(No Model.) 2 Sheets—Sheet 1.

# A. M. A. BEALE.

## MULTIPLE TELEGRAPH SYSTEM.

No. 360,988. Patented Apr. 12, 1887.

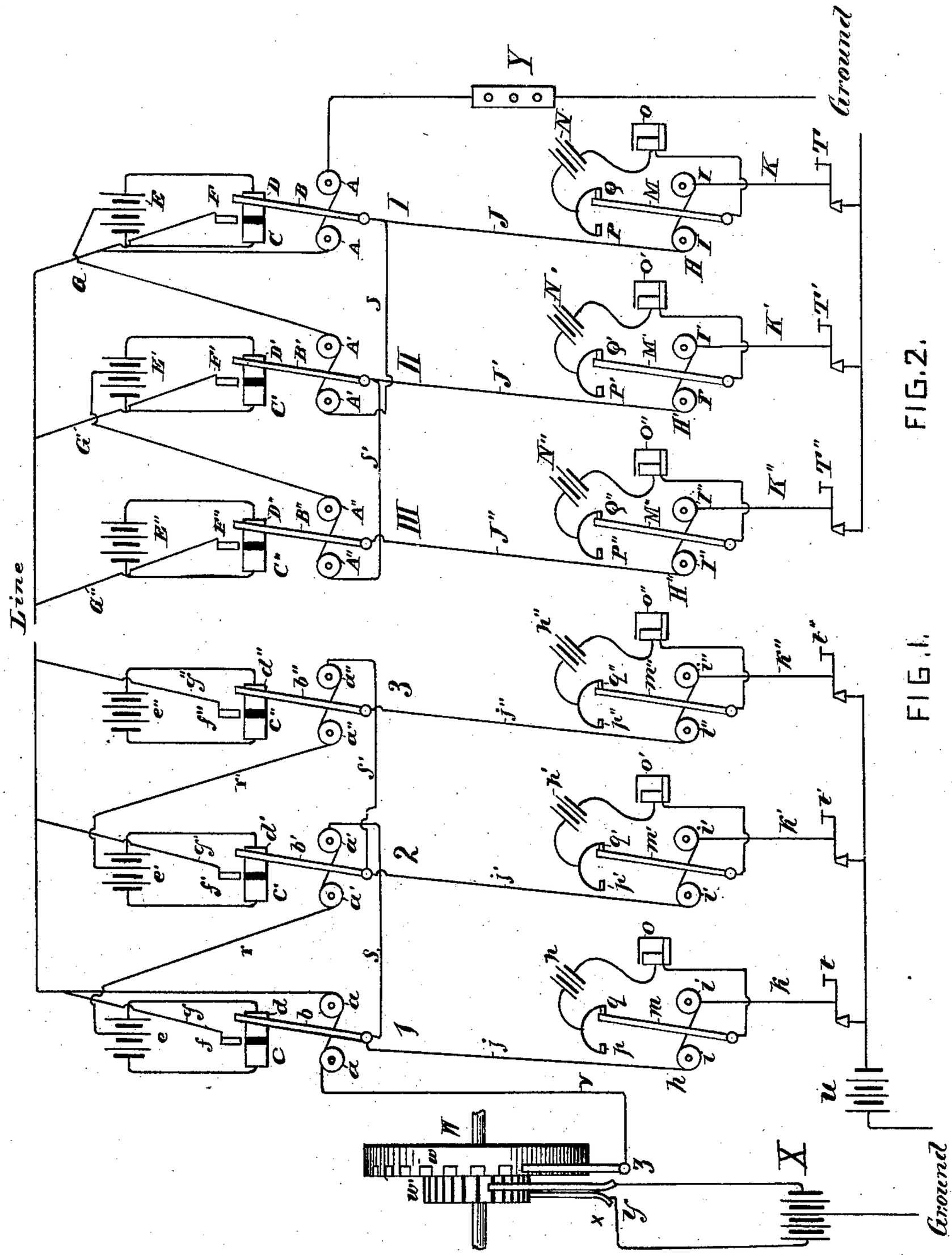


FIG. 2.

FIG. 1.

WITNESSES

C. W. Benjamin

Edgar Goodwin

INVENTOR

Alfred M. A. Beale

by Rufus Benjamin

his Attorney.

(No Model.) 2 Sheets—Sheet 2.

