Oct. 31, 1961 A. E. SCHIERHORST 3,007,001

CALL LETTER KEYER

Filed Nov. 26, 1958 4 Sheets-Sheet 1

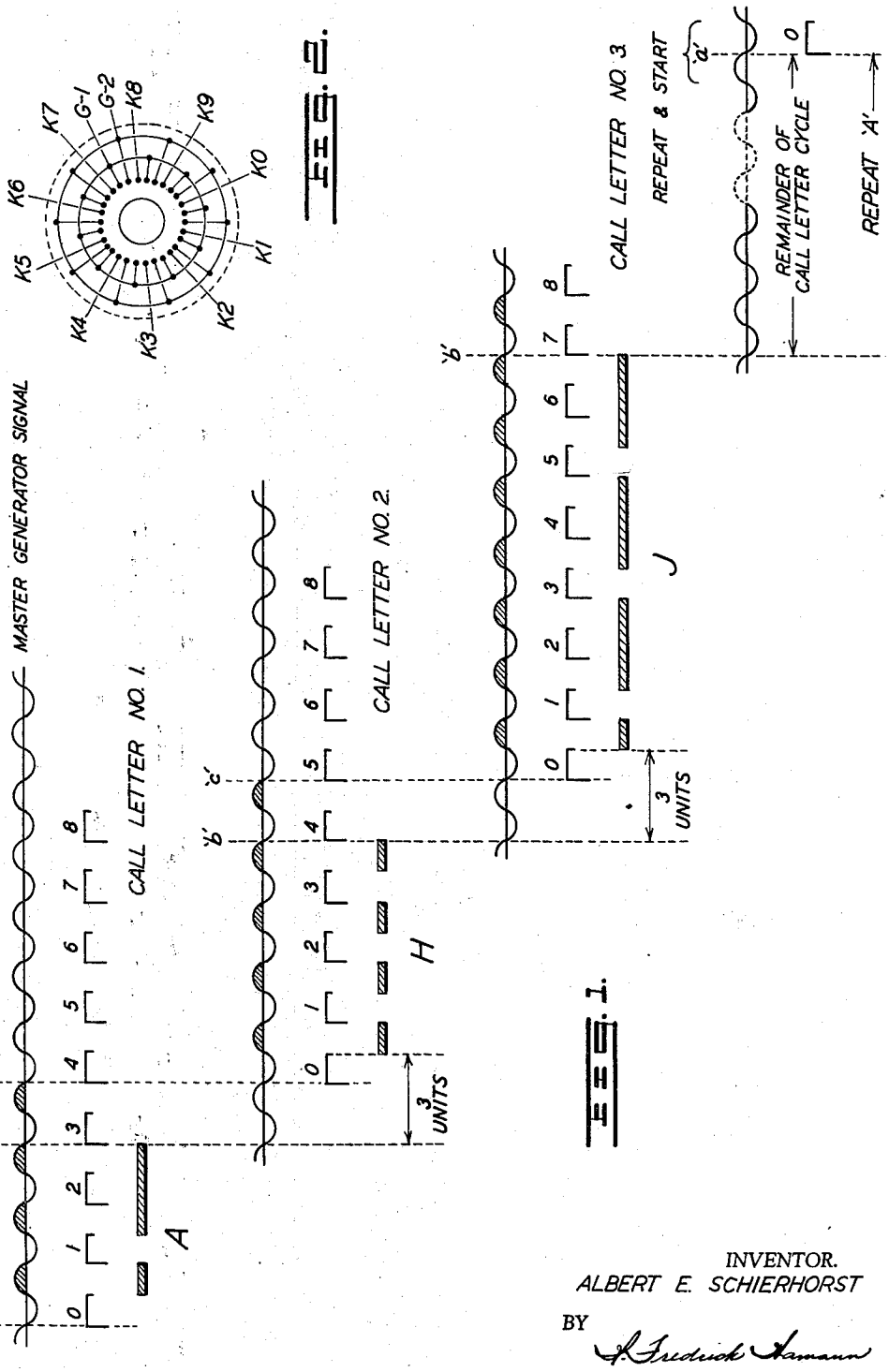


Fig. 1.

Fig. 2.

