

Nov. 16, 1943.

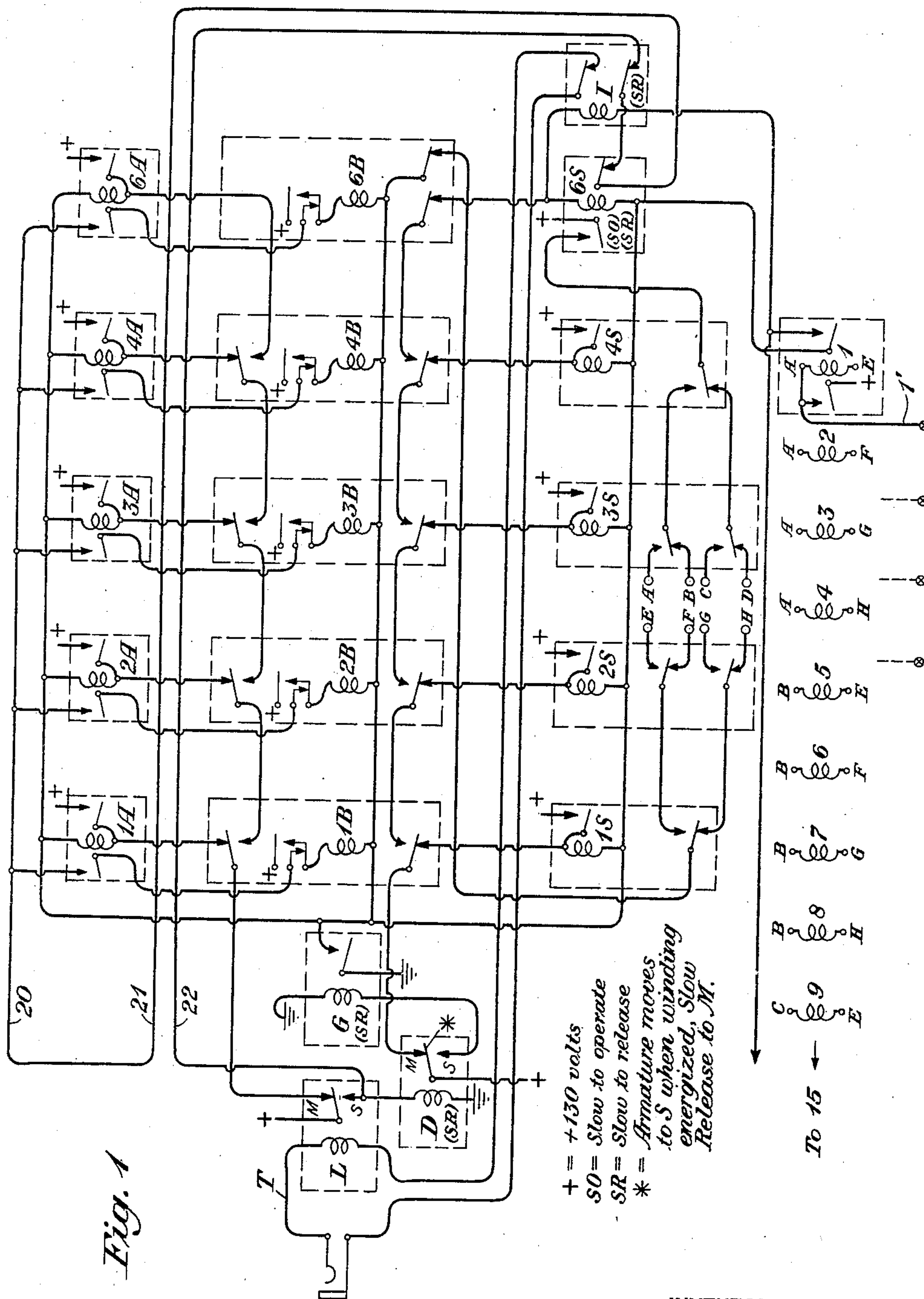
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2,334,574

