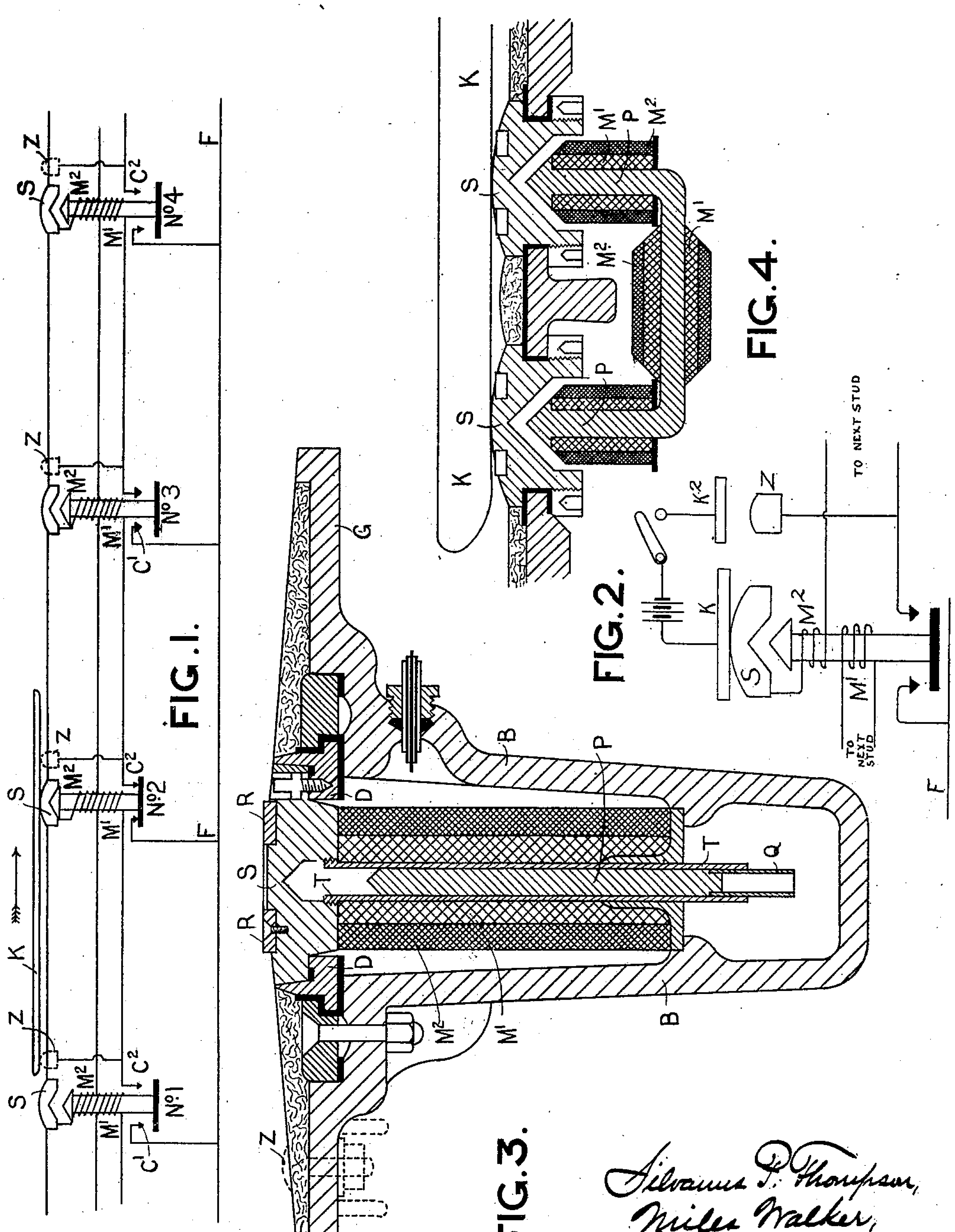
No. 668,781. Patented Feb. 26, 1901.

S. P. THOMPSON & M. WALKER.

ELECTRIC TRACTION SYSTEM.

(Application filed Oct. 22, 1897.)

(No Model.) 3 Sheets—Sheet 1.



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3 Sheets—Sheet 2.

