, 3, 4, 5, 6, 7, 8, and 9) is intended, first, to feed the reservoirs placed under the vehicles; second, to make up, automatically, for the loss of air resulting from eventual leakages, and, third, to exercise the pressure desired in the principal pipe to work the brake according to the speed attained by the train and the value of the adhesion and according to the more or less energetic action I wish to produce. This apparatus is composed of a properly so-called "cock," formed of a box E′ and a plug G′, worked by a handle 42, fitted with a catch 43, moving upon a divided face *m*, sliding itself in a groove made by the plate 44, fixed to the box of the cock. Moreover, the disk *m* is provided with a groove in which is fixed a screw 45 to enable the fixing of the disk, brought by means of a knob 46 into a determinate position according to the greatness or smallness of the adherence. At the upper part of the box E′ a part H′ is fixed, provided with a certain number of cylindrical chambers *o*, *oo*, *ooo*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14, forming reservoirs and communicating with the box E′ through the pipes 47, Figs. 1, 5, and 10. Below the box E′ is fixed a part I′, comprising two cylinders, each divided into two compartments by the diaphragms K′ and K² and shut at their lower ends by covers 48 and 49. The upper compartments *n n′* of the cylinders communicate through the passage 50 and the lower compartments *p p′* by the passage 51. Moreover, the chamber *n′* is connected by a tube with the gage L′, which indicates the air-pressure in the main reservoir. The periphery of the plug G′ of the cock is provided with a certain number of different grooves whose communications are established or suppressed by the working of the plug, which in Figs. 1, 2, 3, 4, 5, 6, 7, 8, and 9 is shown as turned off. The groove 52 communicates through the tube *q* with the main reservoir and through the tubes 53, 51, and 54 with the compartments *p*, *p′*, and *n′*. The groove 55 communicates, on the one hand, with the tube *q* by the longitudinal groove 56 and correspondingly, on the other hand, with the passage 57, leading to the compartment *n′*. The longitudinal groove 58 puts the groove 52 into communication with the passage 59, leading to the chamber *n*. The groove 60 communicates with the outside by the orifice 61 and is provided with a longitudinal groove 62, communicating with the passages 47 of the compartments H′ for their supply. The groove 63 communicates with the compartment *n* through the passage 64 and with a certain number of reservoirs H′ for expanding with precision the air contained in *n*. The groove 65 communicates with the outside by the opening 66 and with the passage 67 by means of the passages 68 and 69. The diaphragms K′ and K² are preserved by perforated partitions 70, limiting their course, and are provided the diaphragm K′ with a helicoidal rod 71, bearing a plate forming a contact, and the diaphragm K² with a rod 72, bearing a slide-valve O. The end plate 48 of the left cylinder has on its upper face a nipple 73, traversing the partition 70 and by which the pipe 67 empties into the chamber *p* when the diaphragm K′ is lifted. This same cylinder-end bears on its lower face a tubing of the general conduit M′, along which the wires 74 and 75 pass, each respectively put into communication with the wire *t* by the contact of the rod 71 and the contact-nipple 76, fixed in the groove 69 of the cock, the wire *t* itself communicating with a pile or any electric source whatever.

The working of the cock is as follows: The catch 43 being in the notch *r*, Fig. 9, the working cock is shut, and the air coming from the principal reservoir by the tubing *q* travels along 52, 53, and 51 into the compartments *p* and *p′* and from the former into the general conduit M′, which leads the air into the reservoirs of the vehicles. On the other hand, in passing along 58 and 59 the air also penetrates into *n*, and consequently into *n′*, passing through 50. When the gage L′ indicates that the normal working pressure is attained, the catch 43 is placed in the notch *t′*. The feeding-ways are then intercepted, for the groove 52 surpasses the orifice of the admission-tube *q;* but the longitudinal groove 56, terminating in 55, is in front of *q*, and the bottom end of the groove 55 uncovers the passage 57, leading to the slide-valve O. From this moment if through any leakage whatever a depression is produced in the main pipe M′ this depression is driven back to *p* and *p′* and the diaphragm K² descends and draws with it the slide-valve O, Fig. 1, whose opening puts into communication the pipes 54 and 57, Fig. 1. The air coming from the main reservoir by the tubing *q* and the grooves 56, 55, and 57 passes by the head of the slide-valve O to arrive through 54, 53, and 51 at *p*

and p' and then at M'. This resupplying is effectuated until the equilibrium is established at p' and n'. As soon as the pressure at p' inclines to become greater than at n' the diaphragm K^2 rises and the apparatus is again in its normal position.

