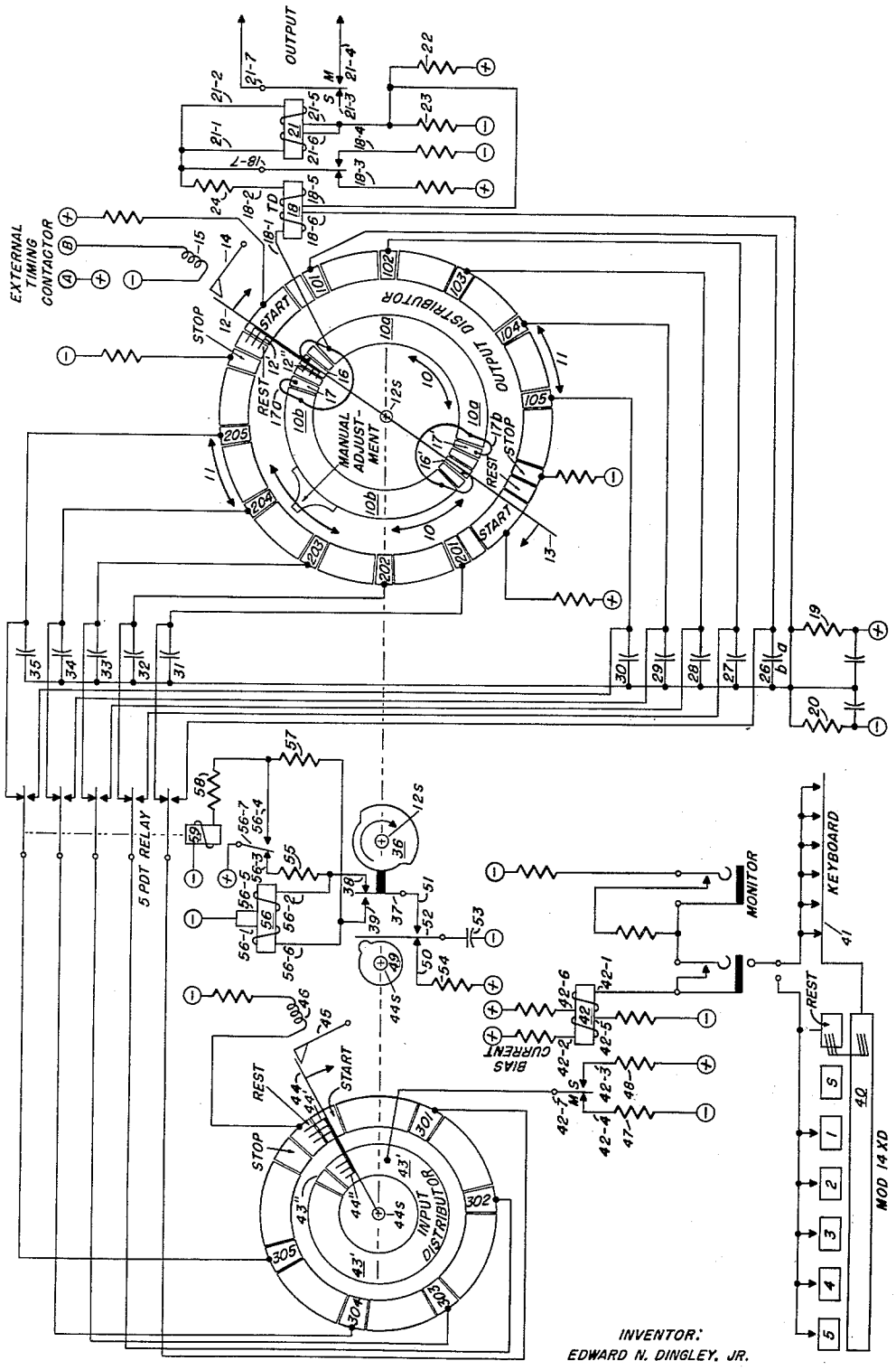
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TELEGRAPHIC SYNCHRONIZING SYSTEM

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TELEGRAPHIC SYNCHRONIZING SYSTEM

Edward Nelson Dingley, Jr., Arlington, Va.