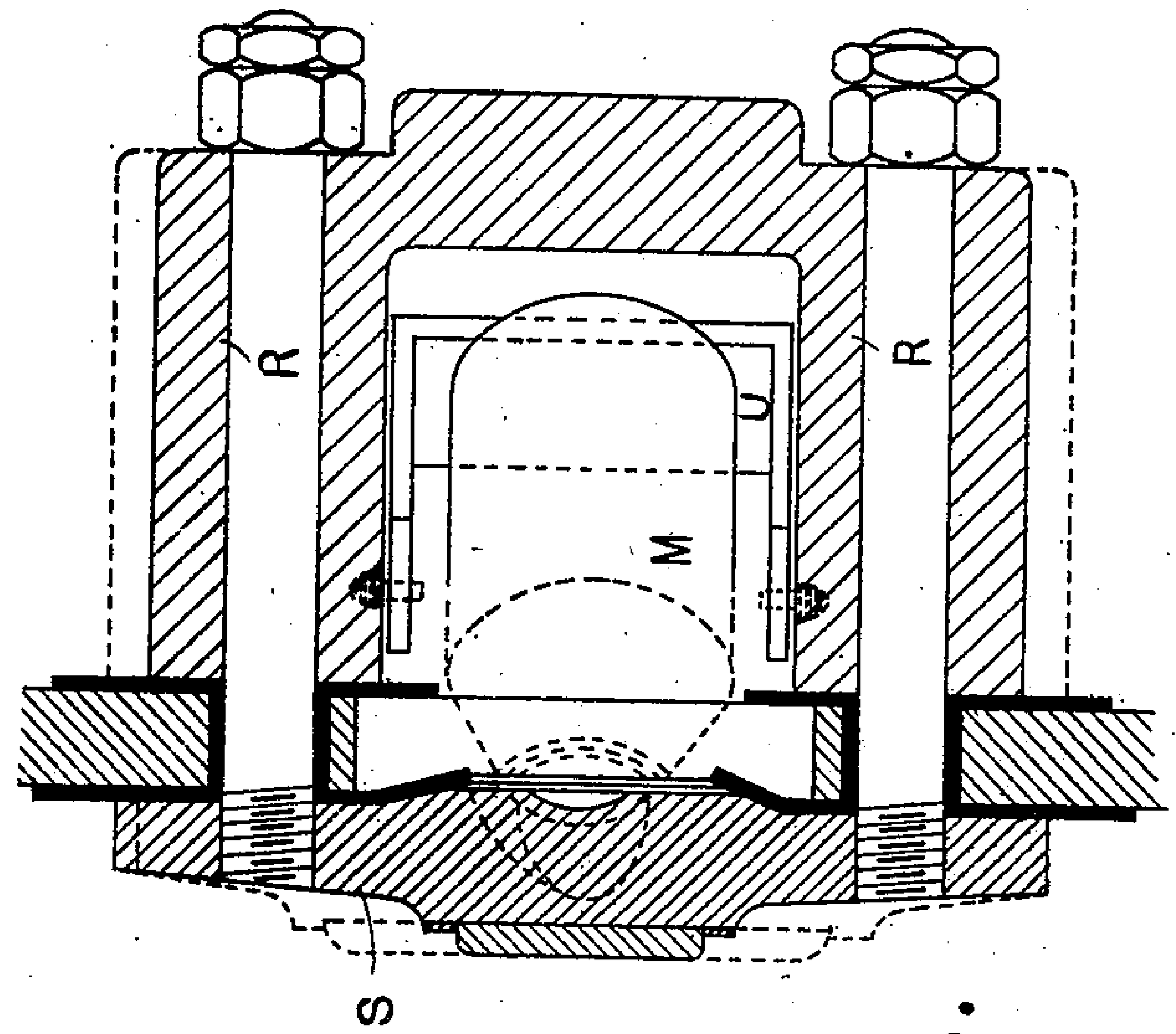

FIG. 8.