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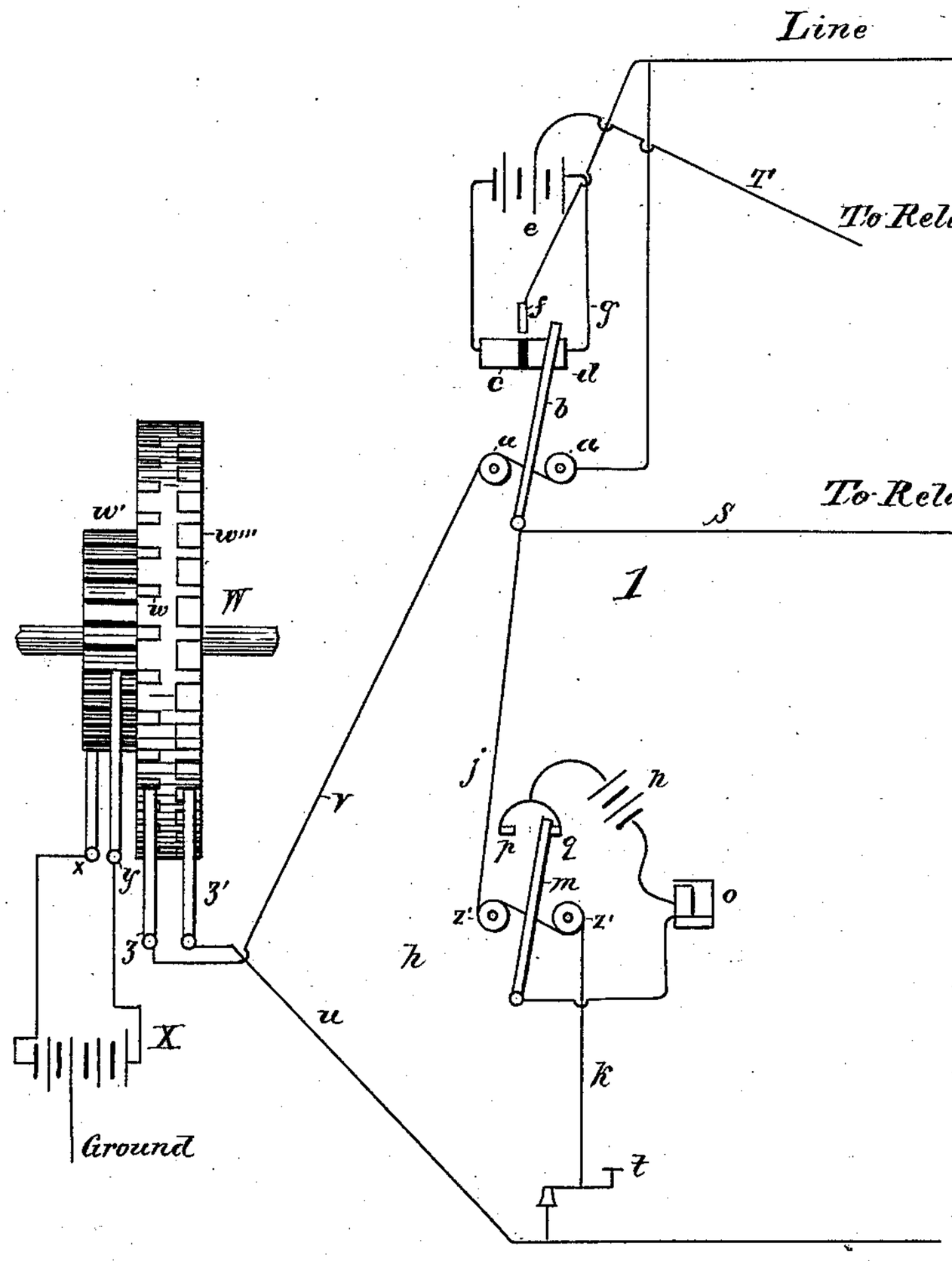


FIG. 3.

WITNESSES
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# UNITED STATES PATENT OFFICE.

ALFRED M. A. BEALE, OF NEW YORK, N. Y.

## MULTIPLE TELEGRAPH SYSTEM.

SPECIFICATION forming part of Letters Patent No. 360,988, dated April 12, 1887.

Application filed July 27, 1886. Serial No. 209,260. (No model.)

*To all whom it may concern:*

Be it known that I, ALFRED M. A. BEALE, of the city, county, and State of New York, have invented a new and useful Improvement in Multiple Telegraphic Systems, of which the following is a specification.

