Oct. 29, 1963 C. E. MATHIS 3,109,064

CODE CONVERTING APPARATUS

Filed June 27, 1958 3 Sheets-Sheet 1

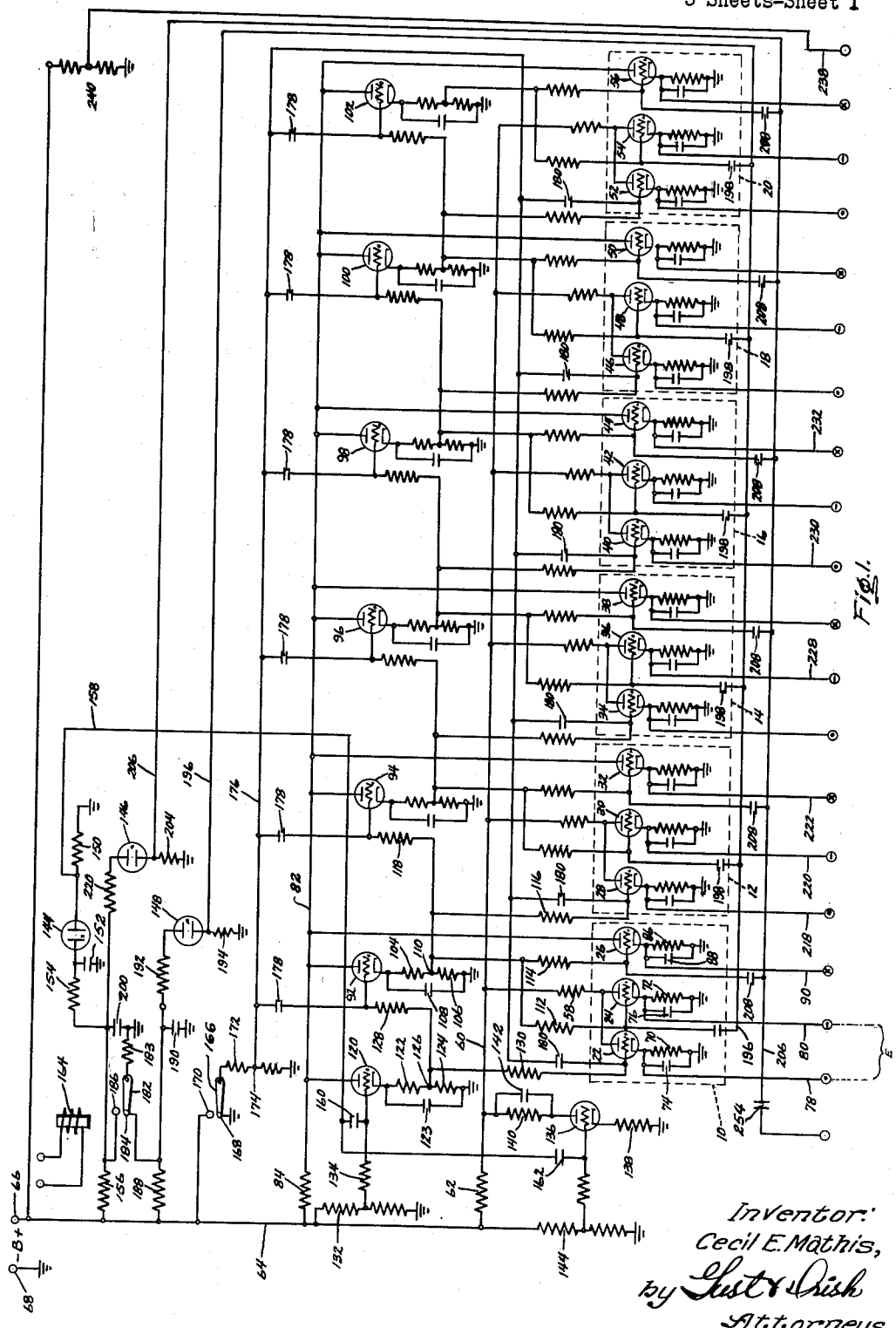


Fig. 1.

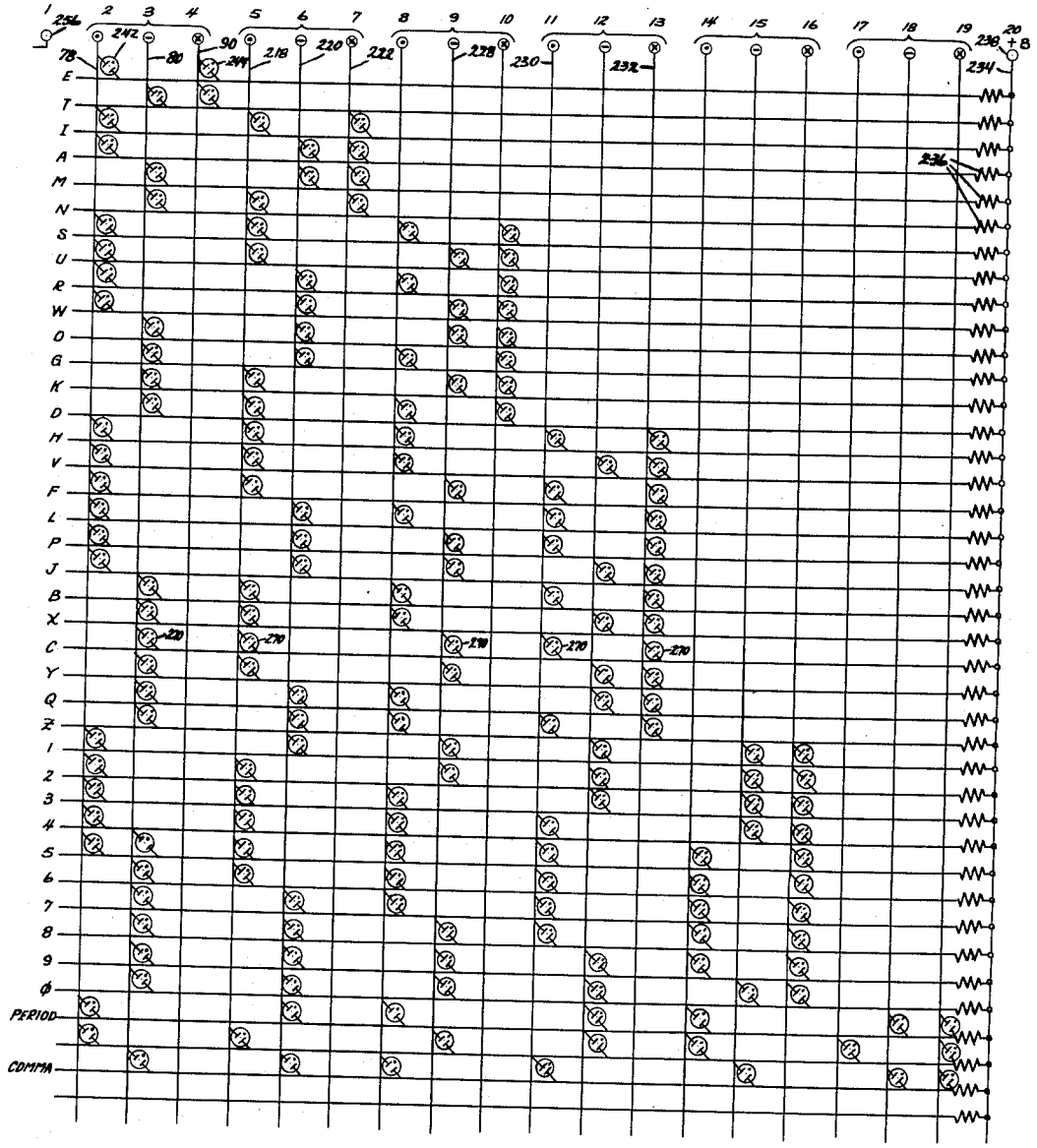
Inventor:
Cecil E. Mathis,
by Lust & Dish
Attorneys.

Oct. 29, 1963 C. E. MATHIS 3,109,064

CODE CONVERTING APPARATUS

Filed June 27, 1958 3 Sheets-Sheet 2

Fig. 2.



Inventor:
Cecil E. Mathis,
by Gust & Orish
Attorneys.

Oct. 29, 1963 C. E. MATHIS 3,109,064

CODE CONVERTING APPARATUS

Filed June 27, 1958 3 Sheets-Sheet 3

Fig. 3.