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5 Claims. (Cl. 178—17.5)

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The invention described in the following specification and claims may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

My invention relates broadly to means by which printing telegraph signals having an irregular character rate may be introduced into and transmitted by a synchronous printing telegraph system wherein the character rate is very constant.

My invention relates chiefly to means by which printing telegraph signals originated at an irregular character rate by a keyboard-operated transmitting distributor or originated at a regular character rate during random time intervals by punched-tape transmitter-distributor, may be introduced into and transmitted over a printing telegraph system wherein the line-transmitting apparatus and the line-receiving apparatus are maintained in synchronism and in fixed phase relationship, dispite noise or circuit-outages, by the use of frequency (rate) standards at each terminal.

One of the objects of my invention is to provide a device that will permit keyboard operation over synchronous printing telegraph circuits.

Another object of my invention is to provide a simple, dependable, and relatively inexpensive printing-telegraph start-stop extensor.

Other and further objects of my invention will be understood from the following specification and claims.

The drawing illustrates diagrammatically one embodiment of my invention.

Referring to the drawing, the output distributor comprises an inner ring **10** of electrically conductive segments insulated from each other, an outer ring **11** of electrically conductive segments insulated from each other and insulated from ring **10**, a brush arm having two ends designated by symbols **12** and **13**, a pair of electrical brushes **12'** and **12''** electrically joined together and mounted on end **12** of brush arm **12—13** which make rubbing electrical contact with rings **10** and **11** respectively, an electric motor (not shown) which through the means of suitable gears (not shown) and a friction clutch (not shown) rotates the brush arm **12—13** at the velocity of one-half revolution in T_R milliseconds, a stop lever **14** capable of engaging end **12** or end **13** of brush arm **12—13** so as to stop the rotation of said brush arm when the brushes are in the position depicted in the drawing or diametrically opposite thereto, and a start-magnet **15** which when energized retracts the stop lever **14** and permits the brush arm to rotate. Timing means for the magnet are indicated but not shown in detail as conventional devices may be used.

The start magnet **15** is energized during an interval of approximately $T/7$ milliseconds once each T milliseconds. The time T_R required for a half-revolution of the output distributor brush arm is chosen so that T_R is approximately equal to $8T/9$ thus permitting the brush arm end **12** or **13** to strike the stop lever **14** and remain

at rest for approximately $T/9$ milliseconds until the next electrical pulse is applied to start-magnet **15**.

In rest position as shown in the drawing (or diametrically opposite thereto) the brushes of the output distributor rest on non-energized (Rest) segments of the inner and outer rings; however, shortly prior to their arrival at rest position they had connected negative battery from the outer ring Stop segment to the inner ring segment **17** or **17'**, through the jumper **17*a*** or **17*b*** shown connecting segment **17** to the long segments **10*b*** and **10*a*** of the inner ring, to terminal **18–1** of polar relay **18**, out terminal **18–6**, through resistor **19** to positive battery. Current flowing in the aforesaid direction through terminals **18–1** and **18–6** causes the armature **18–7** to engage spring **18–4** thus connecting negative battery from spring **18–4** through armature **18–7** through resistor **24**, to terminal **18–2**, out terminal **18–5**, through resistor **22** to positive battery and also thus connecting the same negative battery to terminals **21–1** and **21–2** of polar relay **21**, out terminals **21–6** and **21–5**, through resistor **22** to positive battery. Current flowing in the aforesaid direction through **18–2** and **18–5** of relay **18** constitutes a holding current which holds the armature **18–7** in close contact with spring **18–4** even though the current through terminals **18–1** and **18–6** is interrupted by the brushes of the output distributor coming to rest on the non-energized segments as shown in drawing. Current flowing in the aforesaid direction through the windings of relay **21** holds the armature **21–7** in close contact with spring **21–4** thus closing the circuit of the output line.

