(No Model.) 2 Sheets—Sheet 1.

M. G. CRANE.

REPEATER.

No. 541,225. Patented June 18, 1895.

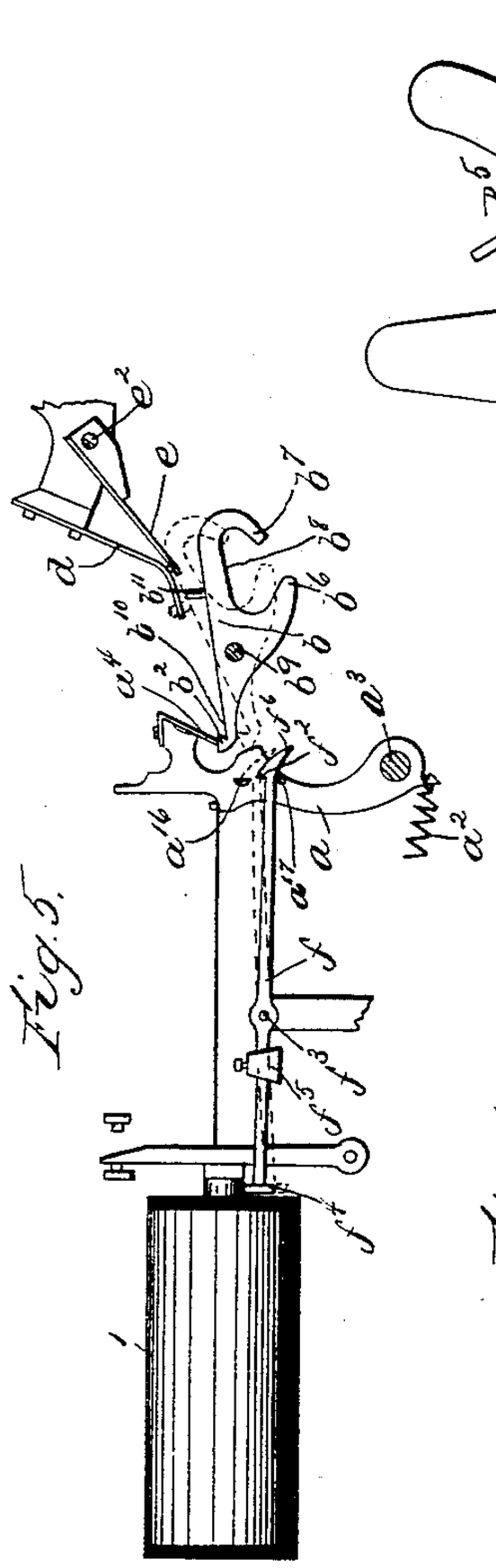

Fig. 2.

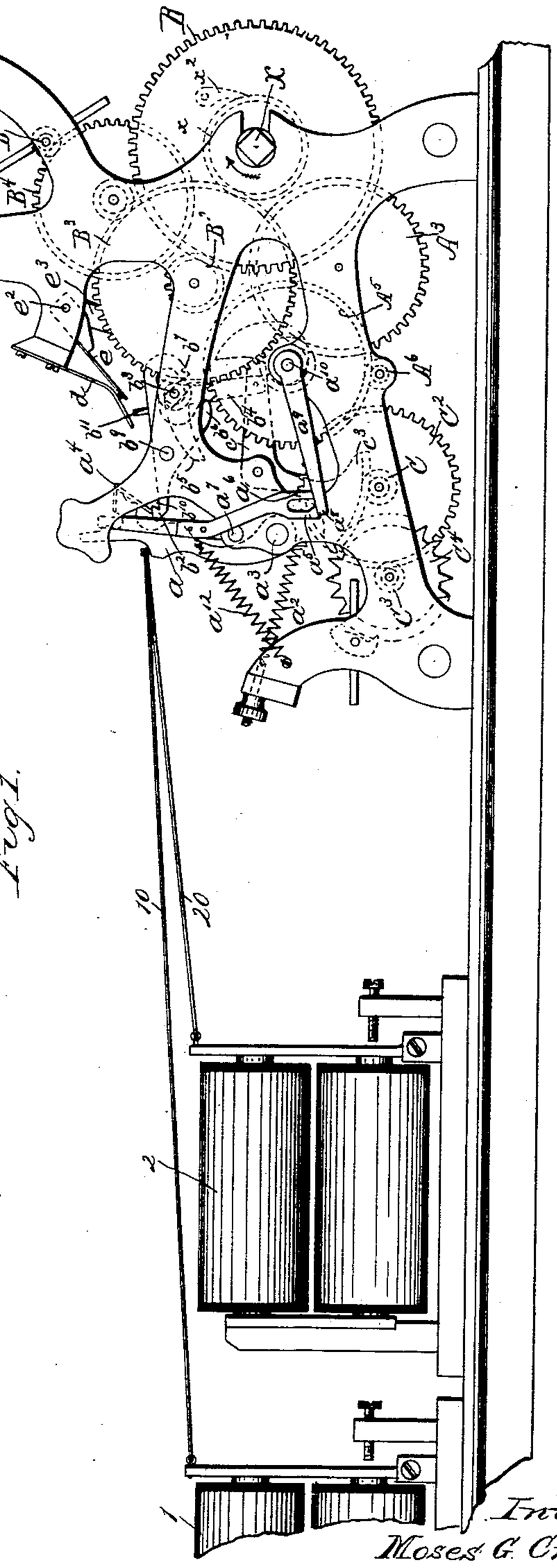

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

M. G. CRANE.

REPEATER.

No. 541,225. Patented June 18, 1895.

Fig. 1.