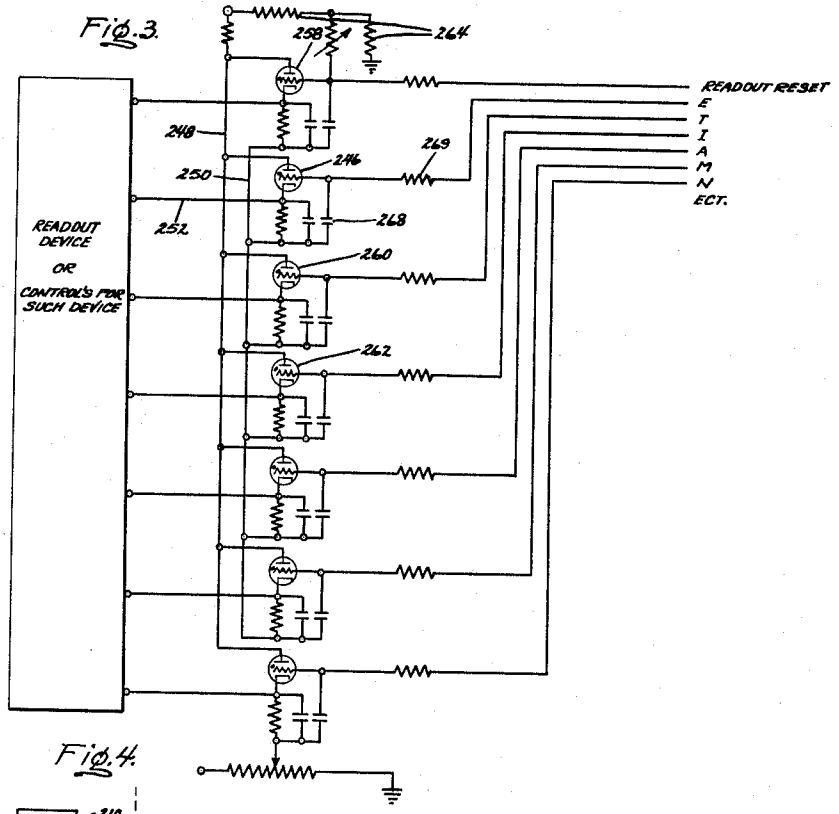


Fig. 4.

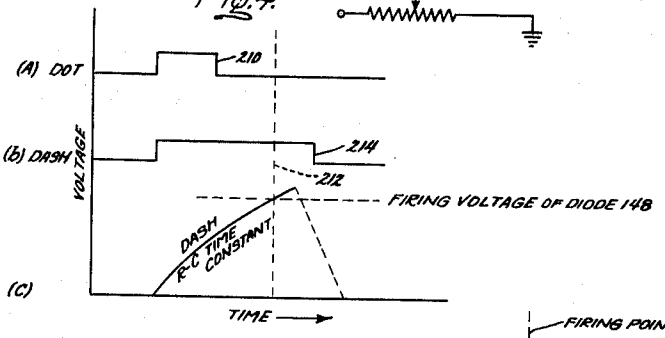
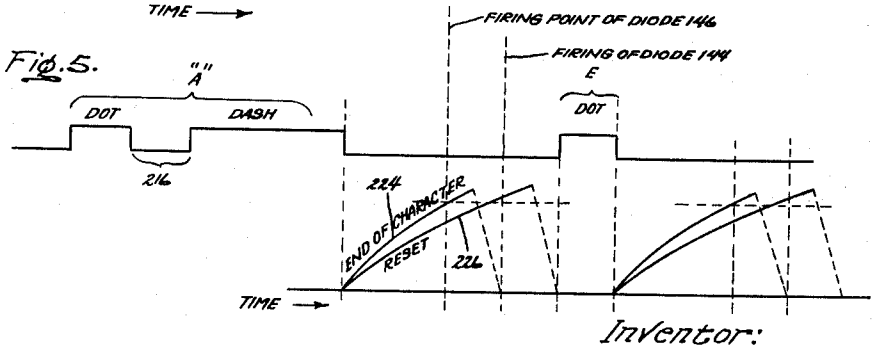


Fig. 5.



Inventor:
Cecil E. Mathis,
by Gust & Irish
Attorneys.

United States Patent Office 3,109,064 Patented Oct. 29, 1963

3,109,064

CODE CONVERTING APPARATUS

Cecil E. Mathis, Indianapolis, Ind., assignor to Regency Electronics, Inc., a corporation of Indiana

Filed June 27, 1958, Ser. No. 745,803
19 Claims. (Cl. 178—26)

The present invention relates to code converting apparatus, and more particularly to apparatus for converting coded electrical signals into representative signals useful in visibly or mechanically reproducing directly the respective letters, characters or symbols of the code as they are transmitted.

Prior art devices capable of converting coded signals, such as signals of the International Morse code, audibly reproduce the signals at a fixed frequency or tone. These signals cannot be interpreted or transformed into clear text by the layman, but require the talents of an operator skilled in receiving the code.

While some apparatuses are available for printing the dots and dashes as they are transmitted, these dots and dashes must, nevertheless, be converted by an operator, skilled or unskilled, into clear text.

The present invention relates to apparatus which is capable of receiving and transforming such coded signals directly into readable form, this transformation being substantially instantaneous and not requiring the efforts of a skilled operator.

It is an object of this invention to provide apparatus for converting coded electrical signals into representative read-out signals.

It is another object of this invention to provide apparatus for converting coded signals into representative signals useful in visibly or mechanically reproducing directly the respective letter, character or symbol transmitted.

It is yet another object of this invention to provide an apparatus for receiving the International Morse code, which discriminates between dots, dashes and combinations thereof for generating representative electrical signals useful in the visual or mechanical reproduction of the letter, character or symbol received.

Other objects will become apparent as the description proceeds.

To the accomplishment of the above and related objects, the invention may be embodied in the forms illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that specific change may be made in the specific constructions illustrated and described, so long as the scope of the appended claims is not violated.

In the drawings:

FIGS. 1, 2 and 3 together constitute a schematic diagram of one embodiment of this invention;

FIG. 4 is a graph used in explaining the operation of the apparatus of the preceding figures; and

FIG. 5 is another graph used in explaning operation.

Referring to FIGS. 1, 2 and 3, the apparatus therein illustrated functions to receive International Morse code signals and to transform these signals into other signals which may be directly utilized to operate a read-out device such as a visual indicator or typewriter. The visual indicator or typewriter may be so connected that it will register the particular letter, word, character or symbol which is fed to the apparatus.

Referring to FIG. 1, that portion of the circuitry responsible for the selection of the elements (dots or dashes) of the letter or character being received, is the bank of "element selectors" indicated by the reference numerals **10**, **12**, **14**, **16**, **18** and **20**, respectively. Each of these "selectors" contains three individual thyratron

triode or switching circuits, circuits **22**, **24** and **26** being in selector **10**, circuits **28**, **30** and **32** in selector **12**, circuits **34**, **36** and **38** in selector **14**, etc. Since the circuitry of these selectors is identical, respectively, a description of one selector will suffice for all.

Referring to the element selector **10**, the anodes of the two thyratrons **22** and **24** are connected together and to a dropping resistor **58** which in turn is connected to an anode voltage supply line **60**. A second dropping resistor **62** is series-connected between this supply line **60** and the power line **64**. The positive side of a power supply delivering a unidirectional voltage is connected to the terminal **66** on the power line **64**, the negative side being grounded by terminal **68**.

The cathodes of the two thyratrons **22** and **24** are grounded through suitable cathode resistors **70** and **72**, respectively, which are bridged by two charging capacitors **74** and **76**, respectively. To the same cathodes are connected two output lines **78** and **80**, respectively, the line **78** being considered a "dot" line and the line **80** being considered a "dash" line. Thus, the thyratron **22** may be characterized as the "dot" tube, the thyratron **24** the "dash" tube.

The thyratron **26**, which may be characterized as the "character-defining" tube or the "end-of-character" tube, has its anode directly connected to a second anode voltagle supply line **82** which is series-connected to the power line **64** by means of a dropping resistor **84**. The cathode of this thyratron **26** is grounded through a suitable cathode resistor **86** which is bridged by a charging capacitor **88**. An output line **90** is directly connected to the cathode, this output line being characterized, for convenience, as either a "character-defining line" or an "end-of-character line." This essentially completes the description of the individual "element selectors" **10**, **12**, **14**, **16**, **18** and **20** with the exception of the "cocking" or biasing and pulsing circuits which will be described hereinafter.

