

Oct. 17, 1961

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3,005,041

TELEGRAPH TRANSMITTER CONTROL SYSTEM

Filed Dec. 31, 1957

4 Sheets-Sheet 2

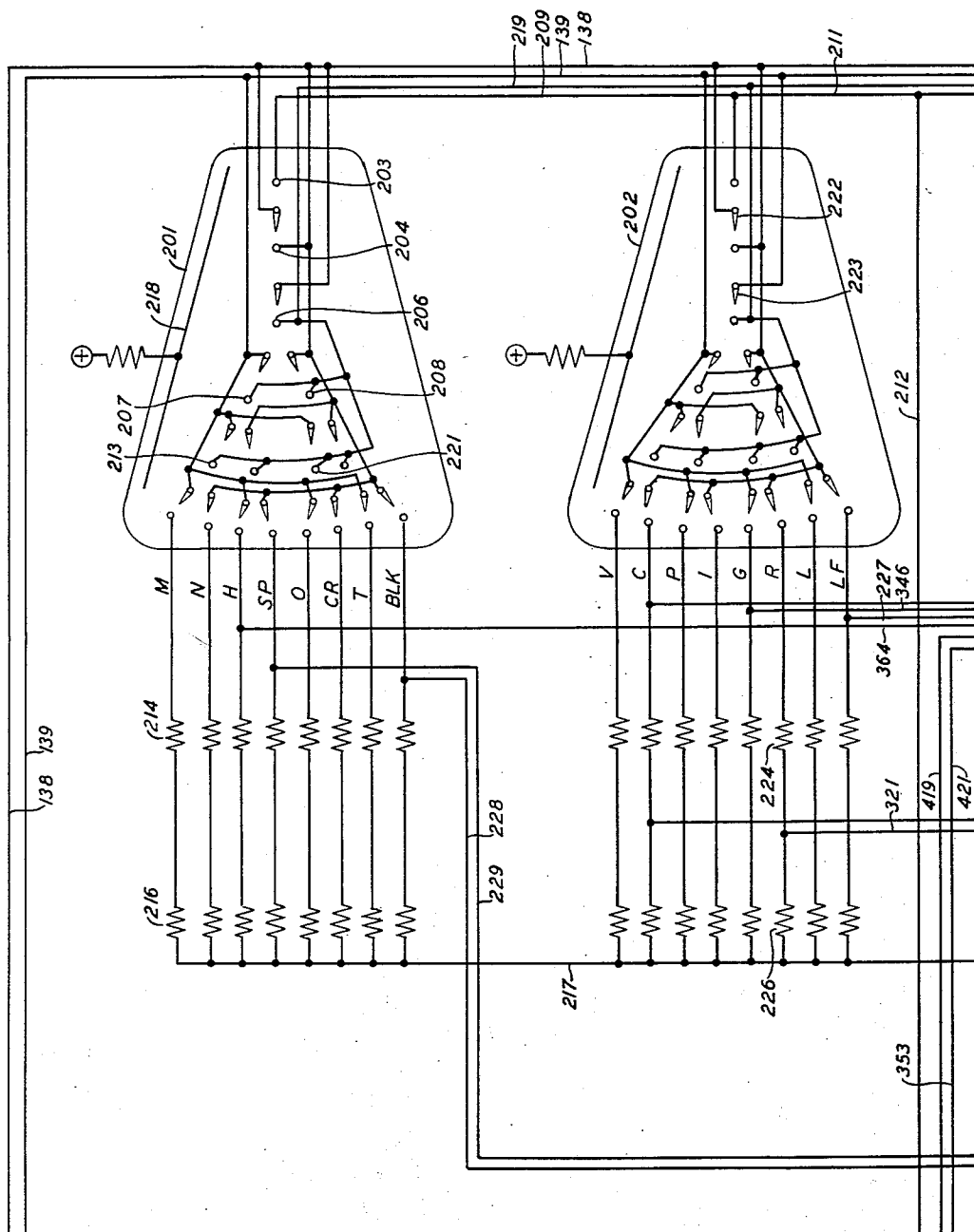


FIG. 2

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4 Sheets-Sheet 3

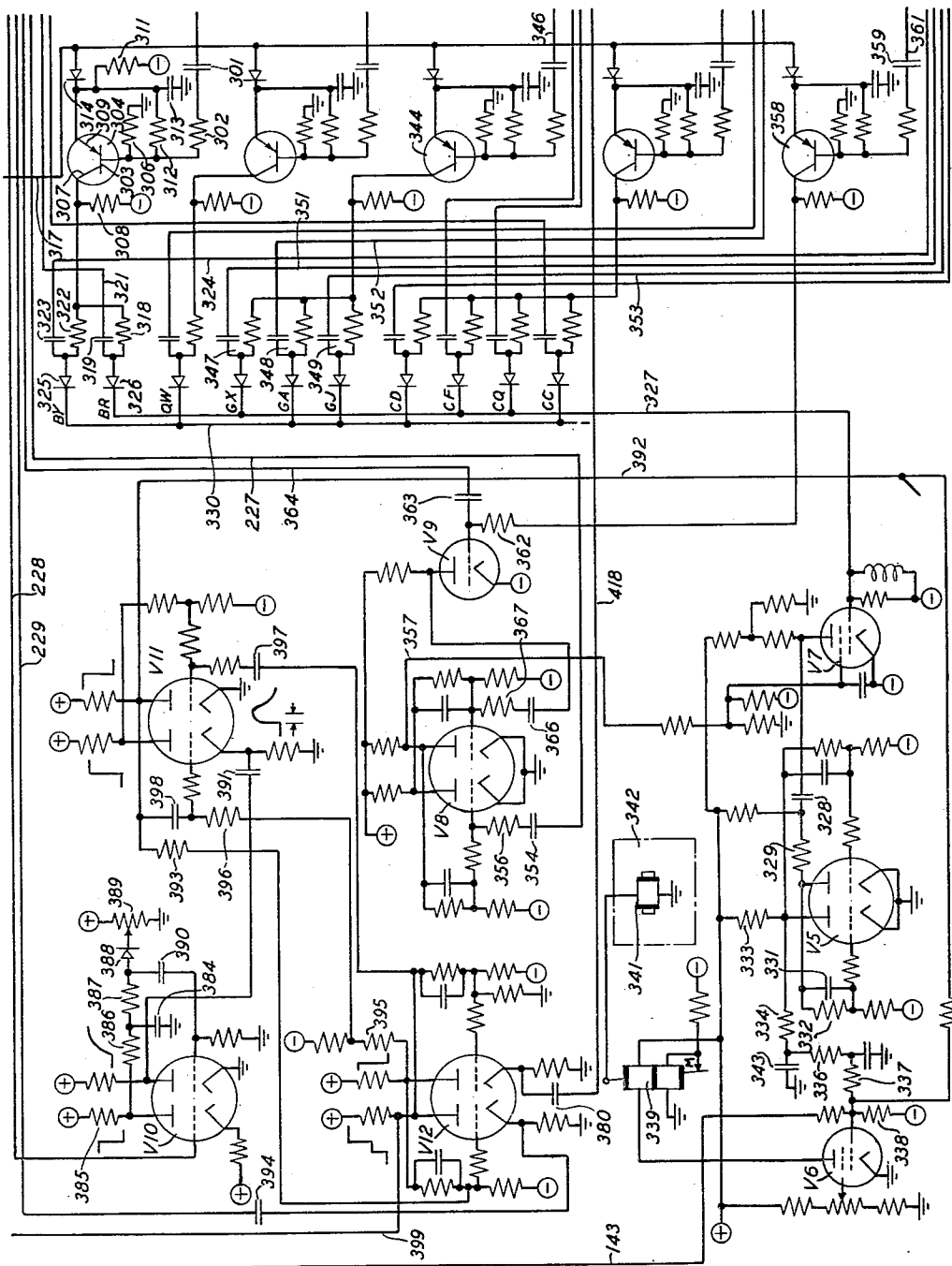


FIG. 3

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4 Sheets-Sheet 4

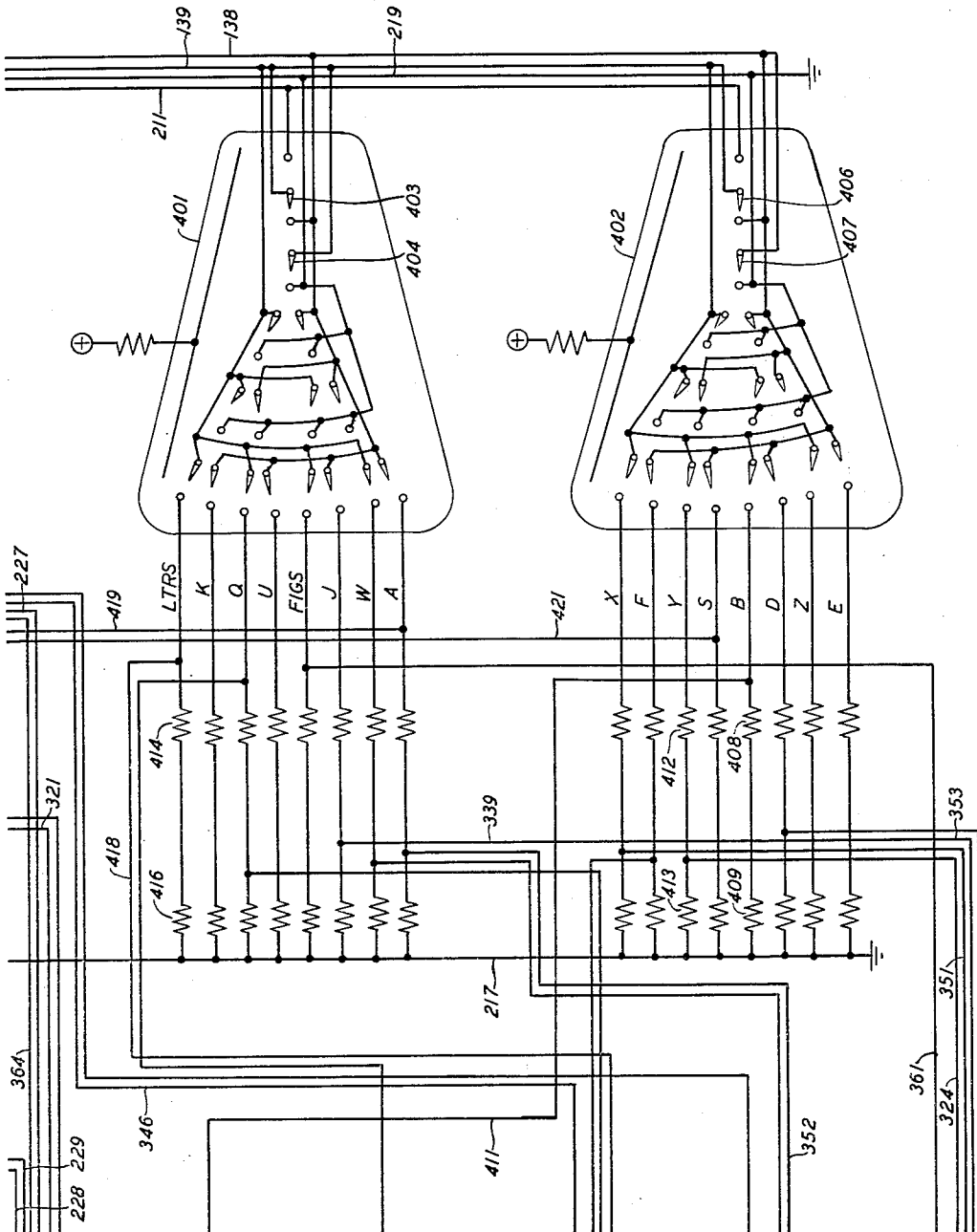


FIG. 4

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1

3,005,041

TELEGRAPH TRANSMITTER CONTROL SYSTEM

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11 Claims. (Cl. 178-4.1)

This invention relates to signal responsive selector mechanisms and particularly to instrumentalities for making selections under the conjoint control of two or more telegraph code combinations received in succession.