Upon the release of the output distributor brush arm **12—13** by stop lever **14**, the brushes rotate in a clockwise direction until they engage the leading edge of the Start segment of the outer ring and the leading edge of segment **16** of the inner ring thus connecting positive battery to segment **16**, through the jumper shown connecting segment **16** to the long segments of the inner ring, to terminal **18–1** of polar relay **18**, out terminal **18–6** through resistor **20**, to negative battery. Current flowing in the aforesaid direction through terminals **18–1** and **18–5** of relay **18** causes armature **18–7** to engage spring **18–3** thus connecting positive battery from spring **18–3** through armature **18–7**, through resistor **24**, to terminal **18–2**, out terminal **18–5**, through resistor **23** to negative battery and also connecting the same positive battery to terminals **21–1** and **21–2** of polar relay **21**, out terminals **21–6** and **21–5**, through resistor **23** to negative battery. Current flowing in the aforesaid direction through terminals **18–2** and **18–5** of relay **18** constitutes a holding current which holds the armature **18–7** in close contact with spring **18–3** even though the current through terminals **18–1** and **18–6** of relay **18** is interrupted by the brushes of the output distributor advancing in a clockwise direction to the next pair of non-energized segments of the outer ring. Current flowing in the aforesaid direction through the windings of relay **21** holds the armature **21–7** in close contact with spring **21–3** thus opening the circuit of the output line and providing the beginning of the required spacing-start pulse of standard teletypewriter code.

The spacing condition of the output line endures until the brushes connect segment **101** of the outer ring to the long segment **10*a*** of the inner ring. The leading edge of segment **101** is spaced from the leading edge of the Start segment by an angle such that the brushes, when rotating at the velocity of half-a-revolution in T_R milliseconds, will require $T/7.42$ milliseconds to travel through the aforesaid angle. Because of slippage in the friction clutch, the acceleration of the brush arm is not infinite upon its release from the rest position. In consequence and in order that the duration of the start pulse may be adjusted to be exactly $T/7.42$ milliseconds, the

inner ring of the output distributor is designed to be capable of manual rotation through an arc of about six degrees in order that segment **16** of the inner ring, which governs the instant of beginning of the start pulse, may be adjusted to a lesser angular distance from segment **101** of the outer ring, thus achieving a start pulse of $T/7.42$ milliseconds duration despite constant clutch slippage during acceleration of brush arm **12—13**. Manual clockwise rotation of the inner ring (from the extreme counter-clockwise position shown) through an angle in excess of the arc width of segment **17** will place a portion of segments **17** and **17'** in radial alignment with portions of the Start segments of the outer ring. In order to obviate the undesirable condition which would result from such juxtaposition, the jumpers **17***a* and **17***b* connecting segments **17** and **17'** to the long segments of the inner ring may be removed thus de-energizing segments **17** and **17'**. Segments **17** and **17'** may be considered as extensions of long segments **10** and **10***a*, respectively, when their jumpers are connected.

At a time $T/7.42$ milliseconds after the beginning of the spacing start pulse previously described, the clockwise rotating brushes connect the leading edge of segment **101** to the inner ring and complete a circuit from the "*a*" side of capacitor **26** to terminal **18–1** of relay **18**, out of terminal **18–6** and back to the "*b*" side of capacitor **26**. If capacitor **26** is uncharged, tongue **18–7** of relay **18** will remain engaged with its spring **18–3**. If the "*a*" side of capacitor **26** has a positive charge, the resultant discharge of current through terminals **18–1** and **18–6** of relay **18** will reinforce the pressure of tongue **18–7** against spring **18–3**. If the "*a*" side of capacitor **26** has a negative charge, the resultant discharge of current through terminals **18–1** and **18–6** of relay **18** will cause tongue **18–7** to move from contact spring **18–3** to contact spring **18–4** where it will be constrained to remain by the holding circuit previously described. Resistor **24** limits the holding current to a value sufficiently less than the current through winding **18–1—18–6** of relay **18** so that the latter signalling current invariably overcomes the effect of the holding current.

