(No Model.) 2 Sheets—Sheet 1.

T. N. VAIL.

AUTOMATIC SIGNALING APPARATUS FOR TELEPHONE CIRCUITS.

No. 275,296. Patented Apr. 3, 1883.

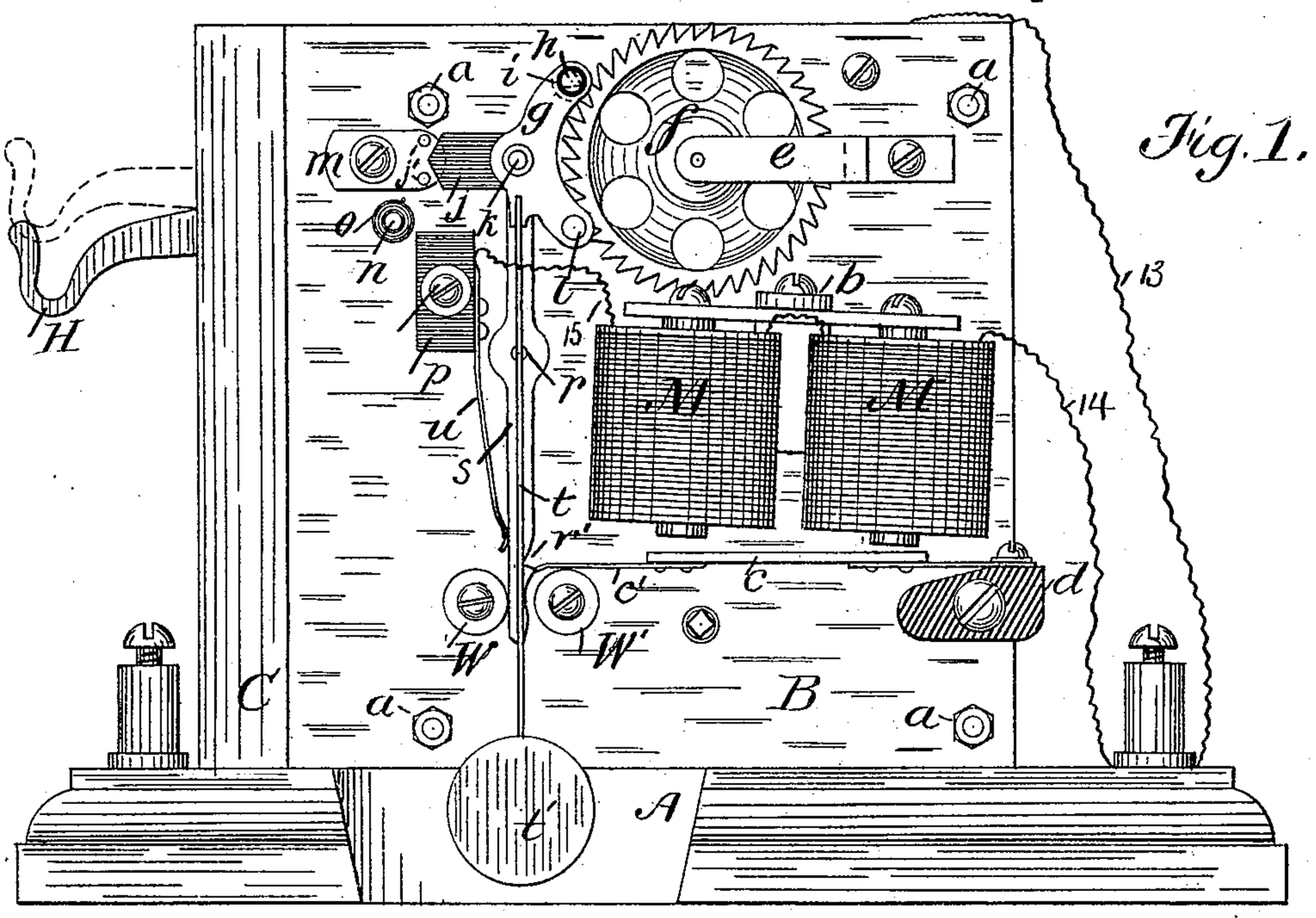
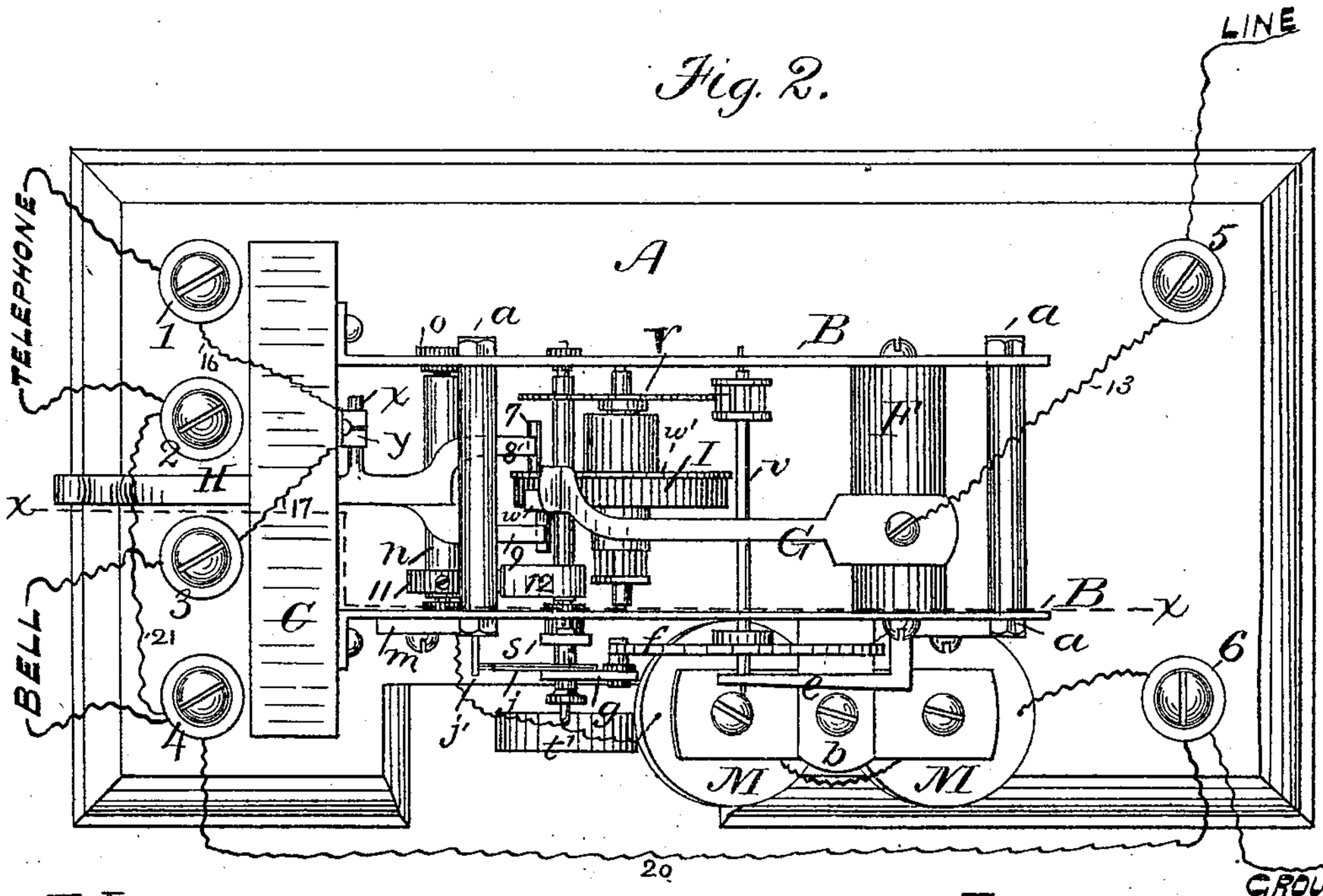


Fig. 1.

Fig. 2.



Witnesses.
Geo. Willis Pierce.
Thos D Lockwood

Inventor:
Theo Vail

(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

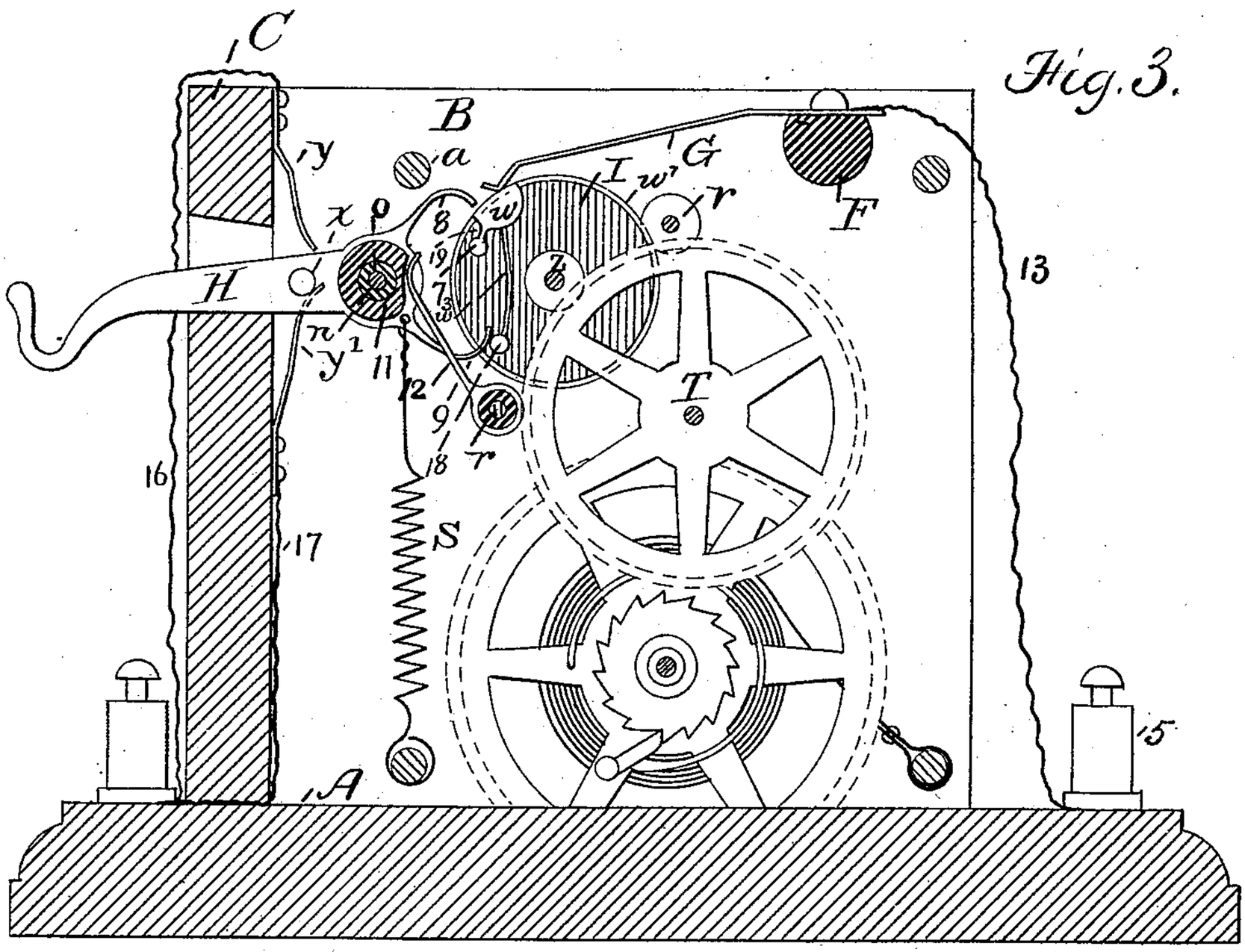
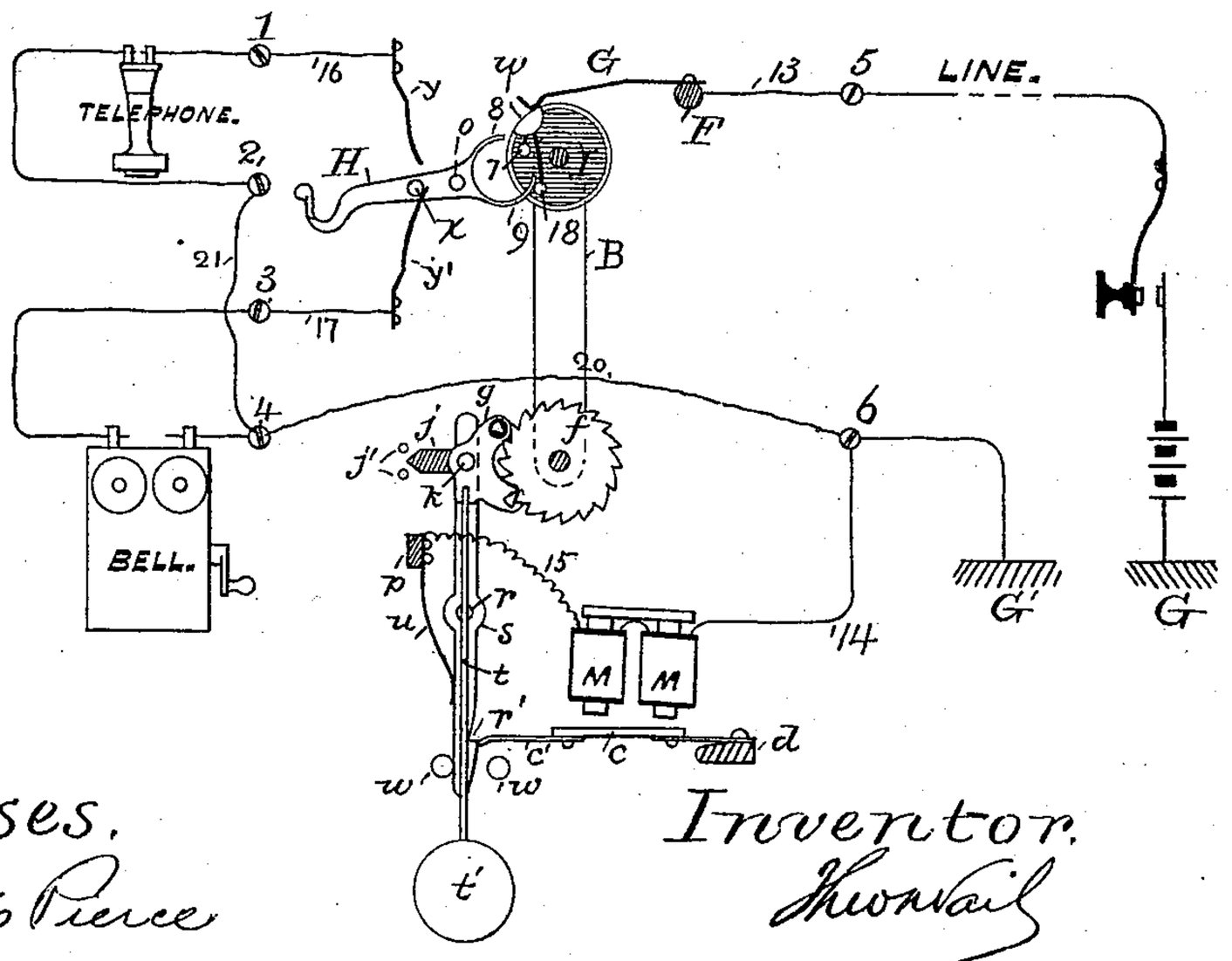


Fig. 4.



Witnesses.
Geo. Willis Pierce
Thos D Lockwood

Inventor.
Thon Vail

UNITED STATES PATENT OFFICE.

THEODORE N. VAIL, OF BOSTON, MASSACHUSETTS.

AUTOMATIC SIGNALING APPARATUS FOR TELEPHONE-CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 275,296, dated April 3, 1883.

Application filed December 18, 1882. (No model.)

To all whom it may concern:

Be it known that I, THEO. N. VAIL, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Automatic Signaling Apparatus, of which the following is a specification.

My invention relates to improvements in the construction and arrangement of apparatus for use in the sub-stations of a telephone-exchange.

In an application for Letters Patent filed of even date herewith I have described certain devices, instrumentalities, and modes of operation by which the central-office operator is enabled to ascertain quickly and easily the condition of any two interconnected lines. One of the methods described in the said application consists in the use of a circuit-wheel which is capable of being rotated by any suitable motor, and which, when tripped by the replacement of the telephone, either directly or by means of intermediate electro-magnetic devices, operates as an intermittent circuit-breaker, and in some cases as a transmitter, by which electrical pulsations are transmitted over the line. To act effectually it is necessary that the rotation of the circuit-wheel shall be protracted through several minutes of time, and it is therefore necessary to wait until the termination of such rotation before the same sub-station can be again signaled and its line connected with that of another sub-station.

The object of my present invention is to provide an instrument which shall combine the functions of a motor and a circuit-breaker, and which, when uninterrupted, shall continue its vibrations during a definite and comparatively long period of time, but which is capable of being positively controlled from the central station and caused to complete its revolution at one rapid bound, so that if during the progress of the successive makes and breaks produced by the revolution of the rotary circuit-breaker it becomes necessary to signal the subscriber again, (which would be a very difficult achievement if there were no way of stopping the successive vibrations,) this can readily be done, because the first strong pulsation of electricity proceeding from the central station to the sub-station will cause the instrument to complete its revolution, instantaneously restoring the line to its ordinary termination through the signal-bell.

To this end my invention consists in a clock-train motor which is normally detained by one of two pallets affixed to the lever of the ordinary gravity telephone-switch, and which operates as hereinafter described. The said gravity-switch has another pallet, which engages a pin, forming a second detent. While the telephone hangs upon the hook of the gravity-switch, as it uniformly does when at rest, the former pallet engages a pin on one side of a detent-wheel, preventing any movement of the motor, and when in this condition the line-circuit is led through the signal-bell of the sub-station. When the telephone is removed from the hook-switch the first pallet releases the motor, which advances a short distance, but comes to rest by the engagement of the second pallet with the pin forming the second detent, and by the contact so produced and by the changed position of the hook-switch the line is now transferred from the bell branch to the telephone, where it remains until the conclusion of the communication. At the termination of the communication the telephone is again hung on the hook; but the line-circuit is not immediately transferred thereby again to the bell, but continues through the frame and works of the clock-train, and through a vibrating circuit-breaker and separate electro-magnet to earth direct.

The vibrating circuit-breaker I prefer to construct in the form of an escapement operated by a pendulum, and operates both to control the motion of the clock-train by its engagement with the escapement-wheel and to alternately make and break the main-line circuit by the same engagement and disengagement. To aid in the latter operation one of the pallets of the pendulum-escapement is insulated. The clock-train, if not retained in any way, will continue in motion for any predetermined period of time, preferably about five minutes; but can at any time be caused to complete its revolution at one rapid bound and come to rest. This operation is accomplished by causing a current of electricity to traverse the line-circuit, which, entering the sub-station, passes through an electro-magnet, attracting its armature. This, when attracted, disengages the

escapement for an instant, permitting the now uncontrolled mechanism to fly round and rapidly reach the zero-point, when the bell is once more brought into circuit, and may be again signaled from the central station.

In the drawings which form part of this specification, Figure 1 is a side elevation of a machine embodying my invention, and Fig. 2 a plan view of the same. Fig. 3 is a sectional elevation on the line *x x* of Fig. 2 to show the internal arrangement, and Fig. 4 is a diagram drawing of the electric circuits and their methods of operation.

A base, A, provided with a front piece, C, supports in a frame, B B, a train of clock-work, propelled by a spring or weight in a manner well understood.

The clock-work, as particularly shown in Fig. 3, when at rest, is held by the engagement of the pallet 9 of a lever-switch, H, with a pin, 18, protruding from the side of a solid wheel, I, which, when released, is capable of rotation, being by its pinion *z* geared into the wheel T.

On the axis of the solid wheel I is another spur-wheel, V, which gears into a pinion on the arbor *v*, while on the end of this arbor, which projects through the casing B, is fastened an escapement-wheel, *f*, which, when the clock-train is in motion, engages with the pallets *h l* of an escapement, *g*, which is pivoted on the pin *k*, and which is provided with a pendulum-rod, *t*, carrying a pendulum, *t'*. This escapement is hereinafter referred to in describing the electrical connections of the instrument.

The body of wheel I consists of non-conducting material; but a metal flange, *w'*, raised just above its periphery, is fastened to its inner side, and is in permanent electrical contact with the metal frame-work of the machine. A metal plate, *w*, is let into the peripheral surface of the wheel, and is not in metallic contact with the flange or rim *w'*, but makes contact, by means of a wire, w^3, with the projecting pin 18 on the front side of the wheel, and another pin, 7, which, as shown in Fig. 2, extends in a similar manner from the rear side of the wheel, both of the said pins being metallic. A flat spring, G, is fixed upon an insulating-block, F, and presses with its free end upon the plate *w* when the mechanism is at rest and either of the pins 7 or 18 is detained by the pallets 8 or 9. The plate *w* is arranged so as to project a little farther from the edge of the wheel than the flange or rim *w'*, and when the spring G rests on it it is lifted out of contact with the said rim *w'*; but when by the rotation of the wheel the plate *w* passes from under the spring, the contact between the spring and the rim *w'* is resumed.

The switch H, which forms, as usual, the telephone-support, is pivoted by its arbor *n* in bushings *o* of insulating material, by which it is insulated from the metal frame, and on its side is a metal contact-pin, *x*, which, when the hook is depressed by the weight of the telephone, makes contact with the spring *y'*, leading to the bell branch, while, when the hook upon the removal of the telephone is elevated by the influence of the spring S, which is attached at one end to the base of the machine and at the other to the hook-lever on the inner side of the fulcrum thereof, the same pin *x* makes contact with the upper flat spring, *y*, leading to the telephone branch. The respective pallets 8 and 9, branching from the inner end of the hook-lever, are not in the same vertical plane, but spread from the main stem, as shown in Fig. 2, so that pallet 8 is adapted to engage with pin 7 on one side of the wheel I, and pallet 9 has the power to engage with pin 18 on the other side of the wheel.

On the axis or arbor *n* of the hook-lever is a washer, 11, of vulcanite or like material, which at one side is cut away to present a flat surface, and one corner thereof presses, when the weight is removed and the hook elevated, upon a spring, 12, which at its other end is rigidly attached to the arbor *r* of an upright rod, *s*, (see Fig. 1,) extending upward and downward from its arbors, and carrying at its upper end the pivot or center of motion, *k*, of the pendulum-escapement, and provided near its lower end with a notch, *r'*, which, under certain conditions hereinafter specified, is adapted for the reception of the end of the armature-spring *c'*. The office of the spring 12 is to prevent any such engagement when the telephone is off the hook, and being rigidly attached to the same arbor *r* it tends when in action to press the rod *s* firmly against the limit-stop W and away from the opposing stop W', both of which are insulated from the frame. The arbor *r* is, by vulcanite bushings on each side of the frame, also insulated. A flat contact-spring, *u*, is affixed to an insulating-block, *p*, on the side of the instrument, and its free end presses constantly against the rod *s*, as in Fig. 1. It is by the wire 15 in circuit with the electro-magnet M M, which, by the standard and screw *b*, is attached to the side of the instrument. The armature *c* of this electro-magnet is attached by a spring to the non-conducting block *d*, and from its other end an extension proceeds and normally impinges against the rod *s* at the edge of the notch *r'*.

The extreme end of the arbor of the escapement-wheel *f* is supported in a bracket, *e*, screwed to the frame B. The frame is held together by bolts *a a a a*.

The swing of the pendulum *t'* is limited by the non-conducting projecting piece *j*, which oscillates between two limiting-pins, *j'*, inserted in the plate *m*, Fig. 1.

I will now proceed to describe the electrical connections of my apparatus.

Referring to the plan view, Fig. 2, it will be seen that at one end of the base are four and at the other two binding-screws. Wires from the telephones are inserted in the binding-screws 1 and 2, and wires from the signal-bell in 3 and 4. The line-wire is connected in screw-post 5, and the ground-wire, or, in the case of an intermediate station, the return-wire, in

screw-post 6. As more clearly shown in Fig. 4, the line-post 5 in the instrument is connected by wire 13 with the flat spring G, this normally resting on the plate *w*, which, as hereinbefore described, is in electrical connection with the detaining-pins 7 and 18. When the hook is depressed by the weight of the telephone, which is the normal condition of the apparatus, the line-circuit is continued from the pin 18, hook-pallet 9, hook-lever and pin *x*, spring *y'*, and wire 17 to the binding-screw 3, and from thence through the bell-magnets. Binding-screws 2 and 4 are connected with one another by wire 21 and with the ground-post 6 by wire 20. Thus, after passing through the bell the normal circuit reaches screw-post 4, and from thence *via* wire 20 to screw-post 6 and earth. If the hook-lever is elevated, as it will be on the removal of the telephone, the line-circuit is from the plate *w* to pin 7, pallet 8, hook-lever H, spring *y*, wire 16 to binding-screw 1, thence through the telephone to screw 2, and by wires 21 and 20 to the ground-post 6. If the wheel I has rotated so far that the plate *w* has passed from under the end of the line-spring G, the said spring will now rest upon and make contact with the metal rim *w'*, which is always in metallic connection with the frame B. (Represented in Fig. 4 by two straight lines extending between the wheel I and the escapement-wheel *f*.) Through the metal frame B the circuit continues to the escapement-wheel and to the lower pallet, *l*, of the escapement operated by the pendulum. From the pallet *l* it passes to the rod *s*, on which the pendulum-rod is pivoted, and from the rod to the flat spring *u*, and by wire 15 to the electro-magnet M M, and finally by wire 14 to binding-post 6, and to earth. Since the arbor *r* of the rod *s* is insulated, it has no electrical connection with the frame except through the escapement. The upper pallet, *h*, of the escapement is likewise insulated from the metal work *g*, so that contact between the pendulum and escapement-wheel, and consequently communication between the main line and electro-magnet M and ground, is only effectuated when the lower pallet, *l*, strikes any one of the teeth of the escapement-wheel. At all times when the said wheel is in rotation the bell and telephone branches are completely disconnected from the main line.

The operation of this apparatus is as follows: When an oral communication is to be sent or received at a sub-station provided with my invention, the receiving-telephone is taken from the switch-hook, and the hook, under the influence of the spring S, flies up, disengaging the detent-pin 18 from the lever-pallet 9, and simultaneously transferring the contact-pin *x* on the lever from the spring, *y'*, leading to the bell branch to the other spring *y*, leading to the telephone branch. When released from the engaging pallet the clock-work, impelled by the mainspring or by a weight, and connected by the pendulum and escapement, makes several steps forward, and again comes to rest by reason of the engagement of the upper pallet, 8, with the upper pin, 7. As the contact-pin *x* is now touching the spring *y*, the main line is now placed in contact with the telephone branch, and communications may be exchanged. Upon the conclusion of the message the telephone is once more restored to the hook, and the wheel I, being disengaged from the control of the upper pallet, 8, recommences its rotation, and continues the same until the side pin, 18, in the course of rotation again reaches the pallet 9, when it again comes to rest, as shown in the diagram, Fig. 4. During the rotation of the wheel I, which may last any suitable period, the spring G cannot press on the plate *w*, through which the circuit continues to the hook-lever and telephone branches, because the said plate has advanced from under it. It therefore presses upon the rim *w'*, which, being in connection through the instrument-frame and circuit-breaking escapement with the magnet M and ground while the wheel I is in transit, completes the circuit through those instrumentalities. During the entire period of the revolution of the wheel I the pendulum continues to alternately engage and disengage the escapement-wheel, and also to break and close the main-line circuit by the same action, and the intermittent changes so produced in the line may be by any suitable testing instrument made apparent to the operator, who thus is apprised that the communication has terminated, and that he may disconnect the lines. If, however, the sub-station is wanted immediately for another connection, it is obvious that it cannot be signaled, because the bell branch is out of circuit. By sending a pulsation of electricity from the central to the sub station the electro-magnet M becomes energized and attracts its armature *c*, and this rising, its extremity *c'* falls into the notch *r'* of the rod *s*, which, being pressed forward by the internal spring, 12, causes the escapement *g* to be thrown entirely out of engagement with the escapement-wheel *f*, and the clock-train, being thus left without controlment, flies round until the pin 18 on the solid wheel I strikes against the pallet 9 of the hook switch lever, thus instantaneously restoring the line to the bell-branch terminal.

The transmitter is of course located in the same branch with the telephone shown; but as its position is well understood it is not deemed necessary to indicate it in the drawings.

I do not confine myself to the precise mechanism described, as its form may in many ways be varied without departing from the spirit of my invention, which, broadly stated, is an instrument which normally directs the main-line circuit through the signal-bell, which, upon the removal of the telephone from its support, transfers the main line to the telephone branch, which, when the telephone is restored to its support, sets in motion a vibrating circuit-breaker, which alternately makes and breaks

the circuit of the main line, and which is adapted to conclude the circuit-breaking operation, and to instaneously restore the normal condition of the apparatus when a strong electrical current is sent from the central office. Neither do I confine myself to the use of a battery-current for the purpose described, as the first impulse of a magneto-current is also adapted to accomplish the disengagement of the escapement, while the succeeding pulsations may be employed to give the signal.

Having now described my invention, I claim—

1. In a switch apparatus for telephone-stations, the combination, substantially as hereinbefore described, of a clock-train, a rotary commutator driven thereby, provided with two contacts, one leading to the signal-bell and telephone branches and the other through a vibrating circuit-breaker and auxiliary electro-magnet, a pivoted lever switch provided at one end with a telephone-support and at the other with pallets to engage, detain, and make electrical contact with the rotary commutator, and fitted with a contact-point adapted when actuated by the weight of the telephone in one direction to make contact with a signal-bell branch circuit, and when oppositely actuated by a retracting-spring to make contact with a telephone branch circuit, a controlling-escapement, pendulum, and pallets therefor adapted to simultaneously control the clock mechanism and vibratively break and close the main-line circuit, and an auxiliary electro-magnet in circuit with the circuit-breaking escapement, which, when energized, operates to disengage the pendulum-pallets from the escapement, all arranged as specified.

2. The combination, in a telephone-switch apparatus for sub-stations, of a main line extending from a central station, three branch lines, the first of which includes a signal-bell, the second one or more telephones, and the third a vibrating circuit-breaker and an escapement-controlling electro-magnet, means, as indicated, for automatically connecting the main line with either of the three branch lines, and other means whereby the main line when connected with the third branch line may be instantaneously restored to the first branch line, substantially as described.

3. In a telephone switching apparatus, a clock-train, a rotary circuit-changer driven thereby, and a pendulum-escapement controlling the said clock-work and permitting it to advance by successive movements, combined with an electro-magnet in a branch circuit leading from the rotary circuit-changer and passing through the escapement, which is adapted to serve also as an automatic vibrating circuit-breaker, and an armature therefor normally maintaining the escapement in operation, but adapted when attracted to permit the disengagement thereof, substantially as described.

4. In a telephone-switch apparatus, the combination, substantially as hereinbefore described, of a main line in permanent contact with a rotary commutator, two branch lines diverging from said commutator and adapted to be brought at different periods of the revolution of said commutator into contact with main line, one of said branch lines leading to a gravity-switch and the other through a vibrating circuit-breaker and escapement-detaching electro-magnet to earth, a gravity lever switch in the circuit of the first branch line and adapted to transfer the same to either of two sub-branch lines, one including a signaling-instrument and the other one or more telephones, as described.

5. A compound automatic telephone-switch or circuit-changer, consisting of a rotary commutator in permanent contact with the main-line circuit, provided with detent-pins in electrical connection with the main line when the commutator is inert, and provided also with other connections leading through an auxiliary magnet when the commutator is in rotation, contact-springs leading respectively to the signal-bell and telephone branches, and a pivoted hook-lever furnished with a sliding contact-point, and with pallets adapted to engage the detent-pins of the rotary commutator and detain the same, interposed between the rotary commutator and the said contact-springs, whereby, when the telephone is in its support and the instrument at rest, the main line is directed through one of the detent-pins and pallets, the sliding contact-point, and lower contact-spring to the signal-bell, and when the telephone is displaced the main line is transferred to the other detent-pin and pallet, the sliding contact-point, and the upper contact-spring, as specified.

6. In a telephone-switch apparatus, an escapement forming part of the electric circuit, and provided with contacts and connections, as indicated, whereby the movement of the escapement alternately makes and breaks the circuit by intermittent contact with the detent-wheel, substantially as described.

7. In combination with the gravity-switch of a telephone apparatus, an escapement adapted to be automatically included in circuit by the movement of said switch when the telephone is restored at the close of a communication, substantially as and for the purpose described.

8. In a switch apparatus, the combination of a main line, a clock-work-impelled rotary commutator, two branch lines diverging from said commutator, one of the said branch lines leading through a gravity-switch, and from thence, according to the position of said switch, to either of two sub-branch lines containing respectively a telephone and a signal-bell, the other branch line leading through an escapement circuit-breaker and an electro-magnet to earth, whereby, when the electro-magnet branch is during the rotation of the rotary commutator connected with the main line, the said electro-magnet may be energized by a cur-

rent of electricity from a distant station and operate to disengage the escapement, permitting the mechanism to complete its revolution at one bound, as herein described.

9. In a switch mechanism for telephone-stations, the combination of a rotary switch impelled by a clock-train, and adapted at different periods of its revolution to direct a main-line circuit through either of two branch circuits, an escapement for controlling the impelling clock-train, an electro-magnet, armature, and lever in a branch circuit, whereby the escapement may be maintained in position or electrically detached, and a pivoted lever switch forming the telephone-support, provided with pallets adapted to engage and detain the clock mechanism and to direct the circuit of one of the lines branching from the rotary commutator through either of two other branch lines, substantially for the purpose, and in the manner described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 14th day of December, 1882.

THEO. N. VAIL.

Witnesses:
GEO. WILLIS PIERCE,
THOS. D. LOCKWOOD.