More especially, the invention relates to an electronic circuit arrangement for decoding and giving effect combinationally to two or more successively received telegraph signals.

An object of the invention is to distinguish by means of combinations of circuit components between intervals of different durations intervening two successively received telegraph signals.

Another object of the invention is to qualify selectively operable circuits to respond to their selecting signals only upon the detection, by combinations of circuit components, of a predetermined interval between two particular successively received telegraph signals.

Another object of the invention is to cause the automatic generation of a permutation code signal combination by means of a circuit arrangement including electron discharge devices.

Another object of the invention is to generate marking and spacing signal elements by the conjoint output of a plurality of electron discharge devices.

Another object of the invention is to pulse in differential manner the control grids of a plurality of electron discharge devices having a common output circuit to cause the generation in said output circuit of marking and spacing elements.

A feature of the invention is a circuit arrangement associated with an interval timer for selectively disabling the timer before completion of the timing operation or precluding registration of completion of the timing operation.

Another feature of the invention is a bistable trigger circuit associated with a monostable interval timing trigger circuit and conditionable by said monostable trigger circuit for operation, and bistable trigger circuit, upon operation, precluding self-restoration of said monostable trigger circuit, and upon restoration, forcing restoration of said monostable trigger circuit.

Still another feature of the invention is the provision of a delay circuit including a diode between the output circuit of a discharge tube and the input circuit of another discharge tube for delaying response of the latter tube to a controlled change in conductivity in the former tube.

Yet another feature of the invention is a telegraph signal transmission instrumentality controllable from the common output circuits of a plurality of electron discharge devices to cause the transmission of one kind of signal element when all of the discharge devices are in one condition of conductivity and to cause the transmission of another kind of signal element when at least one of said electron discharge devices is in another condition of conductivity.

Patent 2,766,318, granted October 9, 1956 to W. M. Bacon, G. J. Kandel, J. A. Krecek, and G. A. Locke, discloses, as part of an automatic teletypewriter switching system, a multistation line having one or more station control circuits each arranged to connect a teletypewriter station in message receiving relation to the line in response to address codes each comprising two

2

permutation code signal combinations. An electromechanical selector mechanism for making a station selection in response to the combined selective attributes of two or more received code combinations is disclosed generally in the Bacon et al. patent, and is disclosed in considerably greater detail in Patent 2,543,174, granted February 27, 1951 to G. G. Keyes and in Patent 2,568,264, granted September 18, 1951 to W. J. Zenner. This electromechanical selector mechanism includes a plurality of pairs of individually selectable elements, one element being normally blocked against selection by a blocking lever which the other element, upon selection, disables. Upon reception of a particular code combination all of the unblocked or primarily selectable elements that are coded to respond to that code combination are selected and moved to operated positions in which they become latched. In the latched positions, the primarily selectable elements unblock their associated secondarily selectable elements. Any unblocked selectable element is then free to respond to its selective code combination, providing that code combination is next received, to close contacts or perform some other operation by which effect is given to the selection, such as the selection of a teletypewriter station. Following the selection of a secondarily selectable element, all of the operated primarily selectable elements are unlatched and restored to unoperated condition. The same signal may serve as the first code combination of certain address codes and as the second code combination of other address codes, so that in the same receiving cycle in which a secondarily selectable element is selected and operated one or more of the primarily selectable elements may also be selected and operated. Each address code comprising two code combinations is followed by a Letters signal, the primary purpose of which is to place a teletypewriter printer in the lower case or unshift condition, but which is also sometimes used as an idling signal to provide time for switching or other operations or to perform supplementary functions not inconsistent with its use as an unshift signal. The supplementary function that the Letters signal performs as it follows the two-character address code is the unlatching of the primarily selectable elements that operate and latch in the same receiving cycle and in response to the same code combination as a secondarily selectable element.

It is the purpose of the system disclosed herein to perform the functions of the electromechanical selector mechanism by an electrical circuit arrangement of circuit components particularly employing space discharge devices and semiconductor devices.

Briefly, the electrical system for making selections in response to two or more code combinations successively received includes a normally dormant oscillator that is held dormant under the control of a telegraph receiving relay associated with a telegraph line, the relay being held in a steady marking condition by the current that flows in the rest condition of the line. When the receiving relay responds to the start element of a telegraph code combination, it sets in operation the oscillator and also triggers a monostable flip-flop circuit to its off-normal condition. The flip-flop circuit includes timing elements such that without external control it will return to its normal condition in an interval slightly longer than that of a received code combination. The frequency of the oscillator is such that each cycle has a duration equal to that of an element of correctly timed telegraph code signals. The flip-flop circuit, in the off-normal condition, is pulsed by the oscillator once in each cycle thereof, but the circuit constants of the flip-flop circuit prevent it from returning to normal condition until the oscillator circuit pulse associated with the last selecting code element of a received code combination occurs, at which instant the oscillator forces the re-

turn of the flip-flop circuit to normal condition, the oscillator being thereby stopped. The oscillator thus supplies the external control that restores the flip-flop circuit slightly ahead of the time at which its own circuit components would restore it.

Associated with the receiving relay is a pulsing circuit for separating received marking and spacing signal elements and for pulsing, under the control of the oscillator circuit, one or the other of two conductive paths, one of which is pulsed for marking elements and the other for spacing elements. The conductive paths that are pulsed selectively in accordance with the marking and spacing nature of received code elements are connected to discharge transferring cathodes of gas-filled stepping tubes according to the arrangement of apparatus and principle of operation disclosed in M. A. Townsend Patent 2,606,309, granted August 5, 1952. This patent discloses a gas-filled stepping tube in which there is directional selectivity in the stepping of a discharge from cathode to cathode in a fan circuit arrangement, whereby any one of a plurality of cathodes may be selected under the control of two types of code elements which may be designated as marking and spacing elements. The Townsend patent discloses a tube having eight final cathodes which is an arrangement that is feasible of manufacture. In accordance with the teaching of Townsend, a discharge may be transferred to any one of the eight final cathodes in three steps under control of three code elements. In the arrangement according to the present invention, four such tubes are employed to provide a total of thirty-two final cathodes, which is the maximum number of selective possibilities of the five-unit permutation code. Each of the tubes includes not three but five steps, the first two of which are non-directional, the fanning beginning at the third step. By properly connecting the transfer control cathodes to the marking and spacing pulsing leads, a discharge will appear at a different one of the thirty-two final cathodes for each code combination of the five-unit permutation code.

The transfer of a discharge to a selected final cathode of one of the tubes causes a voltage to be impressed upon a memory or indication circuit connected to that particular final cathode. Each of the memory or indication circuits is a bi-stable single transistor flip-flop circuit having the arrangement and mode of operation described in copending application Serial No. 292,875, filed June 11, 1952 by B. Ostendorf, Jr., now Patent 2,831,983, issued April 22, 1958.

Each of the indication or memory circuits has associated with it one or more combiner circuits, the number of those circuits associated with a single memory circuit, depending upon the number of selections that have the same first character. When a single transistor flip-flop circuit has been operated to the off-normal condition in recognition of reception of a character code, it causes the charging of a condenser in each of the combiner circuits connected to it. At the beginning of the next code combination received, the discharges are reset in the fan circuit gaseous stepping tubes, and upon the energization of a final cathode in response to the second code combination, a pulse is applied to the condenser of each of the combiner circuits associated with the particular final cathode. In the case of a combiner circuit which has its condenser charged by the associated code storage circuit, the pulsing of the condenser in the combiner circuit will cause the activation of a station receiving circuit. The station receiving circuit is a two-condition circuit, and when activated, it renders an associated teletypewriter receiving printer or reperforator responsive to signals received by the receiving relay.

One or more of the station receiving circuits may be activated in the manner described above. When all of the address codes preceding a message have been decoded in this manner and the appropriate station receiving circuits activated, the signals for carriage return and line feed fol-

low and are received ahead of the text of the message for the selected receiving stations. In response to the decoded line feed signal, an activate-deactivate circuit, which is a two-condition circuit, is operated to the deactivate condition, in which it imposes upon the station receiving circuits a condition preventing them from being activated in response to sequences of character codes that appear in the text of the message and are the same as address codes. At the end of the message, a disconnect signal comprising the codes for Figures, which is the upper case shift code, the opposite of the Letters signal, and an H signal operate through a memory circuit and associated combiner circuit to restore the activate-deactivate circuit to the activate condition, thereby rendering the station receiving circuits responsive to their appropriate two-character address code signals.

The present invention comprises an electronic selector circuit arrangement for controlling the starting of any one of a plurality of telegraph transmitters associated with a multistation line comprising full-duplex transmitting and receiving channels. A roll call of transmitters, seeking one that has been conditioned for transmission, comprises a succession of single character codes, each designating one of the transmitters. A pattern of signals for indicating that a roll call of transmitters is to follow, and for blinding any selected receiving station against response to the roll call, comprises a Blank signal, followed by a measured pause during which the channel remains in the steady marking condition and ending with a Space signal. As disclosed in a Patent 2,871,286 which issued January 27, 1959, to W. M. Bacon, D. E. Branson, G. J. Kandel, and G. A. Locke, a transmitter start circuit, which controls the transmission of the preparatory pattern of signals and the roll call, may interrupt message transmission for the purpose of making a roll call of transmitters. It is desirable to prevent the recording of the transmitter start roll call signals by the teletypewriter recorder of any station or stations that have been rendered responsive to message transmission, and this is the reason for blinding them. When the roll call has been completed, by the starting of a transmitter or by canvassing all transmitters without finding one conditioned for transmission, any teletypewriter recorder that was blinded is unblinded and message transmission is resumed.

The hereinbefore identified Bacon et al. patents disclose arrangements for starting selectively the transmitters at any of the stations on a multistation line under the control of transmitter start signals received by an electromechanical selector mechanism from a switching center to which the multistation line is connected. The types of transmitter start signals employed in the two systems disclosed in the aforementioned Bacon et al. patents are somewhat different, but in the system shown in the Bacon et al. Patent 2,871,286, they consist of: a Blank signal, followed by a measured pause, during which the channel over which the signals are received remains in steady marking condition; a Space signal ending the pause and indicating the nature of signals to follow as having the purpose of selectively and individually starting tape transmitters; single character signals each selectively pertaining to the starting of one of the transmitters; and, upon the starting of a transmitter which has been conditioned by the insertion therein of a message tape, or upon completion of a roll call of all transmitters without finding any having a message awaiting transmission, a Letters signal indicating the end of a transmitter start signal sequence.