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CALL LETTER KEYER

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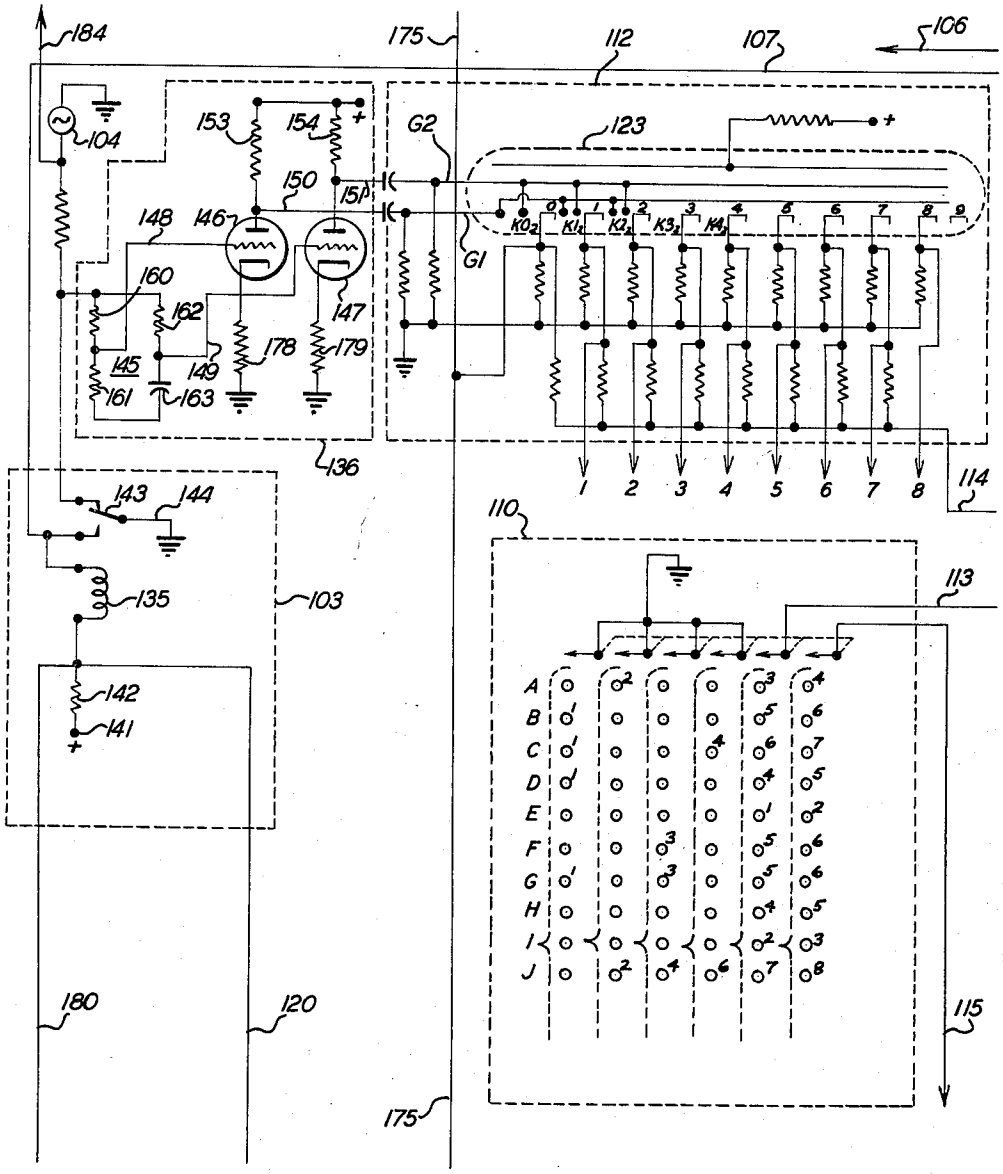


FIG. 3a.

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CALL LETTER KEYER

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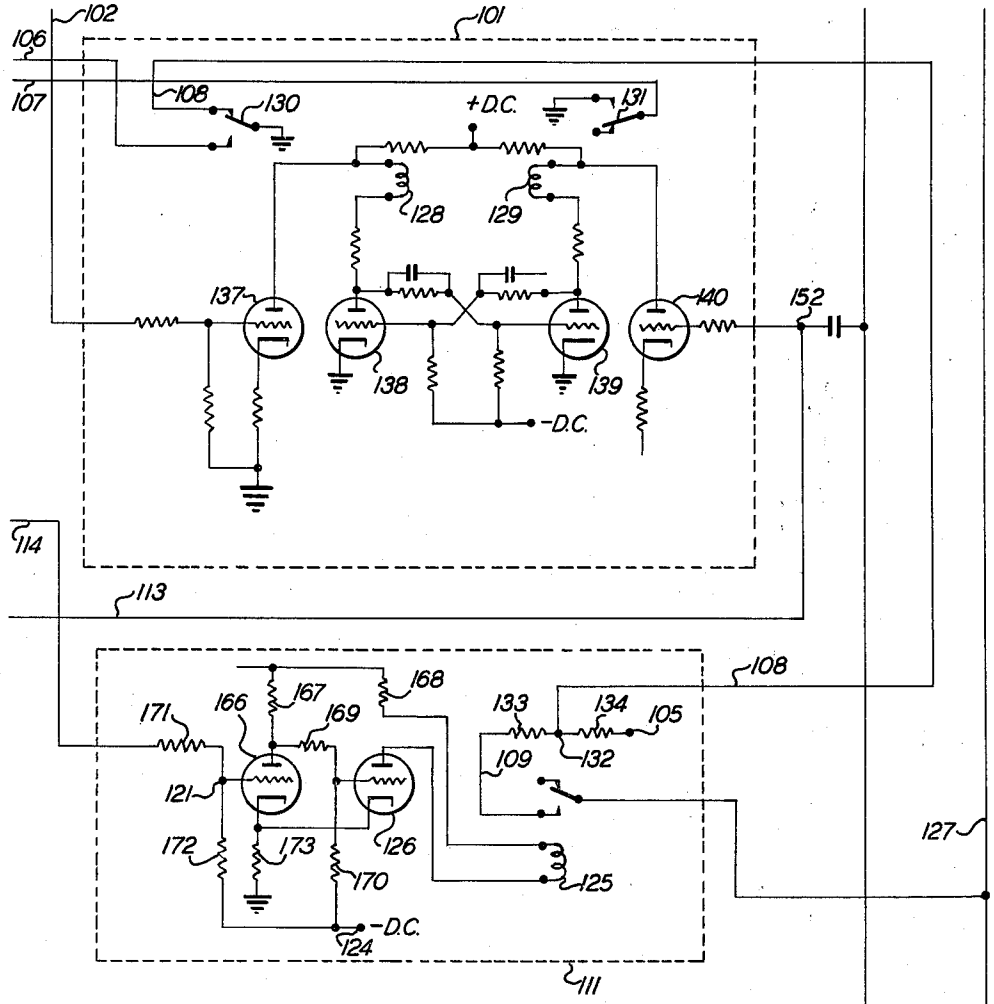