Preceding these element selectors, **10** through **20**, is a plurality of "element-counting" or switching circuits tandemly arranged and provided, respectively, with thyratrons **92**, **94**, **96**, **98**, **100** and **102**. The circuitry associated with each of these thyratrons **92** through **102** is the same, so here again a description of one of these circuits will suffice for all.

Generally speaking, a single counting circuit **92** through **102** is functionally associated with only a single selector circuit **10** through **20**, so in considering the operation of the overall apparatus, the thyratron **92** will be observed as directly affecting the operation of the selector **10** and a portion of the selector **12**, the thyratron **94** similarly affecting the selector **12** and part of the selector **14** and so on. Hence, the term "element-network" is used in the claims to identify the combination of one selector **10–20** with its counter **92—102**.

The anode of the thyratron **92** is directly connected to the supply line **82**. The cathode is grounded through two series-connected resistors **104** and **106** across which is bridged a charging capacitor **108**. The juncture **110** of the two cathode resistors **104** and **106** is connected to the grids of the two thyratrons **24** and **26** through two resistors **112** and **114**, respectively. This juncture **110** is also connected to the grid of the thyratron **28** through a resistor **116**, and further to the grid of the thyratron **94** through another resistor **118**.

The values of the two resistors **104** and **106** are so chosen that when the thyratron **92** is fired and is thereby fully conductive, the voltage appearing at the juncture **110** will be of a value below critical grid voltage, which, if exceeded, will cause the connected thyratrons to fire. This particular voltage appearing at the juncture **110** is

hereafter referred to as either a "cocking" or bias voltage of such value as will not cause the thyratrons to fire.

To be considered in connection with this cocking voltage are the supply voltages appearing on lines **60** and **82**. These supply voltages applied to the anodes are preset to a value insufficient to cause the associated thyratrons to fire, the individual voltage, however, being adequate to cause and maintain firing when a potential exceeding critical grid voltage is applied to the thyratron grids.

The cathode resistors of the succeeding thyratrons **94** through **102**, as in the case of the thyratron **92**, bias or cock the succeeding thyratrons as just described; hence, it is not necessary to describe this succeeding circuitry in detail.

A "counter-reset" thyratron **120** has its anode connected to the supply line **82** and its cathode grounded through the two series-connected resistors **122** and **124**. The juncture **126** of these two resistors is connected to the grid of thyratron **92** through a suitable isolating resistor **128** and to the grid of the thyratron **22** through another isolating resistor **130**. These two resistors **122** and **124** may be identical to the resistors **104** and **106**, supplying a cocking voltage to the two thyratrons **92** and **22**, respectively.

The grid of the thyratron **120** is connected to a voltage divider **132** through a limiting resistor **134** at a point which biases the grid below critical grid voltage. This voltage divider **132** is connected between the power line **64** and ground as shown.

As will be explained more fully in the following, the thyratron **120** controls the operation of the counting circuitry **92—102**, and the third stage of each element selector **10—20**.

A "selector reset" thyratron **136** controls the operation of the first two stages of each element selector **10** through **20** and comprises a cathode resistor **138**, an anode resistor **140** which is connected to the supply line **60**, a charging capacitor **142** being connected in parallel with the resistor **140**. The grid of this thyratron **136** is biased by the voltage divider **144** below critical grid voltage, which is connected between the power line **64** and ground.

Keying Circuitry

The circuitry controlling the operation of the apparatus thus far described comprises three gaseous diodes or triodes, or neon lamps **144**, **146** and **148**. A dropping resistor **150** is connected between one element of the diode **144** and ground. The other element of the diode is connected to one terminal of a charging capacitor **152** which is grounded as shown. To the ungrounded side of this capacitor **152** is series-connected a charging resistor **154** which is series-connected with the power line **64** by a resistor **156**. These two resistors **154** and **156** in combination with the capacitors **152** and **200** provide a time-constant circuit which permits the capacitor **152** to acquire a charge in a predetermined period of time. The gas diode **144**, which may be an ordinary neon lamp, is actually connected in parallel with the capacitor **152** so that when the latter acquires a charge equal to the diode's firing voltage, the diode will fire, producing a voltage drop across the resistor **150**. This voltage drop is conducted from the upper end of the resistor **150** by means of a "reset" line **158** to the grids of the two thyratrons **120** and **136**, respectively, by means of coupling capacitors **160** and **162**. The value of the dropping resistor **150** is so selected as to provide a voltage when the diode **144** fires that will exceed the critical grid voltages of the thyratrons **120** and **136** when this voltage is added to the grid bias. Without this grid bias, the diode generated voltage alone is insufficient to cause the thyratrons to fire.

It will now be noted that when the diode **144** fires, both triodes **120** and **136** will be fired. Since the triode **120** is actually connected in parallel with the counting thyratrons **92** through **102** and "end-of-character" thyratrons **26**, **32**, **38**, **44**, **50** and **56**, any one of these tubes previously fired will be extinguished when the tube **120** is fired. This is true for the reason that, when the tube **120** fires, an additional voltage drop occurs across the series resistor **84** which substantially lowers the voltage on the supply line **82** to the point where the previously fired counting tube or "end-of-character" tube last fired can no longer sustain ionization. Thus, briefly summarizing, by firing the "reset" tube **120**, any fired counting tube **92** through **102** or "end-of-character" tube **26** through **56** will be extinguished and thereby be placed in readiness for receiving coded information.

The "reset" tube **136** operates similarly to tube **120**, but differs in the respect that it is self-extinguishing. This tube **136** is essentially connected in parallel with the first two tubes in each of the selectors **10** through **20**, so that when this tube **136** fires, these particular selector tubes will be disabled or extinguished. The tube **136** is self-extinguishing, because as it fires, the anode capacitor **142** starts to charge according to the voltage drop across the resistor **140** until such time as this charge reduces the anode voltage and current to a point which will not sustain ionization. Thus, the tube **136** only operates momentarily to fire and then self-extinguish.

Recapitulating the operation thus far described, when "B" voltage is applied to the terminals **66** and **68**, the diode **144** will fire after a predetermined lapse of time, causing the two reset tubes **120** and **136** to fire. Since upon first application of "B" voltage the proper conditions do not exist to permit firing of any other tubes, the firing of tube **136** performs no function and the firing of tube **120** only provides cocking bias for tubes **92** and **22**. If initial peculiarities of the power supply or normal operation has fired counting or selector tubes, the firing of reset tube **120** clears or extinguishes any fired counting tubes **92** through **102** or any fired third tube in each selector **10** through **20**, and the firing of reset tube **136** clears or extinguishes any fired first or second tube of each selector **10** through **20**.

A keying relay **164** or suitable switching device is provided with two sets of single pole double throw switches or the equivalent. One switch is provided with an armature **166** which is normally closed against a grounded contract **168**. When the relay is energized, the armature **166** is moved upwardly against the second contact **170** which places the voltage divider **172** across the "B" supply. A line **176**, characterized as a "pulsing line," is connected to the juncture **174** of this divider **172** which provides a voltage of insufficient magnitude to fire the associated thyratrons. However, if any of the associated thyratrons are provided with the cocking or bias voltage as already described, the sum of these voltages will be sufficient to fire those thyratrons. In other words, the amplitudes of the biasing and juncture **174** voltages, respectively, are individually below critical firing voltage; however, when these voltages are added together, the sum exceeds critical voltage. Thus, only when the various thyratrons are cocked or biased can they be fired by a voltage appearing on the pulsing line **176**.

The grids of all of the counting thyratrons **92** through **102** are coupled to the pulsing line **176** by means of suitable capacitors **178**. Similarly, the selector tubes **22**, **28**, **34**, **40**, **46** and **52** are connected to the pulsing line **176** by capacitors **180**.

The second switch of the keying relay **164** has an armature **182** normally closed on contact **184**. Upon actuation of the relay, the armature **182** is moved upwardly into engagement with the upper contact **186**. The armature **182** is grounded as shown through a low value of resistance **183**. A time-constant circuit or network composed of a resistor **188** and the capacitor **190** is series-connected between the power line **64** and ground, with the juncture thereof being connected to the contact **184**. The upper end of the capacitor **190** is connected to

one element of the diode 148 through a limiting resistor 192, the other element of the diode being grounded through a dropping resistor 194. A "dash" or "triggering line" 196 is connected from the upper end of the resistor 194 to the grids of the selector thyratrons 24, 30, 36, 42, 48 and 54 through coupling capacitors 198, respectively. The values of the components are so selected that when the capacitor 190 charges sufficiently, the diode or neon lamp 148 will fire, causing a pulse of voltage to be applied to the line 186. This same pulse is applied to the various thyratrons through the coupling capacitors 198. The amplitude of the pulses is insufficient to fire the thyratrons unless they have been biased.