SELECTIVE SIGNALING SYSTEM

Filed Jan. 8, 1941

2 Sheets-Sheet 1



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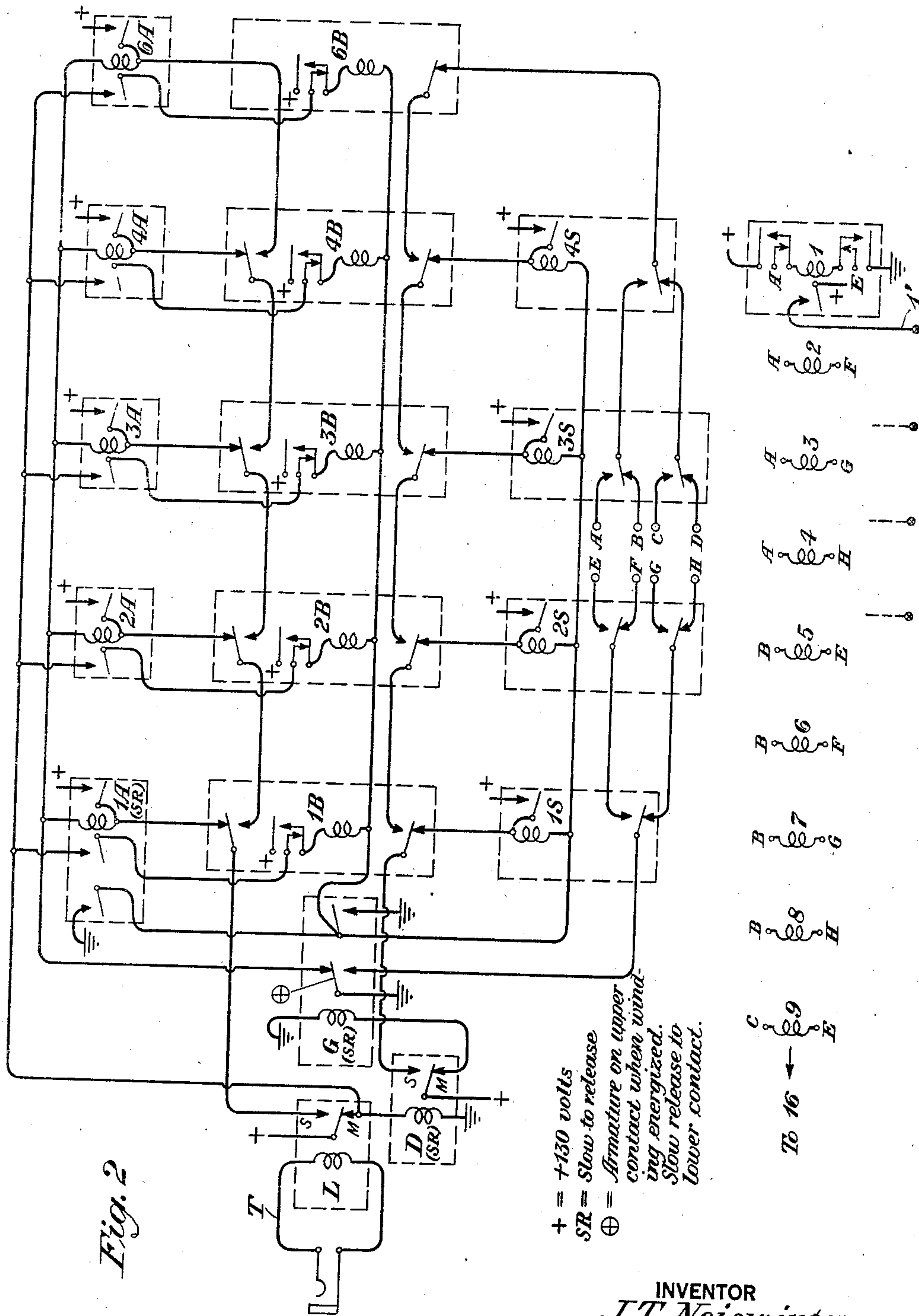
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2 Sheets-Sheet 2



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SELECTIVE SIGNALING SYSTEM

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8 Claims. (Cl. 177—353)

This invention relates to selective signaling systems and more particularly to such systems in which a code consisting of dots and dashes may be used to effect the selective operation.

One of the objects of the invention is to provide a selective signaling circuit employing a dot-dash type of code which may be transmitted over a manual telegraph circuit or a teletypewriter circuit without any substantial possibility of interference due to the transmission of ordinary Morse signals in the former case, or of teletypewriter code combinations in the latter instance.

Another object of the invention is to produce a selective signaling system using dots and dashes for selective purposes in which the dots and dashes may be either marking signals or spacing signals.

Another object of the invention is to provide a selective signaling system using dots and dashes in which the dots and dashes comprising the code may be formulated from teletypewriter code combinations.

A still further object of the invention is to produce a selective signaling system which may be used in connection with teletypewriter circuits, manual telegraph circuits, signal circuits for telephone circuits and circuits for remote control of equipment of all kinds.

The invention may be more fully understood from the following description when read in connection with the accompanying drawings Figure 1 of which shows a selecting circuit adapted to be operated by dots and dashes produced manually, while Fig. 2 shows a modification in which the dots and dashes may be produced from teletypewriter code combinations. In the circuit of Fig. 1 the dots and dashes are marking signals, while in Fig. 2 the dots and dashes are spacing signals.

Considering first the arrangement of Fig. 1, four selecting relays are employed which by various arrangements of operated and inoperated conditions of the relays permit a total of sixteen combinations to be selected. By adding an additional set of selecting relays to the chain it will be obvious that the number of combinations may be doubled. In the arrangement of Fig. 1 the code for setting up a selective combination consists of four units either dots or dashes. These four units, as already stated, are marking signals, and, of course, are necessarily separated from each other by spacing signals.

In the arrangement of Fig. 1 the operation and non-operation of the selecting relays is ac-

complished as follows: The first opening of the telegraph circuit to which the equipment is connected produces a spacing signal which makes the first selecting relay of the chain available. If it is desired to operate this relay, a long marking dash is sent. If it is not desired to operate the relay, a marking dot is sent. In either case the relay is then disconnected from the transmission circuit and the second selecting relay is prepared. The sending of a long dash will now operate this second relay, but if a dot is transmitted, the relay will not operate. In either case the second relay is disconnected from the circuit and the third relay is presented. This operation is continued until four marking dots or dashes have been transmitted. The last marking signal, if a dash, operates the fourth selecting relay, and if a dot, does not operate the relay.

After the last dot or dash is transmitted a fifth relay is connected into the chain. This fifth relay performs certain functions including the final operation of the selected element. The fourth marking dot or dash of the code combination is, of course, followed by an open circuit or spacing signal after which the circuit would normally be closed to transmit a continuous marking signal. The sending of this final marking signal after the fourth dot or dash is transmitted operates the fifth relay which in turn operates the particular element that had been selected by the selecting relays. If, however, instead of finally closing the circuit the operator sends a fifth dot, the space following this fifth dot operates a relay which locks up and prevents any further functioning of the equipment until it has been cleared out by again closing the circuit for a period of about at least two seconds, this period being longer than the normal selecting dash of the code combination. Thus even if a combination is set up in the equipment the sending of a single additional dot will prevent the equipment from operating.

