(No Model.) 3 Sheets—Sheet 1.

F. W. COLE.

REPEATER.

No. 445,797. Patented Feb. 3, 1891.

Fig. 1,

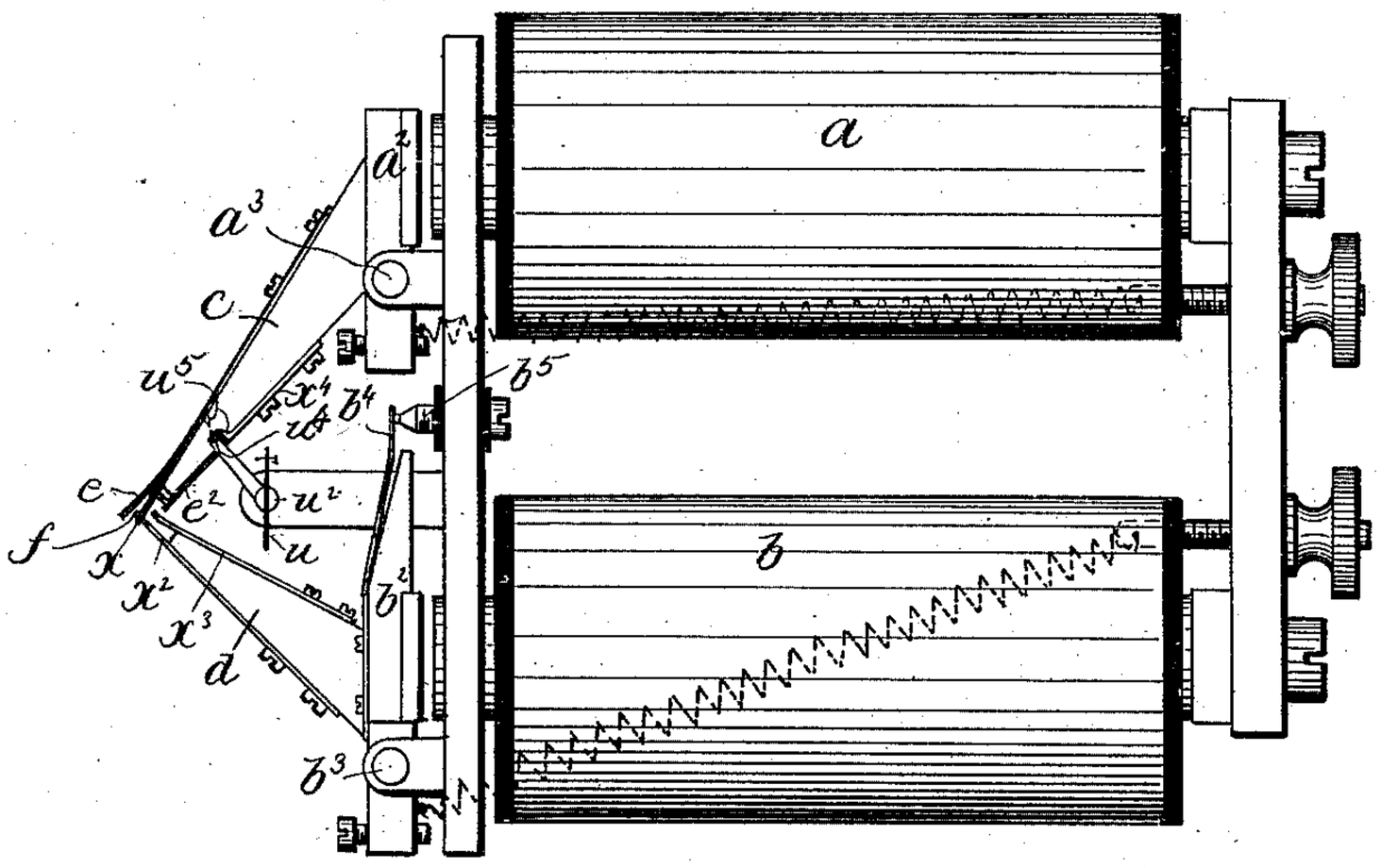
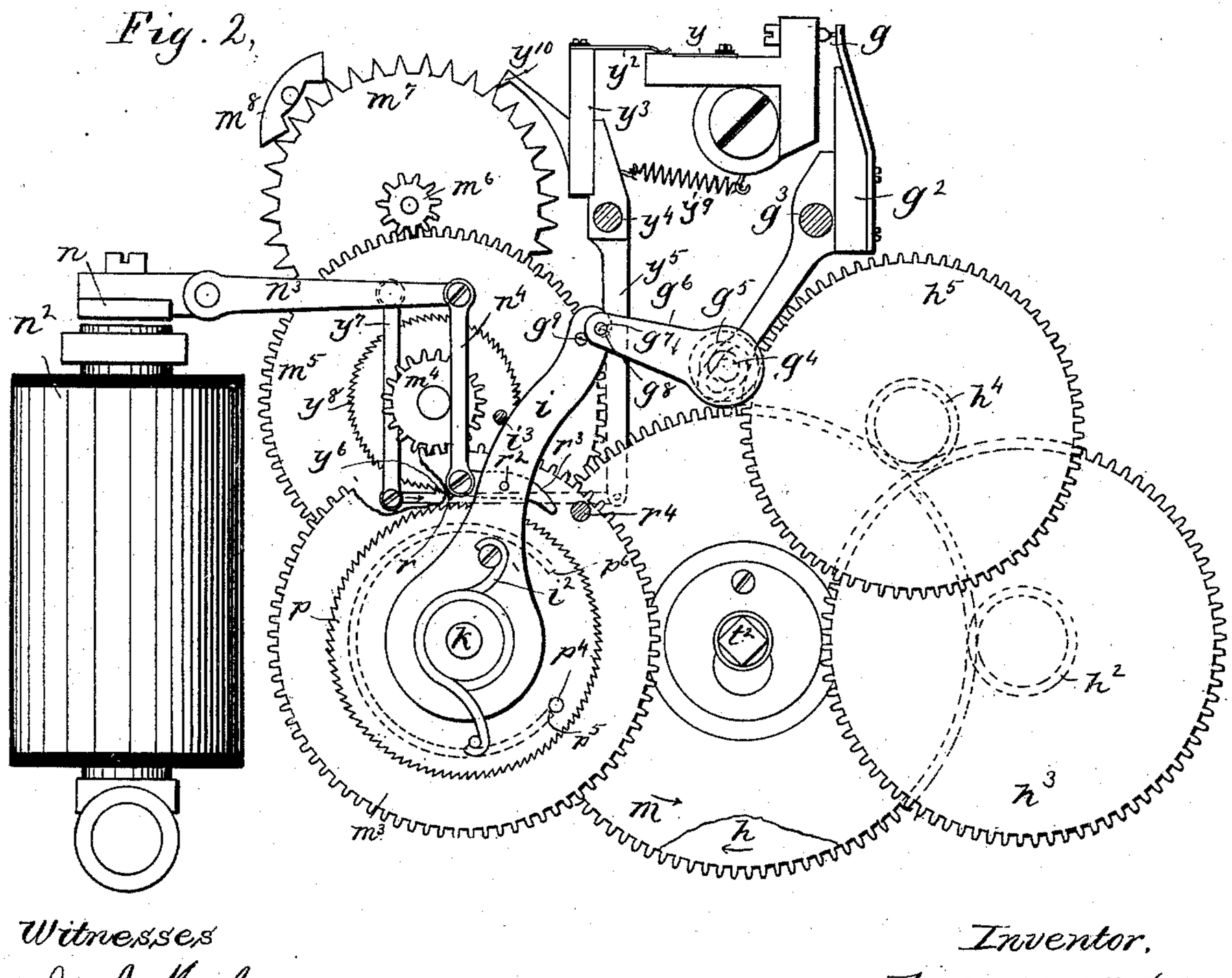


Fig. 2,



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(No Model.)