To the contact 186 of the relay 164 is connected the time-constant circuit 156, 200. The gas diode or neon lamp 146 is connected to the upper end of the capacitor 200 through a limiting resistor 202, the diode being grounded through a suitable dropping resistor 204. An "end-of-character" or "character-defining" line 206 is conected between the upper end of the resistor 204 and the grids of the selector thyratrons 26, 32, 38, 44, 50, and 56, respectively, by capacitors 208.

It is helpful to recognize at this point that the voltage drops produced across the dropping resistors 150, 204 and 194, when the associated neon lamps are fired, are individually insufficient to cause the thyratrons to fire, or in other words, the voltages are below critical grid voltage. On the other hand, these voltages are of sufficient magnitude that when added to the grid bias of the respective thyratrons, the critical grid voltage will be exceeded and the thyratrons will be caused to fire.

Explanation of Operation of FIG. 1

Considering that the apparatus thus far described has no power applied thereto, application of "B" supply voltage to the terminals 66 and 68 clears the circuitry for the receipt of intelligence. Upon application of this supply voltage, the time constant circuit 156, 200, 154, 152 charges over a period of time causing diode 146 and then diode 144 to fire. The firing of diode 144 produces a voltage pulse over the resistor 150 which is coupled to the grids of the reset thyratrons 120 and 136 by means of the line 158. These particular thyratrons have been pre-biased by means of the voltage dividers 132 and 144, so with the addition of this voltage pulse, these two thyratrons are caused to fire. The thyratron 120 fires and remains fired. The thyratron 136 fires and self-extinguishes after a moment, depending upon the charging time of the capacitor 142. With the firing of these two tubes 120 and 136, none of the counting tubes 92 through 102 nor any of the selector tubes 22 through 56 are fired. However, since the tube 120 is fired and current is passing through its cathode resistors 122 and 124, the counting tube 92 and the selector tube 22 are pre-biased. None of the other thyratrons in the succeeding circuitry have a pre-biasing or cocking potential applied thereto; hence, such succeeding thyratrons cannot fire upon the receipt of any kind of a keying pulse.

At this point, it should be noted that the time constant circuit 156, 154, 152 has a longer charging or time constant characteristic than the circuit 156, 200. This being true, application of "B" supply voltage to the terminals 66 and 68 results in the diode 146 firing ahead of the diode 144. The output pulse from diode 146 is connected to the selector tubes 26, 32, 38, 44, 50 and 56, but since these particular tubes have not been cocked or pre-biased, nothing happens when tube 146 fires. Thus, when power is applied to the terminals 66 and 68, the only thing that occurs is the resetting or clearing of the entire apparatus by the firing of the diode 144 which triggers the two thyratrons 120 and 136. Thus cleared, the apparatus is ready to receive coded information.

Considering now that the type of informaiton which is coupled to the relay 164 is in the form of dots and dashes, the moment the relay is energized, regardless of whether the code element is a dot or a dash, the relay armatures 182 and 166 move upwardly against their contacts 186 and 170, respectively. When this happens, capacitors 152 and 200 are shorted to ground through a low value of resistance 183. Armature 166, however, connects the pulsing resistor 172 across the "B" supply producing a voltage drop at 174. This voltage in the form of an instantaneous pulse is now communicated to the pulsing line 176. This line is coupled to all of the counting tubes 92 through 102 and to the first of the selector tubes, but serves to trigger or fire only the pre-biased ones, namely 92 and 22. None of the other tubes will fire, because the grids have not been pre-biased.

With the firing of tube 92, tube 120 is extinguished by reason of the charge on the cathode capacitor 123, as well as the reduced anode voltage caused by the drop across resistor 84.

Tube 22 fires and remains fired, thereby causing a voltage drop across its cathode resistor 70. This places a unidirectional signal voltage on the output line 78.

The firing of the two tubes 92 and 22 is substantially instantaneous, occurring upon actuation of the keying relay 164. Now consideration must be given to whether or not the relay 164 has been actuated by either a dot or a dash. Assuming that the relay has been actuated by a dot of duration as illustrated in FIG. 4(*a*), the relay is released or deactuated at the end 210 (see FIG. 4) of the dot. While the relay is energized for the duration of the dot, the capacitor 190 is charging through the resistor 188. However, the time constant of this resistor-capacitor network 188, 190 is selected such that the capacitor 190 will not charge, within the duration of the dot, to the firing potential of the diode 148. Thus, when the relay 164 is closed for the duration of a dot, nothing happens in the circuitry with the exception of the firing of the two tubes 92 and 22 which provides a unidirectional signal voltage in the output line 78. This voltage on the line 78 therefore represents a dot.

However, if the relay 164 is energized for a period longer than a dot, such as a period long enough to represent a dash, (see FIG. 4), the capacitor 190 will have time within which to charge to the firing potential of the diode 148. This charging time constant of the network 188, 190 and the firing potential of the diode 148 are illustrated by the curve in FIG. 4(*c*) which shows that the diode 148 fires at about the time 212 which falls between the end 214 of the dash and the end 210 of the dot.

With the keying relay held closed for a period of time exceeding a dot, the diode 148 fires producing a pulse on line 196 which is coupled to the thyratrons 24, 30, 36, 42, 48 and 54 of the selectors. Of all of these thyratrons, only thyratron 24 will fire, since it is the only one that has a pre-biasing potential applied to the grid. Note that upon first closure of the keying relay 164 and firing of the thyratron 92, current through the cathode resistors 104, 106 biases thyratrons 24, 26, 28 and 94. Thus, only these four thyratrons can be fired or triggered upon the receipt of a signal pulse. Since the line 196 which has just received a pulse from the diode 148 is coupled to only thyratron 24 of these four tubes, only this one thyratron will fire. This produces a voltage drop across the cathode resistor 72 which is coupled to the output line 80 in the form of a unidirectional voltage. Thyratron 22 which just previously was fired now extinguishes for the reason that the anode potential suddenly drops and the charge on capacitor 74 is sufficiently large to cause extinguishing. Thus, only one or the other of the two tubes 22 and 24 can be fired at any given moment. With the extinguishing of tube 22, the signal voltage on line 78 disappears, leaving only output line 80 energized. Line 80 is characterized as the "dash output" and when energized indicates that a dash has been received and repeated by the keying relay 164.

Having now explained how a dot and dash may be dis-

criminated in the selector output circuitry 78 and 80, it will now be explained how these elements (the dot or the dash) can be defined into a letter or character such as an E (dot) or T (dash). If the only information conducted to the relay 164 is a dot or a dash (E or T), after the sending of the dot or dash, the relay 164 will remain unenergized for a protracted period of time.

As previously explained, the charging time of the capacitor 152 is longer than that for the capacitor 200. With the contacts of the unenergized keying relay as illustrated, the charging capacitor 200 will cause the diode 146 to fire ahead of the diode 144. This results in the first application of a pulse of voltage to the "character-defining line" 206 which is coupled to the grid of the selector thyratron 26. This same pulse is coupled to other selector thyratrons, but these latter ones will not fire since they have not been pre-biased. Thyratron 26 now fires and produces a unidirectional signal voltage in the output line 90. At this moment, two of the three lines 78, 80 and 90 are energized depending upon whether or not a dot or a dash was applied to the relay 164. If a dot was sent, the two lines 78 and 90 will be energized. If a dash was sent, lines 80 and 90 will be energized.

By the use of suitable terminating equipment as illustrated in FIGS. 2 and 3, the presence of signals in these output lines may be used to determine whether a dot or a dash was applied to the relay 164.

At the moment, it should be recognized that firing of the tube 26 caused by firing of the diode 146 indicates the end of a character; hence, the thyratron 26 may be characterized as a "character-defining" tube or as an "end-of-character" tube.

Immediately following the firing of the diode 146 (and the firing of the selector thyratron 26), the condenser 152 continues to charge causing the diode 144 to fire a predetermined time later. In other words, the diode 144 fires a predetermined period of time following the firing of diode 146. Firing of the diode 144 produces a pulse on line 158 which fires the reset thyratrons 120 and 136. As previously explained, these thyratrons reset or clear all of the fired thyratrons in the circuitry, thereby readying the apparatus to receive a new character. In being thus reset, only the two thyratrons 92 and 22 are pre-biased.