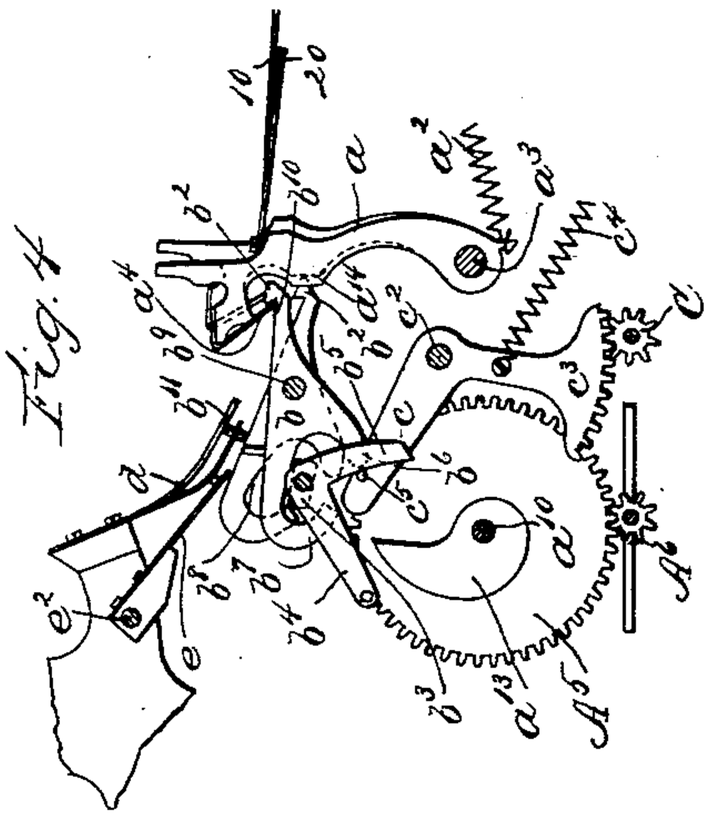


Fig. 3.

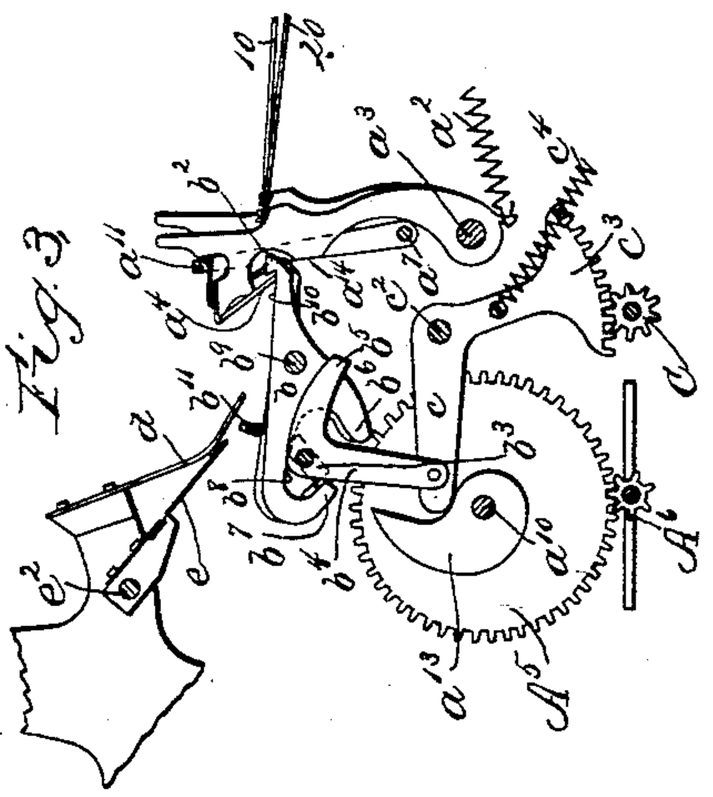
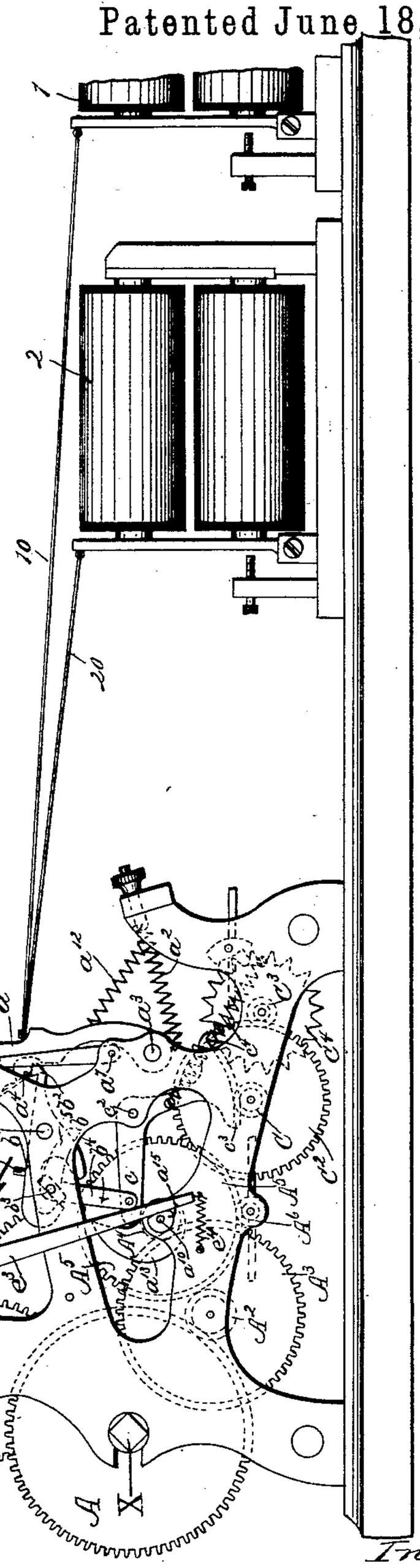


Fig. 2.



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UNITED STATES PATENT OFFICE.

MOSES G. CRANE, OF NEWTON, MASSACHUSETTS.

REPEATER.

SPECIFICATION forming part of Letters Patent No. 541,225, dated June 18, 1895.

Application filed August 4, 1894. Serial No. 519,499. (No model.)

To all whom it may concern:

Be it known that I, MOSES G. CRANE, 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.

The present invention relates to electric signaling or fire alarm telegraph apparatus and is embodied in an instrument known as a non-interfering repeater such instruments being intended to repeat over all the circuits connected therewith a message from a signal box located in any one of said circuits. It is necessary in instruments of this kind when a message is being received that it shall be rendered impossible for a message from a box or station located in any circuit except the one in use to affect the repeater, or in other words, it is necessary to prevent messages coming in on different circuits from interfering with each other; and also to prevent messages repeated over the various circuits from affecting the repeater.