The arc length of segment **101** and of all similar short segments **102—105** and **201—205** of the outer ring is such that the duration of brush contact therewith is the minimum required to assure proper response of polar relay **18**, that is, approximately $T/25$ milliseconds. The capacitance of capacitors **26** thru **30** and of capacitors **31** thru **35** is chosen such as to assure their complete discharge through winding **18–1—18–6** of relay **18** in $T/25$ milliseconds.

The leading edges of the short segments **101—105** and **201—205** of the output distributor are spaced from each other by an angle such that the time required for the leading edge of the outer ring brush to travel from the leading edge of one short segment to the leading edge of the next is $T/7.42$ milliseconds. As the brush sequentially makes contact with segments **101—105** or **201—205**, capacitors **26** through **30** or capacitors **21** through **35** are discharged in sequence through winding **18–1—18–6** of relay **18**, thus causing the tongue **18–7** of relay **18** (and consequently the tongue **21–7** of relay **21**) to more from spacing (contact **18–3**) to marking (contact **18–4**) in accordance with the positive and negative charges stored on capacitors **26** through **35**.

The leading edge of the Stop segment of the outer ring of the output distributor is reached by the brush $T/7.42$ milliseconds after the passage of the brush over the leading edge of segment **105** and there is established a circuit from negative battery on the outer ring Stop segment to inner ring long segment (either directly or through the jumper from segment **17** or **17'** depending on the position to which the inner ring has been manually rotated), to terminal **18–1** of relay **18**, out terminal **18–6**, through resistor **19** and to positive battery. The resultant current flow through the indicated winding of relay **18** causes the tongue **18–7** to make and maintain contact with its spring **18–4** even after the brush has advanced beyond the Stop segment and come to rest upon the unenergized Rest segment. In consequence of this action, the tongue **21–7** of relay **21** is caused to make and maintain contact with its spring **21–4**, thus closing the output line and producing the marking-stop signal of a standard teletypewriter signal.

The Start segments of the output distributor are always at positive potential and the Stop segments are always at negative potential. In consequence, the output distributor causes the contacts of relay **21** to key the output circuit with standard 7.42 unit teletypewriter start-stop signals. When capacitors **26—35** are not charged, relay **21** remains in a spacing condition between the end of the start pulse and the beginning of the stop pulse. In conseuqence, the output distributor sends the "blank" teletypewriter character at the rate of $60{,}000/T$ characters per minute whenever the capacitors **26—35** are not charged.

The shaft **12***s* of the brush arm **12—13** is provided with a cam **36** and a cam operated switch **37—38—39** arranged so that the tongue **37** engages spring **38** during the clockwise rotation of brush arm **12** between segments **203** and **103**, and so that tongue **37** engages spring **39** during the clockwise rotation of brush arm **12** between segments **103** and **203**.

The illustration includes a schematic representation of a tape reading transmitter-distributor **40** of known type (Teletype Model 14XD) and a keyboard transmitter **41** of conventional type arranged to key the tongue **42–7** of relay **42** in the usual manner. These transmitters are not part of this invention but are normal ancilliary apparatus for providing the input signal.

The input distributor depicted comprises an inner ring **43** comprising two electrically conductive segments **43'** and **43''** insulated from each other, an outer ring comprising fourteen electrically conductive segments insulated from each other and insulated from the inner ring, a brush arm **44**, two electrical brushes **44'** and **44''** electrically joined together and mounted on brush arm **44** which brushes make rubbing electrical contact with the inner and outer rings, an electric motor (not shown) which through the means of suitable gears (not hsown) and a friction clutch (not shown) rotates the brush arm **44** at the velocity of one revolution in T_S milliseconds, a stop lever **45** capable of engaging end **44** of the brush arm so as to stop its rotation when the brushes are in the position shown, and a start-magnet **46** which when energized retracts the stop lever **45** and permits the brush arm to rotate.

When no teletypewriter signals are originated by the keyboard or other input devices, tongue **42–7** of relay **42** engages negative battery at its spring **42–4**. This negative potential is conducted from the inner ring **43** thru the brushes to the outer ring Rest segment, through start magnet **46** and back to the same negative battery. There being no potential difference, magnet **46** is not energized and stop lever **45** prevents brush arm **44** from rotating. Whenever a code character is received by relay **42**, the first element of the signal causes tongue **42–7** of relay **42** to engage positive potential at spring **42–3**. The resulting potential difference operates magnet **46** and releases brush arm **44** which starts to rotate at the velocity of one revolution in T_S milliseconds.