3 Sheets—Sheet 2.

F. W. COLE.

REPEATER.

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Fig. 3,

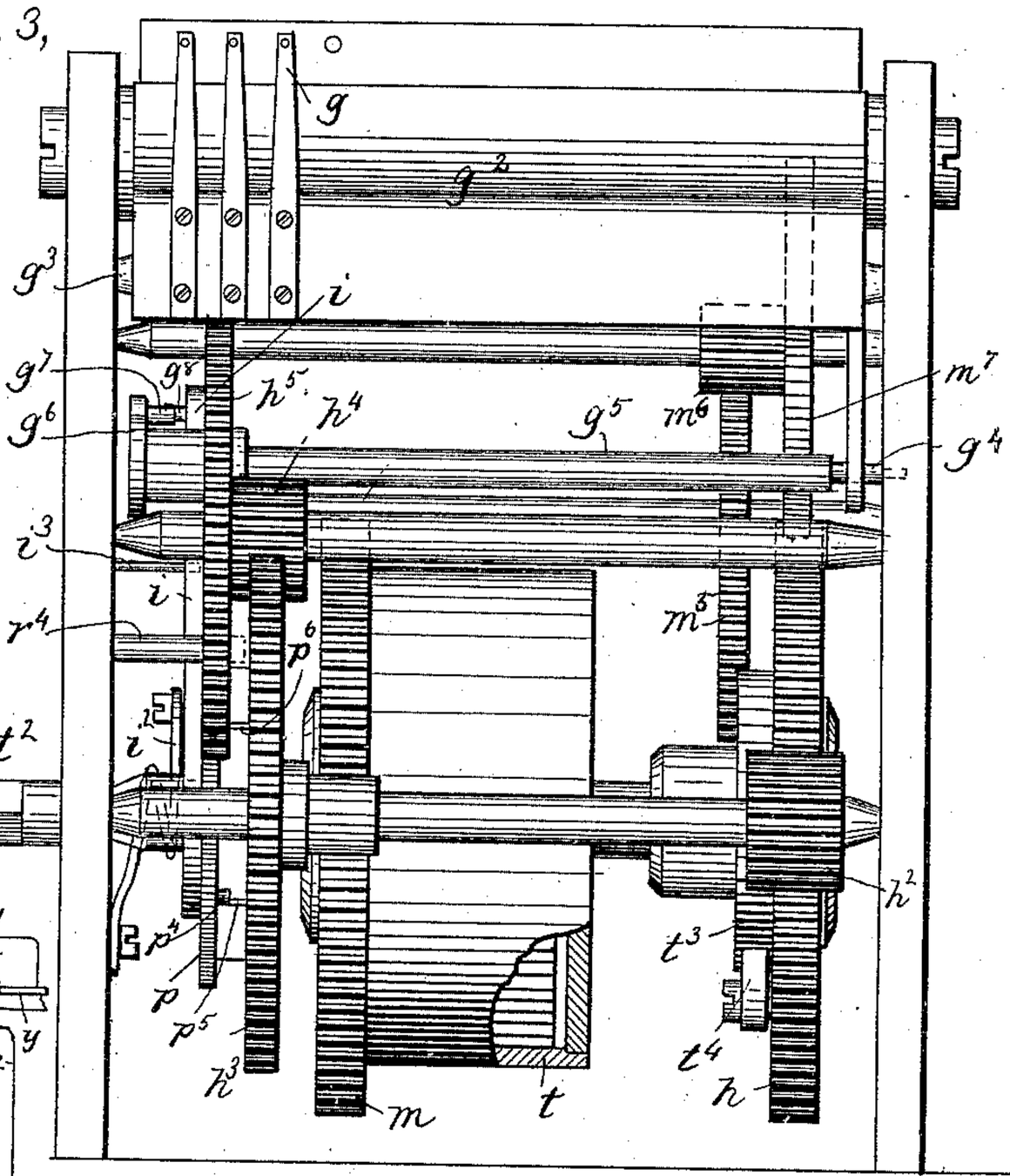


Fig. 6.