As commonly constructed fire alarm systems operate on a closed circuit; that is, all of the circuits throughout the system remain normally closed, the signaling apparatus consisting of a suitable break wheel the first operation of which is to break the circuit after which the message is completed by a number of brief closures at the end of which the circuits resume their normally closed condition; the said closures being indicated in any suitable way, as by strokes of a gong, or printed dots and dashes. Thus it is necessary that all the circuits should be normally closed through the repeater so that a signal consisting of a break in the circuit at a box located in any one of said circuits will cause the instrument to operate. The repeater must also be so arranged that the circuit over which a signal is being sent shall remain closed through the repeater, in order to retain it responsive to the makes and breaks in said circuit produced at the signal box which is being operated. The remaining circuits on the other hand must be removed from the control of their respective boxes, the makes and breaks therein being made at the repeater itself in response to the makes and breaks at the box from which the message is being sent; it being desirable moreover that the circuits should remain practically open during the transmission of a message, the signals in which are recorded by momentary closures, since the non-interfering devices of the boxes on the same circuit commonly depend for their operation upon such a circuit condition. In order to attain these ends the repeater is provided with two motors usually clock work trains, normally held inoperative by suitable detents, one of the said trains which may be called the main or signal repeating motor being arranged to operate at each of the successive movements of the armature which go to make up a complete message sent in from a box upon any of the circuits of the system; while the other of said motors, which may be called the secondary or locking motor, operates in response to the first movement of the said main motor to lock out or render inoperative the devices adapted to respond to all of the circuits except the original circuit which has started the repeater, and at the same time to open and hold open all of the said circuits at the repeater, the main motor, however, being adapted at each successive operation to momentarily close the said circuits, thus normally held open. The said secondary motor or train is normally held inoperative by a detent upon some moving part of the main motor so that upon the initial movement of the said main motor it is released and allowed to operate through a predetermined distance during which movement it carries certain locking devices into a locking position, and co-operates with certain circuit closers at the repeater. At the end of this movement it is arrested by a detent (thus retaining said locking devices in the locking position to which it has moved them), and held there until the message has been completed after which it is released by a restoring device and continues its movement until it reaches its normal position, at the same time releasing the locking devices, thus permitting them to move from their locking position to their normal unlocking position, if they are not otherwise held in locking position as will be herein described. In order that the said

motors may be operated by any signal coming in from any of the boxes, the different circuits over which signals are to be sent are each provided with an electro magnet the armature of which co-operates with a suitable controlling device, the said controlling devices co-operating in common with the main motor and individually with the aforesaid locking devices which are adapted when acted upon by the secondary motor to lock out or render inoperative so far as the repeater is concerned, all the circuits except the one over which a message is being delivered. The locking mechanism consists of the said secondary motor and a number of independent locking devices one for each circuit of the system, the said devices all being normally held by their respective controllers in a position to be operated upon by the said secondary motor, when said secondary motor is released by the main motor, in such a manner that they lock their respective controlling devices so that the said controlling devices are temporarily rendered inoperative, that is to say, incapable of responding to makes and breaks in their respective circuits. In order to set the secondary motor in motion, however, it is necessary that the main motor should have moved owing to the action of one of the armatures, and the controlling device which belongs to the armature which has thus acted must therefore have also been moved in response to the movement of the said armature; and the instrument embodying the present invention is so arranged that this initial movement causes the said locking device to leave its normal position and assume a new position in which it can no longer be operated upon by the said secondary motor, the result being that a movement of any of the said armatures in response to a signal places its own controller beyond the control of the secondary motor, at the same time releasing the main motor which then operates and releases the secondary motor permitting it to make its initial movement and lock out all of the circuits except the one which has caused the repeater to start its operation. The main motor then continues to operate in response to the successive makes and breaks at the box from which a message is being sent in until said message is completed; the secondary motor being meanwhile retained in the position assumed at the end of the initial movement and again released at the end of the signal, and permitted to make its final movement around to its normal position as will be hereinafter described.

As has been stated, the message is made up of signals due to brief closures in the circuits which are for the most part open during the transmission of the message. It is necessary therefore, that the circuits over which the message is to be repeated should be opened at the repeater at the beginning of the message and retained normally or for the most part open until the completion of the message, being however momentarily closed in response to each closure at the box from which the message is being received. For this purpose each of the locking devices is adapted when operated by the secondary motor to engage a circuit breaker in such a manner as to open and hold open its own circuit until it is restored to its normal position by the final movement of the secondary motor at the completion of the message. To effect the momentary closures in the circuits thus held open, however, the main motor is also adapted, each time it moves in response to its own controller, to also engage said circuit breakers in such manner as to effect a closure thereof, thus duly repeating the signals over other circuits.

As has been hereinbefore stated the secondary motor in moving from its normal to its locking position travels only a portion of its complete cycle and it is held in this locking position by means of a detent moved by the action of the main motor into the path of a moving member of said secondary motor; and in order that the said secondary motor may complete its cycle at the end of a message so that it may return to its normal position, suitable restoring means are employed, the said restoring means consisting of a motor operating upon the detent which holds the secondary motor in its locking position. This restoring motor as it may be called, acts upon the said detent to withdraw it from the path of the secondary motor but is so timed that it takes longer to fully operate upon said detent than the longest interval between successive signals which go to make up the complete message. Thus before the restoring motor has released the secondary motor during the transmission of the message the main motor has operated in response to the signal and carried the detent back to its original locking position. After the message is completed however, so that the said detent is no longer set back by the successive actions of the main motor, the restoring motor completes its operation releasing the secondary motor and allowing it to complete its cycle until it resumes its normal condition. It thus becomes impossible for a message coming in over any circuit except the one which has control of the repeater to affect the said repeater, and it is also impossible for the makes and breaks in said other circuits which are produced at the repeater for the purpose of repeating the message which is being received, to affect the controllers pertaining to the said circuits, so that the said repeater is practically maintained in such a condition that it can respond solely to the circuit which first obtains control. The locking mechanism is also so constructed that the particular locking device which at the beginning of a signal has moved through the action of its controller to a position in which it is not operated upon by the initial movement of the secondary motor becomes by said movement so placed with