The present invention comprises an electronic selector circuit arrangement for responding to transmitter start signals of the type hereinbefore described and for controlling the starting of any one of a plurality of telegraph transmitters associated with a multistation line comprising full duplex transmitting and receiving channels. As disclosed in the Bacon et al. Patent 2,871,286, a transmitter start circuit, which is located at a switch-

ing center serving the multistation line, may interrupt outgoing message transmission to one of the stations on the multistation line for the purpose of making a roll call of transmitters in order to initiate operation of a transmitter that is prepared to transmit to the switching center. It is desirable to prevent the recording of the transmitter start roll call signals by the teletypewriter recorder of any station or stations that had been receiving the message prior to interruption of transmission. The Blank signal and the pause, which precedes the transmission of the Space signal, are employed for blinding the recorders in order that they shall not respond to the code combinations comprising the selective transmitter starting signals. When the roll call has been completed, upon the starting of a transmitter or by canvassing of transmitters without finding one that has been conditioned for transmission, any teletypewriter recorder that had been blinded is unblinded and thereby conditioned to respond to resumed message transmission.

Each station on the multistation line, upon receiving the signal for starting its transmitter, responds by initiating transmission of a message if one is awaiting transmission, or by automatically generating and transmitting the code combination for the character H. The latter signal indicates that the transmitter has no message awaiting transmission and authorizes the transmitter start circuit at the remote switching center to continue the roll call of transmitters.

In accordance with the present invention, a circuit including electron discharge components for generating the H signals is activated at each station which, having responded to the signal for the starting of its transmitter, has no message material awaiting transmission. The signal generator comprises timing circuits for causing the transmission of the marking and spacing elements of which the signal for the character H is comprised.

For a complete understanding of the invention, reference may be had to the following detailed description to be interpreted in light of the accompanying drawings, in which:

FIGS. 1 to 4, inclusive, when arranged with FIG. 1 above FIG. 3, and with FIGS. 2 and 4 disposed at the right of FIGS. 1 and 3 respectively, show the complete circuits of an electronic system for selecting stations in response to address codes each comprising two-character code combinations.

The format of a message to be directed by the selector mechanism to a particular station is like that described in the Bacon et al. Patent 2,766,318. It comprises an address code for the station that is to be selected, which might be the two-character code BR, followed by a Letters signal which in turn is followed by the carriage return and line feed signals. It is the function of the carriage return and line feed signals to condition the teletypewriter recorder at the selective station for printing at the beginning of a new line on the teletypewriter stationery. The line feed signal is also employed for deactivating the selector mechanism so that it shall not select other stations in response to character code sequences occurring in the body of the message that correspond to call-directing or address codes. The line feed signal may also be followed by a Letters signal to afford a brief time interlude between the line feed signal and the beginning of the body of the message. Such interval is not needed in connection with the operation of an electronic selector mechanism, such as that which will be described herein, because the circuits and components provide an inertialess system that is extremely fast in operation. It has been the custom to provide the interval to accommodate the operation of slower mechanical selector mechanisms so that the deactivate or other function could be completed before other signals were received. More than one address code may precede the carriage return and line feed signals, each being followed by a Letters signal to separate the call-directing codes from one another. The body of the message, including

perhaps the identification of the called station as well as the calling station in full text, follows the line feed signal or the Letters signal accompanying the line feed signal. At the conclusion of the message, the disconnect signal, comprising the codes for Figures, H and Letters, terminates the message.

In the description which is to follow, the circuit components in the several figures of the drawings are identified by three-digit reference numerals, the first digit of which identifies the figure of the drawings in which the element or component appears, and the other two digits distinguish among the components in each figure of the drawings. An exception to this rule is the case of certain conductive paths which extend from one sheet of drawings to another. A conductive path carries the same reference numeral from its point of beginning to its terminus or to a junction with one or more other conductors.

Referring now to FIG. 1 of the drawings, the reference numeral 101 designates a telegraph station which is a point of origin or transfer for messages to be switched through the switching apparatus embodying the present invention to one or more receiving stations. In a switching system such as that shown in the Bacon et al. patent, station 101 may be a switching center where messages received from various telegraph stations over lines or trunks are relayed to selected outgoing channels for retransmission toward ultimate destinations. For the purpose of simplicity, station 101 has been shown merely as a message source comprising a telegraph transmitter 102 of conventional type associated with a teletypewriter recorder for producing a home record or monitor copy of message material transmitted, the teletypewriter being represented symbolically by selector magnet 103. It is pointed out that the signal combinations transmitted from transmitter 102 each have seven elements. The first or start element is always a no-current or spacing element. The last or stop element is always a current or marking element. Each of the five intermediate elements may be either marking or spacing depending on the particular character or function to be thereby defined. A positive battery connection 104 for supplying transmission current is provided at station 101 and the station is connected by transmission channel 106 to the input of the selector mechanism, the input being receiving relay 107 which has line conductor 106 connected to one terminal of its lower winding and the other terminal connected to ground. Current flowing through the lower winding during the idle condition, when no messages are being transmitted, causes the armature of relay 107 to engage its marking contact. Relay 107 is a polarized relay and has its upper or biasing winding included in a conductive path from positive battery through resistor 108, the upper winding of the relay, and resistor 109 to ground. When the transmitter 102 at station 101 interrupts the current through the operating winding of relay 107, which is the lower winding, current in the circuit just traced operates the armature of the relay to its spacing contact. The spacing contact of relay 107 is connected through resistor 109 to ground, and the marking contact is connected through resistor 111 to a potential difference source that is negative at 27 volts with respect to ground. All positive battery indications represent a voltage of 260 relative to ground and all negative battery terminations not otherwise identified herein represent battery connections at 160 volts negative with respect to ground.

Resistors 108 and 109 are of such magnitude that the spacing contact is at a potential of approximately 70 volts positive with respect to ground. The armature of relay 107 is connected through a resistor 112 to a junction point 113 to which is connected the cathode of the right-hand triode section of electron discharge tube V3, which is preferably a vacuum tube. From the junction point 113 there is also a connection through resistor 114 to the grid of the left-hand triode of tube V3. Both

triode sections of tube V3 are biased substantially to cut-off by virtue of negative battery connections to the grids. The left-hand cathode of tube V3 is grounded and the right-hand cathode has negative 27 volts in the marking condition of relay 107 and positive 70 volts in the spacing condition. It follows from this that the negative bias on the left-hand triode is reduced when relay 107 operates to spacing because its grid swings towards positive, whereas the negative bias on the right-hand triode is increased with relay 107 in the spacing condition because the right-hand cathode swings toward positive. The bias on both triodes of tube V3 is such that neither triode is conductive in the idle condition of the circuit, with the relay armature on its marking contact, but the right-hand triode is at a lesser negative bias than is the left-hand triode. Moreover, the bias on the grids of tube V3 is such that when the armature of relay 107 operates to spacing, the reduction in negative bias on the left-hand triode of tube V3 is not sufficient to render that triode conductive. Resistor 112 connected between the armature of the relay and junction 113, and capacitor 115 connected from resistor 112 to ground, serve as a filter to prevent the occurrence of voltage fluctuations at junction 113 due to bouncing of the armature of the relay, since the application of multiple pulses from the junction point 113 to the left-hand grid and right-hand cathode of tube V3 might produce spurious pulses in the output of the tube.

The positive potential that is applied to junction 113 when relay 107 goes to spacing is extended over conductors 116, 117, and 118, resistor 119, capacitors 121 and 122, and resistor 123 to the grid of the left-hand triode of tube V1. Tube V1 is a monostable flip-flop circuit and its purpose is to time a received code combination. Its normal condition, prior to the response of relay 107 to the start element of a code combination, is that the left-hand triode is cut off and the right-hand triode is conducting. In this normal condition, with the right-hand triode conducting, a negative potential of the cathode of the right-hand triode applied through the potential divider comprising resistors 124 and 126 connected between negative battery and ground holds the right-hand anode at negative potential and this potential is applied to the grid of the left-hand triode of tube V2, holding that triode cut off. Tube V2 is a free-running multivibrator which has symmetrical half cycles and provides a timing wave, each cycle of which has a duration equal to correctly timed start and selecting elements of code combinations.

When a positive pulse is applied to the grid of the left-hand triode of tube V1 over a previously traced path as relay 107 responds to the start element of a code combination, that triode is rendered conductive, and due to the flip-flop connection, including capacitor 125, with the grid of the right-hand triode the latter triode cuts off. The right-hand anode of tube V1 swings positive and holds the left-hand triode conductive through a clamping connection to the grid of the latter triode for the interval in which the right-hand triode remains cut off. Resistor 127 and varistor 128 connected from the junction of capacitors 121 and 122 to ground by-passes the negative pulses resulting from return of the armature of relay 107 to the marking contact so that the left-hand triode of tube V1 is not influenced by that return. The timing circuit comprising capacitor 125 and resistors associated with the grid of the right-hand triode of tube V1, which time the interval for self-restoration of tube V1 to its normal condition, have such values that that interval is slightly longer than five and one-half elements of correctly timed signals, thereby bringing the time of self-restoration into the interval between the middle of the fifth selecting code element and the beginning of the stop element. An external influence from the free-running multivibrator comprising tube V2 accelerates the time of restoration of tube V1 as will be described hereinafter.

With tube V1 in its off-normal condition, the right-hand anode of the tube is positive and this potential is impressed upon the left-hand grid of tube V2, permitting that tube to operate as a multivibrator. The left-hand triode conducts in the first half of a received start element, and the right-hand triode conducts during the last half of the start element and each received significant element. It follows from this that the left-hand anode swings negative at the beginning of the start element and at the beginning of each selecting element, and swings toward positive at the middle of the start element and the middle of each selecting element. The left-hand anode of multivibrator tube V2 is connected through conductors 129, 130, and 131 and branching paths to the grids of tube V3, each of the branching paths including a blocking condenser, these condensers being designated by the reference numerals 132 and 133. The positive swing is sufficient to render one or the other of the triodes of tube V3 conductive momentarily, depending upon the position of the armature of relay 107 at the time of occurrence of the pulse. If the armature is on the marking contact, biasing the left-hand triode more negative than the right-hand triode, the latter triode will conduct momentarily. On the contrary, if the armature engages the spacing contact, biasing the right-hand triode more negative than the left-hand triode, the latter triode will conduct momentarily.

The external control for accurately timing the restoration of tube V1 to normal condition is derived from the right-hand anode of tube V2 and is supplied through capacitor 134 to the right-hand cathode of tube V1. While tube V2 is operating as a free running multivibrator, a negative charge on capacitor 125, through which the right-hand triode of tube V1 was cut off, is leaking off and the right-hand grid of tube V1 is rising toward positive. Since the left-hand anode of tube V2 swings toward negative at the beginning of each code element and swings toward positive at the middle of each code element, it follows that the right-hand anode of tube V2 does just the opposite, swinging toward positive at the beginning of each code element and toward negative at the middle of each code element. These voltage swings are applied through capacitor 134 to the right-hand cathode of tube V1. The positive swings merely increase the negative bias on the right-hand triode of tube V1. The negative swings, being swings toward the potential of the grid, reduce the bias on the right-hand triode of tube V1. When the negative cathode swing occurring at the middle of the fourth code element occurs, capacitor 125 has not lost enough of its negative charge to permit the cathode swing to render the right-hand triode of tube V1 conductive. However, at the next negative swing of the cathode, which occurs at the middle of the fifth code element, the right-hand grid of tube V1 has risen toward positive sufficiently that the negative cathode swing will render the right-hand triode of tube V1 conductive. The right-hand anode of tube V1 swings toward negative, cutting off the left-hand triode and holding it cut off until the next positive pulse is applied through capacitors 121 and 122. This pulse should occur at the start transition of the next received code combination, because relay 107 returns to marking for the stop and rest condition following the fifth code element, applying a negative pulse to capacitor 121 as the armature of the relay returns to marking. With the monostable flip-flop circuit comprising tube V1 in its normal condition, the operation of the free running multivibrator is suspended and that multivibrator remains in its rest condition with the right-hand triode conductive and the left-hand triode cut off.