Fig. 3b.

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CALL LETTER KEYER

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FIG. 4.

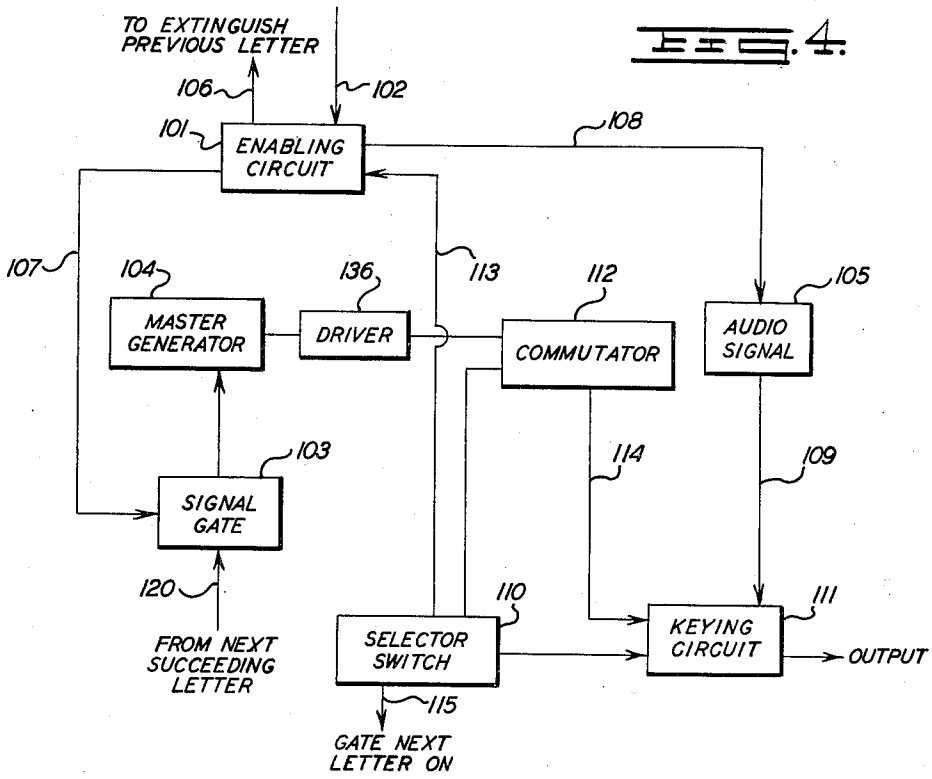
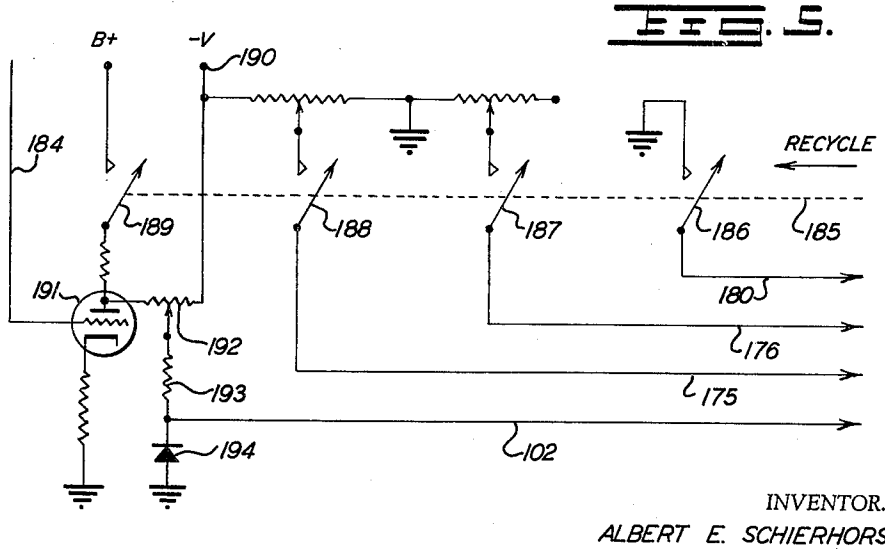


FIG. 5.



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CALL LETTER KEYER

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12 Claims. (Cl. 178—79)

This invention relates to an electronic call letter keyer, and more particularly to a system to produce coded call letters in a predetermined sequence. The form of the signals is that of being time spaced, each letter being formed by a separate generator, and the generators being connected in cascade to individually form their letters one after another.