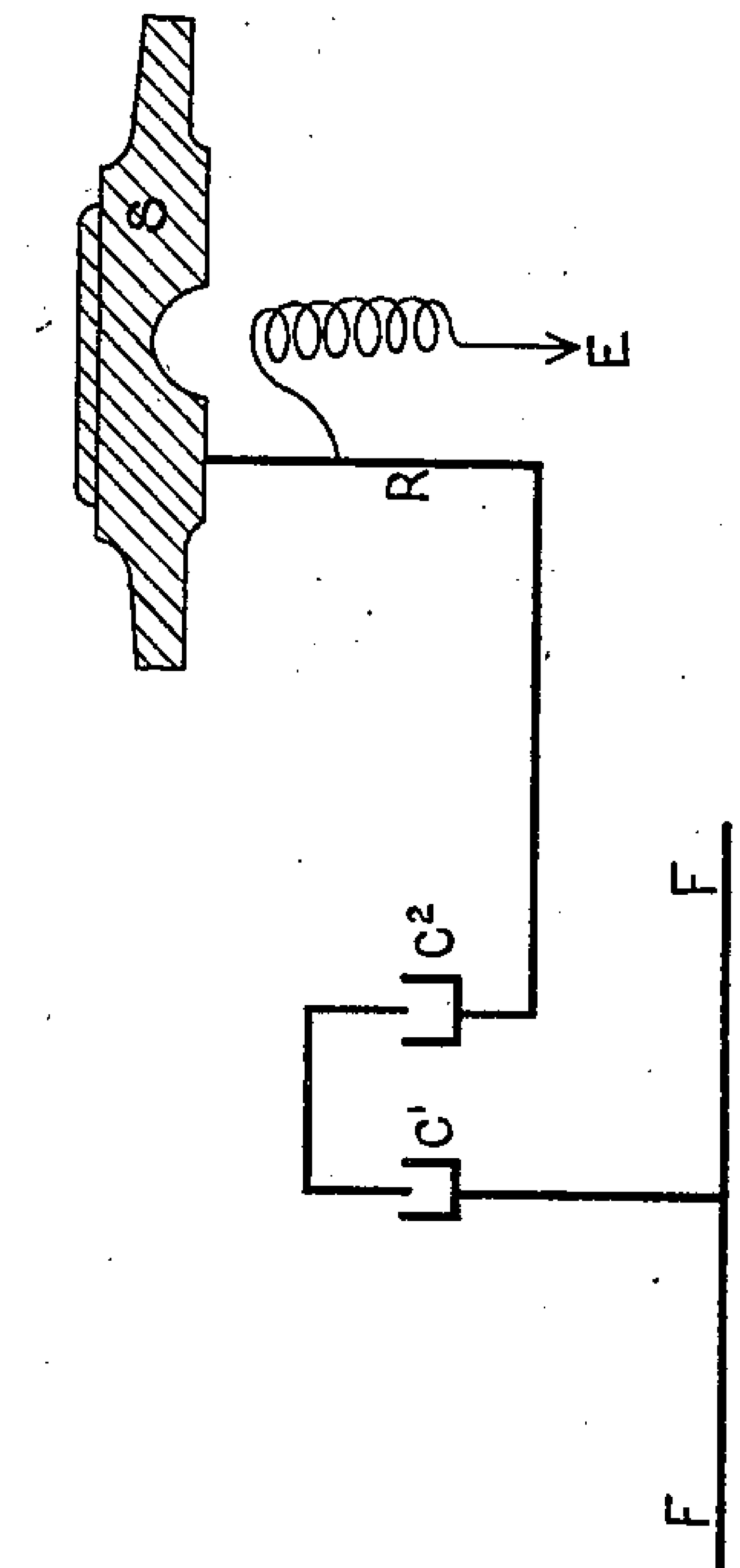

FIG. 9.