To obtain in the main conduit M' the desired depression corresponding with a determinate pressure of the brakes, the screw 45 is previously undone, and by acting upon the knob 46 the disk m is placed in such a way that the orifices 1 2 3 4, &c., immediately follow the orifices *o oo ooo* of the plate 44. Then the catch 43 is brought into the notch S, which indicates the position the cock must occupy in order to obtain the necessary pressure in ordinary working conditions. Through this movement of the cock the desired number of the chambers of the system H' is put in direct communication with the compartment n by 63 and 64, Fig. 1, and the air, compressed to the normal pressure in n and n', will expand and determine a pressure in these chambers proportionate with the capacity of the compartments H', put into communication with 63. The diaphragm K^2 not being able to rise, the diaphragm K' alone undergoes an upward movement owing to the decrease of pressure of the air contained in n. The compressed air contained in p and p' escapes into the open air by passing through 67 69 68 65 and the opening 66. This exit of the air contained in p and p', and consequently at M', continues until the equilibrium is fixed between p and n—that is to say, until the depression of the general conduit M' is equal to the depression at n. To instantaneously evacuate the main conduit M', and consequently to insure the instantaneous working of the brakes, an electric local-train-pipe exhaust is joined to the regulating-distributer and is automatically worked by the diaphragm K' in the following manner: Every time a depression is made in the chamber n of the working cock, Fig. 1, the diaphragm K' rises and draws with it the rod 71 and its small plate, which causes the contact between the conducting-wires t and 74 and drives the current to the electromagnet Z of each regulating-distributer D. (See Fig. 11.) The suction-valve y is consequently drawn by the electromagnet Z, and the air being able to escape under each of the vehicles the action is produced instantaneously. The electrical command is therefore effectuated automatically by the compressed air. To release the brakes, it suffices to refill the main conduit M' by placing the catch 43 in the notch r. During this returning movement of the working cock to its former position the compartments of the system H', which had entered into action, successively evacuate by the passing of 62 before the openings of the passages 47.

The instantaneous releasing of the brakes, which is also very important to effect, is also made electrically and automatically at the same moment as the working cock is in action for producing the refilling. For this purpose the cock during its rotary movement establishes the contact between the wires t and 75 by the contact-button 76, Fig. 1, and the electric current goes to an electromagnet u', working a purging-valve S', fixed upon each of the brake-cylinders, Fig. 24. The compressed air of the cylind r therefore escapes immediately into the open air without the necessity of waiting for the ordinary action of the distributers. These distributers have, besides the properly so-called "distributer," an automatic pressure-regulator and an electric local-train-pipe exhaust. The regulating-distributer D (shown in Figs. 10, 11, and 12) is essentially composed of a vertical cylinder N', divided internally into four compartments u v w x by the diaphragm O', the partition 78, and the piston P'. Besides, the cylinder N' is supplied externally with the four tubes R', S', M', and M^2, the first two corresponding, respectively, with the air-reservoir of the vehicle and with the brake-cylinder and the last two connecting the apparatus with the main pipe. The cylinder of the distributer is shut at its lower end by a plate bearing the hollow part 79 and provided with an opening, which is shut by the valve y, which when lifted puts the compartment x into communication with the exterior by the opening 80. The valve y is worked by the electromagnet Z, fixed on the lower face of the perforated disk a' by two vertical rods serving as guides for the piston P', which is surmounted by a vertical rod properly guided and upon which is fixed a slide-valve T', which connects the tube 81 alternately with the tubes 82 and 83, the latter communicating with the outside. The chamber v, through the lateral opening 85 and the tube 84, communicates with the main conduit M', and when the diaphragm O' is lifted the reservoir of the vehicle communicates with the brake-cylinder by R', 86, 87, 88, u, 89, 90, 82, and S'. Besides, the electric wire 74 enters the distributer and leaves it by the general tube M' M^2.