The invention described herein is usable to produce call letters of the type heard by a pilot of an aircraft, which letters are used as an aid to navigation. It also finds a setting in a flight simulator wherein navigation call letters in code are received by a trainee, during simulated flight.

The prior art call letter devices are usually operated by a series of mechanically driven cams which open and close switches to produce the dots and dashes to form the coded alphabetic characters. This type system is unrealistic in that the time taken to generate each letter is the same. For example, a coded letter consisting simply of a single dot or dash occupies the same time interval as one which consists of several dots and dashes. A manual operator, of course, never sends messages with this timing sequence and it appears unrealistic to the receiver of such a coded message. As will later be more fully pointed out herein, one of the prime advantages of the disclosed system is that the call letters of any group are rationalized as to time and length automatically. Hence, the time assigned for the keying of any letter is directly proportional to its Morse length, or code length. This preserves realism both in a simultated aid to navigation and in an independently situated call letter generator station.

It is accordingly a broad object of this invention to provide a time coded signal generator.

It is a further object of this invention to provide a method of generating intelligence bearing signals.

It is a further and more distinct object of this invention to provide a system to produce coded call letters in the form of signals, each having a predetermined time spacing.

Another object of this invention to provide a call letter system having *n* circuits for *n* call letters, each circuit having a commutating device and a driver circuit to control the rate of commutation.

A more specific object of this invention to provide a call letter system wherein a plurality of circuits are provided, one for each letter to be called, having means interconnecting the circuits to trigger the next succeeding letter upon completion of the letter being called.

The novel features of the invention are set forth with particularity in the appended claims and specification and the invention will be best understood from the consideration of the following description when read in connection with the accompanying drawings, hereby made a part of the specification, in which:

FIG. 1 is a time history representation of the sequential generation of the Morse code letters A, H and J by this invention.

FIG. 2 is a schematic representation of the type of commutating tube utilized by the invention.

FIGS. 3*a* and 3*b* are schematic representations of the apparatus for generating one call letter.

FIG. 4 is a block diagram of the system for generating one call letter.

FIG. 5 is a schematic of the start or recycle circuit for the letter generators.

The preferred embodiment of this invention provides for the generation of pulses in accordance with a switching arrangement and a commutating tube whereby the length of each pulse and the time interruption between pulses is controlled by the switching arrangement's return of the commutating tube's cathodes to one of two possible operating conditions.

In the following detailed description of the apparatus by which the objects of the invention are realized a glow transfer tube is utilized as a basic counting element in a preferred embodiment of the invention. One such tube is shown in FIGS. 2 and 3.

It is obvious that this invention is not limited precisely to this particular discharge device but similar tubes may be utilized in practicing the same. The discharge device as shown in FIGS. 2 and 3 has a plurality of elements. A disc shaped element called the "anode" is affixed in the center of the device and a number of cathodes, designated K0, K1 K2, etc., are arranged in a circle about the anode. Situated between each pair of cathodes are two similar rod like elements which may be called guides. Those guides located immediately clockwise from respective cathodes are interconnected forming guide set G1 and an external terminal is provided for connected to a control signal lead. Those guides immediately clockwise from the aforementioned guides are all interconnected and may be referred to as guide set G2 which also has an external terminal. If a voltage in excess of the ionization potential of the gas within the tube is applied to the anode and a given cathode, for instance K0, a gaseous glow discharge will become established therebetween. Now, if a more negative voltage than that on the cathode is applied to the guide set 1 the glow will transfer so as to become established from the anode to the adjacent clockwise guide and will no longer exist between the cathode K0 and the anode. If next the potential of guide set 2 is made more negative than that of guide set 1 then the glow will be further translated clockwise to exist between the anode and the guide electrode 2. Then if the voltage of the cathode next in line clockwise, K1, is made more negative than that of guide set 2 the glow will transfer to cathode K1. In this manner a translation from one cathode to an adjacent one has been made. This very useful transfer function is used in a circuit for sampling cathode connections, and, in cooperation with a switching device, is used to trigger a keyer to provide the signals which make up the coded letters.

The basic operation of the preferred embodiment of the invention is to generate audio signals of Morse code type intelligence by cascading a series of letter generators. Each letter generator upon activation by an initiating signal interrupts an audio signal in accordance with the conduction of the glow transfer tube from anode to a given cathode, unless a particular cathode is returned to ground potential as a result of the selector switch position. The application of phase displaced A.C. signals on the two grid sets provides the commutating means whereby the glow or conduction is transferred from K0 to G1 to G2 to K1 to G1, etc. At the end of each letter the letter generator activates a flip flop enabling circuit to turn itself off and to turn on the next letter generator.

Consider FIG. 3 and 4 for an understanding of the overall circuit operation. A signal from an operator or from the last letter called is applied to flip flop enabling circuit 101 by means of conductor 102. This signal causes the bistable enabling circuit 101 to change its conduction condition so as to activate a relay which in turn allows the signal gate initiating circuit 103 to allow conduction of the master generator driver 104. At the same time the enabling circuit unlocks the source of audio frequency 105 and breaks the holding circuit of the signal gate circuit 103 of the preceding letter through conductor 106.