It was previously stated that the grids of tube V3 are pulsed positively at the middle of each received code element, the right-hand triode conducting momentarily when a marking condition is being received and the left-hand triode conducting momentarily when a spacing condition is being received. The external anode circuit of the left-

hand triode of tube V3 includes the primary winding of a transformer 136, and the external anode circuit of the right-hand triode of the tube includes the primary winding of a transformer 137. The secondary winding of transformer 136 is shunted by a resistor and is connected between ground and an output conductor 138. Similarly, the secondary winding of transformer 137 is shunted by a resistor and is connected to output conductor 139. A control pulse is impressed on conductor 139 at the middle of each marking code element by transformer 137 and a control pulse is impressed upon conductor 138 by transformer 136 at the middle of each spacing code element.

In FIGS. 2 and 4 are shown four gas-filled stepping tubes designated by the reference numerals 201, 202, 401 and 402. Each of these tubes contains an anode and two different types of cathodes usually designated as the A and B cathodes, the A cathodes being represented by small circles and the B cathodes being represented by triangles, each pointing toward an individual one of the A cathodes. The A cathodes are all returned to a point at or near ground, and the B cathodes are connected selectively to the marking and spacing control conductors 139 and 138. The A cathodes are rest cathodes, and a steady state discharge will exist between any one of the A cathodes and the anode. The B cathodes are transfer cathodes, and will transfer a discharge from one A cathode to another in one direction only, which is the reason that the tube is called a stepping tube. The cathode at the point of beginning of the stepping path is called a reset cathode, and the pulsing of that cathode will cause the transfer of a discharge to it from any other cathode in the tube that is then conducting a discharge.

Referring now specifically to FIG. 2, the reset cathode in tube 201 is designated by the reference numeral 203. Immediately to the left of reset cathode 203 is a B cathode which, when pulsed, will cause the discharge to transfer from reset cathode 203 to A cathode 204. To the left of this cathode is another B cathode which, upon being pulsed, will cause the discharge to transfer to A cathode 206. To the left of the latter cathode is a pair of B cathodes, and the pulsing of one of these will cause the selective transfer of the discharge to either of the A cathodes 207 or 208. To the left of each of the cathodes 207 and 208 is a pair of B cathodes, and the pulsing of any one of these will cause the selective transfer of the discharge to any one of four A cathodes. Similarly, there is a pair of B cathodes to the left of each of the four A cathodes, and the selective pulsing of any one of these will cause the transfer of the discharge to any one of eight final cathodes.

Reset cathode 203 is connected by conductors 209, 211 and 212 to the cathode of the left-hand triode of tube V4 in FIG. 1. This triode has its cathode returned to negative battery through resistor 140a, which is the output load resistor for the triode, its anode having no other connection than to positive battery through resistor 140b and its grid being biased negatively by a potential divider comprising resistors 140 and 141 connected between negative battery and ground. A pulsing connection from the anode of the left-hand triode of character timer flip-flop tube V1 to the left-hand grid of tube V4 includes capacitor 142. When the left-hand triode of flip-flop tube V1 is rendered conductive at the beginning of the start element of a code combination and its anode swings toward negative, a negative pulse is impressed through capacitor 142 to the left-hand grid of tube V4, reducing the conductivity of this triode. Because the output is taken from the cathode, which follows the potential of the grid, a negative pulse is applied over conductor 212 to reset cathode 203 to transfer the discharge to that cathode. The negative charge on capacitor 142 leaks off and restores the left-hand triode of tube V4 to normal conductivity near the end of the received start element, thereby maintaining the left-hand triode of tube V4 at reduced conductivity during almost the entire received start element. With a negative potential impressed on the reset cathode

for this interval, the pulsing of an adjacent B cathode during the interval will not result in the transfer of a discharge from the reset cathode. It will be noted that the B cathode immediately to the left of the reset cathode 203 is connected to spacing conductor 138 which is pulsed about the middle of the received start element. This pulsing of the B cathode does not result in the transfer of the discharge to A cathode 204 because the cathode cannot effect a transfer until the reset cathode has returned to its normal potential near ground. The reset cathodes in the other three tubes are also connected to conductor 212, so that the discharge is reset in the tubes during the reception of the start element and is prevented from being stepped during that element.

The first B or transfer cathode in tube 201 is connected to spacing pulse conductor 138, as is also the second B cathode. It follows from this that the first spacing element received after the start element will cause the transfer of a discharge from reset cathode 203 to rest cathode 204, and the next spacing element will cause another transfer to rest cathode 206. From that point on, the transfer cathodes appear in pairs, doubling in number for each step, and comprising one, two and four pairs. The upper transfer cathode of each pair is connected to the marking pulse conductor 139, and the lower one is connected to the spacing pulse conductor 138. A marking pulse occurring on conductor 139 when the discharge is at rest cathode 206 will cause the discharge to transfer to rest cathode 207, whereas a spacing pulse will cause it to transfer to rest cathode 208. By similar selective transfer in the next two ranks of transfer cathodes, the discharge may be brought to any one of eight final rest cathodes.

The eight final rest cathodes have been designated by the character or function signals to which they correspond. For example, should the received signal comprise two spacing elements followed by three marking elements, the discharge will be reset to cathode 203 during the start element, will be transferred to rest cathode 204 during the first spacing element, to rest cathode 206 during the second spacing element, to rest cathode 207 during the first marking element, which is the third element of the code combination, to rest cathode 213 during the second marking element, which is the fourth element of the code combination, and to final cathode M during the third marking element, which is the fifth element of the code combination. The final cathode M is connected through resistors 214 and 216 to ground conductor 217, and the discharge current flows from ground through those resistors and from final cathode M to anode 218, which is common to all of the cathodes of the tube. All rest cathodes in tube 201 other than the final cathodes are connected to conductor 219 which is grounded. If the code combination for carriage return, which consists of the code elements space, space, space, mark, space, should be received, the discharge will transfer from reset cathode 203 to rest cathode 204 in response to the first spacing element, to rest cathode 206 in response to the second spacing element, to rest cathode 208 in response to the third spacing element, to rest cathode 221 in response to the first marking element, and to rest cathode CR in response to the final spacing element.

Consideration will now be given to the response of tube 201 to a signal which does not have its first two code elements of spacing nature. It will be supposed that the signal for the character W, which is comprised of the elements mark, mark, space, space, mark, is received. Since the transfer of the discharge from reset cathode 203 occurs only in response to spacing elements in tube 201, the discharge will remain on reset cathode 203 during the first two elements of the code combination for W. In response to the third element, which is of spacing nature, the discharge will transfer to rest cathode 204, and during the fourth code element, which is also of spacing nature, the discharge will transfer to rest cathode 206. During the final code element, which is of marking nature, the discharge will transfer to rest

cathode 207. Since the code combination contains no more code elements, the discharge will not advance beyond this point, but will be reset during the start element of the next received code combination. Thus the discharge will reach one of the final cathodes in tube 201 only in response to code combinations corresponding to one of the eight characters or functions by which those eight final cathodes are identified. These are the code combinations which have the first and second elements of spacing nature.

Tube 202 has its first transfer cathode 222 connected to spacing pulse conductor 138, and its second transfer cathode 223 connected to marking pulse conductor 139. The remaining transfer cathodes are connected to conductors 138 and 139 in the same manner as those of tube 201, and tube 202 provides selective response for those eight code combinations which have the first element of spacing nature and the second element of marking nature. Similarly, tube 401 is effectively responsive to the eight code combinations having the first and second elements of marking nature, by having first and second transfer cathodes 403 and 404 connected to marking pulse conductor 139, and tube 402 is effectively responsive to the eight code combinations having the first element of marking nature and the second element of spacing nature, by having the first transfer cathode 406 connected to marking pulse conductor 139 and the second transfer cathode 407 connected to spacing pulse conductor 138.

As previously stated, the selector mechanism being described herein effectuates selections in response to call-directing codes comprising two characters. In order to do this, it is necessary to register and store an indication of reception of any code combination in order to produce a combinational result from two successively received code combinations. The instrumentality used for registering the reception of code combinations is a single transistor flip-flop circuit shown in FIG. 3. This circuit is fully described and claimed in the previously mentioned B. Ostendorf, Jr., patent and the disclosure of that patent is incorporated herein by reference as if fully disclosed in the present specification. It will be described in the present specification only to the extent necessary to convey an understanding of its operation for the purposes of the present invention.

It will be assumed that a message is transmitted from station 101, preceded by the address code BR. The code combination for the character B has its first code element of marking nature and its second code element of spacing nature, and the code combination is effectively decoded by stepping tube 402 to establish a discharge at final rest cathode B and a resulting flow of current through resistors 408 and 409. The establishment of a discharge through final rest cathode B results in a swing of that cathode toward positive, and the swing is impressed over conductor 411 on the right-hand terminal of capacitor 301. The other terminal of capacitor 301 is connected through resistor 302 to the base 303 of transistor 304, and the base is also connected through resistor 306 to ground.

The collector 307 of transistor 304 is connected through resistor 308 to a negative potential source. The resistor 308 is of relatively low resistance, perhaps of the order of 820 ohms, and the battery connection serves to bias the collector in the reverse direction and is perhaps of the order of 26 volts.

The emitter electrode 309 is returned to negative potential through the load line resistor 311 which is large in comparison with the internal emitter resistance of the transmitter, and in one embodiment of the invention has a value of 3 megohms. The negative voltage to which the emitter is returned through resistor 311 is the full negative battery potential of 160 volts. The emitter also has connection through self-biasing resistor 312 to base 303, through capacitor 313 to ground, and through the crystal diode or varistor 314, and conductor 317 to the cathode of the right-hand triode of tube V4 which is

connected through resistor 143 to negative battery supply at 45 volts. In the steady-state condition of the right-hand triode of tube V4, the tube is sufficiently conductive to provide a potential of approximately 11½ volts negative at the cathode, and this is the potential applied to the right-hand terminal of varistor 314.