In another application for Letters Patent filed simultaneously herewith and serially numbered 209,261, I have claimed the improvement in the art of multiple telegraphy as hereinafter set forth. In my present application I therefore do not claim said improvement in the art.

My invention has for its object the transmission of practically a large and theoretically any number of messages in the same direction over a single conductor at the same time, and their reception simultaneously and separately.

Assuming a line, a certain number of operators—say six—at one end, and an equal number of receiving-operators at the other end, my invention involves the giving to each sending-operator and his corresponding receiving-operator entire control of the line for a certain interval of time. Each pair of operators (sending and receiving) has control of the line in turn—that is to say, circuit is completed through between the first pair of operators, then between the second pair, then between the third pair, and so on for as many pairs as there may be; or, in other words, the line opens intermittently for each sending-operator in turn, and while it is so open for him his signals go upon the line; but while it is open for any other operator his signals do not go to line. In this way the line opens for operator No. 1, then for operator No. 2, then for operator No. 3, and so on until, say, operator No. 6, or the last operator in succession, has his turn. Then operator No. 1 has his turn again, and so on. Now, although operator No. 1 has thus to wait, so to speak, until all the other operators have had their turns, yet in practice this period of delay is so infinitesimally short that he may write continuously, and to the senses there will be no break in the continuity of his signals. The same thing is equally true of all the other sending-operators; and so, while in fact their signals are successive, the practical effect is as if all the messages were coming over the single conductor at one and the same period.

Assume three telegraphic relays. Assume that a current sent into relay No. 1 causes its armature to move so as to close a local circuit through relay No. 2, and that the movement of the armature of relay No. 2 closes a local circuit through relay No. 3. Clearly the armature of relay No. 2 cannot begin its motion until the armature of relay No. 1 has completed some part of its stroke and has moved sufficiently to establish circuit to relay No. 2. Equally the armature of relay No. 3 cannot begin its movement until the armature of relay No. 2 has moved over some portion of its path. Therefore it follows, necessarily, that although to the senses these three armatures may appear to begin and complete their movement in precisely the same instant of time, they do not, in fact, do so; but, on the contrary, the armature of relay No. 2 follows the armature of relay No. 1, and the armature of relay No. 3 follows the armature of relay No. 2, and this would be the case, theoretically, for an infinite number of relays. The result is that between the successive movements of the armatures there are electrically-utilizable instants or intervals of time, and there are as many successive instants or intervals as there are armatures. At each of these instants a different event may happen, or a different person or mechanism be given an opportunity to act. If, then, at each successive instant I arrange matters so that a different operator may have independent communication with the line, then clearly each operator will in turn, as above described, be enabled to send his signals upon the line without regard to the signaling of the other operators.

The mode in which I carry this principle into practical effect is simply this: After the armature of relay No. 1 starts, and before it establishes the contact which allows a current to pass to relay No. 2, I cause it to establish temporarily a circuit direct to line through the key of operator No. 1. Operator No. 1 can then signal. As soon, however, as the armature of relay No. 1 has broken this contact with the line, it establishes the current to relay No. 2, and the armature of that relay moves in like manner, and during its passage establishes a line-connection for operator No. 2. In the same way the armature of relay No. 3 is started and a line-connection made in the same manner for

operator No. 3; but to the senses these three relay-armatures appear to move simultaneously, and thus the line-connections seem to be simultaneous, and the operators may write sensibly at the same time, although their signals go to line at successive but very rapidly-recurring intervals, and therefore do not mutually interfere.

In the accompanying drawings, Figure 1 is a diagram showing the apparatus and the arrangement of circuits at the transmitting end of the line. Fig. 2 is a diagram showing the apparatus and the arrangement of circuits at the receiving end of the line, and Fig. 3 is a diagram showing a modification of the circuit-breaking wheel and circuit therefrom.

Similar letters of reference indicate like parts.