The operation of the selected element, which in the circuit illustrated is a relay, will result in the operation of another relay which functions to open and close the telegraph circuit over which the signals were sent at a rate of about twice per second. The steady "clicking" thus produced on the circuit indicates to the sender that the selected equipment is operated, and also serves to hold the circuit for the sender until the called office has answered. Opening the circuit at either the sending or called office or at any other office connected in the same line causes the

"clicking" to cease and "selected" relay to release, and arranges the equipment so that the next two second close of the circuit will result in a release of all of the relays and the restoring of the equipment to its normal condition for receiving any selection.

Referring to Fig. 1, at the left the terminal T indicates a transmission line which may be a telegraph line for either Morse or printer operation, a telephone line, or other type of signaling circuit. This terminal includes a line relay L which responds to marking and spacing signals and thereby controls the selecting operations to be hereinafter described. The armature of this relay is normally on its marking contact. When shifted to its spacing contact it operates a slow-release relay D to shift the armature of said latter relay from its normal marking contact to its spacing contact, thereby in turn closing the circuit of a slow-release relay G which applies a controlled ground to the various relays in the selecting chain about to be described.

The selecting relay circuit consists of a chain of five sets of relays, each set consisting of three relays. The first four sets of three relays each set up the selection, while the fifth set of three relays effects the final operation of the selected element and performs certain other functions which will be described later. The first set of relays of the chain consists of relays 1A, 1B and 1S. The second set consists of relays 2A, 2B, 2S, etc., the final set of three relays being designated 6A, 6B and 6S. The A relays of the chain are connected to the marking contact of the line relay L and are operated by any marking signal regardless of whether it is a dot or dash. The S relays, however, are controlled over the marking contact of the slow-release relay D, and are, therefore, only operated when the line relay L transmits a marking dash. The B relays are each controlled by a contact of the corresponding A relays and are operated by the spacing signal following each dot or dash to shift the selecting circuits from the first set of relays of the chain to the succeeding set of relays.

The last set of relays of the chain designated 6A, 6B and 6S effect the final operation of the selected device and perform certain controlling and other functions, such as the operation of the slow-release relay I which sends a "clicking" or answer-back signal after the selection has been completed. The four selecting S relays by means of their armatures set up operating circuits through any one of a number of final selected relays 1, 2, 3, 4, etc. These selected relays as shown are nine in number, but actually may be as many as fifteen. Theoretically a sixteenth relay could be provided, but this would involve using a selective code consisting of four dots, and as this combination might be produced in ordinary Morse, it is best not to attempt to select a sixteenth relay. It will be noted that the final selected relays illustrated are not actually shown connected in the selecting circuits, but the letters A—E, A—F, etc., at the terminals of each of various windings indicate that the terminals of the windings are to be connected across the correspondingly lettered terminals in the final selecting circuits controlled over the armatures of relays 2S and 3S.

Further details of this circuit will be understood from the following description of its operation.

Assuming that the line circuit is normally

closed, the armature of the line relay L will be resting upon its marking contact and slow-release relays D and G will be deenergized so that the ground controlled by the latter is disconnected from the various selecting relays and the armature of relay D is resting upon its marking contact. The ground supplied over the armature of the slow-release relay G is necessary for the operation of all of the A, B and S relays of the chain and also for the operation of the slow-release relay I. Consequently in the normal condition with the line circuit closed, no ground is connected to any of the chain relays. The relay G is operated, as will presently appear, upon the initiation of the selecting operation. But if any time it should be released either during or after the selecting operation, the ground which it supplies to each of the selecting relays will be disconnected and all of the relays of the chain restored to normal.

In order to send a dot or dash, the operator must first operate his key to momentarily open the circuit thus sending a space signal. The armature of the line relay is thereby shifted momentarily to its spacing contact S, thus operating the slow-release relay D, which in turn shifts its armature from its marking to its spacing contact and operates the slow-release relay G to supply the ground connection for all of the chain relays.

The circuit is now in condition to receive the first selecting impulse which is sent by closing the telegraph circuit T. This operates the line relay L to its marking contact, thereby closing a circuit from positive battery, marking contact of relay L, upper back contact of relay 1B, winding of relay 1A and thence to ground over the closed contact of relay G. Note that in tracing this circuit and other circuits hereinafter described, the winding of each relay and the armatures and contacts controlled thereby are enclosed within a dotted rectangle to avoid confusion between contacts of different relays. Relay 1A at once locks up over its right-hand front contact to positive battery, and at its left-hand front contact prepares a circuit path for the operation of the relay 1B.

The relay 1A operates upon a marking signal regardless of its length, since it is operated over the marking contact of the quick-operating relay L. Whether or not the actual selecting relay 1S is operated or not depends upon the length of the marking signal. If the marking signal is merely a dot, the relay D being slow to release, will not shift its armature from its spacing to its marking contact, and no circuit will be closed for the relay 1S. If, however, the marking impulse sent over the telegraph circuit is for the length of a long dash, relay D will release and shift its armature to its marking contact, thereby completing a path for relay 1S from positive battery, over the marking contact of relay D, lower back contact of relay 1B, winding of relay 1S and thence to ground over the contact of relay G. Relay G is, of course, a slow-release relay and, therefore, holds its controlled ground applied to the various selecting relay circuits for such length of time as is required for the slow-acting relay D to release, and thereafter for the slow-acting relay G to release. This period is substantially longer than the length of any dash that is to be transmitted. If the close of the telegraph circuit is for a period of approximately two seconds, however, relay G would also release, thereby causing relays 1A and

1S to release, so that the circuit would be cleared.