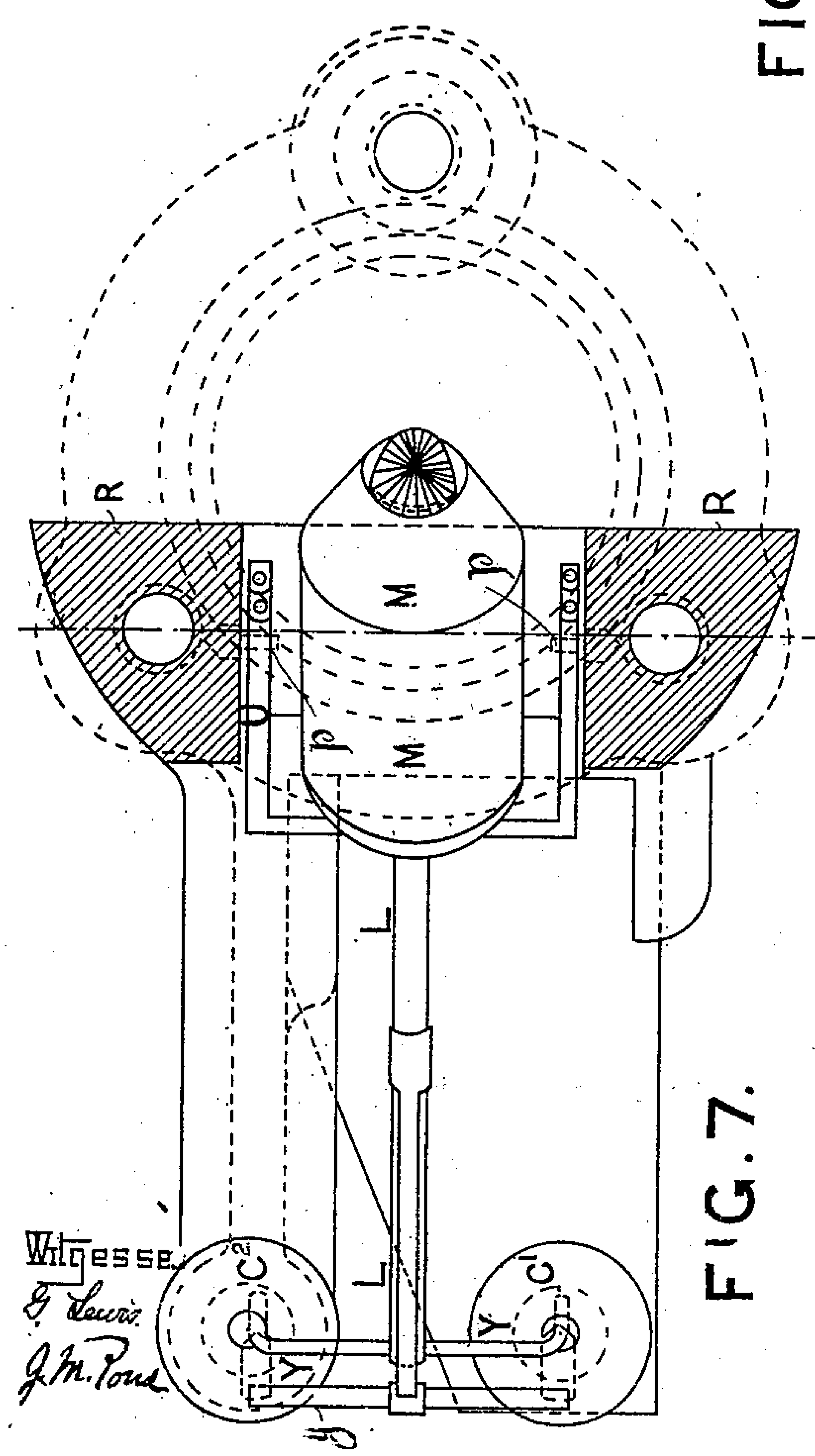

FIG. 7.