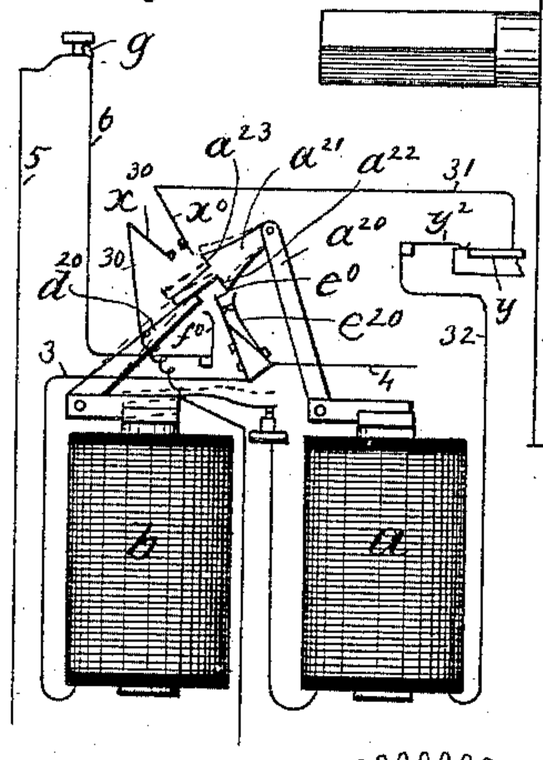


Fig. 4,

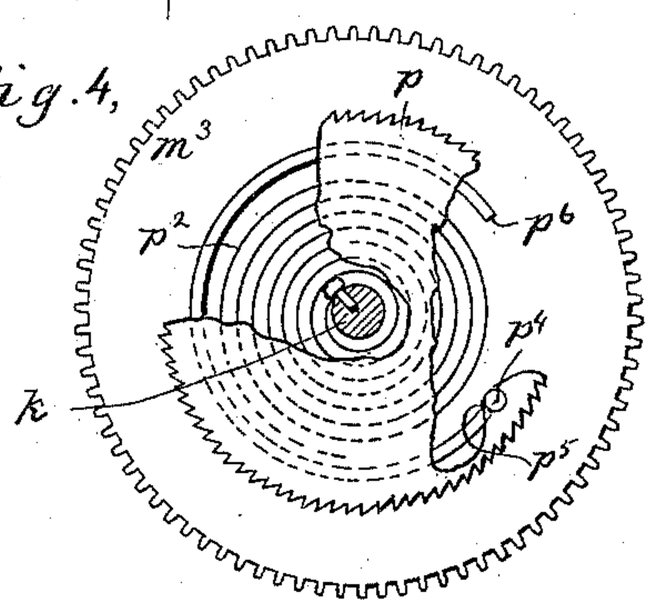
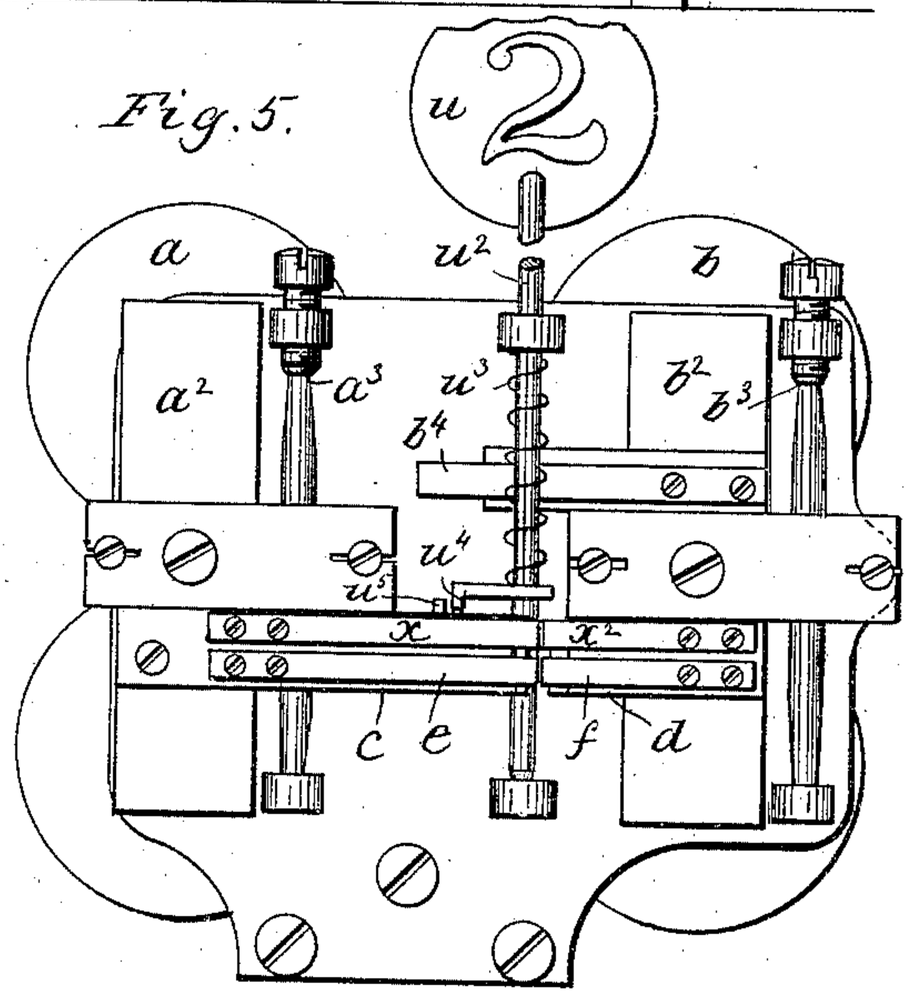


Fig. 5.



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3 Sheets—Sheet 3.

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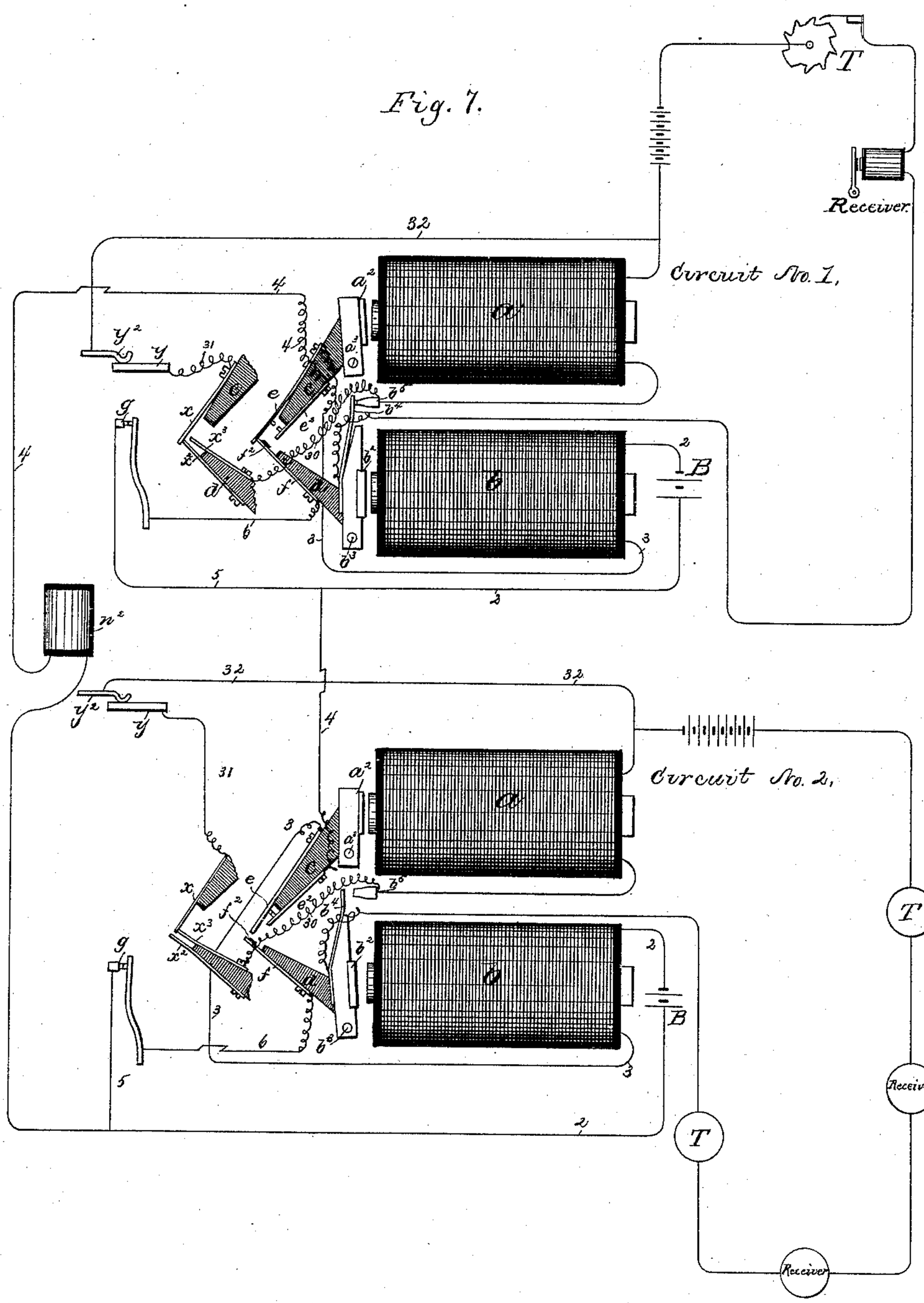
REPEATER.

No. 445,797.

Patented Feb. 3, 1891.

Fig. 7.



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UNITED STATES PATENT OFFICE.

FREDERICK W. COLE, OF NEWTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO MOSES G. CRANE, OF SAME PLACE.

REPEATER.

SPECIFICATION forming part of Letters Patent No. 445,797, dated February 3, 1891.