Having up to this point explained the conversion of the dot or dash into signal voltages in the output lines 78, 80 and 90, the conversion of a more complicated character, such as the Morse code equivalent of an "A" will now be explained. As is well known, the character "A" is composed of a dot-dash, the dash being three times longer in duration than the dot. Also, the time or space between the dot and dash elements correspond to the period of a dot. A graphical representation of the character "A" is illustrated in FIG. 5.

Assuming first that a dot has been conducted to the keying relay 164, which results in firing thyratrons 92 and 22, only, line 78 will be energized. At the end of the dot, the relay 164 is released for a space of time indicated by the reference numeral 216 in FIG. 5. At the end of the period 216 the relay 164 is closed again producing a pulse in line 176 which is communicated to the various pre-biased circuits, these circuits being those connected to the cathode resistor 104, 106 of tube 92. Specifically, these circuits are 94, 24, 26 and 28. Since only two of these last-mentioned circuits are coupled to the pulsing line 176, namely tubes 94 and 28, only these two will be fired. At the moment tube 94 fires, tube 92 is extinguished by reason of the reduced anode voltage and the charge on the cathode capacitor 108. This removes the bias from the tubes 24, 26 and 28, but 28 has already been fired and remains in this condition. The output line 218 (FIG. 1) is now energized and remains so until the relay has been closed or energized for a period longer than a dot as indicated in FIG. 4. This longer period permits capacitor 190 to charge and to fire the diode 148. A pulse is then produced on line 196 and conducted to the only pre-biased tube in the selector circuitry which is tube 30. Note that tubes 30, 32, 34 and 96 were pre-biased the moment tube 94 fired. Upon the firing of tube 30, tube 28 is immediately extinguished and the output line 220 is energized.

The "A" (dot-dash) now having been developed, lines 78 and 220 momentarily stand energized. Since a dot-dash may also be employed as the first two elements of other characters, it is necessary to determine that no other elements follow closely as part of the same character. By allowing a time lapse greater than the space 216 between elements before again actuating the relay 164, the capacitor 200 will charge to a value sufficient to fire the diode 146 which in turn produces a pulse on line 206. The only tube coupled to line 206 having a pre-biasing potential is thyratron 32, so only this tube 32 fires upon receipt of the pulse. This results in energization of the output line 222 indicating the end of the character. At this particular moment, lines 78, 220 and 222 are energized and the termination equipment illustrated in FIGS. 2 and 3 utilize this information for registering the character sent, in other words, the letter "A".

Following the ending of the character, it is now necessary that the apparatus reset itself to receive a new character, and this automatically happens by the capacitor 152 charging to a potential sufficient to fire the diode 144. When this happens, the line 158 is pulsed, which in turn fires the thyratrons 120 and 136 which clears the remaining thyratrons as already explained.

The ending of the character and resetting of the apparatus is graphically represented in FIG. 5 by the two time constant curves 224 and 226. The curve 224 illustrates the charging time of the capacitor 200 which is longer than the spacing between elements of the characters as indicated by the numeral 216. The curve 226 illustrates the charging time of the capacitor 152, which is longer than that for capacitor 200.

Now having explained the conversion of two different characters, namely an "E" or "T" and an "A," it will now be obvious that the remaining counters 96, 98, 100 and 102 as well as the remaining selectors 14, 16, 18 and 20 will be sequentially actuated by elements of a more complex character, for example, a "C" (dash-dot-dash-dot). Assuming, for example, that the keying relay 164 is actuated according to the Morse code equivalent for the letter "C," the following lines will be concurrently actuated when the letter is finally defined: lines 80, 218, 228, 230 and 232, the last line mentioned being the "end-of-character" line.

Presentation Circuitry

Referring to FIGS. 2 and 3, the circuitry which is capable of utilizing the information appearing in the output lines 78, 80, 90, 218, etc. for visibly or otherwise indicating the character created will now be described. FIG. 2 illustrates the circuit of a gas diode panel or table. It comprises a matrix of crossed wires which are insulated from each other. The horizontal wires are connected to a "B" supply bus bar 234 through suitable isolating resistors 236. The terminal 238 of this bus bar is connected to the "B" supply terminal 66 through a suitable voltage divider 240. The vertical wires of the matrix are assigned the same reference numerals as the output lines of FIG. 1 to indicate that they are common. The letters of the alphabet as well as the numerals and certain punctuation marks for the various horizontal wires are indicated at the left-hand side of the matrix, these letters being vertically arranged.

Considering only the "E" line, remembering that "E" in the Morse code is a single dot, two gas diodes 242 and 244 have one electrode connected to the "E" line and the other electrode connected to the output lines 78 and 90, respectively. Now assuming that neither of the selector thyratrons 22 and 26 are fired, these diodes 242 and 244 will have a potential applied thereacross from the bus bar

234 through resistor 236 and the respective cathode resistors 70 and 86, respectively. The potential applied to the bus bar 234 is adjusted by means of the voltage divider 240 to several volts above the firing potential of diodes 242 and 244 which is approximately 75 volts. Under these conditions, one of the diodes will fire and regulate the voltage on horizontal line "E" downward from the original 90 v. or 100 v. or 120 v. of bus bar 234 to the maintaining voltage of the particular diode which fired, or approximately 65 volts. The diode which fires will be the one with the lowest firing potential-characteristic among those attached to the same horizontal line in random order. When this particular diode fires and the potential of the horizontal line drops, because of the current through resistor 236 and the regulating characteristic of the diode, no other diodes attached to that horizontal line can fire because of insufficient potential across them. Considering only horizontal line "E," one of two conditions may exist; diode 242 may be fired or diode 244 may be fired. Assuming now that an "E" has been received and repeated by relay 164, output line 78 will be energized first and its voltage may rise to 65 to 90 volts. If diode 242 were fired, then, when its grounded end rises in potential as line 78 is energized, the potential on horizontal line "E" will rise until the firing potential of diode 244 will be reached, that potential being slightly higher than the initial firing potential of diode 242, and diode 244 will fire. When diode 244 fires it will regulate the voltage on horizontal line "E" downward again to its maintaining voltage, possibly slightly over 65 volts. If, initially, diode 244 had fired and diode 242 had not fired, then when output line 78 is energized no change will take place on horizontal line "E" because diode 244 is fired and is still grounded through cathode resistor 86 and is still regulating the voltage on horizontal line "E" approximately at its maintaining voltage. In both of the preceding conditions, after line 78 is energized, diode 244 is fired and the ground return of diode 242 has been raised and held at possibly 65 to 90 volts above ground so that it cannot fire. To complete the character "E" a pulse on the "end-of-character" or "character-defining" line 206 fires thyratron 28 and energizes output line 90, raising the potential on output line 90 to possibly 65 to 90 volts. With the potential on bus line 234 adjusted so that it is less than the sum of the potential on line 90 and the potential required to maintain firing of diode 244, diode 244 will be extinguished and, with no current through resistor 236, the potential of horizontal line "E" will rise to equal the potential on bus line 234. Note that when output line 78 is energized, all the diodes connected between it and any horizontal line are "affirmatively extinguished," that is, extinguished or positively prevented from firing. In like manner, all diodes connected to any vertical line may be "affirmatively extinguished." Also in like manner, by energizing the proper combinations of vertical lines, all the diodes attached to any particular horizontal line may be affirmatively extinguished, while, at the same time, at least one diode in each of the other horizontal lines will not be affirmatively extinguished. This permits the potential on one particular horizontal line to rise several volts above the potential of all the other horizontal lines as the result of applying extinguishing potentials to a particular combination of vertical lines.

Summarizing briefly, initially one diode connected to each horizontal line in FIG. 2 is fired and the other diodes are not fired. As the vertical lines connected to a particular horizontal line by diodes are energized, these diodes are affirmatively extinguished. When a diode which was not fired is positively prevented from firing, no appreciable change in potential takes place on the related horizontal line. When a diode which was fired is extinguished, the potential on the related horizontal line increases from the maintaining potential, possibly 60 to 65 volts, to the firing potential, possibly 75 to 80 volts of one of the diodes connected to the same horizontal line but not affirmatively extinguished or positively prevented from firing. If no remaining diode on that horizontal line can be fired, all the conditions have been satisfied to permit the potential of that particular horizontal line to rise from the maintaining voltage of the last diode approximately to the potential of the bus line 234.