Selector switch **110** is set by hand to a desired letter thereby determining which of the cathodes of the glow transfer tube will be returned to ground potential. At the end of the generation of one letter a gating pulse from commutator **112** is conducted through selector switch **110** to conductor **113** to turn off the enabling circuit **101**. This is followed by another pulse on conductor **115** to gate the next letter on. This later pulse corresponds to the pulse received via conductor **102** to pulse this letter on. When the next letter is triggered a locking signal returns to this letter via conductor **120** to extinguish the signal gate. Conductors **106** and **120** are equivalent signal carrying leads of two different letter generators.

Keeping in mind that the primary purpose of this invention is to provide a time coded signal, it is important to remember that the time rate is set by a combination of the frequency of the master generator signal from A.C. generator **104** and the setting of the selector switch **110**. The commutating device or glow transfer tube **123** will conduct and transfer conduction from cathode **K0** to guide set **1** to guide set **2** to cathode K1, etc., at the rate set by the master generator **104**. A signal control bus **114** is connected through isolating impedances to the cathode of the glow transfer tube **123**. It is this bus **114** which reacts to the conduction of tube **123** to provide a positive voltage pulse during that period of time when conduction occurs between the plate of tube **123** and any one of the cathodes. During that time when conduction or glow is occurring between the plate and either one of the guide sets G1 or G2, the common signal bus **114** is at a negative potential due to the minus D.C. source **124**. The bus **114** is utilized to operate the plate relay **125** of vacuum tube **126** when there is a negative potential at junction **121**. When, due to conduction from the plate to any of the cathodes of the commutating device **123**, the cathode will become more positive, thus, applying a more positive potential on bus **114** and making junction **121** more positive and thereby cutting off the plate relay **125** to extinguish the audio signal output. The audio signal generator **105** of FIGS. 3 and 4 may be of any standard configuration and may be tuned to any frequency desired. The standard frequency tone for continuous wave communication is normally 1020 cycles and therefore that frequency would be preferred in most embodiments.

From the description thus far it may be seen that the commutation of conduction or glow transfer of tube **123** would result in alternate periods of audio output and silence of equal duration. The periods of a signal output exist when conduction occurs between the anode and a guide while silence or no signal output exists when conduction occurs from the anode to a cathode.

This basic time interruption signal may be altered by a call letter selector switch **110** which has the capability of converting a normal silence period of the interrupted signal to a signal period. The effect of this when coupled with the immediately adjacent signals occurring due to conduction from anode to guide sets is to produce a signal three times the length of a normal signal. It is this fact which is utilized so successfully in time duration signals such as those occurring in transmissions of Morse code communication.

The signal control is accomplished by returning some of the cathode conductors of tube **123** to a ground potential. When this occurs the conduction from anode to that particular cathode does not affect the bias on signal bus **114** and the negative D.C. voltage **124** controls the grid junction **121** so that an audio signal is passed to the output conductor **127**.

FIG. 1 shows the time sequence history of the transmission of generation of a 3-call letter signal of the Morse code letters A, H, and J. The apparatus necessary for the generation of each of the three call letters, 1, 2 and 3 is that shown in FIGS. 3*a* and 3*b*. The three letter signal is instituted by the enabling pulse on conductor **102** which will cause the plate relays **128** and **129** to alter their operating condition so as to move the contact arms **130** and **131** to the contact opposite the ones shown in FIG. 3*b*. Prior to the initial pulse **102** it may be seen that relay arm **130** conducts ground potential through conductor **108** to the junction **132** between impedances **133** and **134**. The effect, of course, is to ground the audio signal from audio generator **105** to insure that no audible signal reaches the output conductor **127** prior to the initiating pulse. It may be seen that prior to this pulse relay arm **131** which is tied by conductor **107** to one side of relay **135** is in a floating condition having neither a ground or voltage applied to it. Relay **135** acts as a start and hold relay for the guide driver **136** by controlling the presence or absence of the A.C. signal from generator **104**.

As previously mentioned, the enabling pulse **102** triggers vacuum tube **137** which in turn controls vacuum stages **138**, **139** and **140** so as to alter the operating condition of the bistable multi-vibrator enabling circuit **101**. The effect of this is to energize relay **128** and de-energize relay **129**. In doing this relay arm **130** moves down to transmit a ground potential by means of conductor **106** to the previous signal generator circuit so as to extinguish its master generator operation. The conductor **106** shown in FIGS. 3 and 4 acts to extinguish the previous signal whereas conductor **120** transmits a signal from the next succeeding letter generator so as to extinguish the letter generator shown in FIGS. 3 and 4 at the proper time. In other words, conductor **106** and conductor **120** are equivalent conductors of two different letter generators.

With the de-energizing of relay **129** the relay arm **131** moves up to make contact with a ground potential and transmits that ground potential to one side of relay **135**. The positive D.C. source **141** operating through impedance **142**, relay coil **135** and conductor **107** to a ground conductor energizes or closes the relay arm **143** which is held in by the grounding action of conductor **144**. The removal of the ground conductor **144** by the energizing of relay **135** permits the A.C. signal from generator **104** to be conducted through the phase shift network **145** to the grids of the two amplifier stages **146** and **147**. The effect of the phase shift network **145** is to provide on the two grid conductors **148** and **149** two A.C. signals approximately 45 degrees out of phase. These two amplified signals appearing on conductors **150** and **151** will transmit to the guide sets G1 and G2 and provide the basic commutation drive for the tube **123**. Once conduction has begun it will transfer from the first cathode to the first guide set to the guide grid set to the second cathode, etc., at a rate dependent on the frequency of the A.C. signals applied to the grid sets. Commutation is caused only by positive half cycle of A.C. input which appear on the guide sets as negative voltages.