relation to the secondary motor that it in turn is operated upon by the final movement of said motor and carried thereby into its locking position. Thus if the circuit is open its controller will become locked by the said locking device which will be crowded into contact therewith by the motor and frictionally held there, but if on the contrary the said circuit is closed as it will be at the end of a signal except in case of accident, the said locking device not being frictionally held drops back to its normal position, ready for the next operation. Thus at every complete operation of the repeater, every locking device is moved to its locking position, those of the inactive circuits being thus moved at the beginning of the message, and that of the active or original circuit at the end. Furthermore, the said locking devices are so arranged with relation to their respective controllers as to positively engage and move them from their abnormal to their normal position if they are in such abnormal position at the time when the locking device is moved to its locking position. It should be stated in this connection that there are practically two locking positions for each locking device in one of which it not only locks its controller but opens and holds open the switch or circuit breaker controlling its own particular circuit through the repeater itself, the said circuit being momentarily closed by other means as has been already mentioned, at each closure of the active or original circuit, while in the other it locks its controller without so opening its circuit. Thus when the controller belonging to the active or original circuit is acted upon as above stated by the final movement of the secondary motor it is carried to a position in which it locks its controller provided that the said controller is not held up by the attraction of its armature, but not to the position in which it also breaks the circuit of said controller at the repeater this being obviously necessary owing to the fact that unless the circuit belonging to said controller is closed, the locking device will not return to its normal position. To the same end, the final movement of the said motor also acts upon the locking devices belonging to the other circuits and positively moves them from the position in which the controllers are locked with their circuits open at the repeater to the other position in which they are locked with their circuits closed at the repeater it being understood that they are retained in this position solely by frictional contact with the controllers the mselves and are free to return to their normal position if the said controllers are otherwise held; or in other words, if their respective circuits are in their normal closed condition. When the locking devices are in this latter position, moreover, there is no portion of them in position to be engaged by the secondary motor, so that they will remain there indefinitely so long as the controller is not held up by its armature, and subsequent operations of the instrument will have no effect on them.

Repeaters as before constructed have been controlled directly from the armatures of the magnets included in the different circuits of the system thus rendering it a matter of difficulty to arrange the instrument for a large number of circuits and also necessitating the installment of a new instrument when a new circuit is added to the system. This difficulty is obviated by the present invention the instrument embodying which is provided as has been described with a number of controllers each having a locking device, the said controllers consisting merely of a number of arms which may be arranged in a row it being possible to provide a large number of these controllers without complicating or increasing the size of the instrument, since the said controllers co-operate with a single train of mechanism common to all. The locking devices for the said controllers moreover, are so arranged that when the said controllers are not otherwise held in their normal position they will be operated upon by the said locking devices to hold them there and when performing this function the locking devices are not operated upon by any part of the repeater mechanism but will remain out of the way and inoperative until the said controllers are held in their normal positions by some other means as by being connected to an armature controlled by a magnet in a circuit. An instrument may therefore be made having a large number of controllers and any number desired of said controllers may be connected respectively to the armatures of electro magnets, placed in any convenient position, the controllers not so connected becoming locked at the end of the first message received over the instrument and remaining so indefinitely. If it is desired, however, to add a new circuit to the system it is only necessary to install an electro magnet and connect its armature to one of the said controllers the locking device belonging thereto being released and dropped into its operative position as soon as the said controller is held by the attracted armature to which it is connected.

Figure 1 is a side elevation of the instrument embodying the present invention, having two circuits connected therewith. Fig. 2 is also a side elevation of the said instrument, looking toward the side opposite that shown in Fig. 1. Fig. 3 is a detail showing the parts operated by the two motors in the position assumed just as the signal is received, but before the signal-repeating motor has begun to operate. Fig. 4 is a like detail showing the position of the parts at the end of a single operation of the signal-repeating motor, but before the restoring mechanism has begun to operate; and Fig. 5 is a modification.

It is to be understood of course that while but two circuits are shown in order to sim-

plify the illustration of the device the number of circuits operating through the instrument might be indefinitely multiplied by adding a corresponding number of electro magnets and controllers co-operating therewith; the instrument, as before mentioned, being commonly constructed with a number of such controllers so that circuits may be added at will. The armatures of the electro magnets 1 and 2 each of which is included in one of the said circuits are connected respectively by links 10 and 20 to controllers *a* consisting of upright, pivotally supported arms normally held by the attractive force of the said armatures in the position shown in Fig. 1, but provided each with a spring a^2 connected with the lower extremity thereof below the pivot a^3 upon which they are mounted so that their upper portions will move to the right, Fig. 1, when the armature is retracted owing to a break in the circuit. A spring catch or projection a^4 at the upper end of each of the said arms engages the upper portion of the hooked extremity b^2 of a rocker *b* which forms part of the locking mechanism, which will be hereinafter more fully described. A double detent a^5, a^6, is mounted on a pivot a^7 in the frame of the instrument and the finger a^5 of the said detent normally engages a pin a^8 upon an arm a^9 connected to a shaft a^{10}, which is operated by a suitable motor or train A, A^2, A^3, A^4, A^5, terminating in the fly A^6 which train as above mentioned may be called the main or signal repeating motor. A cross bar a^{11}, shown in section, Fig. 3, extends from the upper portion of said detent arm across the path of all the controllers *a* so that the retractive movement of any of them, which takes place when the magnet of the armature connected therewith is demagnetized, will operate the said detent to release the said main motor. The said detent is normally held by the action of the spring a^{12}, in such position that the cross-bar a^{11}, is in contact with the upper portion of the controllers *a* the springs a^2 of which however, are each strong enough to overcome the stress of the said spring a^{12}, so that when any of the said controllers is released by its armature it will move the said detent and release the signal repeating motor, said detent however, through the action of its own spring a^{12}, following the said controller when it is restored by its armature, back to its normal position. Thus when any of the circuits are broken by the first signal from the box located therein, the detent a^5, a^6, moves to the left Fig. 1, owing to the release of the armature belonging to the circuit thus broken, and the arm a^9 is in turn released by the detent allowing the shaft a^{10}, to turn nearly a complete revolution, the said shaft being stopped, however, by coming in contact with the finger a^6 of the said double detent as is necessary owing to the fact that the circuit remains open during a length of time greater than that occupied by a single revolution of the shaft a^{10}, so that the finger a^5 remains out of the path of the arm a^9.