Assuming that extinguishing voltages are applied to the vertical lines 78 and 90, the two diodes 242 and 244 are extinguished and the voltage rises on line "E". This voltage is coupled to the grid of thyratron 246 of FIG. 3 which is coupled across the supply lines 248 and 250. These supply voltages are adjusted so that thyratron 246 will not fire when the firing potentials or maintaining potentials of the diodes 242 or 244 are coupled to its grid, but it will fire when line "E" rises to the potential of bus line 234. When tube 246 fires, it produces a unidirectional signal on an output line 252 which is connected to a read-out device such as an incandescent lamp connected between this line 252 and the line 250, an electronic segment-selective device, a relay similarly connected, or an electro-magnetic actuating device on a typewriter key, Thus, with the presentation of a signal on the line 252, the letter "E" which has just been formed is reproduced.

As already explained, when a character has been ended, a pulse is produced by the diode 146 (FIG. 1) which is coupled around to the "character-defining" thyratron 26. As will be noted, this same signal is coupled by means of capacitor 254 to a read-out line 256 which is connected to the grid of a "read-out reset" thyratron 258. This particular thyratron 258 is connected across the two lines 248 and 250 the same as the other presentation thyratrons in the circuitry of FIG. 3. Thus thyratron 258 is pre-biased or cocked by the voltage divider 264 at all times so that it will fire upon receipt of the "end-of-character" pulse on line 256, causing any previously fired presentation thyratron 246, 260 or 262, etc. to be extinguished. At the same time the same pulse causes a "character-defining" or "end-of-character" thyratron 26, 32, etc. to fire, the output of which almost instantaneously fulfills the final condition required to permit a particular horizontal line in FIG. 2 to rise to the voltage of supply line 234. The purpose of thyratron 258 is to extinguish any previously fired presentation thyratron 246, 260 or etc. a short time before firing a presentation thyratron representing the next character received, that is, the character completed as described above. To cause thyratron 258 to fire a short time before the next presentation thyratron, all the triggering voltages to the presentation thyratrons must be delayed slightly, and this is accomplished by a time constant charging capacitor 268 and a resistor 269, or resistor 269 and resistor 238 which may be combined. This resetting would not be necessary if it were not for the fact that successive identical characters might be presented, since for different characters successively presented, each presentation thyratron 246, 260, 262, etc. extinguishes any other which is fired. For repeating identical characters, it is necessary to turn off or extinguish the particular presentation thyratron 246, 260, 262, etc. just prior to the repetition, and it is the purpose of the reset thyratron 258 to do this. If a read-out device is employed in which the symbol is continuously visibly presented so long as the presentation thyratron output line 252 (for example) is energized, the resetting action of reset thyratron 258 will permit or cause the symbol to be extinguished for a short time. In this manner, successive presentations of the same symbol or character will be interrupted between each presentation, that is, "E–E–E" (a series of E's) can be distinguished from "E" being presented for a long interval of time.

Assuming again that an "E" has been received and identified in the circuitry of FIG. 1, the moment the "end-of-character" or "character-defining" diode 146 fires,

a pulse is coupled to both the thyratron **26** and the "read-out reset" line **256**. Thyratron **26** fires, permitting the horizontal wire "E" of the matrix of FIG. 2 to increase in voltage as charging capacitor **268** charges through resistors **269** and **236**. Thus, the reset thyratron **258** fires, extinguishing any previously fired presentation thyratron, and after capacitor **268** charges to the proper firing potential, presentation thyratron **246** fires, extinguishing reset thyratron **258**, and energizing the output lead **252** of thyratron **246**. The character "E" may remain presented until reset thyratron **258** fires again just before the next character is presented.

Briefly summarizing, and considering the matrix of FIG. 2 in the event the letter "C" is created in the circuitry of FIG. 1, it will be noted in FIG. 2 that the lines **80, 218, 228, 230**, and **232** will have output voltages applied thereto, thereby affirmatively extinguishing the five diodes **270**. When this occurs, line "C" will be the only line of the entire matrix having no fired diodes, whereupon it will have the highest voltage of any of the character lines. The increased voltage on this "C" line will be coupled through to the presentation circuitry of FIG. 3 for firing the associated thyratron, thereby indicating that the letter "C" was received.

Alternative Circuitry

While diodes **144, 146** and **148** with associated time constant networks have been illustrated in connection with providing triggering or control pulses for the related circuitry, it will occur as obvious to a person skilled in the art that multivibrators of, for example, the flip-flop type may be used instead. These multivibrators incorporating time delay circuitry are designed to respond to the actuation of the keying relay in proper order. As to the matrix of FIG. 2, ordinary resistors may be substituted for the neon lamps for obtaining a change in voltage condition on a selected one of the horizontal wires.

The circuitry of FIG. 3 could consist of vacuum tubes, transistors or switching devices so arranged to accept character and reset signals and provide amplified character signals.

It is obvious that self-extinguishing thyratron circuits can be substituted for diodes **144, 146** and **148**. In such an arrangement, the dropping resistor would be connected between the cathode and the reference potential, the grid would be coupled to the charging network, and the anode circuit would be coupled to a supply voltage.

For a code-converting apparatus capable of receiving and presenting the International Morse Code at a speed of between ten (10) to fifteen (15) words per minute, the following listed components may be used, the values of these components being given by way of example only and not to be considered in any respect as limiting the scope of the invention.

Thyratrons	HI VAC, XC–18.
Gas diodes	NE–2, NE–51, SC–12, NT–2.
Cathode resistors 70, 72, 86	100,000 ohms.
Charging capacitors 74, 76, 88	.02 mfd.
Dropping resistor 58	100,000 ohms.
Dropping resistor 62	15,000 ohms.
Dropping resistor 84	8,200 ohms.
Biasing resistors 112, 114	4.7 megohms.
Coupling capacitor 180	500 mmfd.
Coupling capacitor 198	500 mmfd.
Coupling capacitor 208	500 mmfd.
Cathode resistors 104, 106	220,000 and 270,000 ohms.
Capacitor 108	.02 mfd.
Coupling capacitor 160	500 mmfd.
Coupling capacitor 162	500 mmfd.
Anode resistor 140	10 megohms.
Anode capacitor 142	.02 mmfd.
Cathode resistor 138	3,900 ohms.
Voltage divider 144	3.9 and 1.5 megohms.
Voltage divider 132	4.7 and 1.5 megohms.
Isolating resistor 128	4.7 megohms.
Isolating resistor 130	4.7 megohms.
Coupling capacitor 178	500 mmfd.
Resistor 116	4.7 megohms.
Resistor 118	4.7 megohms.
Voltage divider 172	100,000 and 33,000 ohms.
Resistor 188	100,000 ohms.
Capacitor 190	.1 mfd.
Resistor 192	100,000 ohms.
Resistor 194	1 megohm.
Resistor 156	330,000 ohms.
Capacitor 200	.1 mfd.
Resistor 154	560,000 ohms.
Capacitor 152	.2 mfd.
Resistor 150	1 megohm.
Resistor 204	1 megohm.
Voltage divider 240	120,000 and 62,000 ohms.
Resistor 236	3.9 megohms.
Voltage divider 264	3.9 and 1.8 megohms.
Resistor-capacitor circuit 268	1 megohm and .01 mfd.
Capacitor 254	500 mmfd.
Supply voltage 66–68	+180 v. D.C.
Supply voltage 238	+125 v. D.C.
Supply voltage 250	+20 v. D.C.
Supply voltage 248	+200 v. D.C.

What is claimed is:

1. Code-converting apparatus comprising a first switching circuit having cocking-signal producing means, a second switching circuit having an output circuit, means actauting both said first and second switching circuits whereby said first circuit produces a cocking signal, a third switching circuit having an output circuit and cocking means operatively coupled to said cocking-signal means, said third switching circuit being actuable only when a signal is applied to its cocking means, a fourth switching circuit having an output circuit and cocking means operatively coupled to said cocking-signal means, said fourth switching circuit being actuable only when a signal is applied to its cocking means, means actuating said third switching circuit after it has been cocked by said cocking signal and after a predetermined time following actuation of said second switching circuit by the first-mentioned actuating means, means disabling said second switching circuit when said third switching circuit is actuated, means actuating said fourth switching circuit after cocking by said cocking signal and after the actuating of said second and third switching circuits, and means operatively coupled to all of said output circuits and responsive to the simultaneous occurrence of signals in the output circuit of said fourth switching circuit and one of the output circuits of said second and third switching circuits for generating a signal representative thereof.