I will first refer to the transmitting end of the line, which is represented in Fig. 1. At W is a wheel or disk, of insulating material, having on its periphery equally-spaced contact-plates *w*. Attached to said disk is a commutator, *w'*, the contact-plates of which communicate with the contact-plates *w*. *x* and *y* are springs or brushes which bear against the commutator-plates, the brush *x* being in contact with a plate when the brush *y* is in contact with the insulating material between said plates, and vice versa. The brushes *x* and *y* communicate with the poles of a split battery, X, which also connects with ground. Bearing against the plates *w* on the periphery of wheel W is a brush or spring, *z*. Any suitable means—such as a train of gearing operated by a descending weight—may be provided for causing the uniform rotation of the wheel W. It will be readily understood that by this arrangement the current from the battery X passes to the contact-plates *w* on wheel W alternately in opposite directions, so that the brush or spring *z*, as it meets each plate in turn, conducts away alternately positive and negative currents. At 1 is a polarized relay, of which *a a* are the magnets and *b* the armature. In proximity to the armature *b*, I arrange two contact-plates, *c d*, insulated from each other. With these plates the armature *b* makes electrical contact during its passage or vibration between the poles of the magnets *a a*. I so dispose these contact-plates and make them of such dimensions that during all of its period of travel, except when it is passing over the narrow interval or strip of insulating material between said plates, the armature *b* maintains electrical contact with one or the other of said plates. The plates *c* and *d* are connected to the terminals of the local battery *e;* also in proximity to the armature *b* is a contact-plate, *f*. This plate is so disposed that the armature *b* makes contact with it just at the middle of the stroke of said armature, or rather just when said armature is passing over the interval or partition of insulating material between the plates *c* and *d*. Consequently the armature *b* completes contact with the plate *f* when it is not in contact with either the plate *c* or the plate *d*, and vice versa; or, in other words, in moving over from one pole to the other, the armature for nearly half its stroke maintains contact with the plate *d*, for example, then passes over the interval between plates *c* and *d*, and during said passage makes contact with the plate *f*, and, finally, after leaving plate *f*, makes and maintains contact with the plate *c;* hence, for a very brief period during the middle of its vibration, the armature *b* establishes connection with the plate *f*.

I have referred to the parts *c*, *d*, and *f* as plates, and described them as if the armature *b* actually wiped across them. I do not mean to limit myself to such specific arrangement, because other devices may be arranged to perform the same result, and also because I have invented a special mechanism for the purpose, which I do not here describe or claim, because I intend to make it the subject for another application for Letters Patent hereafter to be filed.

The brush or spring *z* connects by wire *v* to the relay-magnets *a a*, and thence to line. The contact-plate *f* is also connected to line by wire *g*. At *h* is another polarized relay, the magnets *i i* of which are connected by wire *j* to armature *b*, and by wire *k* to a key, *t*. This key makes and breaks contact with the battery *u*. The armature *m* of the relay *h* is in local circuit with a local battery, *n*, a sounder, *o*, and in branch with the two stops or points, *p* and *q*, with one or the other of which the armature *m* makes contact, according as it is moved to one side or the other.

I will now, before proceeding further, describe the operation of the above-detailed portion of my apparatus. It has already been stated that the brush or spring *z* receives alternately positive and negative currents as the contact-plates *w* on wheel W successively pass under it. The effect of these rapidly-reversing currents entering the magnets *a a* of the polarized relay 1 is to cause the armature *b* to vibrate from one side to the other as often as the direction of the energizing-current is reversed. These currents pass to line; but it should be clearly understood that they are not signaling-currents. Their function is to vibrate the armature *b* in the first instance, and a corresponding armature at the other end of the line, as will be explained further on. Now, leaving out of consideration for the moment the contact-plates *c* and *d* and local battery *e*, thereto connected, it will be clear that, inasmuch as during each vibration the armature *b* makes temporary contact with the plate *f*, therefore during the period of said contact circuit is established from the battery *u* through the relay *h* to the armature *b*, plate *f*, and so to line. Consequently, during this period of contact of armature *b* and plate *f*, it will be possible to send signals upon the line by the manipulation of the key *t;* and, furthermore, if the wheel W be rapidly rotated, the vibration of the armature *b* will be correspondingly

fast, the times of contact of armature *b* and plate *f* will recur more frequently—in fact so frequently as to be for practical purposes continuous—and a sensibly uninterrupted series of signals may be sent.

The point which I desire to make clear here is, that I have an armature vibrating rapidly between the poles of a relay, which armature during each vibration and at or about the middle of its stroke establishes a circuit for signaling purposes from a battery to line. The circuit, which includes the armature *m* of the relay *h*, and also the local battery *n* and the sounder *o*, is provided for receiving purposes, and will be referred to more particularly hereinafter with reference to the receiving end of the line.