A cam a^{13}, upon the shaft a^{10}, rotates therewith and carries upward the arm *c* of a rock shaft mounted on a pivot c^2 the opposite end of which rock shaft is provided with a toothed sector c^3 the movement of which due to the action of said cam is opposed by a spring c^4 the return movement of said sector under the influence of said spring being retarded by a suitable retarding train, a wheel C of which meshes with said sector. The said retarding train is a portion of the restoring mechanism which causes the parts to return to normal position after a signal is completed, and said train is, as it were, wound up by the cam a^{13}, at each rotation thereof. As shown in the present instance, the said retarding train consists of a pinion C^2 on the same shaft with the pinion C, the said pinion C^2 meshing in turn with a pinion C^3 carrying an escapement wheel C^4. The upward movement of said arm *c* releases the shaft b^3 which is operated upon by the locking train or motor B, B^2, B^3, controlled by the gear B^4 and the fly B^5, the said train being normally held stationary by means of an arm b^4 which engages with a pin c^5 upon the arm *c*. The said main and secondary motors consist respectively, of wheels A, B, mounted on a common shaft X and free to rotate thereon. A suitable spring is connected at one end to the wheel A and at its opposite end to the shaft X the said shaft X being connected to the wheel B by a ratchet *x* and pawl x^2 so that the spring may be wound up by turning the shaft X in the direction of the arrow, after which the stress of the spring will tend to rotate the wheel B in one direction and the wheel A in the opposite direction, this being a convenient arrangement since one spring thus suffices for both motors. The upward movement of the arm *c* of the restoring train releases the said arm b^4 allowing the shaft b^3 of the secondary motor to turn in the direction of the arrow Fig. 2, until a second arm b^5 thereon is brought in contact with said pin c^5 after the said shaft has completed about a quarter of a revolution. The said shaft rotates between the extensions b^6 and b^7 of the rockers *b*, and the said shaft is so shaped in cross section as shown, as to form a cam which is so arranged with relation to the rockers *b* that as the said shaft rotates the said cam engages the extension b^6, the extension b^7 or the surface b^8 between the said extensions, according to the position assumed by the rockers due to the action of their respective controllers, as will be described. The normal position of all the rockers is such that the extensions b^7 thereof are in the path of the edge of said cam, so that as the shaft b^3 rotates, the said cam lifts the said extensions, rocking the rockers on their pivots b^9 and depressing the hooked extensions b^2 at the opposite ends of the rockers until they reach the position best shown in Fig. 4, against the surfaces a^{14}, upon

the controllers a, thus locking said controllers in their normal position so that they cannot be retracted by their respective springs when released by their respective armatures.

The foregoing description applies to all the circuits which are found closed or inactive when a signal is received at the repeater, and it is clear therefrom that all the locking devices b when in their normal positions co-operate with the locking motor to lock out their respective controllers, and that they are brought to their locking positions by the initial movement of the said motor, which has thus far been described, and held there by said motor which becomes stationary at the end of said initial movement, being held by the engagement of the arm b^5 and pin c^5, the length of time during which it is so held being dependent upon the duration of the message, as will be hereinafter shown. While the said locking devices are collectively operated by the locking motor common to all of them, each one of said devices forms an independent locking device for its own controller and it is obvious that the said devices must be capable of operating differently under different circumstances, since it is necessary that the controller belonging to the circuit over which a message is being transmitted should remain unlocked in order to control the operation of the signal repeating motor at each successive signal of the message. Since the first operation which affects the repeater is a movement of one of the controllers due to the action of its spring a^2 when said controller is released by its armature, it is obvious that the locking device b belonging to the said controller may be made responsive to such movement in such a manner that it will assume a position out of the path of the locking motor and thus remain unaffected thereby. This is accomplished by so arranging each locking device that it tends to automatically move to such a position, being held in its normal position, however, by engagement with the controller, which in its movement from normal to abnormal position in response to a break in its circuit allows said locking device to become disengaged. As shown in the present instance, the pivot b^9 of the rockers b is placed at such a point that the inner ends of said rockers (*i. e.*, the ends having the projections b^6 and b^7) tend to fall, being held, however, in their normal positions by the hooked extensions b^2 engaging with the ends of the spring catches a^4 as shown in Fig. 1. When, therefore, one of the controllers is retracted upon being released by its armature, the spring catch a^4 moves to the inner edge of the hook b^2 upon the rocker b which belongs to the said controller so that the inner end of the said rocker b falls until stopped by the engagement of the upper surface b^{10} thereof with the said spring catch, this movement being sufficient to cause the extension b^7 to move out of the path of the cam carried by the shaft b^3 as shown in Fig. 3, which therefore does not when said shaft rotates engage the said rocker b to carry it to locking position, as is the case with the other rockers b which are still in their normal positions. At the end, therefore, of the initial movement of the secondary motor, the parts are in the positions shown in Fig. 4, the rockers b which belong to the inactive circuits being held in locking position by the engagement of their extensions b^7 with the cam carried by the shaft b^3 while the rocker b belonging to the active circuit is in a position to allow successive movements of its controller, the surface b^8 thereof, however, being in a position to be engaged by the final movement of the locking motor, as will be hereinafter set forth.

The various circuits through the repeater are completed by a series of springs d and e said springs e being mounted on a rock shaft e^2 operated by a cam a^{15} on the shaft a^{10}, at each rotation of said shaft under control of its detent, as before described. The said cam acts directly upon an arm e^3 connected with the said rock shaft e^2 as clearly shown in Fig. 2.

In order that the inactive circuits over which is to be repeated the message received from a box in the active circuit may be broken at the repeater in response to the first break in said active circuit and afterward momentarily closed in response to momentary closures in said active circuit, the rockers b, are adapted when operated upon by the locking motor to come in contact with the springs d extensions or pins b^{11} being preferably provided to engage the said springs as shown in Figs. 3 and 4, thus lifting the said springs out of contact with the springs e and holding them in this condition while the said rockers b remain in their locking position. The momentary closures are then effected in response to the successive operations of the main motor due to the momentary closures on the active circuit by means of the cam a^{15} upon the shaft a^{10}, of said motor, the said cam operating as before stated on the arm e^3 connected with the rock shaft e^2 the said arm being held against the surface of the cam by means of a spring e^4. Each rotation of the said cam therefore in response to the momentary closure at the box from which the message is being sent carries the said arm e^3 to the right, Fig. 2, thus rocking the springs e to the right and bringing them again into contact with the springs d which have been raised by the rockers b that have been acted upon by the secondary motor. Since the rocker b which belongs to the active circuit has not been operated upon by the said secondary motor it is obvious that the spring d belonging in the circuit thereof will not be lifted, so that the said circuit will remain in its normally closed condition during the operation of the repeater, the movement of the rock shaft e^2 merely increasing the pressure tending to close the contacts d and e belonging to said circuit so that no difference is

made therein during the successive signals which make up the complete message.