With the circuit arrangement of the transistor as described, the transistor is normally held cut off by a small negative bias current flowing through resistor 311 from the negative battery supply. At the time of the positive voltage swing applied to conductor 411 by the final rest cathode B, a positive pulse is applied through capacitor 301 to the transistor base 303. This pulse effects no change in the steady-state condition of the transistor. During the start element of the next received signal combination, the discharge is reset in the stepping tubes 201, 202, 401 and 402. The final cathode B returns to ground potential, applying a negative-going pulse through capacitor 301 to transistor base 303. The negative transition applied to the transistor base causes the emitter 309 to be momentarily more positive than the base and hence positive current flows from the base to the collector. Feedback action obtained because of resistor 306 to ground causes an even more negative excursion of the base, and the emitter is pulled negatively along with the base because of the low internal emitter-to-base resistance. Upon reaching the holding potential of approximately negative 11.5 volts applied over conductor 317, the varistor 314 becomes a low impedance source of current supplying a high value of emitter current, which in turn sustains a high collector current. When the circuit has stabilized in the new condition, the collector-to-ground voltage is about negative 14 volts, an increase in potential of approximately 12 volts. The transistor is stable in this new condition, which is its off-normal condition.

The collector electrode 307 of the transistor is connected through resistor 318 to one terminal of a capacitor 319, the other terminal of which is connected over conductor 321 to the junction of resistors 224 and 226 connected between the final cathode R of stepping tube 202 and grounded conductor 217. The same transistor collector electrode is also connected through resistor 322 to one terminal of capacitor 323, the other terminal of which is connected over conductor 324 to the junction of resistors 412 and 413 connected in series between final cathode Y of stepping tube 402 and grounded conductor 217. The circuit comprising resistor 318 and capacitor 319 is a combiner circuit which is primed by transistor 304 in preparation for possible reception and decoding of the code combination for the character R. Similarly, the circuit comprising resistor 322 and capacitor 323 is a combiner circuit that is primed by the same transistor 304 in anticipation of possible reception of the code combination for the character Y. In the off-normal stable condition, collector electrode 307 of the transistor is more positive than it is in the normal stable condition, and the increased potential causes a charging current to flow through resistors 318 and 322 to charge capacitors 319 and 323, respectively.

When the code combination for the character R has been decoded by tube 202, a discharge is established between final cathode R and the anode of tube 202 to produce a positive voltage swing at the junction of resistors 224 and 226. The positive voltage swing, occurring about the middle of the fifth element of the code combination, is impressed on capacitor 319 and is in additive relation to the charge already impressed thereon by transistor 304. The resultant pulse, applied through crystal diode 326 and conductor 327 to the control grid of tube V7 renders that tube conductive for the duration of the pulse. The positive screen voltage for tube V7 is removable under circumstances to be described hereinafter, but it will be assumed for the present that the tube has proper screen voltage and that the positive pulse on its control grid will render it conductive. The anode of tube V7 is coupled

through capacitor 328, resistor 329, which is part of the anode load of the right-hand triode of tube V5, and capacitor 331, shunted by resistor 332, to the left-hand grid of tube V5. This tube has circuit connections establishing a bi-stable flip-flop circuit, and it may be assumed to be conductive in its left-hand triode at this time, holding the control grid of tube V6 sufficiently negative that the latter tube is insensitive to positive potential applied from conductor 117 over conductor 143 to the control grid of tube V6 each time the armature of receiving relay 107 operates to spacing. The negative swing of the anode of tube V7, as it becomes conductive, cuts off the left-hand triode of tube V5, which renders the right-hand triode conductive. With the left-hand triode of tube V5 cut off, the anode of the tube swings toward positive, thereby raising the potential of the control grid of tube V6 through a potential divider circuit comprising resistors 333, 334, 336, 337 and 338. The resulting potential on the control grid of tube V6 brings it close to the threshold of conductivity, but the tube is not rendered conductive under the control of the left-hand triode of tube V5 alone. The anode circuit of tube V6, in which no current is flowing, includes the operating winding of a repeating relay 339 which has its armature held in engagement with the marking contact by current through the biasing winding. A circuit through the armature and marking contact of repeating relay 339 includes the selector magnet 341 of a receiving teletypewriter station 342, which is the station designated by the address code BR. When a current flows in the anode circuit of tube V6, the armature of relay 339 moves out of engagement with the marking contact, impressing a spacing element upon the selector magnet 341.

The code combination for the letter R, in common with fifteen other code combinations of the five-unit code, has its fifth code element of spacing nature. Since tube V7 is rendered conductive momentarily, about the middle of that element, the armature of receiving relay 107 is engaging its spacing contact, applying positive battery over conductor 143 to the grid of tube V6. Since this is the final code element of a code combination, it would be undesirable to permit receiving teletypewriter 342 to respond to that code element, which it would interpret as the start element of a code combination. The removal of the negative holding bias on the control grid of tube V6 is delayed by capacitor 343 connected to the junction of resistors 334 and 336, the delay extending well into the time of reception of the stop element following the final code element. When the negative holding potential is removed from the grid of tube V6, the selector magnet 341 of teletypewriter 342 will respond to all signals received by receiving relay 107.

As previously stated, the character timer tube V1 is restored to its initial condition at the time of generation of the discharge stepping pulse for the fifth element of a code combination. The return of tube V1 to normal condition involves restoration of conductivity in the right-hand triode and cutting off of the left-hand triode. As conductivity is restored in the right-hand triode, the anode of that triode swings toward negative and the negative swing is applied over conductor 144, capacity 147 and resistors 148 and 149 to the grid of the right-hand triode section of tube V4. The function of this triode is to reset any transistor flip-flop circuit that was triggered to its off-normal condition at the end of reception of the preceding code combination. The negative swing of the right-hand anode of tube V1 produces a negative swing of the right-hand grid of tube V4 reducing conductivity of that triode. As previously stated, the cathode of the right-hand triode of tube V4 is connected over conductor 317 and through crystal diode 314 to the emitter electrode 309 of transistor 304. The emitter electrodes of all others of the transistors are connected through individual crystal diodes to conductor 317. Since the right-hand cathode of tube V4 follows the grid toward negative, the emitter of any transistor flip-

flop circuit that is off-normal will be driven toward negative to restore the flip-flop circuit to its normal condition. A capacitor 151 is coupled from the junction of resistors 148 and 149 to ground, and its function is to delay slightly the negative-going transition of the grid and cathode of the right-hand triode of tube V4. It should be remembered that the restoration of tube V1 to normal condition occurs substantially at the same instant that the transfer of the discharge in one of the stepping tubes to a final cathode occurs. Referring specifically to the case under consideration, the transfer of the discharge to the final cathode R of tube 202 and the pulsing of capacitor 319, charged by transistor 304, would occur substantially at that instant. If the restoration of the transistor flip-flop circuit to normal condition were to occur at the same instant, capacitor 319 might discharge to a sufficient extent, that the pulse applied over conductor 321 would be insufficient to activate tube V7 and trigger tube V5. By restoring an off-normal transistor flip-flop circuit after the associated capacitor has been pulsed, the charge on the capacitor will not be lost.

It will also be remembered that the triggering of a transistor flip-flop circuit in response to a received code combination does not occur at the time of transfer of the discharge to the final cathode representing that code combination, at substantially the midpoint of the last code element of the code combination, but occurs instead at the resetting of the discharge in the stepping tube during the start element of the next received code combination. Thus the sequence of events, when the last code element of a code combination has been identified, is to pulse the capacitor of a combiner circuit associated with a transistor flip-flop circuit that was triggered during the start element of that code combination as a result of a selection made in response to the preceding code combination, then to restore that transistor flip-flop circuit, and in the start element of the next code combination to trigger the transistor flip-flop circuit representing the code combination just completed.

It will be noted with reference to FIG. 2 that there is no connection from the final cathode R of tube 202 to a single transistor flip-flop circuit. The significance of this is that among the teletypewriter stations controlled by the decoding circuits contained in FIGS. 2 and 4, there is none having the letter R as the first character of its address code. If there were a station so designated, a single transistor flip-flop circuit would be connected to the final cathode R, and that trigger circuit would be triggered off-normal upon the resetting of the discharge in tube 202 during the start element of the code combination following the address code BR, which is a Letters code combination. That single transistor flip-flop circuit would be restored to normal after the middle of the last selecting element of the Letters signal through the agency of timer tube V1 and the right-hand triode of tube V4, as described. Thus the Letters signal is not used as the first character of any two-character code so that there is no connection from the final cathode representing the Letters signal to a single transistor flip-flop circuit. From this it follows that at the end of the Letters signal none of the single transistor flip-flop circuits is off-normal.

If a message is addressed to more than one station served by the same station selector unit or circuit, the address codes for the stations addressed, each comprising a two-character address code followed by the Letters signal, will be received by relay 107. For example, the address code BY might be received. The transistor flip-flop circuit 304 will be triggered off-normal in response to the character B to prime the combiner circuit comprising resistor 322 and capacitor 323, and the capacitor will be pulsed in response to the signal representing the character Y, delivering a pulse through crystal diode 325 and over conductor 330 to activate momentarily the control tube of a station selector circuit (not shown). The address codes might include a group code, such as code GX. A flip-flop

circuit including transistor 344 is arranged to be triggered off-normal over conductor 346 which is connected to final cathode G in tube 202. In FIG. 3, the transistor 344 is arranged to prime three combiner circuits 347, 348, and 349. The capacitor in combiner circuit 347 is connected over conductor 351 to be pulsed when a discharge reaches the final cathode X of tube 402 in response to the code combination for the character X. This combiner circuit, upon being pulsed, extends the pulse to conductor 327, thereby selecting station 342 in addition to any other station designated by the address code GX and served by the same selector circuit or another similar selector circuit in the system. In this way, a message may be routed to two or more stations in response to an address code jointly designating them. The other two combiner circuits that are primed by transistor 344 are not pulsed in response to the character X, because their capacitors have other connections. Specifically, combiner circuit 348 has its capacitor connected over conductor 352 extending to the resistive path that becomes conductive when a discharge transfers to final cathode A in tube 401, the combiner circuit 348 combining the codes G and A, and the capacitor associated with combiner circuit 349 is connected over conductor 353 to the resistive path associated with final cathode J in the same stepping tube, combiner circuit 349 combining the codes G and J.

The last of the address codes is followed by the carriage return and line feed signals which are effective, in the teletypewriters that have been selected to receive the message, to advance the stationery in the teletypewriter to the point of beginning of a new line for the recording of the message to follow. The combinations for carriage return and line feed are impressed directly from relays such as relay 107 and tubes such as tube V6 to control the selected teletypewriters. They also affect selections in tubes such as tubes 201 and 202, respectively, and the selection effected by the line feed combination is used to blind the station selector circuits against further response to address codes appearing randomly in the text of the message. There is no connection to the resistor path associated with final cathode CR of stepping tube 201, to which a discharge is transferred in response to the carriage return signal. There is a connection, however, to the final cathode LF in stepping tube 202, and this connection extends over conductor 227, capacitor 354 and resistor 356 to the left-hand grid of tube V8. This tube has connections establishing a bi-stable flip-flop circuit. The tube V8, together with the tube V9, comprises an activate-deactivate circuit by means of which the first line feed signal, received following the selection of stations in response to address codes, deactivates the station selector mechanism so that stations cannot be selected in response to character sequences appearing in the text of a message that correspond to the address codes of those stations. The end-of-message signal is subsequently effective upon the circuit comprising tubes V8 and V9 to activate the station selector circuit so that it will effect selections of stations in response to address codes. In the activate condition, the left-hand triode of tube V8 is conducting, and the right-hand triode is cut off. This causes the positive potential of non-conductive right-hand anode of tube V8 to be applied over conductor 357 to the screen grid of tube V7. Earlier in this description it was assumed that this tube had proper screen voltage for its operation. That screen voltage is obtained from tube V8. Since the left-hand triode of tube V8 is conducting, the positive pulse applied to its grid from final cathode LF of tube 202 when a discharge is transferred to that cathode, has no effect on tube V8. When the discharge is reset in tube 202 about the middle of the start element of the next received code combination, a negative pulse is applied over conductor 227 and through capacitor 354 to cut off the left-hand triode of tube V8. The flip-flop connections cause the right-hand triode to become conductive and the anode swings toward negative, removing

the positive screen voltage from tube V7 and thereby rendering that tube insensitive to control by its control grid. During reception of the message, the stepping tubes continue to decode received code combinations, stepping discharges to their final cathodes selectively, triggering associated single transistor flip-flop circuits, and pulsing tube V7 and corresponding tubes when sequences of two code combinations correspond to address codes in response to which those tubes are to be pulsed. The pulsing of the control grids of the tubes is ineffective because of removal of the screen voltage, and those unselected stations cannot be inadvertently selected.