Returning now to the contact-plates *c* and *d*, which, as has been stated, are in circuit with the local battery *e*, it will be observed that said battery is split and is connected by the wire *r* to the polarized relay 2. This relay 2 is in all respects like the relay 1. Its armature *b'* makes contact with plates *c'*, *d'*, and *f'* in the same way as does the armature *b* with the plates *c*, *d*, and *f*. The plates *c'* and *d'* are in circuit with the local battery *e'*. The plate *f'* is connected to line by the wire *g'*. At *a' a'* are the relay-magnets. The armature *b'* is connected to the local battery *u* by the wires *j'* and *k'* through the relay *h'*, and in connection with the armature *m'* of said relay there is arranged a local circuit containing contact-points *p'* and *q'*, battery *n'*, and sounder *o'*, similar in arrangement and function to the corresponding parts associated with the relay *h*. A key, *t'*, similarly arranged to the key *t*, is also provided.

I have explained hitherto what takes place while the armature *b* is in contact with the plate *f*, and I have stated that this contact of said armature and plate *f* occurs when said armature is not in contact with either the plate *c* on one side or the plate *d* on the other. I propose now to consider what takes place when the armature *b* is in contact with either the plate *c* or the plate *d*, and hence is out of contact with the plate *f*. The circuit from the split battery *e* proceeds, as has been stated, to the magnets *a' a'* of relay 2 by wire *r*. Said circuit continues by wire *s* to the armature *b* of relay 1. Consequently, when the armature *b* is in contact with the plate *d*, there is a closed circuit from one side of the battery *e* to said plate *d* to the armature *b*, thence by wire *s* to the magnets *a' a'* of relay 2, and thence by wire *r* back to the battery *e*; or when the armature *b* is in contact with the plate *c*, then the circuit is completed from the other side of the battery *e*. Hence, while the relay 1 is operated by the reversing currents from the wheel W, the relay 2 is operated by the battery *e* in local circuit, the current from which is controlled by the movements of the armature *b* of the relay 1; for, of course, when the armature *b* of relay 1 is on the plate *c*, the current from the split battery *e* proceeds to the magnets of relay 2 in one direction, and when said armature is on the plate *d* the current from said battery proceeds to the relay 2 in the other direction, and therefore the armature *b'* of the relay 2 is caused to vibrate in manner similar to the armature *b* of relay 1. Now let it be supposed that the armature *b* of relay 1 is in the position shown in the drawings—that is, in contact with the plate *d*. Let it further be supposed that the next current, which comes to the relay 1 from the wheel W, is such as to reverse the polarity of said relay 1. Then the armature *b* will move over to the plate *c*, making contact on the way with the plate *f*. As soon as the armature *b* completes contact with the plate *c*, then the circuit, which includes said armature and the relay 2, and which is broken during the period that the armature *b* is in contact with the plate *f*, is re-established, and the armature *b'* of the relay 2 moves over to make contact with the plate *c'*.

It is important that the relation of the movement of the two armatures (*b* of relay 1 and *b'* of relay 2) should be clearly apprehended. The armature *b* starts from plate *d*, breaks contact therewith and simultaneously makes contact with plate *f*, then breaks contact with plate *f* and simultaneously makes contact with plate *c*. Now, when the armature *b* makes contact with plate *c*, and not until then, the circuit is established to the relay 2, so that its armature *b'* can begin to move. Consequently, although to the senses the two armatures (*b* of relay 1 and *b'* of relay 2) appear to move at and in precisely the same instants, the fact is that they move, and necessarily must move, successively—this for the simple reason that relay 2 does not receive the current which starts its armature until the armature of relay 1 has completed more than half its stroke. It follows, therefore, that the contact of armature *b'* of relay 2 with its line contact-plate *f'* occurs after the contact of armature *b* of relay 1 with its line-plate *f*, and therefore there are two successive periods of time when signals may be sent on the line, first by the key *t* and then by the key *t'*. Consequently, if these keys are manipulated by two operators, although, to all appearances, said operators may write simultaneously, yet in fact their signals will go upon the line successively, and there will be no interference between the signals sent by the respective operators. The operator working key *t* will have the line while the armature *b* of relay 1 is in contact with its line-plate *f*. The operator working key *t'* will have the line when the armature *b'* of relay 2 is in contact with its line-plate *f'*. The second event necessarily follows the first. Therefore each operator has independent communication with the line for a certain brief interval; but the intervals or turns of each operator recur with great frequency. For practical purposes there are no breaks between them. Therefore each of the two operators manipulates his key in the ordinary way, and both at once send, sensibly, an uninterrupted series of signals on the line.