In order that the apparatus may be restored to its normal condition after a complete message has been received and transmitted over the various circuits, suitable restoring mechanism must be provided, and said restoring mechanism consists as shown in the present instance of a device for releasing the shaft b^3 when the message is completed and allowing it to finish its revolution into the position shown in Fig. 1; this final movement of said shaft being adapted to restore the repeater to its normal condition. That portion of the apparatus by which this is accomplished is best shown in Figs. 3 and 4, and comprises the arm c and segment c^3 before mentioned, said segment being normally held in the position shown in Fig. 3, by the spring c^4.

As has been hereinbefore described, when the arm b^4 is released by the upward movement of the arm c, the shaft b^3 rotates until the arm b^5 is stopped by the pin c^5 on the arm c in the position shown in Fig. 4. Under the action of the spring c^4 the segment c^3 moves to the right being retarded in the said movement by the retarding train, the said movement lowering the arm c so that the pin thereof travels toward the end of the arm b^5. The retarding train C is so timed, however, that a complete movement of the sector under the influence of its spring, takes longer than the longest interval between successive closures at a signal box and consequently before the said pin has reached the end of the arm b^5 a second closure and break forming a part of the signal have occurred, causing the motor A to operate, whereupon the cam a^{13}, again sets back the arm c to the position shown in Fig. 4, this operation being repeated until the end of the message, when the said segment under the influence of the spring c^4 is gradually carried back to the position shown in Fig. 3, thus releasing the arm b^5 and allowing the shaft b^3 to continue its movement until arrested by the arm b^4 coming in contact with the stop upon the arm c, said arm then being in its normal position, Fig. 3, the result of this final movement of the shaft b^3 being as follows:

Referring to Fig. 4, in which the locking device belonging to the active circuit is shown in full lines in the position which it assumes during the message while the locking devices belonging to the inactive circuits are shown behind the same, partly in dotted lines, in the position which they assume under the same circumstances, it will be seen that when the shaft b^3 completes its movement upon being released by the pin c^5, the edge of the cam carried by said shaft will pass by the ends of the projections b^7 of the locking devices belonging to the inactive circuits, so that the said locking devices will be no longer held thereby in their locking position. As long however, as the said inactive circuits remain open, the locking devices belonging thereto will be held in their locking position by the frictional engagement of their controllers a with the ends b^2 of the locking devices, since the said controllers are pressed inward by the action of their springs a^2 when not held by their respective armatures. It is necessary therefore to close the circuits through the repeater in order that the armature may become attracted, so as to leave the locking devices free to fall back to their normal position when the extensions b^7 thereof are disengaged by the shaft b^3. For this purpose, the extension b^6 is provided and adapted to be engaged by the opposite end of the cam carried by the shaft b^3 during the final movement thereof, the action of said cam thereon being sufficient only to lower the said rockers until the springs d are disengaged from the pin b^{11}, the extremity b^2 however not being moved far enough to pass off the surface a^{14} of the controller a. In this position of the locking devices, moreover, the engaging portions or extensions b^6 and b^7 are both completely out of the path of the cam carried by the shaft b^3 so that as long as the locking devices remain thus, they will not be affected by subsequent operations of the instrument. Thus if an accidental break has occurred in any of the said circuits the controller belonging thereto will not be held up by its magnet and its locking device will not drop to its normal position but will still hold its controller locked. If on the contrary the circuit is in its normal closed condition the closure of the circuit at the repeater due to the action of the cam carried by the shaft b^3 upon the arm b^6 will cause the armature belonging thereto to become attracted, holding up the controller and allowing the locking device to return to its normal position.

The same result might obviously be attained by making the springs d strong enough to move the rockers b against the frictional resistance caused by their engagement with the controllers; but a positive movement is insured by the use of the arm b^6, as shown. The same final movement of the secondary motor operates also upon the locking device belonging to the active circuit, the edge of the cam carried by the shaft b^3 in this case engaging with the surface b^8 and rocking the said secondary device on its pivot through a distance sufficiently great to bring the extremity b^2 thereof into engagement with the surface a^{14} of its controller but not sufficiently to cause the pin b^{11} to separate the spring d from its mate e, as is the case when the locking device is operated upon by the initial movement of the controller. If therefore, for any reason the controller belonging to the said circuit were not held up by its armature it would be mechanically crowded back by the said locking device and frictionally held in its locking position, the position assumed under these conditions being such that the circuit through the repeater is complete, while the locking device is no longer engaged by any subsequent movement of the locking mo-

tor and is capable of being restored to its normal position only by otherwise supporting the controller in its normal position so that the locking device is no longer frictionally engaged after which its return to said normal position is automatic. Thus when an accidental break occurs on any of the circuits a single signal-stroke will be repeated over all the remaining circuits, after which the restoring mechanism is operated and in its operation brings the locking device to its locking position as above described, where it will be frictionally retained since the controller will remain retracted owing to the fact that there is no closure subsequent to the break which caused the apparatus to operate.

The operation of the repeater in responding to changes in a circuit which has been previously started, to the exclusion of any other circuit which may subsequently be started, has now been described, but it is necessary also to show what the operation will be if signals on any two or more circuits are started absolutely simultaneously. Assuming, therefore, that the two circuits herein shown were broken simultaneously, each by the first signal of a message coming in from one of its own boxes, it will be seen that both the controllers will release their respective locking devices so that the operation of the secondary motor will have no effect upon either of them. The same will be true of successive closures which go to make up the message, as long as the said breaks continue in unison. As soon, however, as the first long break of the message having the smaller initial number occurs, the circuit thereof will remain open and the controller a belonging thereto will remain in its forward position due to the action of the spring a^2, thus holding the arm a^9 in contact with the arm a^6 of the double detent so that the main motor cannot operate until the said controller is again restored by the action of its armature. The successive closures on the other circuit can therefore have no effect on the repeater, since the motor is thus held until the end of the long break, at which time the controller which has thus held the motor inoperative is attracted; but this will occur during a time when the other circuit is broken, and said other circuit will therefore in its turn hold the motor inoperative. So long, therefore, as the closures on the two circuits in question do not coincide, it is evident that the motor will be held inoperative. During the period of time, however, that it is thus held inoperative the restoring train is running down, and as soon as the restoring mechanism is released thereby, the controllers of the two interfering circuits are both restored to their normal condition, and the circuit in which the first closure occurs thereafter will get possession of the repeater as hereinbefore described, and bring in its message to the exclusion of all others. Since the closures which cause the successive signals of a message are of the briefest possible duration it is evident that a very slight deviation from absolute unison in the case above described will serve to render the repeater inoperative, until the restoring motor has run down, and as commonly arranged the interval between successive groups of closures is not an exact multiple of the interval between the closures of a group, so that unison cannot be maintained after the lesser group of closures of the two signals is ended.