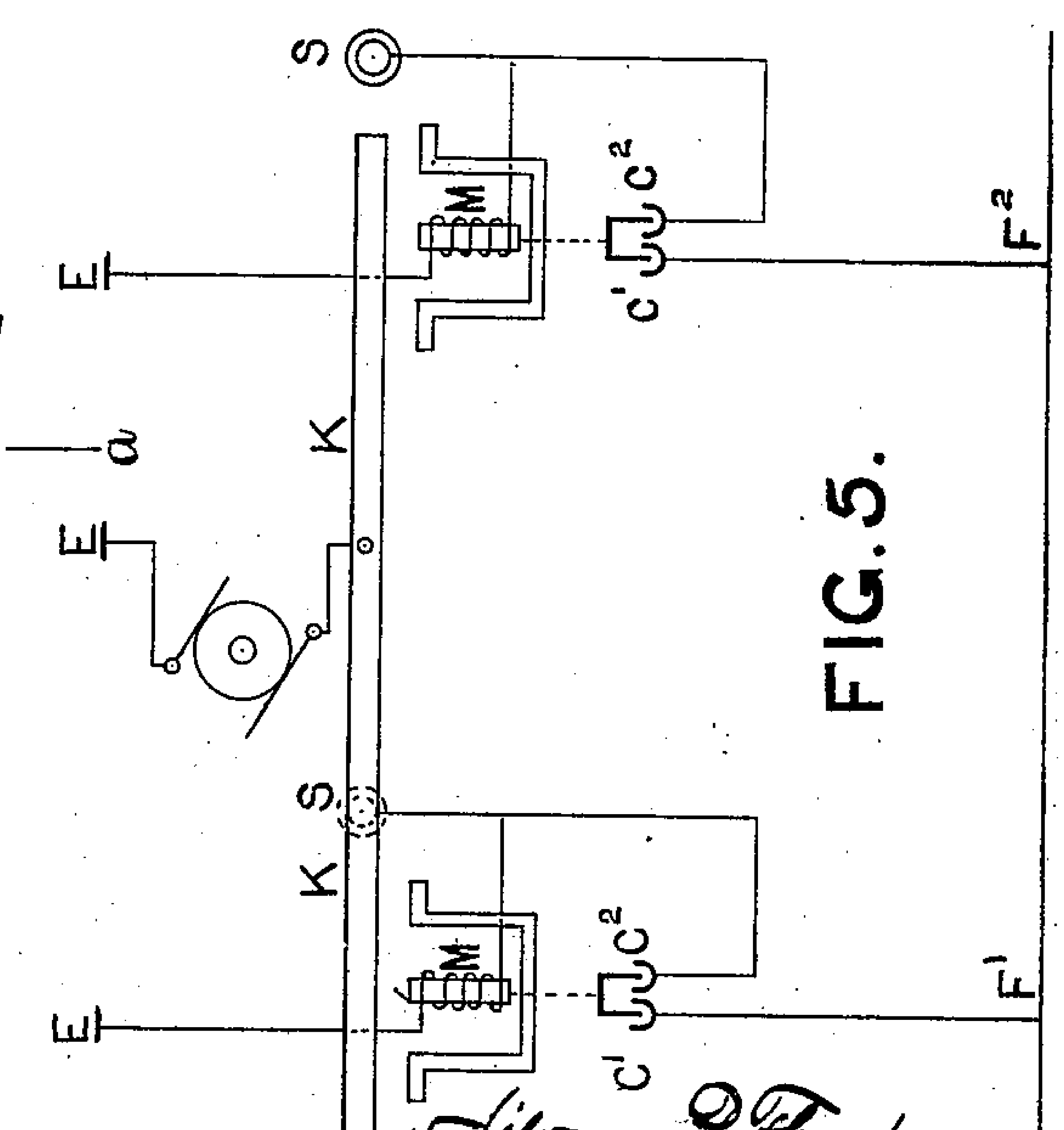

FIG. 5.

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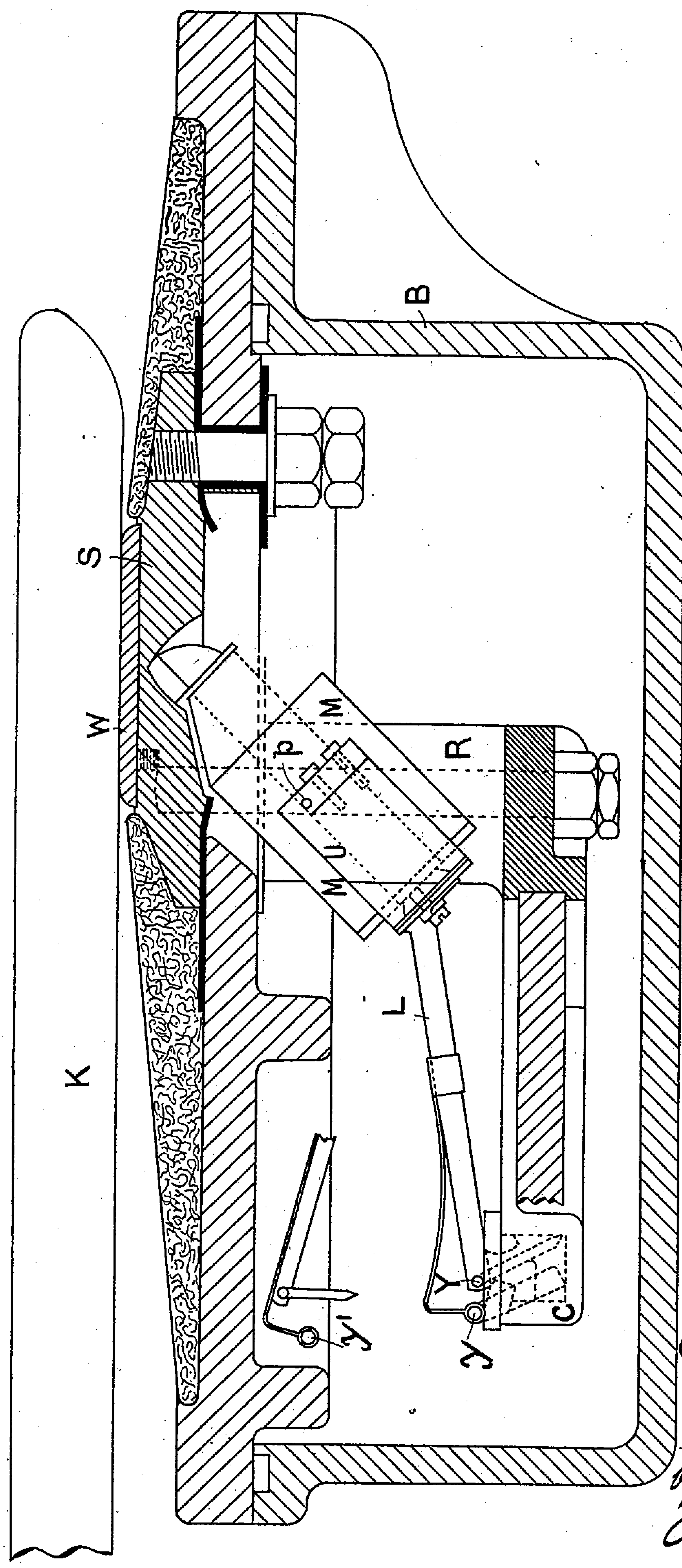
FIG. 6.