The speed of the keyboard transmitter and of the tape transmitter or other input device are adjusted so as to send one complete character in t milliseconds where t is approximately 2% greater than the time T in which the output relay **21** sends one complete character, or $t=1.02T$. The time T_S required for a revolution of the input distributor brush arm **44** is chosen such that T_S is approximately equal to $8t/9$ thus permitting the brush arm to strike the stop lever **45** and remain at rest for

at least $t/9$ milliseconds until the next electrical pulse is applied to start-magnet **46**.

The center of segment **301** of the outer ring of the input distributor is located at an angular position from the rest position of the brushes so that the center of the brushes will reach the center of segment **301** in the time $1.5t/7.42$, that is, in the center of the first selection element of the received character. The angular width of segments **301** through **305** of the input distributor is such that the duration of contact with the brush is approximately $t/25$ milliseconds. The values of resistances **47** and **48** are sufficiently low to insure that each of capacitors **26—35** will be fully charged in less than the $t/25$ milliseconds required for the brushes to sweep across segments **301—305**.

The centers of segments **301** thru **305** of the input distributor are spaced apart by an angle equivalent to $t/7.42$ milliseconds at the prescribed brush velocity. In consequence, the brush will sequentially connect ring **43** of the input distributor (and tongue **42–7** of relay **42**) to segments **301** thru **305** of the outer ring of the input distributor so as to sample the exact center of each selection element of each input character. The position of stop lever **45** with respect to the rings of the input distributor is adjustable to provide a "range" adjustment.

The shafts **44***s* that rotates brush arm **44** is provided with a cam **49** which engages spring **52** with spring **51** for a period of approximately $t/25$ milliseconds immediately following the release of brush arm **44** by stop lever **45**. For the remainder of the cycle, spring **52** engages spring **50** whereby capacitor **53** receives a charge through resistor **54** from positive battery. Whenever the brush arm **44** of the input distirbutor starts from its rest position, cam **49** causes capacitor **53** to discharge by way of springs **52** and **51** to spring **37** and thence through spring **38** and terminals **56–2** and **56–5** of relay **56** to negative battery, or by way of springs **37** and **39** through terminals **56–6** and **56–1** of relay **56** to negative battery.

As previously stated, springs **37** and **39** will be engaged if the output distributor brush arm **12** is in a position more clockwise than segment **103** and less clockwise than segment **203**. In this circumstance the starting of the input distributor will cause capacitor **53** to discharge (as previously described) a positive charge into terminal **56–6** of relay **56** and cause tongue **56–7** to engage its spring **56–4** thus applying a holding potential from positive battery thru resistor **57** to terminal **56–6** and thus also applying positive battery through resistor **58** to the magnet of relay **59** and thence to negative battery. The energizing of relay **59** connects segments **301** through **305** of the input distributor to capacitors **26** through **30**. This connection is initiated at the time that the brush arm **44** of the input distributor starts to rotate and the connection is completed before brush arm **44** reaches segment **301**. If this connection is initiated as the brush arm **12** of the output distributor is just leaving segment **103**, the positive and negative charges representing the selection elements of the character which is entering the input distributor will be stored in sequence on capacitors **26—30** and the resulting voltages will be applied to segments **101** thru **105** in sequence at a rate which never overtakes brush arm **12** because the velocity of brush arm **44** is approximately 2% less than the velocity of brush arm **12**. The character thus stored in capacitors **26—30** will be "read out" from segments **101—105** sequentially beginning with the instant when brush arm **12** completes approximately ¾ of a revolution (in 1.5T milliseconds) and makes contact sequentially with segments **101** thru **105** thus discharging capacitors **26—30** and causing the discharge current to operate polar relay **18** in accordance with the polarity of the selection elements stored in capacitors **26—30**; the convention being that a positive charge entering terminal **18–1** of relay **18** causes tongue **18–7** to engage spring **18–3**.