In Fig. 5 is shown a modification in which the permanent locking out of a broken or disused circuit is effected by means of a latch operated by an auxiliary armature, instead of being held by the frictional contact of the locking device as has been thus far described. In this case, the controller a is provided with a pin or projection a^{16}, adapted to co-operate with a latch f^2 at the end of an arm f mounted on a pivot f^3 and provided at the end opposite the said latch with an armature f^4 shown in this instance as in the field of force of the magnet which operates the main controller, it being essential only, however, that it should be responsive to the same circuit changes. The said bar f is provided with means for somewhat retarding its movement, or otherwise made to respond to a break in the circuit a trifle later than the main armature, said bar being shown as nearly balanced on its pivot f^3 by the weight f^5, said weight, however, being sufficient to cause it to rock slowly, when released. When the apparatus is in its normal condition, the said bar is in the position shown in full lines Fig. 5, but upon a break occurring in the circuit its armature f^4 will cease to be attracted and the said bar will move to the position shown in dotted lines. Since the controller a however, is positively actuated by a strong spring a^2 the said controller will move much more rapidly than the bar f so that by the time the said bar has reached the dotted line position, the pin a^{16}, will have passed beyond the latch f^2 so that it will not be engaged thereby. Thus under normal conditions of breaks and closures the controller a will be free to move in its usual manner; but if, after a signal has been repeated, the circuit to which the controller belongs remains open, the latch will stand in dotted line position so that when said controller is restored to its normal position by the action of the rocker b due to the final movement of the secondary motor, the pin a^{16} will pass over the inclined surface of the latch f^2 and be caught behind the said latch and permanently retained as long as the circuit remains open. A projection f^6 at the outer end of the latch f^2 may also be provided and adapted to co-operate with a pin a^{17}; the parts being so arranged that said pin engages the projection after the controller has passed beyond the latch; the object being to insure the disengagement of the armature end of the bar f from its magnet, if held by residual

magnetism, as it might be, since it is so nearly balanced that a very slight attraction will hold it.

The operation of the device may be briefly summarized as follows: When a message is sent in over any of the circuits the first break in the said circuit releases the controller belonging thereto, allowing its own particular locking device to fall into the position in which it cannot be operated upon by the initial movement of the secondary or locking motor. The release of the said controller at the same time operates the detent which controls the main or signal repeating motor. The said main motor thus turns through substantially a complete revolution and during its movement releases the secondary motor, allowing the said secondary motor to make its initial movement, the said initial movement of said secondary motor carrying all of the locking devices except the one which has been released by its controller into their locking position. At the same time, the said locking devices in moving from their normal to their locking positions co-operate each with one of the several contacts *d*, separating them from their mates *e* each locking device thus opening its own circuit through the repeater. At the end of its initial movement the secondary motor is held substantially stationary by the engagement of the arm b^4 with the pin c^5 of the restoring motor, while the remaining signals which go to make up a complete message are being received and repeated through the action of the controller. The said signals are repeated by means of the main motor which operates through one revolution at the break succeeding each momentary closure in the active circuit, the contacts *e* being operated upon thereby to momentarily close their respective circuits at each successive operation thereof. At the end of the message the restoring motor, which has been wound up at each operation of the main motor before it has run down sufficiently to carry the pin c^5 over the end of the arm b^4 and release the secondary motor, runs down and releases the said secondary motor, which then makes its final movement carrying the locking device belonging to the active circuit into its locking position and releasing the other locking devices, so that they are no longer held in position to open their respective circuits. During the same movement said secondary motor preferably positively engages the said other locking devices and moves them far enough to disengage them from their contacts but does not positively move them from their locking positions. After this final movement of the secondary motor, therefore, all of the locking devices have been thereby carried to and left in their locking positions with their circuits closed through the repeater, and in their movement to said locking positions have positively engaged any controller found in abnormal position, and restored it to its normal position and means are provided whereby the said locking devices are either held in this locking position or not, according to the condition of their respective circuits. If their circuits are all closed, as they normally would be at the end of a message, the said locking devices are all free to return from their locking positions in which they are thus left, to their normal positions, completely restoring the repeater to its operative condition. Moreover this final locking position is such that the locking motor will not, in any of its movements, engage the locking devices thus held. If on the contrary, any of the said circuits are broken accidentally, or intentionally not included in the system, its controller will remain permanently locked and its locking device will not be removed from the locking position at any subsequent operation of the instrument until its controller is held in its normal position by external means, as by connecting it to an active circuit or repairing the broken circuit in which it has been used.

The invention is not limited to the specific form and arrangement of the operative parts herein shown, since various modifications might be made therein, without substantial departure from the essential characteristics of construction and operation hereinbefore described. Such construction, however, is believed to be the simplest and is thoroughly practical and efficient.

I claim—

1. In a fire alarm telegraph repeater the following elements in combination, namely—a controller for each circuit adapted to operate in response to a change in the condition of said circuit; a main motor or train controlled by a detent adapted to operate in response to any of the said controllers; a secondary motor adapted to be released by the movement of said main motor; a circuit closer at the instrument for each circuit, means operated by the secondary motor for opening said circuit closers at the beginning of a message and retaining them normally open until the end of said message, and an actuator for momentarily closing the said circuit closers at each operation of the main motor, whereby the circuit closers of the receiving circuits are opened at the beginning of the signal and produce the repeated signal by momentary closures, substantially as described.