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UNITED STATES PATENT OFFICE.

SILVANUS PHILLIPS THOMPSON AND MILES WALKER, OF LONDON, ENGLAND.

ELECTRIC-TRACTION SYSTEM.

SPECIFICATION forming part of Letters Patent No. 668,781, dated February 26, 1901.

Application filed October 22, 1897. Serial No. 656,019. (No model.)

To all whom it may concern:

Be it known that we, SILVANUS PHILLIPS THOMPSON, doctor of science, and MILES WALKER, electrical engineer, subjects of the Queen of Great Britain, residing at London, in the Kingdom of England, have invented certain new and useful Improvements in Electric-Traction Systems, of which the following is a specification.

Our invention relates to improvements in automatic switches for use in those systems of electric traction in which the electric current is supplied to the cars or locomotives from studs or sectional rails laid in the road, each of such studs or sectional rails being in turn connected to a main conductor or feeder-main by means of an automatic switch when the car is above or near it and disconnected from the main conductor or feeder after the car has passed on.

In the English specification of patent of Ayrton and Perry, No. 2,395 of 1883, it was proposed to operate switches under the roadway by means of magnets carried on board the car, and since that patent several inventors have employed devices of the sort with variations in the arrangement of the parts. These systems may be referred to generally as "magnetic pick-up" systems. In the magnetic pick-up systems hitherto proposed use has been made of an electromagnet or permanent magnet carried on the car, and they have therefore been open to one or other of the following objections: either the poles of the magnet extend for a considerable distance under the cars and are excited along their entire length, involving the use of a bulky magnet for which there is not sufficient room on cars as ordinarily constructed, or the magnet-pole is smaller in size and operates on its armature for such a short instant of time when the car is in motion that it cannot be made to operate a thoroughly-reliable switch. In other cases in consequence of the magnetizing-coils not being wound directly upon the moving parts the operative forces are not sufficiently great to work the switch without having recourse to a relay.

In our system the switches are operated by the approach of a simple piece of iron carried on the car, which is attracted by a plunger or magnetized iron bar energized by an electric current passing through coils wound upon the moving part itself, and the parts of the switch are so balanced magnetically that it is impossible for the switch to operate until the iron comes over the top. We are able in this way to obtain the certainty of action of electrically-operated switches, and yet retain the freedom from danger enjoyed by magnetic pick-up systems, for the switches will open when the car has passed, whatever current may be leaking from the road-contact to earth. Moreover, it is possible on starting the car to pick up the armature of one of these switches by means of a magnet on the car (the car being at rest) without communicating electrically with the switch; but we prefer to dispense with the magnet on the car altogether and pick up at starting in the manner hereinafter described.

Figure 1 is a longitudinal section of the road, showing the manner of interconnecting the switches in order that they may be operated by the current taken by the car. Fig. 2 is a transverse section of road, showing position of auxiliary stud and shoe. Fig. 3 is a section of a road-box, showing magnetic balancing arrangement. Fig. 4 shows a section of similar arrangement when both ends of magnet are employed. Fig. 5 is a diagram of connections, showing how a shunt-current is made to operate the switches. Figs. 6, 7, 8, and 9 show elevation, plan, with the cover removed, transverse section, showing the stud S in place, and diagram of connections of switch used in our system.