The conductors numbered 1 through 8 from the cathodes of the glow transfer tube are connected to terminals on the call letter selector switch **110** in accordance with the time duration of the signal desired for each setting of the switch. For instance, for the generation of the Morse code letter "A" a dot and a dash must be generated. Since a dot may be generated by utilizing the signal which occurs during conduction from anode to guide sets, the first dot may be initiated by sampling that signal which occurs during the conduction from anode to guide sets between the conductions to cathode K0 and cathode K1. As may be seen in FIG. 3*a* the second terminal of the selector switch has indicated the numeral 2 beside it. This indicates that the cathode conductor from K2 is connected to the terminal indicated by the numeral **2**. The effect of this is to prevent the signal bus **114** from going positive during conduction to cathode K2. The effect of this in turn is to produce a signal of a three time unit duration in which an audio signal output will occur on conductor **127**, FIG. 3*b*, during glow tube conduction from anode to guide set, from anode to cathode K2, and from anode to the guide set between

cathodes K2 and K3. This signal is shown in FIG. 1 as call letter number 1 and is indicated as the Morse code letter A. It is seen that the dot is of one time unit duration followed by a one time unit interruption in signal followed again by a three time unit signal, the proper time duration for a Morse code letter A.

Since various call letters vary in total time length a provision must be made to initiate the next succeeding letter upon the completion of each letter. This is done at the end of the letter A just discussed by providing conduction from the cathode K3 when the glow is to that particular cathode, through the conductor 3 of tube 123 to the contact labeled 3 opposite the letter A on the call letter selector switch 110. This arrangement is provided so that when the commutating glow transfers to cathode K3 the resulting positive signal may be conducted on lead 113 to the junction 152 where it may key the bistable flip flop stage 101 into its original operating state. The effect of this is to turn off the first letter. This is accomplished in two ways. First, arm 130 returns to make contact with conductor 108 thereby grounding the audio signal 105 and preventing any further audible signals from reaching the output conductor and also by removing the ground potential from relay arm 131 so that the call letter start and hold relay 135 may be broken by a subsequent signal.

Conductor 115 is connected between a contact on selector switch 110 and the cathode immediatetly following the cut off cathode K3. This signal which occurs due to conduction from the anode to cathode K4 is conducted by lead 115 to initiate the next succeeding letter to be called. This conductor 115 will feed the conductor 102 of the next stage to initiate its operation.

Each letter of the alphabet may be programmed into the selector switch by connecting those cathode leads to the proper switch connections. By doing this the basic signal having equal time units of conduction and non-conduction, may be modified so that any combination of one time unit conduction and three time unit conduction may be generated. By utilizing the cathode next conducting after completion of the signal desired to turn one call letter keyer off and to use the next cathode conductor thereafter to turn the succeeding call letter on, the proper interruption of three time units duration will occur between each call letter. This is graphically illustrated in FIG. 1 by the three half waves of A.C. conduction occurring between the end of one signal and the beginning of the next signal. This is in accordance with the standard Morse code transmission time.

It should be realized that any time coded signal having an intermittent on-off time base may be generated or simulated by the use of this apparatus.

The master generator and driver may be of any well known configuration. One particular embodiment of the driver which has proven successful, utilizes a 12AX7 type amplifying tube for stages 146 and 147 and utilizes plate resistors 153 and 154 of 570K ohms and cathode resistors 178 and 179 of 5.1K and having phase shift resistors 160 and 161 of 82K and having phase shift impedance 162 of 1M ohm and capacitor 163 of 0.05 μf.

In the preferred embodiment the impedances from cathode to ground on the transfer tube 123 were each of 68K ohms and the impedances between the signal bus 114 and the cathodes were of 0.1M ohm. The bistable flip flop utilizes two 12AU7 type tubes for stages 137, 138, 139 and 140 in a standard bistable configuration. The keying circuit 111 utilizes a 12AT7 for the stages 166 and 126. 10K resistors were used for impedances 167 and 168 and 50K resistors were used for impedances 169, 170, 171 and 172. A common cathode impedance of 560 ohms may be used for impedance 173 while 2K resistors were used for impedances 133 and 134. It should be understood that variations in the circuit components or their values may readily be made by those skilled in the art without departing from the spirit or scope of the invention, the above values being merely examples of an operative embodiment.

Reset buses 175 and 176 are provided to align all the call letter keyers prior to an operational cycle. A positive reset pulse applied to the bus 176 will align all of the enabling circuits 101 so that they will be in the operating conditions shown with relay 128 de-energized and relay 129 energized.

The application of a negative reset pulse to the bus conductor 175 will stop the commutation of the glow transfer at cathode K0 and conduction will continue from the anode to cathode K0 as long as there is plate voltage on the tube and no signal is applied to the guide set G1.