Application filed April 12, 1890. Serial No. 347,692. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK W. COLE, of Newton, county of Middlesex, State of Massachusetts, have invented an Improvement in Repeaters, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

My invention relates to a telegraph repeater by which signals or messages produced by current changes in one circuit cause similar current changes to be made in other circuits disconnected from the first-mentioned one, thus repeating the signal or message into the other circuits. The apparatus is so constructed that a message produced in one circuit may be repeated into any required number of other circuits and all the said circuits are mutually dependent one upon the other, any one being capable of acting as the transmitting-circuit, or the one in which the message is originally produced, while the others for the time being are receiving or repeating circuits, in which the message produced in the original circuit is received or transmitted to receiving-instruments located in said circuits. It is necessary for the proper operation of an apparatus of this kind that when a message is begun in one of said circuits it cannot be interrupted by a message that might be begun in any of the other circuits. This result is effected in accordance with the present invention by the following means: Each of the main circuits in which a message can be originally produced or repeated from one of the other circuits contains a main-relay magnet which responds to messages originally produced in that circuit, and the armature of which controls a local circuit containing electro-magnets, one corresponding to each main circuit, the armatures of which control their corresponding main circuits, opening the said main circuits when the armatures are retracted and closing them when the said armatures are attracted. For convenience the two electro-magnets corresponding to each main circuit will be called the "main relay" and the "local relay," the former having its coils in the corresponding main circuit and the armature of the latter constituting a key or circuit-controller that governs the said main circuit. The armatures of the said main and local relays are arranged in definite mechanical relation to one another and are provided with circuit-controlling contacts, which have a different relation to one another according as the main or local relay armature moves first.

The invention is shown embodied in an apparatus in which both circuits are normally closed and the relay-armatures normally attracted, and for convenience the operation will be described throughout as depending upon this arrangement; but such arrangement is not essential and the apparatus may be arranged, if desired, to operate in connection with normally-open main or local circuits, or both. The local relays are all included in a single local circuit in series with one another, so that breaking said local circuit demagnetizes all said relays except the one corresponding to the main circuit originally operated, which is prevented from being demagnetized by means of a local branch including only this one magnet, which branch is closed by the main relay at the same time that it breaks the local circuit for all the other local-relay magnets. This result may be attained by dividing the battery of the local-relay circuit into as many sections as there are local relays, each local branch just referred to containing the corresponding section of the battery, so that the said branch may be closed and retain the corresponding magnet energized, while the local circuit outside the said branch is open for demagnetizing the other local relays. Thus when one main circuit is broken at the beginning of the message originally transmitted therein its main-relay armature is retracted and in its retractive movement it first closes the local branch of its own relay and then breaks the local-relay circuit. Thus its own local-relay armature is not affected, but all the other local-relay armatures are retracted and in such movement break their corresponding main circuits, and thus repeat the break from the circuit in which it was originally produced. Although these successive operations follow as quickly as an armature can respond to a current change, it will be seen that in the re-

peating-circuits the local-relay armature is retracted first—that is, before the main-relay armature, which responds to the break in the main circuit produced by the local-relay armature. This change of relative position of the armatures prevents the repeating-circuits from closing the local branches for their local relays, so that the latter remain under control of the main relay, which was first operated. When the main circuit of the latter is again closed, it closes the local-relay circuits, first restoring the corresponding local-relay armatures to their normal position, and they in turn closing their main circuits, and thus repeating the closure into their main circuits. Unless means were provided to prevent such action the main-relay armatures in the repeating-circuits would respond to the closures produced by the corresponding local-relay armature, as just described, and with certain kinds of messages the main-relay armatures in the repeating-circuits may be permitted to respond to the messages repeated in them; but with messages of certain character such operation would be objectionable, as it might cause interference between two signals, and appliances are provided in accordance with this invention by which the main-relay armatures, when first retracted in response to a message repeated into their circuits from some other circuit connected with the repeater, close a shunt around the corresponding main-relay coils until the message that is repeated into the said circuits is finished, when said shunt is opened and all parts returned to their normal condition. Means are also provided for closing the local circuit at a given relay after it has been opened for a predetermined time slightly greater than the maximum time of opening forming part of a regular message, so that in case one line becomes broken it will not also disable all the other lines.

Figure 1 is a plan view of the main and local relay-magnets corresponding to one main circuit with the parts in normal condition; Fig. 2, a side elevation of a portion of the apparatus by which the local circuit is restored to normal condition if one of the main lines remains open for more than a predetermined interval of time; Fig. 3, a front elevation of the instrument shown in Fig. 2; Fig. 4, a detail thereof; Fig. 5, a front view of the relays shown in Fig. 1; Fig. 6, a detail illustrating a modified construction of the devices operated by the main and local relay armatures; and Fig. 7, a diagram showing the circuit-connections and illustrating the operation when one relay is responding to a signal in its main circuit and the corresponding signal is being repeated at the other circuit, two only of the main circuits being shown in diagram, which are marked "Circuit No. 1" and "Circuit No. 2," and are represented in the condition as sumed when a message is being originally transmitted in circuit No. 1 and repeated in circuit No. 2.

The main relay a and local relay b are mounted on the same frame-work, so that their respective armatures $a^2\,b^2$ are in definite relation to one another, being pivoted at a^3 and b^3, respectively, and acted upon by the usual retractors and provided with the usual stops to limit their movement toward and from the poles of the magnet. The armature-lever a^2 of the main relay has rigidly fixed upon it a block or carrier c, of insulating material, extended so that its end stands near a similar block or carrier d, of insulating material, connected with the local relay-armature b^2. The said carrier c of the main-relay armature is provided with contact-springs e e^2, normally pressed into contact with one another by their elasticity and constituting a circuit-closer in a local circuit 2 3 4 2 3 4, which includes the coils of all the local relays b, the said circuit-closers e e^2 and local-relay magnets b, corresponding to several main circuits, being all in series with one another in the said local circuit 2 3 4 2 3 4, as shown in Fig. 7. The spring e of said circuit-closer projects just beyond a spring f, mounted on the carrier d of the corresponding local-relay armature b^2 in such position that if the main-relay armature is retracted while the local-relay armature remains attracted the spring e comes in contact with the spring f, making electrical connection therewith, and is then pried away from the spring e^2 in the further retractive movement of said armature, thus opening the local circuit 2 3 4 2 3 4, as shown at circuit No. 1, Fig. 7, and demagnetizing the relays therein, permitting their armatures to be retracted, with the exception of the one corresponding to the main circuit, which has been opened as just stated, which local-relay magnet is prevented from being demagnetized as follows: The battery in the local circuit 2 3 4 is divided, a portion B being included near each relay-magnet b, and a connection is made by wire 5 6 with the spring f, carried by the armature b^2 of the local-relay magnet, including a circuit-closer g on the restoring-instrument, (shown in Figs. 2 and 3,) the purpose of which will be hereinafter explained. The said circuit-closer g normally remains closed, so that the wire 5 6 constitutes a branch from the local circuit between which and the magnet b the corresponding section B of the local battery is included. Thus the member e of the local-circuit closer carried by the main-relay armature, and the contact f on the local-relay armature constitute a circuit-closer for the branch 5 6, and when these members are brought into engagement by the retraction of the main-relay armature while the local-relay armature remains attracted, as shown at circuit No. 1, Fig. 7, the said branch is closed, making a circuit for the corresponding magnet b and adjacent section B of the local-circuit battery, which retains said magnet b energized and prevents its armature from moving. When, however, the local circuit is broken at e e^2, as just described, in the normal

operation, by the response of one main relay to a break in its circuit, all other main circuits will be closed, and consequently when the local-relay armatures are retracted in response to the said break in the local circuit they carry their springs *f* out of range of the member *e* of the local-circuit closer carried by the corresponding main-relay armatures.