Each time that a Figures code combination is received, a single transistor flip-flop circuit including transistor 358 is triggered, during the start element of the next code combination, by a negative pulse impressed through capacitor 359 from conductor 361 which is connected to the final cathode FIGS. in tube 401. This single transistor flip-flop circuit, upon being triggered, primes a code combiner circuit comprising resistor 362 and capacitor 363 associated with the grid of tube V9, and capacitor 363 is connected over conductor 364 to the final cathode H of tube 201. The only circumstance under which the H code combination properly follows the Figures code combination is the end-of-message or disconnect signal. Accordingly, any occurrence of the Figures signal in the text of the message will merely result in the priming of the combiner circuit associated with the grid of tube V9, and in response to the next succeeding code combination, transistor 358 will be restored. However, when the H signal follows the Figures signal, the positive pulse applied from the final cathode H of tube 201 through capacitor 363, which is charged from off-normal transistor circuit 358, will render tube V9 conductive momentarily. Its anode, which is connected through capacitor 366 and resistor 367 to the right-hand grid of tube V8, will swing negative momentarily, cutting off the right-hand triode of tube V8 and restoring conductivity to the left-hand triode. With the right-hand triode cut off, the screen voltage will be restored to tube V7 and corresponding tubes, thereby effecting reactivation of the station selecting circuits.

The arrangement for starting a transmitter in response to a roll call is shown in FIG. 1, in addition to circuits already described in that figure, and in the upper and left-hand portions of FIG. 3. A tape transmitter that is to be started in response to transmitter start signals from station 101 is designated by reference numeral 153, and it may be a conventional tape transmitter controlled by clutch magnet 154. The circuit of clutch magnet 154 is closable by relay 156, which is operable upon completion of its operating circuit over either of two paths. Common to the two paths are the contacts 157 that are usually designated as sixth pin contacts, and these contacts close when a perforated tape containing message material to be transmitted is placed in the tape transmitter. Also common to the two paths is the swinger of switch or key 158, which is manually operable to select one or another of two possible energizing circuits. The key 158 is positionable in one or another of two positions depending upon the degree of urgency of the message, which has been described in the Bacon-Branson-Kandel-Locke Patent 2,871,286 as priority or non-priority rating. As disclosed in that patent, one transmitter start code may be assigned to a transmitter for priority message pick up and another may be assigned to the same transmitter for non-priority message pick up. The circuit which originates transmitter start signals invariably first transmits a roll call of priority transmitter start codes in a cycle of operation, and transmits non-priority transmitter start signals only if it makes a complete roll call of transmitters for priority message traffic without finding any such traffic awaiting transmission. It will be assumed that tape has been placed in transmitter 153, causing the closure of sixth pin contacts 157 and that key 158 has

been closed to the left-hand contact as shown, which will be presumed to be the non-priority condition. This selects an energizing path for relay 156 which includes the armature 3 and front contact of relay 160. The transmitter 153 will be started in due course automatically, and in response to its assigned priority roll call signal without further supervisory attention, as will now be described.

It will be presumed that station 342 is receiving a message, and that before the completion of the message a Blank signal is received from station 101. This signal has all of its selecting elements of spacing nature. At the time of reception of the Blank code combination, the selector mechanism is unable to determine whether the Blank signal is the beginning of a transmitter start pattern or whether the signal was inadvertently included in the message transmitted from station 101. In either case, the selector mechanism decodes the signal, and the decoding operation results in the transfer of a discharge to the final cathode BLK in stepping tube 201. The potential of that cathode swings toward positive, correspondingly extending a positive voltage swing over conductor 228 to the grid of the left-hand triode of tube V10 in FIG. 3. Normally, the left-hand triode of tube V10 is held cut off by the positive potential applied to its cathode through a resistor. The excursion of the grid toward positive causes the left-hand triode to swing from cut-off to full-on-condition, and its anode accordingly swings toward negative, as indicated by a fragmentary voltage graph above and to the left of tube V10. Prior to the activation of the left-hand triode of tube V10, a capacitor 384 associated with the circuit of the left-hand anode is charged to a potential determined by a voltage divider comprising resistors 385, 386 and 387, a crystal diode 388, and a potentiometer 389 supplying a potential which is positive with respect to ground. Crystal diode 388 is connected in the low impedance direction with respect to the polarities applied to its two terminals. Following the sudden negative transition of the left-hand anode of tube V10 as the left-hand triode becomes conductive, capacitor 384 begins to discharge exponentially at a rate determined particularly by the values of resistor 386 and capacitor 384. Due to the clamping action of the crystal diode 388, the voltage at the junction of resistor 387 and the crystal diode does not change until the voltage on the capacitor 384 is more negative than the clamping voltage determined by the potentiometer 389. When the point is reached at which the crystal diode 388 no longer passes a significant amount of current and, accordingly, is in the high impedance condition, a fraction of the exponential voltage on capacitor 384 exists at the junction of resistor 387 and crystal diode 388, and is impressed through capacitor 390 on the grid of the right-hand triode of tube V10. This triode is normally conductive, holding its anode at a potential less than full positive voltage. The negative swing of the right-hand grid of tube V10 is accompanied by a positive swing of the anode as conductivity in the tube is reduced, and a positive pulse is applied through capacitor 391 to the cathode of the left-hand triode of tube V11. It will be apparent from the foregoing that the right-hand triode of tube V10 does not undergo a substantial reduction in conductivity until after a delay interval determined mostly by the time constant of resistor 386 and capacitor 384 and the clamping voltage. The amount of delay can be varied by changing the clamping voltage which is under the control of the potentiometer 389. The nearer the clamping voltage is to ground, the longer will be the delay, providing the clamping voltage is more positive than the anode voltage of the left-hand triode of tube V10 when that triode is in the conducting condition. The voltage change at the anode of the right-hand triode of tube V10 is indicated by the fragmentary voltage graph above and to the right of tube V10.

The left-hand triode of tube V11 is normally conduc-

tive, and the positive pulse applied through capacitor 391 to its cathode is the equivalent of a negative pulse on its grid so that the left-hand triode of tube V11 cuts off, its anode swinging toward positive. The left-hand anode of tube V11 is connected through a potential divider circuit to the grid of the right-hand triode, and with the left-hand triode cut off, the right-hand triode is rendered conductive, its anode swinging toward negative. These anode changes are indicated by accompanying voltage graphs. The right-hand anode of tube V11 is connected over conductor 392 to the grid of tube V6, and with the right-hand triode of tube V11 conductive, and while that triode remains conductive, tube V6 is rendered unresponsive to signals repeated by relay 107. This represents the blinding of teletypewriter 342 that has been receiving a message, so that it will not respond to the transmitter start codes that may be expected to be received after a pause of a duration sufficient to cause the cutting off of the right-hand triode of tube V10 and the pulsing of the left-hand cathode of tube V11.

Before proceeding with a description of operations resulting from reception of a proper transmitter start pattern, consideration will be given to the conditions that result when the Blank signal is merely an idle signal in the message and is not followed by a pause of the proper duration. It will be remembered that the discharge is transferred from a final cathode of any of the stepping tubes to the reset cathode during reception of the start element of the next code combination. If the Blank signal, which causes the left-hand triode of tube V10 to become conductive, is followed almost immediately by another and different code combination, the discharge will be transferred from the final cathode BLK of tube 201 to the reset cathode. This will cause the left-hand triode of tube V10 to be cut off before capacitor 384 has timed out and cut off the right-hand triode of the tube. It follows from this that only in response to a rest or pause of a predetermined minimum duration, usually of the order of one second, will the teletypewriter receiving circuits be blinded and other preparations be made for reception of the transmitter start codes. Conductor 392 is connected in multiple to all tubes corresponding to tube V6, so that the blinding condition is applied to all of the receiving teletypewriters.

Tube V11 has its two triode sections connected as a monostable flip-flop circuit. Prior to the pulsing of the left-hand cathode through capacitor 391, the left-hand triode is conductive and the right-hand triode is cut off. When the tube reverses and the right-hand triode becomes conductive, its anode applies a negative pulse through a coupling capacitor 398 to the left-hand grid to hold the left-hand triode cut off for an interval. There is also a connection from the right-hand anode of tube V11 through resistor 393 to the grid of the left-hand triode of tube V12. This tube has cross-connections between its anodes and control grids, establishing a bi-stable, flip-flop circuit, and the left-hand triode is normally conductive. The negative-going swing applied to its left-hand grid from the right-hand anode of tube V11 is preparatory, reducing somewhat the conductivity, but being insufficient to cut off the left-hand triode or cause the right-hand triode to become conductive.

The timed pause following the transmission of the Blank signal from station 101 is ended by the transmission of a Space code combination, and the circuit that controls the transmission of the transmitter start pattern transmits the Space signal before tube V11 times out and restores itself to the initial condition. The Space code combination results in the transfer of a discharge to final cathode SP in stepping tube 201, swinging that cathode toward positive. The positive voltage swing is applied over conductor 229 and capacitor 394 to the left-hand cathode of tube V12. The positive swing of the cathode has the same effect as a further negative swing of the grid would have, and is sufficient to cut off the left-hand triode, there-

by causing the right-hand triode of tube V12 to become conductive. The right-hand anode swings toward negative, and its potential is applied to the left-hand grid of the tube to hold the left-hand triode cut off. Fragmentary voltage graphs above tube V12 represent the voltage changes at the respective anodes. There is a connection from the right-hand anode of tube V12 through resistors 395 and 396 to the left-hand grid of tube V11 to hold that grid negative and the left-hand triode cut off as long as tube V12 remains off-normal even though tube V11, which is monostable, should time out and seek to restore itself to initial condition. Tubes V11 and V12 remain in the off-normal condition throughout the roll call of transmitters and until the reception by relay 107 of a Letters signal, which indicates that a transmitter has been started or that a full roll call has been made without finding a transmitter having material awaiting transmission. The Letters signal is decoded and results in the transfer of a discharge to final cathode LTRS of tube 401. This causes a positive voltage swing to be applied over conductor 418 and capacitor 380 to the cathode of the right-hand triode of tube V12. The positive swing of the cathode causes the cutting off of the right-hand triode, which in turn causes restoration of conductivity in the left-hand triode. With the right-hand triode cut off, the lock on tube V11, applied to the left-hand grid, is removed. At the same time, the negative swing of the left-hand anode of tube V12, as the left-hand triode becomes conductive, is impressed through capacitor 397 on the right-hand grid of tube V11. That triode will be cut off, applying a positive pulse through capacitor 398 to the left-hand grid of the tube to restore conductivity to the left-hand triode. The forcible cutting off of the right-hand triode of tube V11 through capacitor 397 operates as a quick reset arrangement to restore tube V11 to normal condition even though the tube may not have timed out to its self-restoring condition. The restoration of tube V11 results in the re-establishment on the grid of tube V6 of a potential that will enable it to follow signals repeated by relay 107, assuming that station 342 had been receiving a message when the transmission of transmitter start signals was begun. The unblocking of tube V6 represents unblinding of the receiving station.