The general mode of making our connections in order to operate the switches by the main current taken by the car is shown in Fig. 1, which is intended to represent, diagrammatically, the connections between four consecutive studs and the main cable F F. A connection is made from the cable F F to the insulated switch-contact C′. From C^2, the other switch-contact, a wire is carried to the switch next ahead and around the coil M′ of that switch back to coil M^2 of the first switch, and from thence to the insulated road-contact stud S. The operation of this system of switches is as follows: Assume that a car is passing in the direction shown by the arrow in Fig. 1 and that it has just passed stud No. 1, whose switch is shown open. The current-collecting shoe is in contact with stud No. 2, whose switch is shown closed. Current is passing from the main cable through the coil M′ of switch No. 3, through the coil M^2 of switch No. 2 to the contact-stud S, thence to the shoe K of the car, and so through the motors of the car and to the return-rail (not shown in the figures) in the usual way. The current in passing around coil M′ of switch No. 3 cannot completely close the contacts of the switch, because the iron parts are balanced, in the manner hereinafter described, so that they will not make contact until a piece of iron on the car comes over the top. This piece of iron is by preference the shoe itself; but we sometimes use an auxiliary piece of iron on parts of the car to which it is not convenient to extend the shoe. When the car advances so that the shoe K or the auxiliary piece of iron comes above switch No. 3, that switch closes and supplies current to the shoe, at the same time exciting the coil M′ of the switch No. 4, &c. The size of the shoe and its position relatively to the car are preferably arranged so that stud No. 3 is covered by the car when switch No. 2 is operated, so that no piece of iron, such as a horse's shoe, can be over stud No. 3 at the time when the coil M′ of its switch is energized. When the car has passed switch No. 2, it must necessarily drop open whatever current may be leaking from the stud S, because such current is incapable of holding the switch closed unless the piece of iron is over the top. It is, moreover, impossible for the switch to be operated by any piece of iron (such as a horse's shoe) unless the coils are excited, and the coils cannot be excited after the car has passed and the switch opened. In order to start the car, we use an auxiliary shoe K^2, Fig. 2, capable of being lowered upon a small auxiliary stud Z. Current from an accumulator can then be passed from Z, through M′ and M^2, to the stud S and the switch under the shoe operated; but to this arrangement we here make no claim.

Some of the methods of arranging the iron parts so that they can only be operated when they attract a mass of iron on the car are shown in Figs. 3, 4, 5, and 6; but we do not confine ourselves to the methods there shown.

Fig. 3 shows the magnetic parts of one form of switch-box. The switch-contacts are not shown, but may be of the character of those given in Figs. 6 and 7 or of any other character. The box consists of a hollow cast-iron cylinder B B, having a wide flange G G in its upper end. This end is closed by a ring D D, insulated from the iron, and a solid lid S, fitting into the ring, both made of phosphor-bronze or other non-magnetic material. The lid is rendered water-tight by means of a rubber washer in a groove in its seat and is screwed hard home against its seat. The lid is slightly rounded on its surface and forms the stud or road-contact. It may have a renewable top, preferably in the form of a ring R R, to take the wear and prevent horses slipping upon it. Upon the wide flange G and around the stud S is laid a layer of hard insulating material, such as asphalt or artificial stone. This is slightly sloped off, as shown, so that when the box is laid on the road the stud lies a very little above the level of the roadway. Below the lid are fixed the two magnetizing-coils M′ M^2, connected up as shown in Fig. 1, or in case a shunt-current is employed to work the switch only one coil M is used, connected up as shown in Figs. 5 and 9. Within these coils is an iron plunger P, which slides in a brass tube T in line with an indentation in the stud and connected by means of a brass tube Q to a contact-making device, but not shown in the figure, which is preferably the same as the contact-making device shown in Figs. 6, 7, and 8. If a piece of iron is placed over G G and S while an electric current is passing around one of the coils, the plunger P will rise to the top of the hole in the stud and will then complete the electric circuit, as shown in switch No. 2 in Fig. 1. In fact, the current in the coils tends to drag the plunger down a certain distance instead of tending to lift it, and this effect may be still further varied by making the lower end of the bobbin of iron and giving it an inwardly-projecting tubular extension E, embracing the lower end of the plunger. When the plunger is up, this iron tubular extension serves to reduce somewhat the reluctance of the magnetic path; but being of no very great cross-section as compared with the plunger, and, moreover, having the brass tube between it and the plunger the reluctance of the magnetic path is not so small (assuming no shoe over the stud) as when the plunger reaches to the lower end of the coil. As a consequence there is a fairly-uniform magnetic pull on the lower end of the plunger, which exists so long as the lower end of the plunger is above the lower end of the coil. When the shoe is over the stud, this downward pull is entirely overcome; but when the shoe is absent the plunger will take up a position in which the upward pull on the upper end of the plunger is balanced by the downward pull of the lower end and the force of gravity. When iron is placed over the top, the upward pull is greatly increased by direct attraction on it of the moving part. The auxiliary stud Z (see Figs. 1 and 2) is shown dotted in Fig. 3.

In another form of switch-magnet the coils are designed to move with the iron core, as shown in Fig. 4. In this case both ends of the magnetized bar P P are presented to the mass of iron K K on the car. In other respects the operation of the switch is the same as in Figs. 3 or 6. Fig. 6 shows a method of pivoting a single-limbed magnet so as to work the contact-points. This method is equally applicable to the double-limbed magnet of Fig. 4.