Depending on the particular need of the user the beginning of a series of coded letters may be initiated either by the closing of a manual recycle switch or by an automatically programmed switching operation. In many applications a call letter keyer or time coded signal generator requires the production of three Morse code letters sometimes followed by other information and sometimes by a repetition of the three letters. This cycle is continuously repeated. One method of time control of such cycles may be seen from the schematic of FIG. 5 when viewed with the time history of signal origination and duration shown in FIG. 1.

The basic timing for the system originates with the master signal generator 104 which provides the sine wave illustrated in FIG. 1. Only one such generator is needed to feed all of the call letter generators. In FIG. 1 the symbol *"a"* designates that point in time of the initiating and repeat of the whole keying cycle. The event of a keying symbol being disabled is indicated by *"b"* while the event of enabling the commutating and keying circuit of the next succeeding letter is indicated as occurring at that point of master signal generator output designated as *"c."*

The operation by which signal control is transferred from one letter generator to another has been described previously as utilizing a commutating tube cathode signal in conjunction with a selector switch conductor to disable a letter generator at the end of the letter and to use the next commutating signal to activate the enabling circuit of the next succeeding letter.

The circuit of FIG. 5 is provided to start or repeat the whole keying cycle. This is accomplished by either manual or automatic movement of the switch shaft 185 whereby four contact arms are closed. The arm 186 when closed applied a ground connection to conductor 180 so as to de-energize all of the signal gate relays 135 thereby preventing the master generator signal from getting to the guide sets. Arm 187 applies a positive voltage to conductor 176 so as to reset all of the flip flop enabling circuits to the condition shown in FIG. 3*b*. The surge or leading edge of the positive D.C. voltage activates the flip flop. When the arm 188 closes a negative D.C. voltage from the source 190 is applied to conductor 175 to reset all of the glow transfer tubes to the K0 cathode. This reset action occurs because the negative voltage is of such a magnitude as compared with the other cathodes that the conduction will transfer to the K0 cathode from whatever cathode it may be on when the switch 185 is activated.

The fourth arm 189 of recycle switch 185 acts to apply B+ to the amplifier stage 191. Since for the commutator tube to commutate the signals on the plate leads 150 and 151 must be negative, the master generator signals applied to the grids 148 and 149 must be positive. Thus, it is desirable to have any necessary switching action occur during the negative half cycles of the master generator output. To accomplish reset of a signal cycle during the first negative A.C. half cycle after the recycle switch closes arm 189, the master generator signal is applied to the grid of stage 191. This negative going signal appears as a positive signal on the plate lead which is connected through potentiometer 192, impedance 193

to initiating pulse conductor **102**. Diode **194** is provided to short any negative pulses from the plate lead to ground and allow only the positive pulses, primarily the first positive pulse resulting from the first negative half cycle of the master generator, to pass to the enabling circuit **101**.

It is thus seen that activation of the recycle switch applied a ground connection to conductor **180** to reset all signal gate relays **135**; applies a positive signal to all enabling gate flip flop enabling circuits by means of conductor **176** to set all the enabling circuits to a quiescent condition; applies a negative signal to conductor **175** to reset all the glow transfer or commutating tubes so that they are conducting to the K**0** cathodes; applies a positive pulse to the enabling circuit of the letter number 1 generator so as to commence the complete cycle of call letters.

The output conductor **127** will have impressed upon it a time interrupted signal in accordance with the commutating rate as set by the master generator and the conduction programming determined by the selector switch **110**. This signal may be utilized as an aural signal for student pilots in training them in the proper methods of radio navigation operation.

Another important use for this apparatus is for the generation of airport identification signals. Every flight station either of civilian or military jurisdiction must provide call letter information as a navigational aid to pilots. The apparatus described herein may be utilized for generating these call letters. It is thus seen that a method and apparatus have been provided whereby a time coded signal is generated.

Having described a preferred embodiment of the present invention, it is to be understood that although specific terms and examples are employed, they are used in a generic and descriptive sense and not for purposes of limitation; the scope of the invention being set forth in the following claims.

What is claimed is:

1. A system to produce coded call letters in the form of signals having a predetermined timed spacing comprising a series of coded letter generators connected in cascade to automatically originate in seriation a selected group of coded alphabetic characters, each generator comprising a commutating discharge device having a plurality of elements each adapted to generate an output pulse upon receipt of current translated between elements, programmed switching means to select a letter and connected to disable predetermined output pulses, a circuit connected to said commutating device to control the current translation between elements, a circuit including a source of signal energy connected to the commutating device to derive a series of system output signals each having a time spacing in accordance with the programming of the said switching means, and a circuit connected to the said switching means and to the last recited circuit to disable the same upon completion of the respective selected letter, the said commutating device and said switching means connected to generate a gating pulse to initiate the next succeeding letter at the following generator.

2. For use in a system for producing coded call letters, a letter generator comprising in combination switching means programmed to represent various letters and tuneable to select a letter, a commutating tube connected to said switching means to generate output pulses in accordance with the programming of the switching means, a circuit connected to said commutating tube to initiate operation thereof and to control the commutation, and a circuit including a source of signal energy connected to the commutating tube to derive a series of system output signals each having a discrete time duration as predetermined by said switching means.