Each local-relay armature b^2 is provided with a contact b^4, co-operating with a stationary contact b^5, constituting a circuit-closer in the corresponding main circuit, so that when the local-relay armatures are retracted, as previously described, upon the opening of one of the circuit-closers e e^2 their corresponding main lines are opened, thus repeating in the said lines the break that operated the main relay in the circuit in which the message was first begun. The main-relay armatures in the repeating-circuits will consequently be retracted; but as the springs *f*, carried by their local armatures, have been removed from the path of the member *e* of the local-circuit closer (see circuit No. 2, Fig. 7) the latter will not engage the said member *f*, and consequently will not be opened, so that the local circuit will remain under control of the circuit-closer e^2 at the main-relay armature which was first operated. Thus, while the first main circuit is broken at an external point, all other circuits are broken at the points b^4 b^5, and are consequently taken out of control of any external circuit-closer; but the main circuit which was first operated remains connected at b^4 b^5, and is consequently under control of the external circuit-closer shown in Fig. 7 as a break-wheel or transmitting device T.

When the main circuit first operated is closed at T, its main relay attracts its armature, closes the local circuit at e e^2, and thus causes the other local-circuit armatures to be attracted, which will in turn close their main circuits at b^4 b^5, thus repeating the circuit-closure of the first circuit into the others. In this operation the spring *f* will come against the spring *e;* but it is sufficiently yielding to permit the local-relay armature to close its main circuit at b^4 b^5, and the side of the spring *f* is provided with insulation f^2, which prevents it from closing the local branch 5 6 in this return or attractive movement of the local-relay armature, while the main-relay armature is retracted.

Unless prevented by some means the main-relay armatures would respond to the closures of their circuits at b^4 b^5, and if a message were begun in another circuit after the first break in the circuit first operating the line in which the second message was begun would have two breaking-points—namely, at its external transmitter and at b^4 b^5—and would probably be open at one or the other of these points nearly all the time, so that its main-relay armature would not be acted upon at all, and it would be possible for the said second circuit to get control and transmit its own signal only by having its circuit closed at the external transmitter and again broken during the interval between the closure and break in the circuit first operating—a condition which could rarely occur, and be practically impossible if the closed intervals produced by the different transmitters were of substantially the same time duration.

When the apparatus is to be used to repeat messages that are made up of circuit changes of different duration—as, for example, the dot and dash characters of the Morse alphabet—it might happen that a signal of long duration—representing a dash, for example—might occur in the circuit first operating, while a closure of shorter duration was made and completed by an external transmitter in some other circuit, in which case if the main-relay armatures were permitted to respond to the open or closed condition of their main circuits, the one that broke first after a simultaneous closure in two circuits would obtain control of the repeater from that time on, so that under the condition just mentioned the second circuit would break into the message of the first. Means are provided for preventing such occurrence when the apparatus is used with circuits for transmitting messages having closures or impulses of different time duration, which appliances will be described later on, as their operation depends upon instrumentalities that will be next described, it being sufficient for the present to state that the effect of these appliances is to prevent the main-relay armatures in the repeating-circuits from responding to the closures produced in these circuits by their local-relay armatures, so that when they fall back in response to the first break at b^4 b^5, as shown in circuit No. 2, Fig. 7, they remain retracted until the message is completed, the local-relay armature only moving in response to the circuit-closer e e^2 of the main relay that is responding to its external transmitter.

The devices thus far described are sufficient to effect the repetition from one circuit into all others of any number of circuits, each having main and local relays connected and operated as just described, (whether the main relays respond to circuit-closures in the repeating circuit or not,) and it is obvious that any number of local relays can be included in one local circuit, and that they may in fact be placed at various points not necessarily at the same station, it being necessary only that they should be reached by the one local or intermediate circuit, through which the messages are repeated from any one main circuit into all the others. It will be seen, however, that if one of the main circuits should become permanently broken or disabled in any way so that its main-relay armature remained retracted, if there were only the appliances thus far described the latter would retain the local circuit open at e e^2, thus causing all the other local relays to be demagnetized and their main circuits to be opened at b^4 b^5, so that all

the circuits would be opened and disabled so long as any one remained broken. In order to prevent this from happening, each of the local branches 5 6 passes through an independent circuit-closer g, one member of each of which circuit-closers is carried by a cross-bar g^2, (see Figs. 2 and 3,) connected with a rock-shaft g^3, controlled by an eccentric portion g^4 on a shaft g^5, acted upon by a motor-train h h^2 h^3 h^4 h^5 h^6, and provided with a detent-arm g^6, having a projection g^7 co-operating with two projections g^8 g^9 on a co-operating detent-arm i, which is pivoted loosely on a shaft k and acted upon by a spring i^2, tending to hold the said arm i against a stop-pin i^3 on the frame-work, in which position the pins g^7 and g^8 engage, preventing rotation of the detent-arm g^6 and eccentric g^4, or, in other words, preventing movement of the motor that operates the circuit-closers g. Thus as long as the detent g^6 i remains engaged no effect will be produced on the circuit-closers g; but if said detent be released the eccentric g^4 will turn once around and open all the circuit-closers g, thus opening the branches 5 6 of all the local relays, including the one corresponding to the disabled main circuit, permitting the said local-relay armature to be retracted, in which movement the spring f will slip off from the end of the spring e, permitting the latter to snap by its own elasticity into engagement with the corresponding spring e^2, thus closing the local circuit and restoring all other local-relay armatures to their normal position. The local-relay armature of its circuit will also be attracted and the spring f will strike against the end of the spring e; but it is sufficiently yielding to permit the local-relay armature to move far enough to close its main circuit at b^4 b^5, so that as soon as said circuit is repaired externally it will immediately be in working condition. It will be seen, therefore, that it is necessary only to control the detent-arm i in such manner that it shall release the detent after a circuit has remained broken for a period of time greater than that required for any break forming part of a message, and it should not open in a shorter time, as in that case it might interfere with a message that was being transmitted. In order to effect this result with the least loss of time, the said detent-arm i is controlled by another motor-train than the one which operates the eccentric g^4, the said detent-operating train m m^2 m^3 m^4 m^5 m^6, having an escape-wheel m^7 and governor m^8, controlling its speed of movement, and a detent y^{10}, controlled, as will be hereinafter described, by the armature n of an electro-magnet n^2, which may be included in the local circuit 2 3 4 2 3 4 of the local relays b, and thus responds to every break in said local circuit produced by the circuit-breaker e e^2 of one of the main-relay armatures. The detent y^{10} is disengaged when the armature n is retracted, and is so constructed, as will be hereinafter described, as to require a short time to come into engagement again after the armature is attracted, said time required for re-engagement being longer than the longest period that the magnet remains energized during the transmission of a signal, so that the motor last described, which may be called the "detent-motor," is permitted to run as long as the local circut remains open, but is stopped a short time after the local circuit is closed, and remains arrested as long as the said circuit remains closed. The detent-arm i is loose on the shaft k of one of the wheels m^3 of said train, and has what may be called a "time-connection" therewith; or, in other words, is engaged and moved by said motor only after the armature n has remained retracted for a predetermined time, the said interval having to elapse after each time that the armature is retracted before the detent-arm can be engaged and moved. This timed engagement is produced by the following means. The shaft k has a toothed wheel p loose upon it and acted upon by a light spring p^2, (see Fig. 4,) tending to turn it in the same direction that the train-wheel m^3 is turning, tending to keep its stop-pin p^4 in its forward position against the notched flange fixed to wheel m^3. The said wheel p co-operates with a dog r, connected with the armature-lever n^3 of the armature n by a link n^4, so as to be thrown into engagement with the said wheel p each time that the armature is retracted. The dog r is also connected at r^2 with the detent-arm i, and the wheel p, acted upon by its light spring p^2, tends to move the said detent-arm i in the direction to disengage the detent; but the said light spring p^2 is not sufficiently stiff to overcome the stronger spring i^2, acting on the detent-arm, so that, instead of the wheel p turning forward with the train-wheel m^3, it it is arrested by the dog r. The said wheel p has, however, at the proper time a positive engagement with the detent-train, one of the wheels of which, as m^3, is provided with a notched flange, the ends of which constitute two projections or shoulders p^5 p^6, that co-operate with the stop-pin p^4 of the wheel p. The spacing of these shoulders is such that the wheel p has a limited movement independent of the train-wheel m^3, at the end of which it is positively engaged by the said train-wheel, and the action of the spring p^2 tends to hold the wheel p when free in the most forward position with relation to the movement of the wheel m^3 and to throw it into such forward position the moment it is released by the dog r. Thus if the dog r is disengaged from the wheel p at any time while the shoulders p^4 p^5 are disengaged the wheel p will immediately be thrown into its most forward position; but if the said wheel p be arrested long enough by said dog r it will finally be positively engaged by the shoulder p^6 of the train-wheel m^3, tending to carry it in the same direction as the train-wheel, and the train is actuated by power sufficient to overcome the spring i^2, that acts on the de-