If brush arm **12** is just approaching segment **203** when the input distributor starts, the charges representing the input selection elements will be stored in capacitors **26—30** as before, but they will be "read out" from segments **101—105** sequentially beginning with the instant when brush arm **12** completes approximately ¼ of a revolution (in 0.5T milliseconds) and makes contact sequentially with segments **101—105**. The 2% speed differential between distributor brush arms is insufficient to allow brush arm **12** to overtake the energizing of segments **101—105**.

If brush arm **12** is in a position more clockwise than segment **203** but less clockwise than **103**, spring **37** will be engaged with spring **38** and the starting of the input distributor will cause capacitor **53** to discharge (as previously described) into terminal **56–2** of polar relay **56** and cause tongue **56–7** to engage spring **56–3** thus applying a holding current from positive battery thru resistor **55** to terminal **56–2**. The motion of tongue **56–7** from spring **56–4** to spring **56–3** also removes positive battery from relay **59** and causes the 5 tongues thereof to connect segments **301—305** of the input distributor to capacitors **31—35** respectively. This connection is initiated at the time that the brush arm **44** of the input distributor starts to rotate and the connection is completed before brush arm **44** reaches segment **301**. If this connection is initiated as the brush arm **12** of the output distributor is just leaving segment **203**, the positive and negative charges representing the selection elements of the character which is entering the input distributor will be stored in sequence on capacitors **31—35** and the resulting voltages will be applied to segments **201** thru **205** in sequence at a rate which never overtakes brush arm **12** because the velocity of brush arm **44** is approximately 2% less than the velocity of brush arm **12**. The character thus stored in capacitors **31—35** will be "read out" from segments **201—205** sequentially beginning with the instant when brush arm **12** completes approximately ¾ of a revolution (in 1.5T milliseconds) and makes contact sequentially with segments **201—205** thus discharging capacitors **31—35** and causing the discharge current to operate the tongue **18–7** of polar relay **18** as previously described.

If brush arm **12** is just approaching segment **103** when the input distributor starts, the charges representing the input selection elements will be stored in capacitors **31—35** as before, but they will be "read out" from segments **201—205** sequentially beginning with the instant when brush arm **12** completes approximately ¼ of a revolution (in 0.5T milliseconds) and makes contact sequentially with segments **201—205**. The 2% speed differential between distributor brush arms is insufficient to allow brush arm **12** to overtake the energizing of segments **201—205**.

If capacitor **53** discharges (by reason of the starting of brush arm **44**) at a time when spring **37** is transiting between springs **38** and **39**, that is, when brush arm **12** is in the region of segment **103** or of segment **203**, part of the discharge may enter terminal **56–6** of polar relay **56** and the other part may enter terminal **56–2**. In this circumstance it is immaterial whether the discharge of capacitor **53** causes tongue **56–7** to remain in its former position or to transit to the opposite position because when brush arm **12** is in the region of segment **103** or of segment **203**, an input character may be stored in capacitor banks **26—30** or **31—35** indiscriminately. In one case the stored character will be "read out" beginning at an instant approximately $0.5T$ milliseconds later; in the other case, the stored character will be "read out" beginning at an instant approximately 1.5T milliseconds later. In this invention the combined action, as described, of cam **49** and its contact springs, of cam **36** and its contact springs and of polar relay **56**, is such the five tongues of relay **59** will always be connected to a discharged bank of storage capacitors prior to the application to that bank of capacitors of the first charge representing the first selection ele-

ment of an input character, without regard to the instant of time when that first selection element is received.