2. Code-converting apparatus comprising a first element-selecting circuit having an output circuit, a second element-selecting circuit having an output circuit, a character-defining circuit having an output circuit, keying means having to operating positions, said keying means in one position including means instantaneously actuating said first circuit and a predetermined time later actuating said second circuit, means deactuating said first circuit upon actuation of said second circuit, said first, second and character-defining circuits when actuated producing signals in the output circuits thereof, respectively, said keying means in the other position including means actuating said character-defining circuit a predetermined period of time following the operation thereof from said one position to said other position, and means operatively coupled to all of said output circuits and responsive to the simultaneous occurrence of signals in the output cir-

cuit of said character-defining circuit and one of the output circuits of said first and second circuits for generating a signal representative thereof.

3. Code-converting apparatus comprising a first element selecting circuit having an output circuit, a second element-selecting circuit having an output circuit, a character-defining circuit having an output circuit, keying means having two operating positions, said keying means in one position including means instantaneously actuating said first circuit and a predetermined time later actuating said second circuit, means deactuating said first circuit upon actuation of said second circuit, said first, second and character-defining circuits when actuated producing signals in the output circuits thereof, respectively, said keying means in the other position including means actuating said character-defining circuit a predetermined period of time following the operation thereof from said one position to said other position, means operatively coupled to all of said output circuits and responsive to the simultaneous occurrence of signals in the output circuit of said character-defining circuit and one of the output circuits of said first and second circuits for generating a signal representative thereof, and a resetting circuit including means operatively coupled to said first, second and character-defining circuits for deactuating the same, said keying means including means actuating said resetting circuit a predetermined period of time following actuation of said character-defining means.

4. Code-converting apparatus comprising a plurality of element-counting circuits having input and cocking-signal producing circuits, respectively, said element-counting circuits being sequentially arranged with the input circuits thereof operatively coupled to the cocking-signal circuit of the respective preceding element-counting circuits, each counting circuit being actuable only after the receipt of a cocking signal, a plurality of element selectors sequentially arranged and operatively coupled to ones of said element-counting circuits respectively, there being one element selector for one element-counting circuit thereby providing a plurality of element-networks, each selector including two element-selecting and one character-defining circuits having input and output circuits respectively, said output circuits including means generating signals in response to the actuation of the respective element-selecting and character-defining circuits, said element-selecting and character-defining circuits being actuable only after a cocking signal is applied to the input circuits thereof, one element-selecting circuit of each element-network having its input coupled to the cocking-signal circuit of an adjacent element-network, the second element-selecting circuit of each element-network having its input coupled to the cocking-signal circuit of its element-network, the character-defining circuit of each element-network having its input coupled to the cocking-signal circuit of its element-network, means sequentially triggering into actuation said element-networks, means disabling all of said counting circuits except the one triggered, means selectively triggering a character-defining circuit a predetermined period of time following the actuation of particular ones of said element-selecting circuits, and means operatively coupled to all of the output circuits of said element-selecting and character-defining circuits and responsive to simultaneous occurrence of signals therein following the actuation of one of said character-defining circuits for generating a signal representative of the element-selecting circuits actuated.

5. The apparatus of claim 4 but including means disabling one element-selecting circuit of each selector when the other element-selecting circuit is actuated.

6. The apparatus of claim 4 but including means disabling the actuated counting circuit when a character-defining circuit is actuated.

7. The apparatus of claim 4 but including means deactuating said element-selecting and character-defining circuits after said representative signal has been generated.

8. For use in code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one element-selecting device being operatively coupled to the cathode of said element-counting device, means biasing the grids of said element-counting device and the other of said element-selecting devices to a value of voltage below critical grid voltage, the voltage coupled from said element-counting cathode resistor to the grids of said character-defining and said one element-selecting devices being below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon alternative operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, and means operatively coupled to all of said output circuits and responsive to the simultaneous occurrence of signals in the output circuit of said character-defining device and one of the output circuits of said element-selecting devices for generating a signal representative thereof.

9. For use in a code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one element-selecting device being coupled to the cathode of said element-counting device, means biasing the grids of said element-counting device and the other of said element-selecting devices to a value of voltage below critical grid voltage, the voltage coupled from said element-counting cathode resistor to the grids of said character-defining and said one element-selecting devices being below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon alternative operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined

period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, two signal-generating circuits, one signal-generating circuit being coupled to the output circuits respectively of said one element-selecting and said character-defining devices, the other signal-generating circuit being coupled to the output circuits respectively of said other element-selecting and character-defining devices, each signal-generating circuit including means being responsive to the simultaneous occurrence of signals in the respective output circuits coupled thereto to generate a signal representative thereof.

10. For use in code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one element-selecting device being coupled to the cathode circuit of said element-counting device, a reset gaseous discharge device having anode, grid and cathode electrodes, a resistor coupled between the cathode of said reset device and said reference potential, the anode of said reset device being connected to the anode of said element-counting device and to the anode of said character-defining device, the grids of said element-counting device and the other element-selecting device being coupled to the cathode of said reset device to provide a bias voltage below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon alternative operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, and a third time delay circuit coupled from said other keying circuit to the grid of said reset device for firing the latter a predetermined period of time after the firing of said character-defining device thereby extinguishing said character-defining devices.

11. The apparatus of claim 10 including an element-resetting gaseous discharge device having anode, grid and cathode electrodes, a parallel resistor-capacitor network series operatively connected between said element-resetting anode and the anodes of said two element-selecting devices, the cathode of said element-resetting device being coupled to said source of reference potential, and the grid of said element-resetting device being coupled to the grid of said reset device.

12. The apparatus of claim 10 wherein each said first, second and third time delay circuit comprises a resistor-capacitor time constant network and a gaseous diode coupled across the capacitor.

13. The apparatus of claim 10 wherein capacitors are coupled from all of said cathodes respectively to said source of reference potential.

14. For use in code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes, respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one element-selecting device being coupled to the cathode of said element-counting device, a reset gaseous discharge device having anode, grid and cathode electrodes, a resistor coupled between the cathode of said reset device and said reference potential, the anode of said reset device being connected to the anode of said element-counting device and to the anode of said character-defining device, the grids of said element-counting device and the other element-selecting device being coupled to the cathode of said reset device to provide a bias voltage below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit including means coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit including means coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, a third time delay circuit including means coupled from said other keying circuit to the grid of said reset device for firing the latter a predetermined period of time after the firing of said character-defining device, thereby extinguishing both said element-counting and character-defining devices, two electrically separated signal lines having one end coupled to the first-mentioned source of voltage, a first gaseous diode connected between one of said lines and the output circuit of said other element-selecting device, a second gaseous diode connected between said one line and the output circuit of said character-defining device, a third gaseous diode connected between the other line and the output circuit of said one element-selecting device, a fourth gaseous diode connected between said other line and the output circuit of said character-defining device, two thyratrons each having anode, grid and cathode electrodes, the grids of said two thyratrons being connected to said two lines respectively, a source of supply voltage coupled between the anodes and cathodes of said two thyratrons, the voltage on said lines being above the critical grid voltage when said gaseous diodes are extinguished whereby said two thyratrons may be selectively fired.

15. For use in code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes, respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one ele-

ment-selecting device being coupled to the cathode of said element-counting device, a reset gaseous discharge device having anode, grid and cathode electrodes, a resistor coupled between the cathode of said reset device and said reference potential, the anode of said reset device being connected to the anode of said element-counting device and to the anode of said character-defining device, the grids of said element-counting device and the other element-selecting device being coupled to the cathode of said reset device to provide a bias voltage below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit including means coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit including means coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, a third time delay circuit including means coupled from said other keying circuit to the grid of said reset device for firing the latter a predetermined period of time after the firing of said character-defining device thereby extinguishing both said element-counting and character-defining devices, two electrically separated signal lines having one end coupled to the first-mentioned source of voltage, a first gaseous diode connected between one of said lines and the output circuit of said other element-selecting device, a second gaseous diode connected between said one line and the output circuit of said character-defining device, a third gaseous diode connected between the other line and the output circuit of said one element-selecting device, a fourth gaseous diode connected between said other line and the output circuit of said character-defining device, three thyratrons having the anodes and cathodes thereof coupled in parallel across a source of supply voltage, and a source of bias voltage of less than critical grid voltage coupled to the grid of one thyratron, the grids of the other two thyratrons operatively connected respectively to said two lines by means of capacitor-resistor time constant networks, the grid of said one thyratron being coupled to said second time delay circuit whereby said one thyratron is fired when said character-defining device is fired, the voltage on said two lines being above critical grid voltage when said gaseous diodes are extinguished, whereby said two thyratrons may be selectively fired.