tent-arm, so that when such positive engagement occurs the adjacent detent-arm will be carried with the train-wheel m^3 and will release the detent. It is necessary, therefore, only to make the distance between the two engaging points between the wheels p and m^3 such that the time occupied by the wheel m^3 in moving through said space shall be of greater duration than the largest break forming part of a message, and if so the wheel p and detent-arm will never be positively engaged and operated during the transmission of a message; but if one of the main circuits remains open longer than any interval required in the transmission of a message the said detent-arm will shortly after be engaged and operated to release the circuit-breaker actuating-motor, which will effect the opening of the closed branch of the local circuit and the consequent closure of the local circuit, as before described.

The two trains of wheel-work or motors thus far described—namely, the first to operate the circuit-closers and the second to operate the detent for the first—might be entirely independent of one another, except as one controls the detent for the other; but for convenience they are shown in this instance as actuated by one and the same mainspring as follows: The wheel m of the detent-train is connected with the mainspring-barrel t, which is loose on the winding-shaft t^2, one end of said spring being connected with the said winding-shaft and tending to turn it in the direction of the arrow marked on the wheel h, Fig. 2, while the other end is connected with the barrel and wheel m, tending to turn it in the direction of the arrow thereon, Fig. 2. The said winding-shaft t^2 is provided with a ratchet t^3, fixed upon it and engaging with a pawl t^4 on the driving-wheel h of the other train, which wheel is loose on the said winding-shaft t^2. Thus, while one end of the spring tends to turn the barrel and wheel m in the direction of the arrow thereon, the other end of the spring, which is connected with the winding-shaft t^2, tends to turn the said shaft in the opposite direction, and through the ratchet t^3 and pawl t^4 also tend to turn the driving-wheel h of the other train in the opposite direction, and although both trains are thus impelled by the same spring their movements may be wholly independent of one another, the train of wheel m running all the time that a message is being sent, while the other train is permitted to move only after the local circuit has been opened beyond the predetermined limit of time, as before described.

As the detent-arm g^6 is released while the detent-motor is still running and the detent-arm i advancing from its normal position against the pin i^3, the said arm i is provided with the second stop g^9, which arrests the detent g^6 while the said arm i is in advanced position, thus preventing the said arm g^6 from turning more than once. As the pressure of the spring i^2 when applied to the dog r may cause such a hold between the said dog and the teeth of the wheel p as to prevent disengagement by the force of the retractor of the armature n^3, the said dog is provided with a cam-surface r^3, which at the end of a sufficient movement engages with a stationary pin r^4 on the frame-work, which will force the dog r out of engagement with the wheel p, permitting the retractor-arm i to be returned by the spring i^2 to its normal position, and the wheel p to be returned by spring p^2 to its forward position with relation to the wheel m^3. In such return movement of the arm i the detent projection g^7 merely passes from the projection g^9 into engagement with the projection g^8 on said arm i.

When the apparatus is employed for transmitting messages having current impulses of different time duration, as dot-and-dash messages, the following appliances are used in order to prevent interference between messages which might occur if two external transmitters were operating at the same time. Each main and local relay armature is provided with other pairs of contact-springs similar in construction and mechanical mode of operation to those already described, but having different electrical connections, said springs being placed either above or below those previously described on the contact-carriers c d, in this instance above, as shown in Fig. 5. For clearness the carriers c d are shown twice in the diagram Fig. 7, enabling the two sets of springs to be shown separate from one another. The spring x on the main-relay armature co-operates with springs or contacts x^2 x^3 on the local-relay armature, the said contact x^3 being connected by a branch wire 30 with the corresponding main line near one terminal of the main relay, while the spring x is connected by wire 31 32 with the main circuit near the other terminal of the main-relay armature, so that if the said wires 30 31 32 are all connected electrically they form a shunt around the main relay, which prevents the main battery from energizing the said magnet. The wires 31 32 include a circuit-closer y y^2, controlled by the motors by means which will be described, in such manner that they are closed each time that the main-relay armature is retracted in response to a message transmitted over its circuit, and remain closed after the said main-relay armatures are again attracted for a period of time slightly greater than the longest closed impulse of any message. Thus when the main relay responds to a message in its own circuit, its armature being retracted while the corresponding local-relay armature remains attracted, as before described, the spring x on the main-relay armature will engage with the contact x^2, carried by the local-relay armature, which contact x^2 merely acts mechanically as a stop to prevent spring x from making contact with the spring x^3, so that the wires 30 31 32 will not be connected, and consequently the cor-

responding main relay will not be shunted. (See circuit No. 1, Fig. 7.) In those circuits, however, which are repeating from the one in which the message is originally transmitted the local-relay armatures are retracted before the main-relay armatures, as before described, and consequently the latter in its movement will cause the spring x to engage with the contact x^3, carried by the local-relay armature, (see circuit No. 2, Fig. 7,) which will connect the wires 30 and 32, and will thus close the shunt for the corresponding main relay, which therefore will not be energized when its main circuit is closed at b^4 b^5 by the corresponding local-relay armature, no matter what may be the condition of the main circuit externally to the repeater. The stop-spring x^2 is yielding laterally, so as to permit the local armature to respond in repeating the message. By this construction it will be seen that the instant one main relay responds to a message in its own circuit the corresponding impulse will be repeated into the other circuits by the means before described, and in such action the other main relays will become shunted and will be unable to respond to any message whatever in their main lines, either the one being repeated into the said main lines or one that might be begun by an external transmitter in one of said main lines, and they cannot possibly take the apparatus out of control of the circuit which is the first to respond to its external transmitter.