As an example of the operation of this invention, assume that the input distributor is receiving code characters at the rate of $60,000/t$ characters per minute and that the start magnet **15** of the output distributor is pulsed at the rate of $60,000/T$ pulses per minute ($t=1.02T$). In consequence, the output distributor will gain in phase over the input distributor by one character after every $T/(t-T)=N$ characters at which time the cooperative action of cams **49** and **36** will cause two successive input characters to be stored in the same capacitor bank **26—30** (or in **31—35**) instead of in the capacitor banks alternately. As a result, one of the capacitor banks is uncharged during one passage of brush arm **12** over the outer ring short segments associated with that capacitor bank and there is inserted in the output circuit a code "blank" (space, 5 spaces, mark) between the aforesaid two input characters. In the foregoing, N may compute to be a whole number N_w plus a fraction of a character N_f. The number of output characters in the first sequence preceding a blank, will be N_w characters and the fraction of a character N_f will remain in storage. Each succeeding sequence of output characters will comprise N_w characters until the summation of the fractional portions in storage add to one character (possibly plus a fraction) at which time the sequence of output characters will contain N_w+1 characters.

When the input devices are quiet and no code characters are being delivered to the input distributor, the output distributor causes relay **21** to key the output line with a continuous sequence of blanks derived from the fact that when the brushes of the output distributor engage each permanently negative stop segment, the tongue **21–7** of output relay **21** closes and maintains closure of the output line until said brushes engage the next following permanently positive start segment whereupon relay **21** opens the output line and maintains this open condition (there being no charge on capacitor banks **26—30** and **31—35**) until the brushes engage the next following permanently negative stop segment. Under the indicated conditions, brush arm **44** and cam **49** remain at rest; capacitor **53** is not discharged into relay **56** and, in consequence, relays **56** and **59** remain in the positions they had previously assumed.

The arrangement of the drawing and the foregoing description have been solely for illustrative purposes. There are many possible variations of the individual circuits and components that may be utilized to practice my invention. In particular, it is noted that all of the functions performed by the distributors, storage capacitors (storage cells), cams (timers) and switches, are achievable through the use of electron-tube circuits, transistor circuits, bi-stable magnetic circuits, and other electronic devices all of which are well known to those skilled in the art. For the true scope of the invention, therefore, reference should be had to the appended claims.

I claim:

1. In an apparatus of the nature described, an input distributor including an array of contacts, brush means and means for driving the same over said contacts, and an output line for each contact, an output distributor including a first group and a second group of contacts each homologous to the array of said input distributor, second brush means and means for driving the same to traverse in succession the contacts of said first group and then in succession the contacts of said second group, means for connecting the contacts of said input distributor to the contacts of said output distributor group by group including timing means operative to select said first group for such connection if its contacts have been at least substantially half traversed by said second brush means and if said second group has not been substantially more than half traversed.

2. The invention of claim 1 further characterized in that said means for driving said second brush means drives the same to traverse each of said first and second groups of contacts slightly faster than said first mentioned brush means is driven over its array of contacts.

3. The invention of claim 1 further characterized in that said timing means includes a rotatable cam, a switch operated thereby, and means associated with said second brush driving means for driving said cam to operate said switch.

4. In an apparatus of the nature described, an input distributor including an array of contacts, bursh means for sweeping the same, an output distributor comprising two arrays of contacts each homologous to the array of said input distributor, means for selecting one of said two last mentioned arrays for connection with said first mentioned array including a group of capacitors for each of said last mentioned arrays, a multiple contact switch wherein the contacts have normal positions for completing circuits to one of said groups of said capacitors and other positions for completing circuits to the other of said groups of capacitors, electrically energizable means for changing the positions of said contacts, means for energizing said last mentioned means including a source of current, a two-position switch having a normal position and a second position, and means actuated by said input distributor for causing said last mentioned switch to assume its said other position upon initiation of movement of said first mentioned brush means.

5. In an apparatus of the nature described, the combination of means for providing sequences of impulses the sequences being n impulses in length the intervals between the sequences being of unpredictable lengths, an output device including a first group and a second group each of n memory elements for storing impulses and means for scanning said elements successively at a substantially constant rate and at substantially constant intervals thereby to derive any impulse stored therein, means for connecting said first mentioned means to said first group of said memory elements for storing impulses therein after that group has been at least substantially half-scanned and before said second group of said memory elements has been more than substantially half-scanned, and means for connecting said first mentioned means to said second group of said memory elements after said second group of memory elements has been at least substantially half-scanned and before said first group of memory elements has been more than substantially half-scanned.

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