Let us now assume that either a dot or a long dash has been transmitted, and if it was a dash, that the dash was not long enough to cause the relay G to release. Upon the completion of the dot or dash a spacing signal is sent over the telegraph circuit which briefly shifts the armature of the line relay L from marking to spacing. This completes a circuit for the relay 1B from battery over the spacing contact of relay L, over conductor 22 to the lower contact of relay I, over right-hand back contact of relay 6S, over conductors 21 and 20 to the left-hand make contact of relay 1A, through the middle normal contact of relay 1B, winding of relay 1B, and thence to ground over the make contact of relay G. Relay 1B now locks up over an obvious circuit at its middle front contact, and at its upper front contact transfers the circuit over the marking contact of the line relay L from relay 1A to relay 2A. At the same time its lower armature transfers the circuit over the spacing contact of the line relay L from relay 1S to relay 2S.

The second dot or dash on the circuit operates the relay 2A over an obvious circuit which immediately locks itself up. In the case of a dot, the relay 2S is not operated, but in the case of a dash, the relay D falls off and at its marking contact completes a circuit for the relay 2S, which is now operated and locked up. At the completion of the second dot or dash, when the spacing interval is transmitted, relay L over its spacing contact completes the circuit as previously traced to the conductor 20 and thence over the right-hand front contact of relay 2A and over the middle normal contact of relay 2B through the winding of said relay and thence over the make contact of relay G to ground. Relay 2B is thereby operated and locked up and shifts the circuits over the marking contacts of relays L and D to relays 3A and 3S, respectively.

The third dash or dot transmitted over the telegraph line operates the relay 3A, and in the case of a dash the relay 3S is operated, and these relays are locked up over obvious circuits. Upon the completion of the third dot or dash, the armature of the line relay L is shifted from marking to spacing, thereby operating the relay 3B over a circuit previously traced to conductor 20, thence over the left-hand front contact of relay 3A, middle normal contact of relay 3B to ground over the contact of relay G. Relay 3B is locked up and transfers the connection over the marking contact of the relay L from relay 3A to relay 4A. At the lower contact of relay 3B the circuit from the marking contact of relay D is shifted from relay 3S to relay 4S.

The fourth dash or dot transmitted shifts the armature of the relay L to its marking contact and operates the relay 4A over the upper make contacts of relays 1B, 2B and 3B in series, and over the upper back contact of relay 4B. In case the marking signal is a dash, relay D falls off and completes a circuit for relay 4S from its marking contact, over the lower front contact of relays 1B, 2B and 3B in series, and over the lower back contact of relay 4B to selecting relay 4S. Relay 4S now operates and immediately locks up. At the end of the fourth dot or dash relay L shifts to its spacing contact and operates the relay 4B over an obvious circuit including the left-hand make contact of relay 4A. Relay 4B transfers the connection over the marking contact of relay L from relay 4A to relay 6A. At the same time the connection over the marking

contact of relay D is shifted from relay 4S to relay 6S.

This completes the selecting operation, and the individual relays 1S, 2S, 3S and 4S are either operated or not operated, depending upon whether dots or dashes were sent at the time they were connected in circuit. The combination set up on these relays through their various lower armatures has already determined which relay of the final group of relays 1, 2, 3, 4, 5, etc., is to be selected by a circuit which will be hereafter described.

At this point several different conditions may arise producing different results depending upon what the sending operator does. Normally after sending a short space at the end of the fourth marking signal the sending operator will finally close the telegraph circuit, thereby shifting the armature of relay L to its marking position. This operates the relay 6A over the four upper front contacts of relays 1B, 2B, 3B and 4B. If as would normally be the case, this marking condition continues, relay D will, after a short interval, release its armature to its marking position and operate the relay 6S.

Relay 6S in operating will, at its left-hand front contact, place battery on a selecting circuit which depends upon the code combination which was sent, and will thereby operate a selected one of the final relays 1, 2, 3, 4, 5, etc. These final relays are variously connected to the contacts of the relays 2S and 3S, so that a different relay will be operated for each setting. For example, final relays 1, 2, 3 and 4 have their upper terminals connected to the A terminal of relay 3S, while the opposite terminals of the windings of the relays are connected respectively to the terminals E, F, G and H of the relay 2S. Similarly relays 5, 6, 7 and 8 are connected from terminals B of relay 3S to the terminals E, F, G and H, respectively, of relay 2S. Final relay 9 is connected from terminal C to terminal E, and so on for any other relays of the final group which may be provided.

Let us now assume that the code transmitted was four dashes resulting in the operation of all four of the S relays. A circuit for relay 1 will be completed from battery over the left-hand front contact of relay 6S, over the make contact of the lower armature of relay 4S, make contact of middle armature of relay 3S, terminal A, through the winding of final relay 1, terminal E, make contact of the middle armature of relay 2S, make contact of lower armature of relay 1S, and thence to ground over the lower right-hand back contact of relay 6B and the make contact of relay G. Relay 1 is now operated and locked up at its left-hand front contact. This contact also supplies battery to a controlled auxiliary circuit 1' to perform any signaling or other desired operation. It may be noted in passing that the selecting circuit for the relay 1 does not close immediately after the relay D shifts its armature from spacing to marking, because the relay 6S is slow to operate and requires a brief interval before its armature pulls up. The purpose of this delay interval will appear later.

When relay 1 is operated it completes a circuit for the slow-release relay I from the marking contact of relay D, over the front contacts of the lower armatures of relays 1B, 2B, 3B and 4B, over the left-hand back contact of relay 6B, through the winding of relay I, over the right-hand front contact of relay 1, and then to ground over the make contact of relay G. The operation of the

relay I at its upper right-hand front contact opens the telegraph circuit T. This, of course, occurs after an interval long enough to permit the armature of the relay D to shift to its marking contact after the final closing of the telegraph circuit T by the sending operator, plus the time required for the relay 6S to operate, plus the practically negligible time required for the selected final relay to operate. This interval is not, however, long enough to permit the slow-release G to become deenergized.