At 3 is a relay in all respects like relays 1

and 2, and with it are associated parts and mechanism also similar to the corresponding parts and mechanism associated with relays 1 and 2, $a''$ $a''$ being magnets similar to $a$ and $a'$, $b''$ an armature similar to $b$ and $b'$, $f''$ a line contact-plate similar to $f$ and $f'$, and so on. The armature $b'$ of relay 2 is in circuit with the magnets of relay 3 through the wires $r'$ and $s'$ in the same way as the armature $b$ of relay 1 is in circuit with the magnets of relay 2 through the wires $r$ and $s$. Consequently, from what has been already explained, it will be apparent that the movement of the armature $b''$ of the relay 3 occurs after the movement of armature $b'$ of relay 2, so that if three operators manipulate, respectively, the three keys $t$ $t'$ $t''$ each operator will in turn have independent connection with line, and the conditions will be the same as already described with reference to two operators—that is, all three may write simultaneously, and all three sets of signals, for the reasons already given, will pass over the line without mutual interference. What is true of three relays is equally true of four, the fourth set of instruments being the same as each of the other sets and connected to relay 3. So, also, a fifth set may be added, a sixth, and so on, until, as the result of this system, theoretically, any number of operators may transmit sensibly simultaneous messages over a single-line conductor, so that the capacity of said conductor is thus indefinitely increased.

Passing now to the receiving end of the line, Fig. 2, it will be apparent that the arrangement here is substantially the same as at the transmitting end. Thus there are three sets of relays, I, II, and III, in all respects like the relays 1, 2, and 3. The armatures B, B', and B'' correspond to the armatures $b$, $b'$, and $b''$. The armature B of relay I moves to make and break contact with plates C, F, and D, the same as does armature $b$ of relay 1 to make and break contact with plates $c$, $f$, and $d$. The mechanism associated with relay I, and marked A B C, &c., corresponds to the mechanism associated with relay II, and marked A' B' C', &c., and with that of relay III, and marked A'' B'' C'', &c. The mechanism associated with the relays I, II, and III, and marked, respectively, A B C, &c., and A' B' C', &c., and A'' B'' C'', &c., corresponds to the mechanism associated with the relays 1, 2, and 3, and marked $a$ $b$ $c$, &c., and $a'$ $b'$ $c'$, &c., and $a''$ $b''$ $c''$, &c. The line communicates with magnets A of relay I, and thence connects to ground through a resistance, Y. The keys T T' T'' also communicate to ground.

The first current which comes over the line is the one from the wheel W, and this, as I have already stated, is not a signaling-current. It passes simply through the coils of relay I, through the resistance Y, and so to earth; but this current starts the armature $b$ of relay 1 at the transmitting end. Equally it starts the armature B of relay I at the receiving end of the line. Consequently these two armatures move precisely together. Therefore the armature $b$ makes contact with its line-plate $f$ at the same time as the armature B makes contact with its line-plate F. Therefore a clear circuit is opened for the current from battery $u$ through the key $t$, armature $b$, and plate $f$ to line, over the line to plate F, armature B to key T, and ground. In fact there are two paths for the current at the receiving end—that already stated and to ground through the resistance Y. The object of interposing resistance in the direct ground-connection is to cause the greater part of the current to pass to earth by way of the relay H and key T. The utility of the local battery N and sounder O in circuit with said relay H will now be obvious. The current from battery $u$, after coming over the line, passes by plate F to armature B, and so to relay H. With a direct current from a battery, it is of course necessary to adjust a polarized relay in a certain way, so that its armature will be vibrated. Otherwise, with the relay as ordinarily arranged, an alternately-reversing current would be necessary. As this mode of adjusting polarized relays is known to electricians generally, it is not necessary to describe it here; but it should be understood that, whether through an actually alternating current or whether through a direct current, with a suitable adjustment of the relay, the armature M of the relay H is in fact set in vibration. During its vibration, which is very rapid, this armature strikes the stops P and Q, but does not remain in contact with either stop long enough to close the circuit from the local battery N which passes through the sounder O; but if the key at the other end of the line is opened, then the armature M makes contact with one or the other stop, P or Q, and remains in such contact as long as the key remains open. In this way the sounder is caused audibly to indicate the transmitted signals.