It will be observed that although tube V11 is a monostable flip-flop circuit, there is associated with it a lock for precluding self-restoration and a reset arrangement for forcing restoration if the self-restoring circuit has not timed out. The reason for imposing external controls upon tube V11 is that it may be required to be off-normal for intervals that vary considerably in duration. If the transmission of a single start code results in the successful starting of a transmitter, the Letters signal, indicating the end of the roll call, may be received before the tube V11 has self-timed for restoration, and the quick reset arrangement for overriding the self-restoring circuit is necessary. On the other hand, it may happen that a complete roll call is made, and that the tube V11 times out before the completion of the roll call and reception of the Letters signal. In that event, the lock applied to the left-hand grid of tube V11 is necessary. Finally, there is the possibility that a Blank signal might be transmitted from station 101, following which transmission might be suspended. This would be an abnormal condition, but it could occur. This would not be a transmitter start pattern, and there would be no Space signal to operate tube V12 off-normal. It would not be desirable under that circumstance to maintain the receiving circuits blinded for an indefinite interval, since transmission might be resumed at any time. Accordingly, the self-restoring feature of tube V11 permits it to restore and unlock the receiving circuits upon failure to receive a Space signal within a short interval after it should have been received. In actual practice, tube V11 is operated off-normal by tube V10 about .25 second after the reception of the Blank signal, the Space signal is received to operate

tube V12 off-normal about 0.5 second after reception of the Blank signal, and if the Space signal is not received, tube V11 self-restores about .75 second after reception of the Blank signal.

Prior to reception of the Letters signal, one or more single character codes, each representing the call signal of a transmitter, are received. It will be assumed that one of the code combinations received represents the character A, and results in the transfer of a discharge to the final cathode A of tube 401. The potential of this cathode swings toward positive, and the raised potential is extended over conductor 419 to the cathode of crystal diode 159, the anode of which is connected to the grid of the left-hand triode of tube V13. Prior to reception of the Space signal, a potential divider system connected to the cathode of a crystal diode 161, including the left-hand triode of tube V12, which is then conductive and has its anode connected over conductor 399 and resistor 150 to the cathode of crystal diode 161, and also including resistor 155 connected from the cathode of diode 161 to negative battery, maintains the left-hand grid of tube V13 sufficiently negative to hold the left-hand triode cut off. Upon the reversal of tube V12 in response to the Space signal and the raising of the potential of its left-hand anode to a more positive value, the grid of the left-hand triode of tube V13 becomes less negative, but the tube is still cut off. The positive swing applied to the cathode of crystal diode 159 makes the grid of the left-hand triode of tube V13 still less negative, and that triode conducts.

The anode circuit of the left-hand triode of tube V13 includes the winding of relay 160 which operates. At the armature 3 and front contact of relay 160, an energizing circuit for relay 156 is completed, the circuit being traced from ground through the sixth pin contacts 157, key 158 in the non-priority position, the armature 3 and front contact of relay 160, and the winding of relay 156 to battery. Relay 156 locks through its armature 2 and front contact and the sixth pin contacts 157 to ground, the locking path shunting the armature 3 and front contact of relay 160. At its armature 3 and front contact, the relay 156 completes the energizing circuit for transmitter clutch magnet 154 which initiates transmission.

The transmission path that is controllable by distributor face 153 extends from negative battery through the rest segment, and through other segments that may become connected thereto selectively under the control of tape-sensing contacts (not shown), the distributor brushes and collector ring, conductor 177 including dotted section 180, the distributor face or other type of transmitting mechanism of any other one or more transmitters that are controllable from the selector mechanism in FIGS. 2 and 4, being represented by the transmitter contacts 178, and resistor 176 to the grid of tube V15. The dotted section 180 represents transmitters additional to the transmitters 153 and 178. The grid of tube V15 is also connected to the anodes of tube V14 which is normally conductive, and the function of which is to generate an answer-back character, as will be described hereinafter. The combination of potentials applied to the grid of tube V15 when none of the transmitters is in operation, comprising the negative battery connection applied to conductor 177, and those applied through resistive paths from positive battery and from ground through resistors to the grid of tube V15, holds the tube cut off. The anode circuit of tube V15 includes the operating winding of transmitting relay 173, and with tube V15 cut off, no current flows in the operating winding, but the current through a biasing winding of the relay holds the armature on the marking contact to apply marking potential to transmitting conductor 174. When the negative battery connection is removed from the grid of tube V15 as the brushes of distributor 153 pass over the start segment and over segments selectively conditioned for transmission of a spacing element, tube V15 becomes

conductive, and current flows through the operating winding of relay 173 to move the armature to the spacing contact which is grounded, thereby initiating the transmission of a spacing element. Reconnection of the negative potential to conductor 177 results in the cutting off of tube V15 and the reoperation of the armature of relay 173 to its marking contact.

As is fully disclosed in the Bacon-Branson-Knandel-Locke application, the reception at the control station of transmission from a transmitter that is started in response to a roll call signal results in the transmission by the transmitter start circuit at the control station of the Letters signal, which is indicative of the end of a roll call, and is effective when received by relay 107 and tube 401 to unblind any receivers that had been blinded against response to the transmitter start codes. The unblinding as applied to station 342, has been described previously, and is necessary in order that those receivers may be conditioned to resume message reception. After the reception of the code signal combination for the letter A, as a transmitter start signal, which started distributor 153, as assumed, the resetting of the discharge in tube 401 during the start element preceding the Letters signal which is assumed to follow the A signal, results in the removal of the positive potential from the cathode of crystal diode 159 and the cutting off of the left-hand triode of tube V13, thereby releasing relay 160. Since relay 156 locked in the operated condition, there is no further need for relay 160 to remain operated. When the transmission of the message from transmitter 153 is completed and the message tape runs out, the sixth pin contacts 157 open, unlocking relay 156, which releases distributor clutch magnet 154 to suspend outgoing transmission.

In any roll call of transmitters, the priority transmitter start codes are transmitted before the nonpriority roll call, the latter roll call occurring only if no transmitter has been conditioned for priority transmission. The priority code for transmitter 153 is the code combination for the character S. Accordingly, this code combination is transmitted among other priority start codes preceding the transmission of the code for the character A, and when it is decoded, the discharge in tube 402 transfers to final cathode S, swinging toward positive the conductor 421 which is connected to the cathode of crystal diode 163. This diode has its anode connected to the grid of the right-hand triode of tube V13, and there is also associated with that grid a crystal diode 164 which has its cathode connected to the same potential divider network as the crystal diode 161. Accordingly, the preparatory enabling voltage is applied to the right-hand grid of tube V13 at the same time as the application of the enabling voltage to the left-hand triode when tube V12 is triggered. It follows that the right-hand triode of tube V13 becomes conductive in response to the code for the character S and operates priority transmitter start relay 165. Relay 156 is operable through the armature 3 and front contact of relay 165 when priority switch 158 is in the priority position. Thus the switch 158 determines which of the two transmitter start codes can cause the operation of relay 156. When there is no tape in the transmitter, contacts 157 will be open, and relay 156 cannot be operated by either of the relays 160 and 165.

As disclosed in the Bacon-Branson-Knandel-Locke Patent 2,871,286, the transmission of successive transmitter start codes of a roll call is dependent upon a response from each of the called transmitters. When the transmitter responds with message transmission, the reception of that transmission at the control station 101 ends the roll call by transmitting a Letters signal from the control station.

When a transmitter is not conditioned to transmit a message, the code combination for the character H is automatically generated and transmitted to the control sta-

tion, and the reception of that code combination at the control station results in reactivation of the transmitter start circuit for the transmission of the next transmitter start code in the roll call. The present invention includes an arrangement for generating and transmitting an H signal when a transmitter is not conditioned to transmit, and the generation of the H signal is controlled by the character timer comprising the circuit of tube V1. For the purpose of initiating the generation of the H signal, each of the relays 160 and 165 is arranged to connect negative battery through its front contact and armature 1 to conductor 167, from which a path continues over conductor 168 to one terminal of capacitor 169, the other terminal of which is connected through resistor 171 to the grid of the right-hand triode of tube V1. The application of a negative pulse through capacitor 169 to the right-hand grid has the same effect on tube V1 as the application of a positive pulse on the left-hand grid from relay 107, through capacitors 121 and 122, namely, the triggering of the character timer tube, cutting off the right-hand triode and rendering the left-hand triode conductive. With the left-hand triode of tube V1 rendered conductive, its anode swings toward negative, and the negative excursion of the anode is extended over conductor 170 and through resistor 185 to the grid of the right-hand triode of tube V14. This resistor is shunted by resistors 179 and 181 in series, and from the junction of those two resistors, there is a connection to ground through capacitor 182. The right-hand grid of tube V14 is also connected through a resistor to negative battery. The effect of the network comprising resistors 185, 179 and 181 and capacitor 182 is to delay the application of the negative voltage swing to the right-hand grid of tube V14 for an interval equal to one-half of a permutation code character element after the triggering of character timer tube V1. When the negative voltage becomes effective on the right-hand grid of tube V14, it cuts off the right-hand triode, and this cutting off coincides substantially with the end of the first half cycle of multivibrator tube V2 which is set in operation by the triggering of tube V1.

The negative potential applied to conductor 167 by relay 160 or 165, which triggers the character timer tube V1 over conductor 168, is also extended over conductor 172 to a potential divider associated with the left-hand grid of tube V14 and including resistor 188. The left-hand triode of the tube is normally conductive. After closure of contacts on relays 160 or 165 and providing relay 156 doesn't operate, the negative potential applied over conductor 172 cuts it off. The tube remains conductive in its right-hand triode until it is cut off after an interval of one-half of a code element, as has been described, and since the two anodes of the tube are connected together and to the grid of tube V15, that grid does not swing positive and render tube V15 conductive until the right-hand triode of tube V14 cuts off. With tube V14 cut off and tube V15 rendered conductive, the relay 173 operates to spacing, impressing a spacing condition on outgoing transmission channel 174. This is the mark-to-space transition initiating the start element of the H signal.

The right-hand anode of character timer tube V1 is connected through conductor 183, capacitor 184, and resistor 186, to the left-hand grid of tube V16 which has circuit connections establishing a monostable flip-flop circuit. This tube is normally conductive in the right-hand triode, and its left-hand triode is normally cut off. A positive pulse applied through capacitor 184, when the right-hand triode of tube V1 cuts off, results in the activation of the left-hand triode of tube V16 and the cutting off of the right-hand triode. The circuit constants are such that tube V16 will time out and restore itself, without any external control, in an interval slightly longer than the duration of 3.5 code elements. Fragmentary voltage graphs to the left of tube V16 show the voltage changes of the grid and anode of the left-hand triode of tube V16.