The regulating-distributer works in the following manner: At the moment of the feeding of the principal reservoir and of the releasing of the brakes the piston P' is lifted by the compressed air which passes through the annular space 91 and the chamber w to reach, by the tube 86, the reservoir E of the vehicle. When the piston P' is at the upper point of its stroke, the slide T' obstructs the passage 82, but puts the brake-cylinder into communication with the outside through S', 81, and 83, Fig. 11. The releasing of the brake is therefore done during the filling of the reservoirs E of the vehicles, when the brake-cylinders have not been previously emptied by means of the electric local-train-pipe exhaust. As soon as a determinate pressure is produced in the main conduit M' this depression is driven back to x, and the diaphragm O' falls and communicates the reservoir E with the brake-cylinder K through R', 86, 87, 88,

89, 90, 82, 81, and S′, Fig. 11, until the equilibrium is set between *v* and M′, after which the feeding ceases. This distributer therefore allows, by varying the depression, the introduction into the brake-cylinder K of as much air as I wish and to transmit to the brakes a pressure which is variable and proportionate with the speed of the train. The electric local-train-pipe exhaust, directly worked by the working cock B and already described, will insure the instantaneous propagation of the braking action to each vehicle by instantaneously putting, under each of these vehicles, the main conduit M′ into communication with the air; but it is to be remarked that in case the electric action should be defective the depression in the main conduit M′ would be produced by the disengaging of the air by means of the tube 67, the grooves 69 68 65, and the opening 66 of the working cock B, Fig. 1.

The electric local-train-pipe exhaust may be substituted by a compressed-air local-train-pipe exhaust or combined with the latter. The object of the compressed-air local-train-pipe exhaust, like the electric local-train-pipe exhaust, is to quickly distribute under each vehicle the depression made in the working cock in determinating a direct disengaging of the general conduit M′ into the atmosphere. If the compressed-air local-train-pipe exhaust is joined to an electric local-train-pipe exhaust with instantaneous action, the compressed-air local-train-pipe exhaust will only act when the electric local-train-pipe exhaust proves defective.

The regulating-distributer, with electric local-train-pipe exhaust and compressed-air local-train-pipe exhaust, (shown in Figs. 13, 14, and 15,) is composed of a cylinder U′, fitted on the axis of the main conduit M′ M², Figs. 13 and 14, and in the interior of which a piston *b′* and a slide *c′* work. The cylinder U′ bears not perpendicular with its axis the ordinary distributing-cylinder, with its piston P′, its slide-valve T′, and its diaphragm O′; but between the chamber *w* and the diaphragm O′ is intercalated the compressed-air local-train-pipe exhaust, composed of a diaphragm V′, which when it is lowered puts the chamber *x*, situated under the piston P′, into communication with the atmosphere by 93 94 *d′* 92, Fig. 14. Moreover, the chamber *g′* communicates with 4′ by an opening made in its lateral side. The piston *b′* is fixed to the connecting-point of two hollow rods, forming two conduits 95 and 95′, emptying into the chambers *e′ f′* by two lateral openings shut by the valves 98 and 98′, Fig. 14. The rods of the piston *b′* terminate in a truncated part, shutting the annular openings 96 and 96′ of the disks 97 and 97′, screwed in the interior of the cylinder U′, the two compartments *e′* and *f′* of which communicate, respectively, by means of the conduits 2′ and 3′, with the chamber *x* of the distributer. On the left rod of the piston *b′* is fixed the slide *c′*, which communicates the conduit 4′ with the conduit 5′, communicating with M′ of the main conduit, or with 6′, communicating with M² of the same conduit. The piston *b′* and the slide *c′* move longitudinally and are guided by the guides 7′, which prevent every rotary movement of the organs. In this apparatus the diaphragm O′ and the electric local-train-pipe exhaust act in the same way as in the simple distributer already described. This regulating-distributer, with electric and air local-train-pipe exhaust, works in the following way:

The locomotive being in the direction of M′, the compressed air passes through the conduit 95, lifts the valve 98, and penetrates into *e′*, and by its pressure upon the piston *b′* pushes this into the position indicated in Fig. 19, so that the end of the rod 95 comes into contact with the conical opening 96 and breaks the direct communication existing between M′ and *e′*. The compressed air continues to come into the chamber *e′* through the conduit 95 and passes into the compartment *x* through the tube 2′. The piston P′ is lifted by the compressed air, which then penetrates into the chamber *w* to supply the reservoir E afterward in passing through 86. From the chamber *x* the compressed air passes also by the tube 3′ and penetrates into the chamber *f′*, from where through the annular space 96′ it passes into the general conduit M² and feeds the following vehicle. On the other hand, the air also passes along 93 and 94 into *d′* above the diaphragm V′ of the local-train-pipe exhaust; but at the same time the lower face of the diaphragm is submitted to the pressure of the compressed air coming through 5′ and 4′ into *g′*, and the two pressures being equilibrated at *d′* and *g′* the diaphragm V′ remains immovable at the upper point of its course during the whole period of supply and the escape of air by the tube 92 cannot take place. In fact, during the feeding the air coming through 4′ also enters the chamber *v* of the regulator, and thus prevents the diaphragm O′ from lowering through the pressure of the air coming from the chamber *w* and from the reservoir E by the tubes 86, 87, and 88.

The communication between the air-reservoir E and the brake-cylinder K is established by the distributer in the following manner, as I have already explained: When a depression is produced in the main conduit M′ by means of the working cock B, this depression is transmitted through 5′ and 4′ to *g′* and *v*, the diaphragms V′ and O′ fall, and the falling of V′ puts the chamber *x* into communication with the exterior through 93, 94, *d′*, and 92. As soon as the determined pressure is exercised at M′ the piston P′ descends with its slide-valve T′ and the reservoir E is put into communication with the brake-cylinder K, as previously described for the simple regulating-distributer. The depression exercised at *x* is transmitted through the tube 3′ to *f′*

and by 96′ to M² and to the following vehicle. The air from M² consequently escapes to the outside by 96′, *f*′, 3′, 93, 94, *d*′, and 92, and this escape will continue until the depression is set at equilibrium between *d*′ and *g*′, after which, the diaphragm V′ rising, the local-train-pipe exhaust stops working. The depression thus created at M² assures the working of the distributer of the following vehicle, and so on. The propagation of the depression from carriage to carriage is done with great rapidity whatever may be the value of this depression, and it is this that principally distinguishes this quick-working distributer from those actually employed. It must also be noticed that with this apparatus the rapid action begins as soon as, owing to the depression made in M′, the pressure exercised on the piston P′ is sufficient to produce its downward movement. If the locomotive is coupled at M², the compressed air will push during the feeding the piston *b*′ to the other end of its course in shutting the opening 96′, and the slide-valve *c*′ breaks the communication between 5′ and 4′ and opens the communication between 6′ and 4′. The apparatus thus arranged then works as I have already explained when the locomotive is supposed to be at M′.

The only important condition to be realized for assuring the good working of the apparatus consists in giving the piston *b*′ a proper friction in the cylinder U′ in order that when this piston has been pushed to one of the extremities of its course by the compressed air it cannot recede at the moment the depression is transmitted—that is to say, that the rubbing of the piston *b*′ on the cylinder U′ must be equal to the pressure exercised by the air of the chamber *e*′ on the truncated part, when the depression at M² will be complete. It is easy to see that with this distributer, owing to the change of condition resulting from the falling of the piston P′, the passing of the air from the reservoir E to the brake-cylinder K continues whatever may be the capacity of the reservoir until the equilibrium is set between *v* and *u*. It results from this that the larger the capacity of the reservoir E the more air is introduced into the brake-cylinder K, so as to obtain a pressure proportionate with the weight of the loads.

The increase of capacity of the reservoir is obtained by means of small auxiliary reservoirs joined to the multiple-way cocks X′, described hereinafter.

The auxiliary reservoirs are constituted by the cylindrical chambers *h*′ *h*² *h*³ to *h*⁹ *h*¹⁰ of a part V′, fixed on the seat *i*² of a cock, the plug X′ of which is supplied at its periphery with a groove 7², Fig. 16, or two grooves 8′ and 9′, Figs. 17 and 18, according as the cock is worked by hand or automatically. The cylindrical chambers *h*′ *h*² *h*³, &c., are shut with plugs *k*′, having a rod 10′, Fig. 17. This rod, which varies in volume according to the compartments, is intended to regulate each auxiliary reservoir and to give it a capacity corresponding with the volume of air necessary for a certain load. The reservoirs *h*′ *h*² *h*³, &c., communicate by the tubes *j*′ with the box *i*². The tubes *j*′ and the groove 7′, Fig. 16, or grooves 8′ and 9′, Figs. 17 and 18, communicate more or less of the reservoirs *h*′ *h*², &c., according to the load of the vehicle, with the large reservoir E, Fig. 21, specially used for the dead-weight, by means of 12′. On the other hand, the cock X′ communicates with the main conduit M′ by means of the tube 11′, Fig. 18, and conducts to the auxiliary reservoirs the compressed air serving to feed them. When the cock X′ is regulated by hand, a weight-indicator is fixed on each carriage and indicates the weight in tons borne by the vehicle. The scale of this indicator corresponds with the graduation of the auxiliary reservoirs, and according to the indications shown the cock is regulated to put a corresponding number of auxiliary reservoirs *h* into communication with the principal reservoir E of the vehicle. The non-automatic multiple-way cock is regulated at the starting-station according to the load of the vehicle, and owing to its intercalation in the tube leading from the reservoir E to the main conduit M′ it produces its action and is refed at the same time as the reservoir E; but the tube 11′ of this cock, which serves for the introduction of the air into the auxiliary reservoirs, is supplied with a valve, the object of which is to prevent the return of the air contained in the reservoirs *h*′ *h*² *h*³, &c., when a depression takes place in the main conduit M′. In order that the multiple-way cock might be worked automatically, it suffices to join to it an automatic regulating arrangement I.

The automatic regulating arrangement I (shown in Fig. 19, and the application of which is shown in Figs. 20 and 21) is composed of a cylinder *i*′, closed at its ends by two plates, the foremost of which is traversed by the rack-rod 13′ of a piston *m*′, whose front face is pressed by a helicoidal spring 14′. On the back plate of the cylinder *i*′ is fixed a pipe *o*′, communicating the cylinder *i*′ with the conduit *p*′, leading from the distributer D to the brake-cylinder K and transmitting the pressure of compressed air contained in the brake-cylinder to the back face of the piston *m*′. The rack-rod 13′ of the piston gears with a pinion *n*′, working the multiple-way cock H, and is terminated by a needle 15′, articulated with it at 16′, and held horizontally by two springs 17′. The needle 15′ comes into contact with a stop X⁴, formed by a toothed inclined plane and riveted to a U-iron 18′, Fig. 21, fixed upon the axle-boxes of the wheels of the vehicle, and consequently independent of the movement of the frame, while, on the contrary, the multiple-way cock H, the cylinder *i*′, and the other parts of the regulating arrangement are fixed upon the frame of the vehicle, whose movements they consequently

follow in the vertical direction. It follows that when the carriage is empty the needle 15′ faces the vertical butt of the stop X^4, as shown in Fig. 19. When the carriage is loaded, the ensemble of the cylinder *i*″, cock H, rod 13′, and needle 15′ falls, while the position of the stop X^4 is immovable, owing to its juncture with the bearing.

The working of the multiple-way cock with variable automatical action, according to the load, takes place as follows: When the brake is in action, the compressed air passing from the distributer D to the brake-cylinder K, Fig. 20, penetrates behind the piston *m*′ of the cylinder *i*′ and by acting upon this piston pushes the rod 13′ and the needle 15′ until this latter comes into contact with the stopper X^4, as shown in 19′, Fig. 19. This advancing of the needle and of the rack-rod 13′ will consequently decide a proportionate opening of the multiple-way cock H by the movement of the pinion *n*′, and as the heavier the load on the carriage the more the springs bend, and consequently the more the ensemble of the system lowers, the course of the needle 15′ toward the inclined plane increases and through the intermediary of the pinion *n*′ produces the working of the cock H proportionately with the lowering of the frame of the vehicle, and consequently with the whole load. It suffices, therefore, to give the different parts of the whole system the desired proportions, so that at each functioning of the brake the working of the multiple-way cock H might put into communication with the reservoir E of the vehicle the desired series of the small reservoirs *h*, so that the total capacity of the reservoirs in action might be proportionate with the total weight of the carriage, the load included. While the automatic regulating arrangement is in action, the needle 15′ is kept at its extremity by the teeth of the stopper X^4; but it can by its articulation 16′ accommodate itself to the vibratory movements of the frame of the vehicle, at the same time being held horizontally by the springs 17′, Fig. 19. When the brakes are slackened—that is to say, when the air contained in the brake-cylinder K escapes into the atmosphere—the small cylinder *i*′ empties also, and the whole system returns to its primitive position by the action of the back-drawing spring 14′ on the piston *m*′. The cock H in returning to its initial position breaks the communication between the auxiliary reservoirs *h* and the principal reservoir E of the vehicle and, on the other hand, opens the communication by 8′ and 11′, Fig. 18, between the reservoirs *h* and the main conduit M′, which refeeds the auxiliary reservoirs at the same time as the principal reservoir E. The compressed air contained in this reservoir and in the reservoirs *h* is expelled at the moment the brake is in action into the brake-cylinder K. The brake-cylinder K (represented by Figs. 22, 23, 24, 25, 26, 27, and 28) is conceived upon the same principles as the compression-pump—that is to say, by the combination of two pistons successively entering into action the discharge of compressed air is very weak during the first period of action, the object of which is simply to draw the brake-blocks nearer to the friction-drum, the action of the large piston, which causes the greatest discharge of air, taking place only at the moment when the blocks are applied to the drum to form a brake.

The brake-cylinder is composed of a "cylinder," properly so called, A^2, in which a piston B^2 C^2 works, composed of a small piston B^2, working in the cylinder *q*′ constituted by the large piston C^2. The cylinder A^2 is closed by a cover D^2, composed of two superposed cylinders, in which the springs 20′ and 21′ are placed, the spring 20′ acting directly upon the large piston C^2 and the spring 21′ pressing upon the ring E^2, applied against the bottom of the cylinder *q*′ and traversed by the hollow rod 22′, squared on the outside and starting from the cylinder *q*′, Fig. 22. The piston B^2 is surmounted by a rod 23′, sliding in the rod 22′, and supplied with a cotter 24′, a wedge 25′, and a stopper *r*′. The ends of the cotter 24′ pass through two openings in the ring E^2, and the cotter moves longitudinally in the mortise 26′ of the hollow rod 22′, Fig. 22. The rod 23′ also slides in a hollow rod 27′, bearing a connecting-head 32′, Figs. 23 and 23ᵇ, screwed to one of its extremities, and to the other end are articulated, by means of axles 28′, two catches t^4, drawn toward each other by two spiral springs 29′. Moreover, two blades 30′, forming springs, are fixed on the hollow rod 27′, which passes through the cover D^2. The latter is provided with openings Z^2 for controlling the working of the catches t^4. The cylinder A^2 communicates, by means of the passage 31′, Fig. 22, with the distributer D and by the opening 33′, Fig. 24, with the electric local-train-pipe exhaust, composed of an electromagnet *u*′ and of the suction-valve S′, which through the chamber *w*′ and the opening *v*′ puts the brake-cylinder into communication with the outside.

The brake-cylinder works as follows: When the compressed air comes through the tube 31′, the small piston B^2 works alone, the piston C^2 being held by the spring 20′, and the rod 23′ overruns the empty space X^6 before working the hollow rod 27′, and consequently the brake. The effect of the movement of the rod 23′ is by receding the stopper *r*′ to disengage the catches t^4, and the two rods 23′ and 27′ continuing their movement the catches slip on the square part of the hollow rod 22′ and the cotter 24′ travels over the length of the mortise 26′. A little before the cotter 24′ reaches the end of the mortise 26′ the catches t^4 arrive at the extremity of the hollow rod 22′ and under the action of the springs 29′ are placed in the prolongation of this rod, Fig. 22. From this moment the piston C^2, whose rod is drawn by the cotter 24′, rises, and the compressed air producing its action upon the

two pistons B^2 and C^2 these act simultaneously and work the brake. During the upward movement of the pistons the two springs 21′ and 20′ are compressed, the first by the ring E^2, drawn by the cotter 24′, and the second by the piston C^2 itself. As in the compression-pump, where the discharge of steam is remarkably reduced, this combination of the double piston allows a considerable reduction of the discharge of compressed air. When the brake-cylinder is put into communication with the atmosphere, either by the distributer D or by the electric local-train-pipe exhaust of the brake-cylinder, the compressed air escapes outside and the pistons are brought back to their primitive position by the action of the springs 20′ and 21′ on the ring E^2 and the piston C^2, and consequently on the rod 23′ and the piston B^2, by the intermediary of the cotter 24′. This retrograde movement is effectuated in the following way: At the commencement of the action of the spring 21′ the rod 23′ is worked alone first by the cotter 24′, the hollow rod 27′ being held in its place by the pressure of the springs 30′. The effect of this first displacement of the rod 23′ is to reëstablish the space X^6 and lift again the catches t^4 by the action of the stopper r'. After this first displacement the shoulder 25′ of the rod 23′ draws the hollow rod 27′, and the catches t^4, which are disengaged from the extremity of the hollow rod 22′, now slip on the exterior square part of this rod. Finally at the moment the piston B^2 has returned to the plane of the piston C^2 the cotter 24′, having reached the other extremity of the mortise 26′, which it originally occupied, and the ring E^2 being again placed against the cylinder q', the large and the small piston move simultaneously to return to their initial position, Fig. 22. The pistons of the brake-cylinder by means of the rod 27′ and the connecting-head 32′, Figs. 22 and 23, and the lever B^3 and the connecting-rods H^2, Fig. 20, work the brakes L of each vehicle, one of which is shown in Figs. 29, 30, 31, 32, 33, and 34 and is composed, essentially, of a friction-drum, brake-blocks, organs for transmitting the pressure to the brake-blocks, and a wearing-compensator arrangement.

The friction-drum is composed of two semi-cylinders a^2, connected at their ends by bolts which keep them tight upon the arms 33^2 of a cross-piece wedged upon the axle E^4 of the carriage and which allows the free circulation of air in the interior of the friction-drum, the rim of which is perforated with holes to insure a complete cooling.

Each block-holder is made of two supports in the form of a horseshoe c^2, articulated by an axle d^2 with a connecting-rod e^2, suspended to a ⌊-iron f^2, which bears upon the axle-boxes, to which it is bolted, Fig. 29, so as to avoid any untimely friction of the brake-blocks against the friction-drum while in motion. The ⌊-iron f^2 will be securely fastened by a guideway riveted to the frame of the vehicle and in which it can slide when the frame rises or descends, Fig. 29. The two supports c^2 are connected by a tie-beam 35′ and by pieces g^2, forming a slide in which the tail h^2 of the block G^2 moves, which is provided with a groove in which is lodged the lever i^2, articulated with the tail h^2 by an axle 34′, movable in the grooves 36′ of the block-holder c^2. The levers c^2 are connected at their lower ends by a connecting-rod 37′, with which they are articulated by axles 38′, and the upper end of the lever i^2 is articulated by an axle 39′ with a screw moved by the connecting-rod H^2 by means of the nut j^2, fixed in the connecting-rod head and serving to regulate the length of the connecting-rod H^2. The upper end of the levers i^3 is connected by an axle with the wearing-compensator arrangement shown in Figs. 29, 31, 32, and 33. The principle of this automatic compensator is seen in the action of a toothed wheel I^2, Figs. 31, 32, and 33, worked by a catch k^2 each time a wearing of the brake-block takes place. The wheel I^2 works two screws l^2, Figs. 31 and 33, the movement of which causes two wedges J^2 to separate simultaneously, the advance of which causes the upper end of the levers i^3 of the central pivot d^2 to approach each other, Figs. 29 and 31. The extremity of the lever i^3 is simply held by an axle 40′, which slides in a groove of the rod 42′, this latter part having also a mortise 43′, in which the end of the lever i^3 moves. The two rods 42′, serving as a support to the whole system, move around the axle d^2 and have at their end sockets n^2, provided with wedges J^2 and threaded on the inside. Moreover, the rods 42′ are connected by a tie-piece 43^2, upon which is fixed a part 44^2, holding firmly the ratchet-wheel I^2, Fig. 31, whose catch k^2 is held by a spring 44′, Fig. 34, and is articulated by an axle 43^3 with a rod 45′, which is also articulated at 46′ with the lever i^2, Figs. 29 and 31. The brake works as follows: When the compressed air works the piston of the brake-cylinder K, the piston-rod through the intermediary of the balance transmits to the connecting-rods H^2 a traction effort proportionate with the pressure of the compressed air on the piston. This traction effort applied to the upper extremity of the levers i^2 and transmitted by the connecting-rods 37′ to the levers i^3 has the effect of pressing these levers upon the back of the blocks G^2 and applying these latter on the friction-drum a^2 with a force proportionate with the pressure of the compressed air upon the brake-cylinder. When the compressed air escapes from the brake-cylinder K, the piston returns to its primitive position, and, the piston-rod working the balance, and consequently the connecting-rod H^2, in an inverse direction to its previous direction, the levers i^2 and i^3 return to their initial position, drawing, by means of the axles 34′, the brake-blocks, which then cease to press upon the friction-drum a^2. The regulating of the blocks, which is a very important point, to constantly insure the ef-

ficacy of the brakes is effectuated automatically by the wearing-compensator in the following way: According as the blocks wear the lever i^2 when worked by the connecting-rod H^2 draws nearer and nearer to the axle E^4 and through the rod $45'$ increases in the same proportion the course of the catch k^2 on one of the teeth of the ratchet-wheel I^2, without, however, acting upon this wheel so long as the wearing has not attained a determinated limit which corresponds with the length of the teeth of the ratchet-wheel. When the wearing surpasses this limit, the catch k^2 falls under the next tooth when the brakes are applied and draws the ratchet-wheel I^2 when they are slackened. The ratchet-wheel I^2 communicates its rotary movement to the threaded axles l^2, which produce the separation of the sockets n^2, and consequently of the wedges J^2, Figs. 31 and 34, and these latter acting upon the upper extremity of the levers i^3 force them to approach a^2, Fig. 29, and at the same time cause the brake-blocks G^2 to draw together, whose wearing is thus compensated.

As I have already explained, the compressed air is brought into the reservoirs E of the vehicles through the main conduit M′, which also serves to transmit the depression produced in the working cock B. The conduit M′ is placed under the carriages, and each of the sections placed under a carriage is connected with the preceding and the following one by a coupling system. (Shown in Fig. 35.) This system is composed, like those actually in use, of a flexible tube b^3, connected with the conduit M′ of the carriage, which is provided with a cock C^3. The tube b^3 has at its extremity a coupling-box a^3, connected with the coupling of the following carriage by means of wedges 46^2. The coupling-boxes a^3 are provided with rods 45^2, forming contacts when the couplings are united and allowing the electric current to pass along the wires 74 and 75 to work when necessary the electric local-train-pipe exhaust of the distributers D and of the brake-cylinder K.

The general working of the whole system composing the brake takes place as follows: The main reservoir being filled with compressed air to the required tension and the catch 43 of the working cock B, Fig. 9, being in the notch t' corresponding with the movement to work the brake, it suffices by putting the catch 43 into the notch S to communicate by the working cock a certain number of chambers of the system H′, Fig. 5, with the compartment n, Fig. 1, the number of chambers H′ put into communication varying with the pressure we wish to obtain with the brakes. Owing to this communication a depression is produced in the compartments n, Fig. 1, a depression which is transmitted by the action of the diaphragm K′ to the main conduit M′ and the distributers D, and these latter under the influence of this depression, as already described, put the principal reservoirs E of the vehicles, as well as the desired number of auxiliary reservoirs h, Fig. 18, into communication with the brake-cylinder K, the number of the reservoirs h being determinated before the departure in the non-automatic system according to the load of each vehicle, while in the automatic system it is determinated during the action. The compressed air introduced into the brake-cylinder K acts upon the piston by its pressure, and consequently applies the brake. To slacken the brakes, it suffices to refill the principal reservoir and the main conduit M′ by putting back the catch 43 into the groove r, and the distributers at the same time produce the evacuation of the compressed air contained in the brake-cylinders K, whose pistons return to their primitive position.

The tightening and the slackening of the brakes may be accelerated and produced instantaneously by employing the electric or compressed-air local-train-pipe exhaust connected with the distributers and the brake-cylinders.

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

1. In pneumatic train-brake mechanism, the combination of a main reservoir and main conduit with a principal reservoir for an individual vehicle, a number of auxiliary reservoirs for the latter, a cock adapted and arranged to control the feeding of these auxiliary reservoirs and also to make communication between each of them and the principal reservoir of the vehicle, a brake-cylinder communicating with and actuated by the latter and automatic mechanism for operating the said cock, in order that the main reservoir may be reinforced automatically by a greater or less number of the auxiliary reservoirs, thereby applying more or less power to the brake-cylinder according to the load, substantially as set forth.

2. In pneumatic train-brake mechanism, the combination of a brake-cylinder and the principal reservoir of a vehicle, with auxiliary reservoirs and means for making communication between the said principal reservoir and a greater or less number of these auxiliary cylinders each of the latter being regulated by means of plugs having a rod of variable volume, substantially as set forth.

3. In pneumatic train-brake mechanism, the combination of the air-reservoir pipes and brake-cylinder of a vehicle with a multiple-way cock comprising a cylinder and a piston moving therein, a spring bearing against one face of the said piston while compressed air bears against the other, a rack-rod moving with the said piston, a pinion gearing with the said rack and carrying a jointed needle, two springs which hold the said needle horizontal, a stop forming an inclined plane and held in fixed position for contact with the said needle when the latter accompanying the other mechanism above mentioned moves down-

ward with the body of the vehicle, substantially as set forth.

4. In pneumatic train-brake mechanism, a main air-reservoir and main conduit, in combination with a working cock B provided with a series of grooves and the reservoirs feeding and exhaust mechanism and brake-cylinders of the several vehicles of the train, one of the said grooves allowing air to flow from the said reservoir through the said conduit to the reservoirs of the several cars, and another groove according to the position of the said cock making communication between said conduit and certain exhaust-chambers, the said cock also serving by means of one of its grooves to allow the flow of air from the said conduit to devices controlling communication between the vehicle-reservoirs and the brake-cylinders respectively operated thereby, substantially as set forth.

CHARLES LUYERS.

Witnesses:
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