The purpose of the circuit-closer y y^2 is to open the shunt for the main-relay armature, and thus restore it to working condition after the message has been completed in the line that is first operating.

The circuit-closer y y^2 is operated by the following mechanism. (Best shown in Fig. 2.) The members y of the several circuit-closers corresponding to the several main circuits are supported on a stationary cross-bar, which may be the same that supports the stationary members of the circuit-closers g, before described, while the members y^2 are supported on a carrier y^3, supported on a rock-shaft y^4, and provided with an arm y^5, connected with a pawl y^6, which is connected by a link or arm y^7 with the armature-lever n^3 of the motor-controlling magnet n^2. The pawl y^6 co-operates with a toothed wheel y^8, carried by the arbor of one of the wheels, as m^5, of the detent-controlling train, and the connection between the said pawl and the armature through the link y^7 is such that when the armature is attracted the pawl is engaged with the toothed wheel, which tends to move the pawl in the direction of the arrow thereon, and through the connection of the said pawl with the lever y^5 and contact-carrier y^3 tends to move the contact y^2 away from the contact y. When, however, the armature is retracted, the pawl y^6 is disengaged from the toothed wheel y^8, and is free to move in the direction reverse of the arrow on it, and the contact-carrier y^3 or its supporting-lever is acted upon by a spring y^9, which at these times moves the contacts y^2 over onto the contacts y. The contacts y y^2 engage with a sliding movement, and in thus connecting them or closing the circuit between them the contacts y^2 slide a short distance over the contacts y, requiring a corresponding length of movement of the carrier y^3 in the reverse direction before the said contacts are separated. This reverse movement is produced by the action of the toothed wheel y^8 upon the pawl y^6, as before described, and takes place only while the armature n^3 remains attracted, and the speed of movement of the wheel y^8 is such that it requires a longer time for such movement to cause the separation of the contacts y y^2 than the time occupied by any closed impulse in a message, so that after the message is once begun upon any of the circuits the contacts y y^2 will all be closed and will remain closed until the message is completed and the circuit in which it was begun is restored to its normal closed condition, causing the magnet n^2 to remain energized.

The contact-carrier for the contacts y^2 is provided with the detent-stop y^{10}, to engage with the scape-wheel of the detent-controlling motor, and arrests the same a short time after the magnet n^2 is restored to its normal energized condition, it being understood that the movement of the detent y^{10} toward the scape-wheel, that takes place during the comparatively short closure of the circuit of the magnet n^2, forming the part of a message, is not sufficient to bring it into engagement with the scape-wheel, so that the detent-train continues running uninterruptedly during the transmission of a message.

It may be a convenience at any time to know which main circuit is operating, or in case one of the circuits is disabled to show at a glance which one it is. This is accomplished by an indicator disk or target, (shown in edge view at u, Fig. 1,) being mounted on a shaft u^2, acted upon by a spring u^3, (see Fig. 5,) tending to turn the said disk in the direction of the arrow, Fig. 1. The shaft u is provided with a detent projection u^4, engaging with co-operating detent projections u^5 on springs carried by the armature of the corresponding main relay. A pair of springs might be provided near the top of the contact-carrier c for the detent projections u^5; but as the mechanical operation of one of them would be the same as that of the spring x, and as such mechanical operation would not interfere in any way with the electrical functions of said spring x the said projections are, as shown in this instance, carried one on the said spring x and the other on a spring x^4, placed at the other side of the contact-carrier c. When the said springs x x^4 remain in normal position on the carrier c, the projections u^5 are sufficiently close together to prevent the projection u^4 from passing between them, so that the main-relay armature may play back and forth without permitting the projection u^4 to

escape and the target-shaft to turn on its axis, this being the case with those relays which are in the repeating-circuits as they respond to the first action of their circuit-closers b^4 b^5 without having their spring x engaged by the projection x^2. At the main relay, which is responding to an external transmitter, however, the springs x x^4 are pried apart, as before stated, so that when in the movement of the main armature the projection carried by the spring x^4 moves far enough to release the projection w^4 the one carried by the spring x is prevented by the stop-spring x^2 from moving far enough to engage said projection w^4, which is consequently released, permitting the shaft d and target u to turn quarter around, so as to indicate by its changed position which line has been operated. After it has been observed which circuit has been operated the target may be turned back to normal position, and the spring x^4 then yields, so as to permit the projection w^4 to pass the projection w^5, carried by the said spring x^4, without attracting the armature away from the poles of the magnet.

The invention herein described is not limited to the specific construction and arrangement of the various instrumentalities, as they can be varied widely without departing from the invention.

In repeaters of this general character, as heretofore most commonly constructed, the main-relay armatures in repeating-circuits have been locked or mechanically held inoperative while the message is being repeated, to prevent interference if a second message should be begun in their own circuits, and in some cases they have been shunted or cut out of circuit by mechanism called into operation when a message is begun on one of the circuits and is being repeated into the others. All such contrivances require a relatively large expenditure of time in the action of a repeater, while by the present invention, in which circuit-changers, as e e^2, e f, and x x^3, are operated by the movement of one armature, but are controlled as to their effect on the circuits connected with them by the relative position of another armature at the moment when the actuating-armature moves, the circuit changes can be made as rapid as a relay can be made to respond, and consequently any messages that can be transmitted into one circuit from another by a relay can be repeated from any one main circuit into all other main circuits by the apparatus herein shown and described. There are also other important advantages in the construction and mode of operation embodied in the present apparatus, in which the movement of the main-relay armature is not obstructed or prevented, but is caused to produce different effects, according to the position of an engaging portion that is shifted by the local-relay armature. These advantages relate especially to the operation of restoring the apparatus to working condition when one of the circuits becomes disabled, as has been hereinbefore described, the retraction of the local-relay armature permitting the corresponding local-circuit closer e e^2 to be closed without requiring any movement or change of condition of the main-relay armature, although leaving the said main-relay armature in perfect freedom to come under control of its main circuit the moment the latter is repaired. The main novelty of the mode of operation of this part of the apparatus is that the main relays are all permitted to be retracted upon the breaking of their circuits; but such retraction produces a different effect upon the local circuit controlled by them according as the shifting engaging device f is in one or the other position under the influence of the local relay when the main-relay armature is moved. In order to show that this result does not depend upon the specific construction of the contrivances already described, a modification is represented in Fig. 6, in which substantially the same operations are performed in substantially the same manner, but by somewhat different mechanism. In this construction contact-springs are used corresponding exactly in their electrical functions to the springs e, e^2, f, x, and x^3, already described, and said springs are marked, respectively, e° e^{20} f° x° x^{30}. The said springs, however, instead of being carried by the armatures, are mounted on suitable stationary supports, and the armature-lever a^{20} of the main relay is provided with a contact-actuator a^{21}, pivoted in the end of said lever a^{20} and extended between the ends of the springs e° x°, and being provided with shoulders a^{22} a^{23} for co-operating with the said springs, as will be described. The said spring-actuator rests against the arm d^{20}, connected with the armature of the local relay in such position that when the said local-relay armature is attracted the contact-actuator a^{21} is in position for its shoulder a^{22} to engage with the spring e°, while its shoulder a^{23} will pass by the end of the spring x without engaging it. Consequently if the main-relay armature is retracted while the local-relay armature is attracted, as takes place when the message is being transmitted originally in the main circuit, exactly the same effect is produced as represented in circuit No. 1, Fig. 7—that is, the retractive movement of the main-relay armature separates the springs e e^{20} and opens the local circuit, and at the same time connects the springs e° f°, and thus closes the local branch 5 6 for its own local relay. The springs should be so adjusted that the spring e° will make contact with the spring f° before it is separated from the spring e^2. If, however, the local-relay armature is retracted while the main-relay armature remains attracted, (the condition of circuit No. 2, Fig. 7,) the projection d^{20} of the local-relay armature will have shifted the contact-actuator a^{21}, so that when the main-relay armature is immediately afterward retracted in re-