Note that when the telegraph circuit T is closed the armature of relay L rests on its marking contact and the relay D is deenergized so that its armature is also on its marking contact. The opening of the telegraph circuit by the upper right-hand contact of relay I results in shifting the armature of relay L to its spacing contact, whereupon relay D is at once energized and shifts its armature from its marking to its spacing contact. This removes the battery at the marking contact of relay D from the relays 6S and I. Relays 6S and I are temporarily released, and the upper right-hand contact of the latter again closes the telegraph circuit. This results in shifting the armature of relay L to its marking contact so that relay D after a moment releases and shifts its armature to its marking contact, thereby again completing the circuits of relays 6S and I, as previously traced. Relay I being again operated once more opens the telegraph circuit and the cycle just described is repeated resulting in a steady "clicking" on the telegraph circuit.

It will be noted that the closing of the telegraph circuit which occurs when relay I releases is not long enough to permit the relay G to release and remove the controlled ground from the various selecting relays. It will also be noted that when the upper right-hand contact of relay I opens the telegraph circuit so that the armature of relay L is shifted to its spacing contact, the circuit which would otherwise be completed over said spacing contact to the conductor 20 to operate the relay 6B will be held open by the lower right-hand contact of the relay I, thus preventing relay 6B from operating under the conditions producing the "clicking" operation. The right-hand contact of relay 6S, which like the lower right-hand contact of relay I controls the circuit for relay 6B, functions to hold the circuit of relay 6B open for a brief period after the contacts of relay I have closed. This period is long enough to allow the armature of the relay L to leave its spacing contact and hence prevents operation of the 6B relay immediately after the relay I closes its contacts. This action is due to the fact that the relay 6S is slower to release than the relay I.

The "clicking" operation above described results in the line relay L operating periodically in time with the relay I. As shown, the final relay selected (in this case the relay I) is locked up by its own left-hand armature over a circuit to ground previously traced from the terminal E of its winding and over contacts of relays 2S, 1S and 6B to ground over the contact of the relay G. The selected relay, therefore, remains locked up during the "clicking" operation and remains locked up so long as relay G is operated and the relay 6B is not operated. However, if desired, the locking contact for the final relays may be omitted in which case the selected final relay will also operate periodically with relays 6S and I during the "clicking" operation.

If the operator should hold the telegraph circuit open during the time the "clicking" operation is occurring, the line relay L will fall off to its spacing contact and thereby energize the relay D which shifts its armature to its spacing contact where it remains so long as the open continues. This, of course, releases the relays 6S and I and a circuit is consequently closed to operate the relay 6B over the spacing contact of the relay L, over lower right-hand contact of relay I, right-hand contact of relay 6S to conductor 20, and thence over the left-hand make contact of relay 6A, upper normal contact of relay 6B, and through the winding of said relay 6B to ground over the contact of relay G. The relay 6B at its lower left-hand contact opens the circuits of relays 6S and I, and at its right-hand lower contact opens the locking circuit of the selected relay I. Relays 6S and I will be released and cannot again be operated until a new selection takes place. The selected relay I is also restored to normal. If following this opening of the telegraph circuit by the operator the telegraph circuit is again closed for a period of about two seconds or more, the relay G will release and remove the ground connection from all of the A, B and S relays, thus restoring them all to normal so that the circuit is now ready to receive a new selection.

If after the operator has transmitted the four dots or dashes which determine a selection, the operator instead of closing the circuit permanently merely closes it long enough to transmit a dot, the relay 6A will be operated, but the relay 6S will not be operated as the sending of a dot does not permit the slow-release relay D time to shift its armature to its marking contact. During the spacing impulse following the dot the relay 6B will be operated over the spacing contact of the line relay L, lower normal contact of relay I, right-hand contact of relay 6S to conductor 20 and thence over the left-hand contact of relay 6A, upper normal contact of relay 6B, through the winding of said relay and over the contact of relay G to ground. As a result no final relay will be selected because the relay 6B prevents relay 6S and I from operating. No final relay can be selected until the circuit has been closed for two seconds or more to allow the relay G to release and restore all of the apparatus to normal, so that a new combination may be transmitted and recorded. It will be noted that the relay 6B is operated during the open circuit following the dot. There is no possibility of a final relay being selected before the relay 6B operates under these conditions for the relay 6S is slow to operate and thus delays the final selection for a brief interval.

As already stated, by using dots and dashes sixteen code combinations are possible with this circuit as follows:

1		9	— — — — .
2	.. — — .	10	— — — — —
3	.. — — —	11	— — — — —
4	.. — — —	12	— — — — —
5	.. — — .	13	— — — — .
6	.. — — —	14	— — — — .
7	.. — — —	15	— — — — —
8	.. — — —	16	— — — — —

The first of these combinations, which consists of four dots, is preferably not used because of the possibility that such a combination would result from ordinary Morse signals and thus cause false operation.

False operation of the equipment by Morse sig-

nals is made very improbable by the following conditions which must be met to make the equipment operate:

1. The circuit must be closed for at least two seconds before a combination is sent.

2. Each of the combinations (except the first) has at least one dash in it, and is made of a length considerably longer than the dashes sent in normal Morse operation. The dashes used in Morse operation are too short to allow the relay D to release to marking and thus operate an S relay. As is well known, the marking intervals of Morse signals are rarely more than half a second in length.

3. Only four dots or dashes are sent after which the circuit must be closed for about two seconds or more in order to operate the selector. The sending of even a single dot after the four dots or dashes of the combination have been sent prevents the equipment from operating and the operator will know that the selection has failed because the answer-back "clicking" signal does not occur.