So far I have referred only to relay 1 at the transmitting end and relay I at the receiving end of the line, and I have explained how signals sent by key $t$ are received by sounder O; but it will be remembered that the instant the armature $b$ of relay 1 leaves the line-plate $f$ and makes contact with the plate $c$, the current is passed to relay 2. The same thing happens at the receiving end. The armature B of relay I reaches its contact-plate C at the same instant as the armature $b$ of relay 1 reaches its contact-plate $c$; but relay I is connected to relay II in the same way as relay 1 is connected to relay 2. Therefore when relay 1 goes out of operation relay I also goes out, and when relay 2, as it then immediately does, comes into play, so also does relay II; and similarly, relays 2 and II go out together, and relays 3 and III come in, and so on for as many corresponding pairs of relays at opposite ends of the line as may be present. The consequence of all this is that the line is opened for each receiving-station at precisely the same instant that it is opened for each sending-station; or, in other words, circuit is made

through the receiving apparatus to key T at the same instant that it is made through the transmitting apparatus to key *t;* then circuit is made through between keys *t'* and T', then between keys *t''* and T''; or, to put it in still another way, each receiving-operator has the line opened for him to receive at, and for precisely the same intervals, as does a corresponding sending-operator have the line opened for him to transmit. The signals of the operator at relay 1 can be received only by the operator at relay I, because relays 2 and 3, and consequently relays II and III, have not yet come into operation. The signals of the operator at relay 2 can only be received by the operator at relay II, because relays 1 and I have gone out of operation, and relays 3 and III have not yet come in. The signals of the operator at relay 3 can only be received by the operator at relay III, because relays 1 and 2 and I and II have gone out of operation. Theoretically there may be an indefinite number of receiving-stations, as there may be of sending-stations, provided that the number is the same at each end of the line. For each sender there will be a receiver. Each sender will write independently of all other senders. The receiver of that sender's message will receive independently of all other receivers.

Referring now to the wheel W, the period of contact of each of the contact-plates *w* with the brush *z* is of course but momentary and simply long enough to allow the current to energize the magnets *a a* of relay 1, and, as has already been explained, a separate battery, *u*, is employed, whence the signaling-current is supplied to line. I can, however, dispense with the battery *u*, and obtain both the energizing and signaling currents from the battery X by means of the arrangement shown in Fig. 3.

On the wheel W are two sets of contact-plates, *w* and *w'''*. The plates *w* are much shorter than the plates *w'''*, and the two sets of plates are so disposed on the periphery of the wheel that the plates *w* come opposite the intervals between the plates *w'''*, and vice versa. The brush or spring *z* connects, as before, by the wire *v*, with the magnets *a a* of relay 1. A second brush or spring, *z'*, connects by a wire, *u'*, with the key *t*. When the brush *z* is on a contact-plate, *w*, the brush *z'* is not in contact with any contact-plate *w'''*, and, conversely, when the brush *z'* is in contact with a contact-plate, *w'''*, the brush *z* is not in contact with any contact-plate *w*. Consequently the current from the battery X passes first by contact-plate *w* and brush *z* to energize the magnets of relay 1, and then by contact-plate *w'''* and brush *z'* to the signaling-key and line, and so on alternately. As only a momentary current is required to energize the magnets of the relay, the contact-plates *w* are made short; and as the signaling-current must be maintained during the period while each relay in turn comes into operation, for that reason the contact-plates *w'''* are made long.

I claim—

1. In combination with a circuit including a source of electricity, a circuit-breaker, an electro-magnet, and line, a circuit including the armature of said magnet, a line-connection closed by said armature, a signaling apparatus, and a source of electricity, substantially as described.

2. In combination with a circuit including a source of electricity, a circuit-breaker, a commutator, a polarized relay, and line, a circuit including the armature of said relay, a connection to line closed by said armature, a signaling apparatus, and a source of electricity, substantially as described.

3. In combination with a circuit including a source of electricity, a circuit-breaker, an electro-magnet, and line, a circuit including the armature of said magnet, a connection to line closed by said armature, a circuit-breaker, and the aforesaid source of electricity, the said circuit-breakers operating alternately to establish their respective circuits, substantially as described.

4. In combination with a circuit including a source of electricity, a circuit-breaker, an electro-magnet, and line, a local circuit closed by the armature of said magnet, an electro-magnet in said local circuit and in circuit with the armature of said last-mentioned electro-magnet, a connection to line closed by said armature, a signaling apparatus, and a source of electricity, substantially as described.