sponse to the break at b^4 b^5, produced by the retraction of the local-relay armature, the said actuator a^{21} will be in such position that its shoulder a^{22} will clear the spring e°, which will consequently remain in contact with the spring e^{20}, and the shoulder a^{23} will engage the spring x and press it into contact with the spring x^3, thereby closing the shunt 30 31 32 for the main-relay magnet, which will therefore remain in retracted position, as before described, until its shunt is broken at y y^2 at the completion of the message. The pressure between the shoulder a^{23} and the spring x is such that the contact-actuator a^{21} will not move when the local-relay armature is again attracted in the further transmission of the message, and the said shoulder a^{23} may be slightly undercut, if required, as shown, in order to effect this result.

The device a^{21} of Fig. 6 or the projection f of Fig. 5 may thus be regarded as a shifting contact-actuator, the actuation of the contacts being produced by the movement of the main-relay armature, but being made effective only by the said shifting contact-actuator, which is shifted or controlled as to its effect upon the contacts by the local relay, so that it requires the conjoint action of the main-relay armature and the local-relay armature to produce the desired action upon the contacts e e^2 of the local-circuit closer.

I claim—

1. A repeating apparatus comprising two or more main relays, each in a main circuit disconnected from the others, combined with local relays, one corresponding to each main relay, all said local relays being included in the same local circuit, circuit-controllers in said local circuit operated by each main-relay armature, and a shifting contact-actuator controlled by each local-relay armature co-operating with the contacts of the circuit-controller operated by the corresponding main-relay armature without obstructing the movement of main-relay armature, whereby the said movement produces different effects upon the said circuit-controller, according to the position of the local-relay armature and contact-actuator controlled thereby, substantially as and for the purpose described.

2. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, normally-closed circuit-breakers in the circuit of the local relays, one corresponding to each main relay, and circuit-closers for the branches corresponding to the said local relays and their corresponding battery-sections, said circuit-controllers being operated by said main-relay armatures, and shifting contact-actuators controlled by said local-relay armatures co-operating with the contacts operated by the main-relay armatures without obstructing the movement of said main-relay armatures, substantially as and for the purpose described.

3. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, circuit-controllers for the branches corresponding to the said local relays, and an actuating-motor therefor, substantially as described.

4. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, circuit-controllers for the branches corresponding to the said local relays, and an actuating-motor therefor, and a detent for said motor controlled by the said main-relay armature, substantially as described.

5. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, circuit-controllers for the branches corresponding to the said local relays, and an actuating-motor therefor, a detent for said motor, and an electro-magnet controlling the operation of said detent in a circuit controlled by the said main-relay armature, substantially as described.

6. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, circuit-controllers for the branches corresponding to the said local relays and an actuating-motor therefor, a detent for said motor, and detent-motor having a timed engagement with the movable detent member, substantially as described.

7. A repeating apparatus comprising two or more main relays, each in a main circuit disconnected from the others, combined with local relays, one corresponding to each main relay, all said local relays being included in the same local circuit, circuit-controllers in said local circuit operated by each main-relay armature and an engaging portion controlled by each local-relay armature, co-operating with the circuit-controller operated by the corresponding main-relay armature, a visual indicator corresponding to each main circuit, a detent therefor connected and mov-

able with the main-relay armature, and a detent-actuator connected and movable with the local-relay armature, whereby the movement of the main-relay armature releases the indicator when the local-relay armature is in one position, but not when said local-relay armature is in the other position when said movement of the main-relay armature takes place, substantially as described.

8. The combination of the main-relay magnet and armature with a corresponding local-relay magnet and armature controlling the circuit of the said main relay, a circuit-closer carried by the main-relay armature, comprising a pair of contact-springs normally held in one condition by the elasticity of said springs, and an engaging projection for one of said contact springs carried by the local-relay armature and movable thereby into and out of position to engage the contact-spring carried by the main-relay armature, substantially as and for the purpose set forth.

9. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, and circuit-closers for the branches corresponding to the said local relays and their corresponding battery-sections, said circuit-controllers being operated by said main-relay armatures, and shifting contact-actuators operated by the local-relay armatures without obstructing the movement of the main-relay armatures, substantially as and for the purpose described.

10. The combination of two or more main relays, each in a main circuit disconnected from the others, with corresponding local relays, all included in a single circuit, a section of battery corresponding to each local relay and a branch including the corresponding section of battery and the corresponding local-relay magnet, circuit-controllers in the main circuits operated by the armatures of the local relays and circuit-closers for the branches corresponding to the said local relays and their corresponding battery-sections, said circuit-controllers being operated by said main-relay armatures, and shifting contact-actuators operated by the local-relay armatures co-operating therewith, substantially as and for the purpose described.

11. In a repeating apparatus, a main relay and armature and two circuit-controllers adapted to be operated by it, a second relay and armature and a shifting contact-actuator controlled thereby that co-operates with said circuit-controllers without obstructing the movement of the main-relay armature, whereby when the armature of the second electromagnet is in one position when the main relay is moved one of said controllers is operated and when in the other position the other of said circuit-controllers is operated, substantially as described.

12. A repeating apparatus comprising two or more main relays, each in a main circuit disconnected from the others, and local relays, one corresponding to each main relay in a local circuit, circuit-controllers in said local circuit operated one by each main-relay armature, and shifting contact-actuators operated by the said local-relay armatures, controlling the operation of said circuit-closers without obstructing the movement of the main-relay armatures, substantially as described.

13. A repeating apparatus comprising a number of main relays, each in a main circuit independent of the others, and a number of corresponding local relays, combined with branches of said main circuits, each constituting when closed a shunt for the corresponding main relay, and a circuit-closer in said branch operated by said main and local relay armatures, substantially as described.

14. A repeating apparatus comprising a number of main relays, each in a main circuit independent of the others, and a number of corresponding local relays, combined with branches of said main circuits, each constituting when closed a shunt for the corresponding main relay, a circuit-closer in said branch operated by said main and local relay armatures, and a second circuit-closer in said branch operated by a time-motor, substantially as and for the purpose described.

15. A repeating apparatus comprising a number of main relays, each in a main circuit independent of the others, and a number of corresponding local relays, combined with branches of said main circuits, each constituting when closed a shunt for the corresponding main relay, a circuit-closer in said branch operated by said main and local relay armatures, a second circuit-closer in said branch operated by a time-motor, and an electro-magnet and circuit therefor controlled by said main-relay armature, governing the operation of said time-motor, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FREDERICK W. COLE.

Witnesses:
JOS. P. LIVERMORE,
JAS. J. MALONEY.