2. In a fire alarm telegraph repeater, a controller adapted to respond to circuit changes effected at a signal box located in the circuit to which it belongs, a locking device consisting of a rocker normally held by said controller in a position to be engaged by a cam operated by a secondary motor, an extension forming part of the said rocker adapted when said rocker is engaged and moved by said cam to engage and render inoperative the said controller, and a portion of said rocker adapted to engage one member of a circuit closer at the repeater and thus open the circuit belonging to the said rocker through the repeater, substantially as described.

3. The combination with two or more circuits, of a magnet and armature in each circuit, a controller for each circuit adapted to respond to a movement of the armature therein, a train and detent therefor, the said detent being operated to release the said train by a movement of any of said controllers, independently movable locking devices one for each of said controllers; a secondary motor adapted to cooperate with said locking devices when in their normal positions; and means for shifting any of said locking devices from its normal position to a position in which it cannot be operated by said secondary motor, as set forth.

4. The combination with two or more circuits, of a controller for each circuit adapted to respond to changes therein, a secondary motor controlled by said main motor, an independent locking device for each controller adapted to move automatically to a predetermined position, and engaging portions of said locking device adapted to cooperate with said secondary motor and controller respectively, substantially as and for the purpose described.

5. The combination with two or more circuits, of a controller for each circuit adapted to respond to changes therein, a signal repeating motor responsive to any of said controllers, a secondary motor controlled by said signal repeating motor, a locking device for each controller, a pivotal support for said locking devices at a point removed from the center of gravity thereof, engaging portions at one end thereof, one of which portions is engaged by the controller in its normal position, and the other when said controller is moved in response to a change in its circuit allowing said locking device to rock on its pivot, and engaging portions at the opposite end of said locking device adapted to be engaged by the said secondary motor, the cooperation of said motor with said engaging portions being dependent upon the position of said locking devices determined by their relation to said controllers, as and for the purpose set forth.

6. In a fire alarm telegraph repeater, the combination with two or more circuits, of a controller for each circuit responsive to changes in the condition thereof, locking mechanism comprising a motor and a number of independently movable locking devices, each normally held by one of said controllers in a position to be operated upon by the initial movement of said motor to lock its controller, but adapted to move automatically when released by its controller to a position in which it is not operated by said initial movement of said motor, said locking devices each having a portion adapted to be engaged when said locking device is in normal position by said motor to move said locking device to its locking position and means for causing said motor to make its initial movement at the first signal and its final movement at the completion of a message, as set forth.

7. A fire alarm telegraph repeater having a number of independent controllers each adapted by its movement from a predetermined position to control the operation of the instrument and also to be cooperatively connected to the armature of an electro magnet and held thereby in said position, a spring or weight for each controller operating when unopposed to cause such movement, an independent locking device for each controller, and means for moving all of said locking devices to their locking position at each complete operation of the repeater, and retaining all or any of them in such position until said controllers are otherwise held in their normal positions, substantially as described.

8. The combination with two or more circuits, of a controller for each circuit adapted to respond to changes therein, a main motor adapted to operate in response to a movement of any of said controllers, and a secondary motor adapted to restore said controllers to their normal positions, as set forth.

9. The combination with two or more circuits, of a controller for each circuit adapted to respond to changes therein, a main motor adapted to operate in response to a movement of any of said controllers, a secondary motor controlled by said main motor, and independently movable devices, one for each controller, adapted to be operated by the said secondary motor to restore said controllers to their normal positions, substantially as described.

10. The combination with two or more circuits, of a controller for each circuit adapted to respond to changes therein, a main motor adapted to operate in response to a movement of any of said controllers from its normal position, a secondary motor controlled by said main motor, and having an initial and a final movement, and independently movable devices, one for each controller, adapted to be operated by the final movement of said secondary motor to restore said controllers to their normal positions, substantially as described.

11. The combination with two or more circuits, of a controller for each circuit, independently movable locking devices, one cooperating with each controller, a circuit closer for each circuit, an engaging portion of each locking device adapted when said locking device is in locking position to engage one member of the circuit closer in its own circuit and thus open said circuit, and a locking motor adapted to carry said locking devices to said position and retain them there until the close of the message, as set forth.

12. In a fire alarm telegraph repeater having a controller for each circuit of the system, locking mechanism for the several controllers consisting of a motor and means for imparting the initial and final movement thereto, a

locking device for each circuit, an engaging portion, as b^7, of said locking device adapted to be engaged by said secondary motor during its initial movement, whereby said locking device is carried to a position to lock its controller and open its own circuit through the instrument, and an engaging portion, as b^6, adapted to be engaged by said secondary motor during its final movement, whereby said locking device is carried to a position to lock its controller and close its own circuit through the instrument, substantially as described.

13. In a fire alarm telegraph repeater having a controller for each circuit of the system, the combination with said controllers, of an independently movable locking device for each, a motor adapted to cooperate with all of said locking devices, engaging portions of said locking devices adapted to be engaged by said motor at the final movement thereof, whereby all of said locking devices are carried to a position in which they lock their respective controllers and remain unaffected by subsequent operations of the controller, and means for retaining said locking devices in such position dependent upon the condition of their respective circuits, substantially as described.

14. In a fire alarm telegraph repeater, the combination with a number of controllers each having a locking device adapted to be operated by a secondary motor common to all, said motor being adapted by its initial movement to lock all the controllers except the one belonging to the active circuit, and a main motor adapted by its first operation to release said secondary motor and permit it to make its initial movement, and by its subsequent operations to repeat the signal over the inactive circuits; of restoring mechanism consisting of a train adapted to be wound up at each operation of said main motor, and a detent carried by said train adapted to arrest and hold said secondary motor in position to lock said controllers, until said train is run down; the final movement of said secondary motor thus released restoring the locking devices to their normal positions, substantially as described.

15. In a fire alarm telegraph repeater, a motor adapted at each operation to cause a signal to be repeated, a detent for said motor adapted by its movement from a normal to an abnormal position to permit said motor to move through a predetermined cycle and to arrest and retain stationary said motor at the completion thereof; and a controller for each circuit adapted when said circuit is open to move said detent from its normal to its abnormal position and retain it there until said controller is restored to its normal position, substantially as described.

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

MOSES G. CRANE.

Witnesses:
H. J. LIVERMORE,
M. E. HILL.