5. In combination with a circuit including a source of electricity, a circuit-breaker, an electro-magnet, and line, a circuit including the armature of said magnet, a connection to line closed by said armature, a signaling apparatus, and a source of electricity, a local circuit closed by the aforesaid armature and an electro-magnet in said local circuit, and in circuit with the armature of said last-mentioned electro-magnet a line-connection closed by said armature, a signaling apparatus, and a source of electricity, substantially as described.

6. In combination with a circuit including a source of electricity, a circuit-breaker, a commutator, a polarized relay, and line, a local circuit closed by the armature of said relay, a second polarized relay in said local circuit, and in circuit with the armature of said last-mentioned relay a line connection closed by said armature, a signaling apparatus, and a source of electricity, substantially as described.

7. In combination with the line, and at one end thereof, a source of electricity, a circuit-breaker, and an electro-magnet, and a circuit including the armature of said magnet, a connection to line closed by said armature, a signaling apparatus, and a source of electricity, and at the other end of the line an electro-magnet and ground-connection and a circuit including the armature of said magnet, a connection to line closed by said armature, a receiving apparatus, and ground, substantially as described.

8. In combination with the line, and at one

end thereof, a source of electricity, a circuit-breaker, and an electro-magnet, a circuit including the armature of said magnet, a connection to line closed by said armature, a signaling apparatus, and a source of electricity, a local circuit closed by the aforesaid armature and an electro-magnet in said local circuit, and in circuit with the armature of said last-mentioned electro-magnet a line-connection closed by said armature, a signaling apparatus, and a source of electricity, and at the other end of the line an electro-magnet and ground-connection, a circuit including the armature of said magnet, a connection to line closed by said armature, a receiving apparatus, and ground, a local circuit closed by said last-mentioned armature, and an electro-magnet in said local circuit, and in circuit with the armature of said last-mentioned electro-magnet a line-connection closed by said armature, a receiving apparatus, and ground, substantially as described.

9. The combination of a source of electricity, a means of alternately reversing the current thereof, (such as the commutator *x y w'*,) wheel W, having contact-plates *w*, a means of rotating said wheel, brush or spring *z*, polarized relay-magnets *a*, line and circuit connections, with a source of electricity, key *t*, relay-armature *b*, contact point or plate *f*, line and circuit connections, substantially as described.

10. The combination of the split battery X, commutator *x y w'*, wheel W, having contact-plates *w* and *w'''*, a means of rotating said wheel, brushes or springs *z* and *z'*, and in circuit with the brush *z* the polarized relay-magnets *a*, and line, and in circuit with the brush *z'* the key *t*, relay-armature *b*, contact point or plate *f*, and line, substantially as described.

11. In combination with a source of electricity, a circuit-breaker, a commutator, polarized relay-magnets *a*, and line, a source of electricity, a signaling apparatus, relay-armature *b*, circuit-connections, and the contact points or plates *f*, *c*, and *d*, a connection from point *f* to line, split battery *e*, and connections to points *c* and *d*, polarized relay-magnets *a'*, and a circuit including said magnets *a'*, armature *b*, contact-points *c* or *d*, and split battery *e*, armature *b'*, contact-point *f'*, and line-connection therefrom and in circuit with said armature *b'*, a signaling apparatus, and a source of electricity, substantially as described.

12. In combination with a source of electricity, a means of alternately reversing the current thereof, a circuit-breaker, and in circuit with said source of electricity polarized relay-magnets *a*, and line, a source of electricity, polarized relay-magnets *i*, armature *b*, contact-point *f*, and line-connection therefrom, armature *m*, and in local circuit therewith, contact-point *p* or *q*, battery *n*, and sounder *o*, substantially as described.

13. The combination of a source of electricity, a means of alternately reversing the current thereof, a conductor, and in one branch circuit with said conductor a polarized relay and ground, and in a second branch circuit with said conductor a contact-point, the armature of said relay being disposed so as to make and break contact with said point, a polarized relay, and ground, substantially as described.

14. In combination with a line-conductor, and in branch circuit therewith, the polarized relay-magnets A, and ground, and in another branch circuit therewith the contact-point F, armature B, disposed to make and break contact with said point, polarized relay-magnets I, and ground, and the armature M, and in local circuit with said armature M the contact-point P or Q, battery N, and sounder O, substantially as described.

ALFRED M. A. BEALE.

Witnesses:
PARK BENJAMIN,
EDGAR GOODWIN.