Fig. 5 shows the connections of the coils of our switches when it is desired to work them by a shunt-current instead of by the main current taken by the car. A high-resistance magnetizing-coil M is in each switch connected with one end to the stud and the other to earth. When the current-collecting shoe comes over a stud, current passes down from the shoe through the coil to earth and so magnetizes the moving part. After the switch is closed the current flows from the switch through the magnetizing-coil to earth and also through the stud to the shoe, from which it is available to operate the next switch. The switch-coils are in Fig. 1 shown connected with one another in series with the connections through the car-motor; but it is obvious that they may be connected in shunt thereto or as shunts to one another. If arranged as shunts to one another, they may still be combined with the series connections described by us in specification of English Patent No. 19,456 of 1896.

Figs. 6, 7, 8, and 9 are drawings of our safety-switch, showing magnetic arrangement slightly different from Figs. 3 and 4, with lever and switch contacts exactly as made by us. Fig. 6 is a sectional elevation of the switch, box, and stud combined. Fig. 7 is a plan of the switch. Fig. 8 is a section through the line *a a* in Fig. 7. Fig. 9 is a diagram of connections, showing the switch as connected up to be operated by a shunt-current.

The winding of the magnet M is wound on an iron core fixed into a **U**-shaped piece of iron U U. The whole is pivoted at *p p*. The switch-lever L L is attached to the pivoted magnet and carries the copper yoke Y Y, which dips into the two mercury-cups C′ and C² when the switch is closed. The pivot is so placed with regard to the center of gravity that normally the yoke is clear of the mercury-cups, as shown in the position Y′. When current is passed around the winding of the magnet, there is no tendency for the switch to close unless a piece of iron is placed over the stud S, for the other surrounding iron parts are so balanced that they pull on the magnet as much in one direction as in another. As soon, however, as iron is placed over S the switch closes smartly. The iron cheeks R R serve not only as a support for the switch, but also as a return-path for the magnetic lines. Besides the main copper yoke Y Y there is provided a small yoke *y y* of carbon, mounted on a spring which comes in contact with little carbon pieces which dip into the mercury-cups C′ and C². This small yoke *y y* is arranged to break circuit after the main yoke Y Y, so that any spark that may occur will be between carbon points instead of on the mercury. Fig. 9 shows the manner of making the connections of the said switch, so that it may be operated by a shunt-current. The main current passes from the feeder F F to the mercury-cup C′, thence through the yoke to C², which in Figs. 6 and 7 is represented as a mercury-cup in the metal extension of R, and therefore in metallic contact with S. The current is carried to the coils M by soldering the inner end of the winding to the iron core P, which core P is in contact with the cheeks R, and by carrying a light flexible wire from the outer end of the winding to the box-lid G′, which latter is in electrical contact with the earth or rails.

We claim as our invention—

1. In a surface-contact electric-traction system, a safety feeding-switch placed underground, whose operating part is a moving plunger or other piece of iron from which a magnetic field radiates into the air-space above the roadway, the magnetizing-coil being placed around the said plunger and the plunger occupying that part of the magnetic field in which the resultant magnetic pull, whatever current may be passing in the magnetizing coil or coils, is less than the resultant of all the forces which tend to keep the switch open.

2. In a surface-contact electric-traction system, a safety feeding-switch having a magnetic field radiating from the moving part into the air-space above ground, substantially as described, and a mass of iron carried on the car which when removed from the said feeding-switch is unmagnetized but which in conjunction with the said feeding-switch constitutes a combination having the following essential elements: (1) a mass of iron attached to the car; (2) a magnetic field whose lines extend directly to that mass from the plunger of the switch, and whose resultant pull is greater than the resultant of all forces tending to open the switch.

3. In a surface-contact electric-traction system, the combination of a mass of iron carried by the car, and a safety feeding-switch whose moving part is wound with two coils M′ M² interconnected with the similar but opposite coils on the next switch and joined to the mains as described, that is to say, by a connection from the feeder-main through the switch-contacts to the coil M′ of the switch next ahead, then back to coil M² of the first switch and from thence to the insulated road-stud, whereby the moving part opens the switch upon the removal of the mass of iron as set forth, notwithstanding the fact that the current may be flowing in the coils.

4. The combination of a surface-contact stud S, feeding-contacts C′ and C², and a moving iron core wound with magnetizing-coils designed as set forth, whereby however strongly the core may be magnetized it has no tendency to close the contacts in the absence of a mass of iron above it.

5. The combination of the moving lever L

of an electric switch, mercury-cups C′ C^2, a yoke, and carbons attached to the switch-lever by spring attachments as set forth, whereby contact with rods of carbon connected with cups C′ and C^2 is maintained until after the mercury contact is broken.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

SILVANUS PHILLIPS THOMPSON.
MILES WALKER.

Witnesses:
FREDERICK WILLIAM LE TALL,
W. M. HARRIS.