4. After a Morse signal is sent over the circuit, the first five dots or dashes of the Morse message go through the relay chain and lock up all of the relays including the relay 6B so that no final relay can be selected. The S relays will not be operated during the sending of the Morse message because the dashes of the Morse message are too short. The relays of the selector will remain in this locked-up condition until the telegraph circuit is closed for approximately two seconds, and this condition will not normally occur until the end of the message.

For the reasons above stated, the selecting system above described can be operated over a circuit whose normal function is the transmission of Morse signals or printing telegraph signals. Where the system is used in connection with telephone order wire signaling, or on circuits where no signals of a telegraph nature other than the selecting signals are sent over the circuit, the problem of avoiding false operation, of course, does not exist. In such cases the equipment may be operated on short and long impulses produced by a push button, instead of a telegraph key.

Instead of sending the dots and dashes manually by means of a telegraph key or push button, it may be desirable in some instances to use a dial transmitter of the type used in telephone machine switching, in order to make sure that the timing intervals are correct. For example, the dial might be so arranged that by dialing digit 1 a short mark or space would be transmitted, and by dialing digit 5 a long mark or space would be sent. Thus instead of a code comprising dash-dot-dot-dash for a selection we would simply dial 5115. For operators who work every day on a circuit of this type, the manual method of signaling with a telegraph key is so simple, and the proper length of dash is so easily obtained, that no accurate time control device such as a dial is necessary.

With the system as described using the code, four short and long signals, a total of sixteen different selections can be made (fifteen if we omit the four-dot combination). If we use five long or short signals the number of selections may be doubled, as the number of possible combinations double for each additional dot or dash.

The circuit above described can obviously be arranged so that the dots and dashes may be open circuit conditions rather than marking intervals. The circuit may be also modified in a

simple manner so that the type of code transmitted by a teletypewriter may be employed instead of dots and dashes similar to those used in Morse sending. An arrangement employing these two principles is illustrated in Fig. 2.

The arrangement shown in Fig. 2 differs from that of Fig. 1 in that long and short spaces instead of long and short marks are used respectively to operate or to pass by each of the four selecting relays, and no answer-back or acknowledgment signal is included in the circuit. The length of the long space required to operate a selecting relay may be obtained from the teletypewriter code corresponding to the letter T, and the length of the short space required to pass by a selecting relay without operating it may be obtained from the teletypewriter code corresponding to the letter V.

The normal teletypewriter code consists of an open circuit starting impulse, normally about 22 thousandths of a second in length, followed by five character determining impulses each about 22 thousandths of a second long, these in turn being followed by a closed circuit stop impulse whose length is about one and one-half units, or 33 thousandths of a second, making a total of about 165 thousandths of a second. The five character determining impulses may be either open or closed circuit impulses depending upon the character to be printed.

The letter V is well adapted to transmit a short space signal, since its group of five character determining impulses consists of one open circuit impulse followed by four closed circuit impulses. We will then have an open circuit impulse forty-four seconds long consisting of the start impulse and the first character forming impulse of the letter V. This will be followed by four closed circuit impulses comprising the remaining character determining impulses and the stop impulse of about 33 milliseconds, or a total elapsed time of 121 thousandths of a second for the closed circuit condition. Similarly the use of the T combination for the long open circuit or dash impulse gives an open circuit start impulse followed by four open circuit character forming impulses making a total open dash of 110 thousandths of a second. This is followed by a closed circuit condition consisting of one character forming impulse and the stop impulse, or a total closed circuit condition lasting 55 thousandths of a second.

Since the length of these spaces is determined accurately by the Teletype sender, which eliminates the human element from the timing feature, there is less chance of an incorrect signal than in the case of the manual telegraph selector circuit. Consequently no acknowledgment or answer-back signal need be provided. Protection from operation by normal Teletype signals is obtained by requiring either a "break" signal or a blank character signal to be transmitted over the circuit to make the selector circuit ready to receive a combination. A break is an open circuit condition which may be continued any desired length of time. A blank is a teletypewriter signal all of the units of which are open circuits except the final stop impulse. A second break or blank signal is transmitted after the combination has been sent, in order to operate the particular relay that has been selected.

The break signal is, of course, longer than the entire combination for any particular Teletype character, and ordinary slow-acting or slow-

release relays are sufficient to distinguish between the code selecting signal and the break signal. A blank signal in a teletypewriter is simply the signal sent when nothing is being printed, and this consists of an open circuit condition for about 132 thousandths of a second followed by a closed circuit stop signal. In order to distinguish between the blank space of 132 thousandths of a second and the T space of 110 thousandths of a second, the slow-operating or slow-release relays would necessarily have to be carefully designed. In some instances it may be desirable to more accurately control the timing by using gas-filled trigger tubes of a well-known type.

The details of the circuit of Fig. 2 will be clear from a description of its operation which is as follows:

Assume that in Fig. 2 the telegraph terminal with its line relay L is connected to a Teletype transmitter and that the circuit is normally closed. It will be noted that the marking and spacing contacts of the line relay L and the slow-release relay D are reversed with respect to Fig. 1, so that the spacing contact of the line relay is connected to the circuit operating the A relays, and the spacing contact of the D relay is connected to the circuits operating the S relays. The relay G has two contacts, one of which controls the application of ground to the A relays in one position and to the final selecting circuit for selecting a final relay in its other position. The second contact controls the connection of ground to the B and S relays.

With the line circuit closed the relay L is energized so that its armature rests on its marking contact. The relay D is, therefore, normally energized so that its armature is on its marking contact, and it in turn completes the circuit to the relay G, which is also normally energized. Under these conditions the A, B and S relays may be either operated or non-operated, depending upon what may have happened in the line circuit prior to its closed circuit condition.

If now a break signal is sent of sufficient length to allow the D and G relays to release, the G relay at its left-hand contact disconnects ground from the windings of the A relays and releases any that may have been operated. The B and S relays, which normally obtain their ground from the left-hand contact of the 1A relay, are not released during the break signal because of the ground connected to their windings over the right-hand back contact of the relay G in its released position. The close of the Teletype circuit following the break again operates the L, D and G relays. Since the relay 1A was previously released and the G relay is now energized so as to open its right-hand contact, ground is removed from the windings of any B and S relays that might have been operated. The circuit is now entirely cleared and is ready to receive a code combination.

If now a Teletype transmitter is operated to send the combination of letter T into the circuit, the long space of the character will operate the relay 1A over a circuit from battery, over the spacing contact of the line relay L, upper back contact of relay 1B, through the winding of relay 1A and over the normal operated contact of the relay G to ground. Relay 1A at once locks up over its right-hand front contact. At its extreme left-hand front contact relay 1A places ground on the conductors leading to the windings of the B and S relays. At its middle front contact relay 1A prepares a path for the opera-

tion of the relay 1B on the marking signal following the space.

The space of the T signal is long enough to allow the relay D to release to its spacing condition, but is not long enough to release the relay G. The relay D, upon shifting its armature to its spacing contact, closes a circuit for the relay 1S from battery over the spacing contact of the relay D, lower back contact of relay 1B, winding of relay 1S, to ground over the left-hand front contact of relay 1A. If a V combination had been transmitted, it would not be long enough to allow the relay D to fall off and operate the relay 1S. Therefore, the relay 1S operates if a T signal is transmitted, but it does not operate if a V signal is transmitted. The marking condition following the space of the letter T or V operates relay 1B by shifting the armature of the line relay from its spacing to its marking contact. This completes a circuit from battery over the marking contact of the relay L, over the middle front contact of relay 1A, middle normal contact of relay 1B, winding of relay 1B, and over the extreme left-hand front contact of relay 1A to ground.

The operation of relay 1B prepares the path to operate relay 2A on the next space regardless of its length, and also to operate the relay 2S, if the next space is a long one. Thus the space of the next character operates relays 2A and 2S, if the character transmitted is a T, but only relay 2A is operated if it is a V. The mark following the above space operates the relay 2B, which in turn prepares the path for the operation of the relay 3A and the possible operation of the relay 3S.

The space of the third character operates relays 3A and 3S, if a T is transmitted, but only the relay 3A is operated if the character is a V. The mark following the above space operates the relay 3B, which in turn prepares the path for the operation of the relay 4A and the possible operation of relay 4S.

If now a T is transmitted, the space thereof operates the relays 4A and 4S, but if a V is transmitted, only the relay 4A is operated. The marking condition of the relay L following the above space operates the relay 4B, which prepares a path for the operation of the relay 5A, and for the possible connection of battery from the armature of the relay D to the lower armature of the relay 4S, the latter circuit extending over the lower back contact of relay 6B.

A break signal (longer than the dash associated with the character T) will first release the relay D so that its armature is shifted to its spacing contact. Battery is now connected over the spacing contact of the relay D and the lower front contacts of relays 1B, 2B, 3B and 4B in series, and over the lower back contact of relay 6B to the selecting circuit determined by the lower armatures of the selecting relays 1S, 2S, 3S and 4S. This selecting circuit, however, is still open at the back contact of relay G.

However, if the break signal persists for a period substantially longer than the open circuit condition of the character T, the relay G will in turn release its armature and place ground on the lower armature of selecting relay 1S. This results in the operation of one of the final relays of the group 1, 2, 3, 4, 5, 6, etc., depending upon which one was selected by the combination set up on the S relay armatures. If all four of the S relays were operated, the relay 1, which is connected across the terminals A

and E of the armatures of the relays 2S and 3S, will be operated and locked in this position. The manner in which the relay 1 is locked is obvious from the circuit diagram. The locking circuit of relay 1 is independent of the selecting circuit. It will, therefore, remain locked up until some attendant releases it. The left-hand front contact of the selected relay 1 may be used for any desired purpose, such as closing a circuit to some element performing an operation in the test room or in a customer's office.

The release of the relay G on the final break signal also resulted in releasing the A relays by removing the ground from their windings at the left-hand front contact of said relay G. The B and S relays remain operated, however, despite the release of the relay 1A because of the ground connected to the windings of these relays over the right-hand back contact of relay G. The B and S relays, therefore, remain operated until the G relay is again energized when the circuit is again closed at the end of the break signal. This permits the operation of the final relay of the group 1 to 15, inclusive, before the B and S relays are released. Relay 1A is of the slow-release type, so that it will hold ground on the B and S relays until the G relay has completely released and placed ground on these relays. By holding the B and S relays up until the G relay is finally reoperated at the close of the break, the selection and operation of the final relay of the group 1 to 15 is completed before the B and S relays are released.

We have just seen that when four selecting space characters have set up a combination in the selector circuit, and these are followed by a break signal long enough to permit the relay G to release, a selected one of the final relays of the group 1 to 15 is energized due to the fact that the relay G when released applies ground to the lower armature of the selecting relay 1S. If, however, after sending four single space characters to set up a combination in the selector circuit the operator should discover that he had sent the wrong combination, he may prevent the combination from being effective by sending a fifth space character, either a V or a T. As neither of these characters opens the line circuit long enough to permit the relay G to fall off, the relays 6A and 6B will be operated, and the latter at its lower contact prevents the closing of the operating circuit for the selected final relay.

The circuit for operating the relay 6A is closed when the fifth character causes the line relay L to shift its armature to its spacing contact, thereby connecting battery over the four upper contacts of the relays 1B to 4B, inclusive, and through the winding of the relay 6A to ground over the left-hand make contact of the relay G. Relay 6A locks up, and as soon as the space comes to an end and the marking condition begins, the line relay L shifts its armature to its marking contact, thereby connecting battery over the left-hand make contact of relay 6A, through the upper normal contact of the relay 6B, to ground over the left-hand front contact of the relay 1A. The relay 6B is locked up at its upper front contact and, as already stated, at its lower contact it opens the operating circuit for the final relay which would otherwise have been selected. It will now be impossible to complete a circuit for any of the final relays until a break signal has been sent to clear the relays,

and this in turn has been followed by sending a new combination.

By using the characters V and T to obtain the short and long spaces, each combination consists of four characters. The circuit, however, can be designed to operate on a short space of 22 thousandths of a second and a long space of 66 thousandths of a second. If this is done, it is possible to obtain two spaces from one character. For example, we might choose a character having two short spaces; or we might choose a character having one short space in the first part of the code and a longer space in the latter part of the code; or we may find a character in which this arrangement is reversed with the long space in the early part of the code and the short space in the latter part. By using such characters the number of characters which must actually be sent for each selection may be reduced to two characters for nine of the combinations and three for six of the combinations.

For example, the character K can be used to provide two short spaces. The character E may be used to provide a short space and a long space, and the character N may be used to provide a long space and a short space. For the sixteenth combination which requires four characters, either T, O or M, would be available to provide a single long space, and the one to be used might be determined by the location of the other characters of the combination on the Teletype keyboard, an effort being made to keep the characters near each other. In the chart below one column gives sixteen combinations on the basis of using the characters V and T for selecting purposes. In the succeeding column the corresponding combinations of characters are given using two spaces per character in certain instances. The use of the combinations shown in the final column involves no change in the principle of the selecting circuit. It merely involves a change in the timing of the slow-release relays D, G and 1A. The combinations are as follows:

1. VVVV	KK	9. TVVV	NK
2. VVVT	KE	10. TVVT	NE
3. VVTV	KN	11. TVTV	NN
4. VVTT	KMM	12. TVTT	NMM
5. VTVV	EK	13. TTVV	MMK
6. VTVT	EE	14. TTVT	TTE
7. VTTV	EN	15. TTTV	MMN
8. VTTT	ETT	16. TTTT	TTTT

It will be noted that no acknowledgment or answer-back signal, such as is provided in the selecting circuit to Fig. 1, is provided for the circuit of Fig. 2. This is for the reason that in general the operation of the selector is sufficiently reliable to make such an answer-back signal unnecessary. An answer-back signal may be provided, however, in a very simple manner by merely providing means to send a short open signal from the selector circuit into the Teletype circuit T after the final relay desired has been selected. This would be received on the typewriter machine at the sending station as an M or an O, thus indicating the operation of the selector.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a

dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code and from a normal succession of units of a teletypewriter code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, and means whereby the person sending any selective signaling code may defeat said final selection after the lapse of a time period of any length following the last unit of the code.

2. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, and means whereby the person sending any selective signaling code may defeat said final selection after the lapse of a time period of any length following the last unit of the code.

3. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code and from a normal succession of units of a teletypewriter code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are

transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, and means to defeat a final selection in accordance with any selective signal code received unless said selective signaling code is followed by a circuit condition of the same character as the units of a selective signaling code but of an order of time magnitude materially different from that of said units.

4. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, and means to defeat a final selection in accordance with any selective signaling code received unless said selective signaling code is followed by a circuit condition of the same character as the units of a selective signaling code but of an order of time magnitude materially different from that of said units.

5. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code and from a normal succession of units of a teletypewriter code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, means to condition said sets of selecting relay apparatus after each signaling code has been received so that they will not be operated by the next selective signaling code unless said selective signaling code is preceded by a circuit condition corresponding to one of the

units of said selective signaling code but of an order of time magnitude materially different from that of said unit, and means to defeat a final selection in accordance with any selective signaling code received unless said selective signaling code is followed by a circuit condition of the same character as the units of a selective signaling code but of an order of time magnitude materially different from that of said units.

6. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, means to complete said final selection, means to condition said sets of selecting relay apparatus after each signaling code has been received so that they will not be operated by the next selective signaling code unless said selective signaling code is preceded by a circuit condition corresponding to one of the units of said selective signaling code but of an order of time magnitude materially different from that of said unit, and means to defeat a final selection in accordance with any selective signaling code received unless said selective signaling code is followed by a circuit condition of the same character as the units of a selective signaling code but of an order of time magnitude materially different from that of said units.

7. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a

dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code, means comprising a teletypewriter transmitter for sending said dots and dashes, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, and means to complete said final selection.

8. In a signaling system, a signaling circuit over which various selective signaling codes each consisting of the same fixed number of units may be sent, each code unit being either a dot or a dash so that the total number of codes possible will be 2^n where n is the number of code units in each code, the dashes of each of said codes being of an order of time duration materially different from the usual dashes of a Morse code, means comprising a teletypewriter transmitter for sending said dots and dashes in the form of printer character codes, a selective apparatus for making a plurality of different selections of elements to be selected by means of a corresponding number of said codes, said selecting apparatus including a plurality of sets of selecting relay apparatus, one set for each code unit of a code, means responsive to said code units, whether dots or dashes, to successively connect said sets of selective relay apparatus to said signaling circuit as successive units of said selective signaling code are transmitted, means whereby each set of selecting relay apparatus may determine part of a final selection of a desired one of said elements to be selected in accordance with whether the corresponding signal element is a dot or a dash, and means to complete said final selection.

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