3. For use in an aircraft simulator a circuit to reproduce navigation code call letters of the type received by a pilot in an aircraft during flight comprising in combination switching means programmed in accordance with letter characteristics and moveable to select a letter to be called, a commutating vacuum tube connected to said switching means, and a keying circuit connected to the commutating tube and responsive to signals therefrom to derive audio frequency pulses having a predetermined duration-in-time to form a code letter.

4. For use in an aircraft simulator a system to generate a group of coded call letters to simulate navigation call letters of the type received by a pilot of an aircraft during flight, each letter generator comprising in combination switching means programmed in accordance with code letters and tuneable to select a letter, an electronic commutating tube device connected to said switching means, a circuit connected to said commutating tube device to initiate operation thereof and to control the operation thereof, a keying circuit connected to the commutating tube device to derive a series of audio frequency signals each having an individual time duration in accordance with the position of said switch to form a preselected code letter, and a flip flop device connected to said switching means and to said keying circuit to disable the keying circuit and to disable the commutating tube device control circuit upon completion of the selected letter.

5. For use in an aircraft simulator a system to generate a group of coded call letters to simulate navigation call letters of the type received by a pilot of an aircraft during flight, each letter generator comprising in combination programmed switching means to select a letter, a cold cathode gaseous discharge tube commutating device connected to said switching means, a circuit including a relay connected to said commutating device to initiate operation thereof and to control the commutation, a keying circuit to derive a series of audio frequency signals each having an individual time duration to form a preselected code letter, and a flip flop device connected to said switching means and to said keying circuit to disable the keying circuit and the commutating device control circuit relay upon completion of the selected letter.

6. The invention as set forth in claim 5 wherein said switching means includes means responsive to the said discharge tube commutating device to initiate the generation of a succeeding letter in a succeeding letter generator circuit.

7. In a grounded aircraft trainer, a system to simulate to a trainee navigation call letters of the type received by the pilot of an aircraft during flight comprising a series of coded letter generators connected in cascade to produce in seriation a preselected group of coded alphabetic characters, each generator comprising an electronic commutating device having a plurality of elements each adapted to generate an output pulse upon receipt of current translated inter se, programmed switching means to select a letter and operable to disable selected output pulses, a circuit connected to said commutating device to control the translation between elements, a keying circuit connected to said commutating device and to a trainee's receiver to derive a series of audio frequency signals each having a time duration in accordance with the programming of the said switching means, and a flip flop device connected to said switching means and to said keying circuit to disable the same upon completion of the letter.

8. The invention as set forth in claim 7 including means in said programmed switching means connected to the next succeeding letter generator to transmit a gating pulse thereto to initiate the next letter, the said means including connections between the said electronic commutating device and the said commutating circuit control circuit.

9. In a grounded aircraft trainer a system to simulate to a trainee navigation call letters of the type received by the pilot of an aircraft during flight comprising a series of coded letter generators connected in cascade to produce in seriation a selected group of coded alphabetic characters, each generator comprising an electronic commutating device having a plurality of elements each adapt-

ed to generate an output pulse upon receipt of current translated inter se, programmed switching means under the control of an instructor to select a letter and operable to disable selected output pulses, a circuit connected to said commutating device to drive the same, a keying circuit connected to a source of audio frequency voltage and between the commutating device and a trainees receiver to connect a series of audio frequency signals to the receiver each signal having a time duration in accordance with the programming of the switching means, a flip flop device connected to the switching means and to the keying circuit to disable the same upon completion of the letter, and means in said switching means responsive to the commutating device to derive a gating pulse to initiate the next succeeding letter.

10. A signal generator comprising a commutating discharge device having a plurality of elements each adapted to generate an output pulse upon receipt of current translated between elements, programmed switching means connected to disable predetermined output pulses, a drive circuit connected to said commutating device to control the current translation between elements, an audio signal source, a keying circuit connected to the commutating device to derive a series of output signals each having a time spacing in accordance with the programming of the said switching means, and an enabling circuit connected to the said switching means and to the keying circuit to disable the same upon the completion of the selected signal, the said commutating device and said switching means connected to generate a gating pulse to initiate the completion of the signal generated.

11. A time coded signal generator comprising a commutating discharge device having a commutation rate determined by a master generator and having its commutation initiation controlled by a gate circuit, keying circuit means responsive to an audio signal and to the said discharge device for interrupting the audio signal to allow output conduction in a time coded sequence, switching means for biasing various conductors of the commutating device in accordance with the selected time coded signal and enabling means to control the keying circuit output and being responsive to a start signal for triggering the said gate circuit and responsive to the commutating device and switching means for disabling the keying circuit at the end of the time coded signal.

12. A time coded signal generator comprising a commutating discharge device having a commutation rate determined by a master generator and having its commutation initiation controlled by a gate circuit, keying circuit means responsive to an audio signal and to the said discharge device for interrupting the audio signal to allow output conduction in a time coded sequence, switching means for biasing various conductors of the commutating device in accordance with the selected time coded signal and enabling means to control the keying circuit output and being responsive to a start signal for triggering the said gate circuit and responsive to the commutating device and switching means for disabling the keying circuit at the end of the time coded signal, the said time being a function of the commutating rate and the preselected signal as determined by the switching means.

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