An external control for tube V16 is supplied by element timer tube V2. Each time a positive-going swing is applied over conductors 129, 130 and 131 from the left-hand anode of tube V2 to pulse the grids of tubes V3, a pulse is impressed from the junction of conductors 130 and 131 through capacitor 189, resistor 190 and capacitor 191 to the right-hand grid of tube V16. As previously stated, the first pulse occurs one-half of a code element after the triggering of character timer tube V1 and because of the free-running operation of multivibrator tube V2, subsequent pulses occur at the ends of succeeding intervals each having a duration of one character element. Accordingly, the right-hand grid of tube V16 is pulsed positively at 0.5, 1.5, 2.5 and 3.5 code elements after the triggering of character timer tube V1 and tube V16. At the end of 2.5 code elements, tube V16 has not timed out sufficiently to respond to the positive pulse, but the next succeeding positive pulse, at the end of 3.5 code elements, is effective to restore tube V16 to its initial condition, with the left-hand triode cut off and the right-hand triode conductive. As the left-hand triode cuts off, its anode swings toward positive and applies a positive pulse through capacitor 187 to the left-hand grid of tube V14. This pulse renders the left-hand triode of tube V14 conductive, thereby cutting off tube V15 and restoring relay 173 to the marking condition. Since tube V15 was rendered conductive one-half code element after character timer tube V1 was triggered and is cut off 3.5 code elements later, it has been conductive for 3 code elements during which the relay 173 transmits a spacing condition, which is interpreted by a remote typewriter receiver as a start element, and the first and second selecting code elements of spacing nature. The cutting off of tube V15 initiates the transmission of a marking element.

The positive pulse through capacitor 187 becomes sufficiently dissipated by the end of a character element that the left-hand triode of tube V14 again cuts off. This causes tube V15 to become conductive and operate relay 173 to spacing after one marking element, and the spacing condition is interpreted by the remote receiver as the fourth element of a code combination. One character element later, which is a total of 5.5 code elements after character timer tube V1 was triggered, it restores to normal, thereby applying a positive potential to the right-hand grid of tube V14 to render that triode again conductive, cutting off tube V15 and restoring relay 173 to marking. A remote receiver interprets this as the fifth element of a received code combination of marking nature because tube V14 did not initially cut off until one-half of a code element after the character timer tube V1 was triggered. The restoration of conductivity in tube V14, as character timer tube V1 restores, occurs 5 code elements after tube V14 initially cut off. A remote receiver interprets the received sequence of signals as a start element, two selecting spacing elements, a selecting marking element, and a selecting spacing element, followed by a continuous marking condition which it interprets as a fifth selecting element of marking nature, followed by a stop or rest condition. This is the code combination for the character H, which is transmitted by relay 173 under the control of tubes V14, V15, and V16. The potential changes at the anodes of tube V14 are indicated by the voltage graph above the tube. The transmitter start circuit at the control station transmits a start code for the next succeeding transmitter in the roll call sequence in response to reception of the H signal. If the next start code received by relay 107 also pertains to a transmitter that is controlled by the selector circuit in FIGS. 2 and 4, and such transmitter also has no message awaiting transmission, the cycle of operation of tube V14, V15 and V16 will be repeated.

It will be apparent that either of the relays 160 and 165, upon operating, invariably triggers the character timer tube V1 to initiate and control the generation of

the H signal. As previously stated, the H signal is to be transmitted only when a transmitter that is called has no message tape awaiting transmission. The suppression of transmission of the H signal is effected by the transmitter start control relay 156. It will be noted that the positive battery for tube V14 is supplied through the armature 2 and front contact of either of the relays 160 and 165, or through armatures and contacts of corresponding relays associated with other transmitters, such as the transmitter 178, back contact and armature 1 of relay 156, and corresponding armatures and back contacts of relays corresponding to relay 156 that are involved in the starting of any other transmitters, such as transmitter 178, and conductor 193, in which the dotted portion represents such other relay contacts, to the anodes of the tube. When relay 156 is operated, the anode supply battery is disconnected from the anodes of tube V14. Although armature 2 of relay 160 or 165 seeks to supply plate potential for tube V14, relay 156 prevents the connection of that potential. Thus tube V14 is normally without supply voltage and remains so while its grids are pulsed in the manner to cause the generation of an H signal. Without any anode potential for tube V14, the grid of tube V15 is not affected by tube V14, and tube V15 remains cut off so that relay 173 does not operate. It is necessary to prevent tube V14 from controlling relay 173 because it would garble the signals generated by distributor 153 which is set in operation when relay 156 is operated.

Although a specific embodiment of the invention has been shown in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to the specific embodiments but is capable of modification, substitution and rearrangement of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. An electronic switching device comprising a bistable element having first and second stable conditions of operation, a second element, a control means connecting said bistable element and said second element, and instrumentalities in said means for causing said second element to be bistable in operation when said bistable element is in said second condition and to be monostable in operation when said bistable element is in said first condition.

2. An electronic switching device comprising a first flip-flop circuit having a first and a second condition of stability, a second flip-flop circuit having a first and a second condition of stability connected to said first flip-flop circuit, means in said connection for operating said second flip-flop circuit from its first condition to its second condition for an interval and subsequently restoring said second flip-flop circuit to its first condition when said first flip-flop circuit is in its first condition of stability, and a control means between said first and second flip-flop circuits to preclude the restoration of said second flip-flop circuit to its first condition when said first flip-flop circuit is in its second condition.

3. A telegraph code signal generating circuit having a self-restoring electron discharge timing circuit, said discharge circuit having a first and a second condition of operation, said generating circuit including means for operating said discharge circuit to its second condition to time an interval, an oscillator circuit operable while said discharge timing circuit is in its second condition, an electron discharge tube having a plurality of control grids, a control means connecting said timing circuit to one of said grids to suppress current flow in said tube upon operation of said timing circuit to its second condition, a second self-restoring timing circuit operable from a first to a second condition by said first-mentioned timing circuit, a control means connecting said oscillator circuit to said second timing circuit to control the instant of restoration thereof to its first condition, and a control

means connecting said second timing circuit to another of said plurality of grids to produce code signal transitions in the output of said tube.

4. A telegraph station selector system having a code signal receiving circuit, a decoding circuit in said receiving circuit having a plurality of output terminals and adapted to apply a pulse to one of said terminals in response to reception of a particular signal by said receiving circuit, a normally non-conducting electron device having a grid and an anode, a control means connecting said one terminal of said decoding circuit to said grid of said normally non-conducting electron device to cause conduction in said normally non-conducting device upon pulsing of said one terminal, a normally conducting electron device having a grid and an anode, a pulse time delay circuit, and a second control means connecting said anode of said normally non-conducting device to said grid of said normally conducting device including said pulse time delay circuit to suppress conduction in said normally conducting device when said particular signal has been received for a predetermined time.

5. A telegraph station selector system according to claim 4 wherein there is additionally provided a flip-flop circuit having a first condition and a second condition of stability and connected to said anode of said normally conducting device to be driven from said first condition to said second condition by the suppressed conducting condition of said normally conducting device, a teletypewriter select magnet, and a normally responsive electron device operatively interconnecting said code receiving circuit and said select magnet, said normally responsive electron device connected to said flip-flop circuit and caused to be rendered unresponsive only by said second condition of said flip-flop circuit.

6. In a telegraph station selector system, a code signal receiving circuit, a decoding circuit in said receiving circuit having a plurality of output terminals and adapted to sequentially apply pulses to one of said terminals in response to the reception of corresponding predetermined signal by said receiving circuit, a self-restoring flip-flop circuit operable from a first condition to a second condition to time an interval, means interconnecting a particular one of said decoding circuit terminals and said self-restoring flip-flop circuit for driving said self-restoring flip-flop circuit from said first condition to said second condition when a code signal corresponding to said particular one terminal is received, a second flip-flop circuit in a first of two conducting conditions having a control means connecting said self-restoring flip-flop circuit and to another one of said decoding circuit terminals corresponding to another predetermined code signal to cause a change in said second flip-flop circuit to the second of said two conducting conditions in response to the sequential happenings of the operation to said second condition of said self-restoring flip-flop circuit and the pulsing of said another terminal of said decoding circuit.

7. A system in accordance with claim 6 in which said control means connecting said second flip-flop circuit to said self-restoring flip-flop circuit comprises locking means to preclude the restoration of said self-restoring flip-flop circuit to its first condition when said second flip-flop circuit is in its second conducting condition.

8. A system in accordance with claim 7 wherein there is additionally provided a restoring control means connecting still another terminal of said decoding circuit to said second flip-flop circuit to cause restoration of said second flip-flop circuit to its first conducting condition and to render ineffective said locking control means when said still another terminal has a pulse applied there-

to corresponding to still another predetermined code signal, and a reset means connecting said second flip-flop circuit to said self-restoring flip-flop circuit to cause restoration of said self-restoring flip-flop circuit to its first condition in response to restoration of said second flip-flop circuit to its first condition.

9. In a telegraph code signal generating circuit, a self-restoring electron discharge timing circuit operable from a first condition to a second condition to time an interval, a free-running multivibrator circuit operable while said timing circuit is in its second condition, a normally conducting device including a control grid, a pulse delay circuit, a first control means connecting said self-restoring electron discharge timing circuit to said control grid of said normally conducting device including said pulse delay circuit to suppress current flow in said normally conducting device at a time coinciding with a predetermined point in the operative cycle of said free-running multivibrator, a normally nonconducting device including a control grid and a second control means connecting said normally conducting device to said grid of said normally nonconducting device to cause conduction in said normally nonconducting device when said normally conducting device is rendered nonconducting.

10. A telegraph code signal generating circuit in accordance with claim 9 in which there is provided a transmission channel, a line relay connected to said channel adapted to impress marking or spacing conditions thereon, said relay connected to said normally nonconducting device and operable to its spacing condition in response to a conducting condition in said normally nonconducting device, a monostable flip-flop timing circuit operable from a first condition to a second condition to time an interval comprising a predetermined number of cycles of said free-running multivibrator, said monostable flip-flop circuit connected to said self-restoring timing circuit and operable to its second condition in response to the operation of said timing circuit to its second condition, a third control means connecting said multivibrator circuit to said monostable flip-flop circuit to pulse said monostable flip-flop circuit and control the restoration thereof to its first condition, a fourth control means connecting said monostable flip-flop circuit to said normally nonconducting device to cause said normally nonconducting device to momentarily return to the nonconducting condition thereof when said monostable flip-flop circuit restores to its first condition, and a fifth control means connecting said self-restoring electron device timing circuit to said normally conducting tube to cause conduction in said normally conducting tube when said self-restoring timing circuit times said interval and restores to its first condition.

11. A telegraph code signal generating circuit in accordance with claim 10 wherein said first control means is adapted to suppress current flow in said normally conducting device at the end of the first one-half operative cycles of said free-running multivibrator and said monostable flip-flop timing circuit is adapted to operate its second condition to time an interval slightly longer than $3\frac{1}{2}$ operative cycles of said free-running multivibrator.

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