16. For use in code-converting apparatus, two element-selecting gaseous discharge devices having anode, grid and cathode electrodes, respectively, a character-defining gaseous discharge device having anode, grid and cathode electrodes, an element-counting gaseous discharge device having anode, grid and cathode electrodes, a source of anode voltage operatively coupled to all of said anodes, cathode resistors coupled between said cathodes, respectively, and a source of reference potential, the grid of said character-defining device and the grid of one element-selecting device being coupled to the cathode of said element-counting device, a reset gaseous discharge device having anode, grid and cathode electrodes, a resistor coupled between the cathode of said reset device and said reference potential, the anode of said reset device being connected to the anode of said element-counting device and to the anode of said character-defining device, the grids of said element-counting device and the other element-selecting device being coupled to the cathode of said reset device to provide a bias voltage below critical grid voltage, three output circuits operatively coupled to the cathodes of said two element-selecting devices and said character-defining device respectively, a keyer having two alternatively actuable keying circuits which produce keying voltages respectively upon operation of said keyer, said keying voltages being below critical grid voltage, one keying circuit being coupled to the grids of said element-counting device and said other element-selecting device, the sum of said bias and keying voltages exceeding said critical grid voltage, a first time delay circuit including means coupled from said one keying circuit to the grid of said one element-selecting device for firing the latter a predetermined period of time after said other element-selecting device has fired, means extinguishing said other element-selecting device when said one element-selecting device is fired, a second time delay circuit including means coupled from the other keying circuit to the grid of said character-defining device for firing the latter a predetermined period of time after said keyer operates from said one keying circuit to the other keying circuit, a third time delay circuit including means coupled from said other keying circuit to the grid of said reset device for firing the latter a predetermined period of time after the firing of said character-defining device thereby extinguishing both said element-counting and character-defining devices, two electrically separated signal lines having one end coupled to the first-mentioned source of voltage, a first gaseous diode connected between one of said lines and the output circuit of said other element-selecting device, a second gaseous diode connected between said one line and the output circuit of said character-defining device, a third gaseous diode connected between the other line and the output circuit of said one element-selecting device, a fourth gaseous diode connected between said other line and the output circuit of said character-defining device, three thyratrons having the anodes and cathodes thereof coupled in parallel across a source of supply voltage, cathode resistors in series with the thyratron cathodes respectively and said source of supply voltage, capacitors connected in parallel with the last-mentioned resistors respectively, charging capacitors connected between the grids of said thyratrons and the remote ends of the cathode resistors respectively, a source of bias voltage less than critical grid voltage connected to the grid of one of said thyratrons, a first resistor connected in series between said one thyratron and said second time delay circuit whereby said one thyratron is fired when said character-defining device is fired, second and third resistors connected in series with the grids of the other two thyratrons respectively and said two lines, said first resistor and the charging capacitor connected thereto providing a shorter time constant than the time constants of the second and third resistors and the charging capacitors connected thereto, the voltage on said lines being above critical grid voltage a predetermined time after said gaseous diodes are extinguished, whereby said thyratrons may be selectively fired.

17. For use in code-converting apparatus, element-counting circuitry comprising at least first and second thyratrons, the anodes of said thyratrons being connected together, a source of anode voltage, a dropping resistor series connected between said source and said anodes, first and second resistors series connected between the cathodes of said thyratrons respectively and ground, two charging capacitors connected across said first and second resistors respectively, said source of anode voltage being insufficient to fire said thyratrons; element-selecting circuitry comprising at least first and second selectors, each selector having first, second and third thyratrons; in each selector the anodes of the first and second selector thyratrons being connected together, a second source of anode voltage, a second dropping resistor series connected between said second source and the anodes of said first

and second selector thyratrons, the anode of the third selector thyratron being connected to the anodes of said first and second counting thyratrons, parallel resistor and capacitor networks series connected between the selector thyratron cathodes respectively and ground, output terminals connected to the selector thyratron cathodes respectively; a source of biasing potential below critical grid voltage connected to the grids of the first thyratron of the first selector and said first counting thyratron, the grids of the second and third thyratrons of the first selectors being conductively coupled diode-end of the last mentioned resistor, and two capacitors connected at one end to said character-defining line and at the other end to the grids of the third thyratrons of the first and second selectors.

18. The apparatus of claim 17 including a counter-reset thyratron having its anode connected to the anodes of said first and second counting thyratrons, a resistor connected between the cathode of said counter-reset thyratron and ground, a capacitor connected across said resistor, a point on the last-mentioned resistor and the grids of said first counting thyratron and the first thyratron of the first selector being conductively connected together; a selector-reset thyratron having its anode connected through a parallel resistor-capacitor network to said second source of anode voltage, a resistor connected between ground and the cathode of said selector-reset thyratron, a source of biasing voltage connected to the grids of both reset thyratrons; a third resistor-capacitor time constant network series connected between said keying voltage source and ground, a pair of normally open contacts series connected between the juncture of said third resistor-capacitor network and ground, a third gaseous diode having one electrode connected to the last-mentioned juncture and the other electrode connected to ground through a resistor, a reset line connected to the diode-end of the last-mentioned resistor, and two capacitors having one end connected to said reset line and the other end to the grids of the counter-reset and selector-reset thyratrons.

19. For use in code-converting apparatus, first, second and third switching circuits, said circuits having input and output circuits, respectively, each of said first, second and third switching circuits producing a signal in the output circuit thereof in response to a signal being applied to the input circuit thereof, keying means having first and second signal circuits which are coupled to the input circuits of said first and second switching circuits, respectively, said keying means including means which produces a first signal in said first signal circuit and a second signal in said second signal circuit a predetermined period of time following production of said first signal whereby said first and second switching circuits will be actuated in time delayed sequence, means disabling said first switching circuit when said second switching circuit is actuated, said keying means having a third signal circuit which is coupled to the input circuit of said third switching circut, said keying means including means for generating a third signal in said third signal circuit a predetermined period of time following termination of either said first or second signals whereby said third switching circuit is actuated, and means coupled to all three of said output circuits and responsive to the simultaneous occurrence of signals in the output circuit of said third switching circuit and one of the output circuits of said first and second switching circuits; for generatng a signal representative thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,552,126	Van Duuren	May 8, 1951
2,840,637	McNaney et al.	June 24, 1958
2,847,503	Diamond et al.	Aug. 12, 1958
2,850,723	McNaney	Sept. 2, 1958
2,854,192	Bland et al.	Sept. 30, 1958

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,109,064 October 29, 1963

Cecil E. Mathis

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 10, for "186" read -- 196 --; column 19, lines 10 and 11, for "selectors" read -- selector --; line 11, after "coupled" insert the following:

> together and to a point on the first cathode resistor, said point also being conductively coupled to the grid of the second counting thyratron and the first thyratron of the second selector; the grids of the second and third thyratrons of the second selector being conductively connected together and to a point on the second cathode resistor; a source of keying voltage of insufficient magnitude to fire said thyratrons, a normally open pair of keying contacts series connected between said keying voltage source and a pulsing line, four coupling capacitors connected at one end to said pulsing line and at the other end to the grids of the first and second counting thyratrons and the first thyratrons of the first and second selectors respectively; a first resistor-capacitor time constant network having a first gaseous diod conductively connected across the capacitor, a pair of normally closed contacts series connected between the juncture of said resistor-capacitor network and ground, said network being series connected between said source of keying voltage and ground, a dropping resistor series connected between said gaseous diode and ground, a dash-triggering line

connected to the diode-end of the last-mentioned dropping resistor, two coupling capacitors connected at one end to said dash-triggering line and grids of the second thyratrons of the first and second selectors respectively; a second resistor-capacitor time constant network having a second gaseous diode conductively connected across the capacitor, a pair of normally open contacts series connected between the juncture of said second resistor-capacitor network and ground, said second network being series connected between said source of keying voltage and ground, a second dropping resistor series connected between said second diode and ground, a character-defining line connected to the

Signed and sealed this 12th day of May 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents