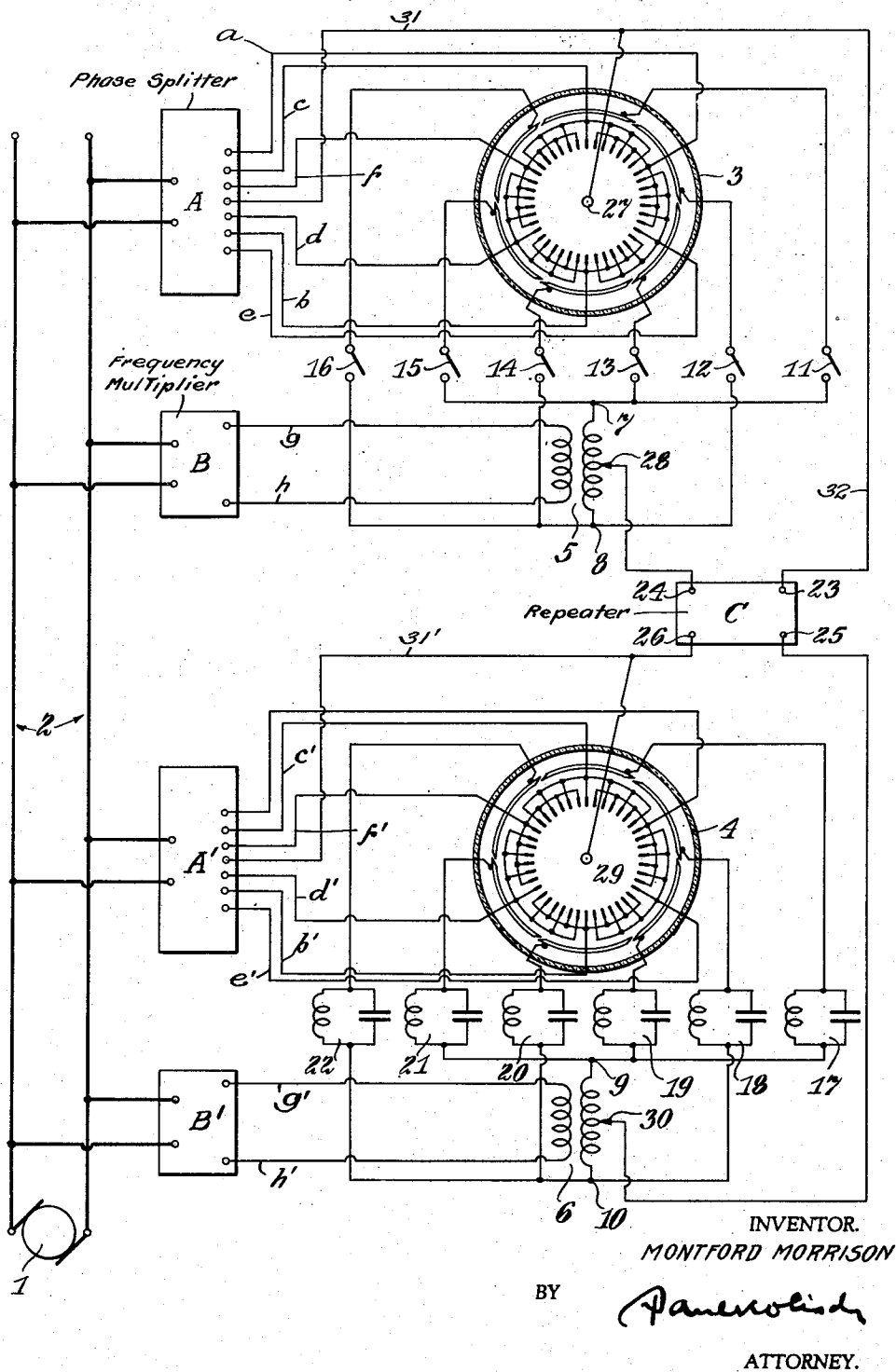


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ELECTRONIC DISTRIBUTOR SYSTEM

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ELECTRONIC DISTRIBUTOR SYSTEM

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This invention relates to new and useful improvements in electronic distributor systems and particularly to circuits for directing the electron discharge to restricted areas of a predetermined one of a multiplicity of electrodes provided in electron discharge tubes.

Among the objects of this invention are; to provide a wave-form of voltage supply for certain of the electrodes of electron discharge tubes which produces a directive effect upon plate current of the tubes, to provide circuit means in the plate circuit itself for directing the plate current; and in electron distributor type of discharge devices to provide plate circuit means for preventing overlapping of electron current between the segments thereof.

These as well as other objects of the invention are preferably accomplished by applying pulsating direct or alternating current to certain groups of electrodes of electron discharge devices. Preferably, plate current selection is accomplished by applying constant amplitude alternating voltage to the grids of the device.

The invention is not limited to any particular type of device or to a single electron discharge device and is applicable to many suitable types of common vacuum tubes.

The invention will now be more fully described in connection with the accompanying drawing, which is a circuit diagram of an embodiment of the invention and employing an electron distributor one form of which is described in my Patent No. 1,977,398, granted October 16, 1934.

The electron distributor described in said patent is particularly useful in circuits where the width of the revolving electron beam is not of importance. However, in certain cases such overlapping is objectionable and is eliminated by the use of the present invention.

Referring to the drawing, 1 is a source of alternating current and 2 is a supply line. A and A' are identical devices for converting single phase alternating current into three phase alternating current by any suitable means. The apparatus described in my Patent No. 1,973,010, granted September 11, 1934, may be employed for that purpose.

The three phase outputs of the two single phase converters A and A' are connected to the control grids of two six-element electron distributors 3 and 4 of the type described in my Patent No. 1,977,398.

a and b are the leads of phase 1 of the output of converter A, c and d are the leads of phase 2 thereof, and e and f are the leads of phase 3

thereof. As shown in my Patents Nos. 1,973,010 and 1,977,398, supra, there are two leads per phase diametrically connected (as termed in polyphase art) with the centers of the phases tied together forming the neutral lead 3i for the return circuit to the filament of tube 3. The phases of converter A' corresponding to those of converter A, bear the corresponding letters with a "prime" attached thereto and the corresponding neutral lead 3i'.

B and B' are identical devices for converting the supply current of one frequency derived from the source 1, into an alternating current of triple frequency. The output of B may have a wide range of wave forms and most desirable of which is often a flat top wave, though a sinusoidal wave form is usually the most practical.

The constituent parts of B may comprise any elements which will produce the result. Some of the successful forms that have been employed for this purpose include a device known as a static frequency tripler, extensively described in the literature on early communication circuit; also an electron tube oscillator providing flat-top wave-forms and locked in synchronism with the power source 1 as well as a motor generator set. The choice between these three devices or any other means will depend upon the specific application.

The outputs of the two frequency converters B and B' are connected to the primary windings of transformers 5 and 6. Each alternate segment of distributor 3 is connected to secondary terminal 7 of transformer 5 and each other alternate segment of distributor 3 is connected to secondary terminal 8 of transformer 5. Similarly, electron distributor 4 has its segments alternately connected to terminals 9 and 10 of transformer 6.

The segment leads from distributor 3 have switches 11, 12, 13, 14, 15 and 16 inserted for opening any or all of the circuits including these segment leads individually or collectively. Similarly, distributor 4 has translating devices 17, 18, 19, 20, 21 and 22 in the segment leads for receiving the channelled energy supply by means of the distributor. Leads 23 and 24 may be connected, respectively, to leads 25 and 26 without an intervening device C, but it is believed that a consideration of the existence of C in the circuit, leads to a simpler conception of the circuit operation. C may be assumed to consist of a simple repeater circuit having a three-element vacuum tube with its grid and cathode connected between terminals 23 and 24 and the grid-cathode circuit shunted by a resistor with the

grid biased to give zero plate current at zero signal current. The plate and cathode of the said three-element vacuum tube will be connected between terminals 25 and 26.

The elements of C form a constant impedance circuit between terminals 23 and 24 and practically a make-and-break effect is produced between the terminals 25 and 26, the "make" being responsive to line current between the terminals 23 and 24. It will, however, be understood by those skilled in the art that for the plate voltage used, merely a change from an extremely high to extremely low resistance takes place between terminals 25 and 26. Terminal 23 is connected to the cathode 27 of distributor 3 and terminal 24 to the center 28 of the secondary winding between terminals 7 and 8 of transformer 5. Similarly, terminal 26 is connected to cathode 29 of distributor 4 and terminal 25 is connected to the center 30 of the secondary winding between terminals 9 and 10 of transformer 6.

In my Patent No. 1,977,398 I have described a four-segment electron distributor employing two-phase voltage on the grids and direct current on the segments thereof, and in my Patents 1,925,104-5-6 and 7, all of September 5, 1933, I have discussed the theory and practice of constructing electron distributors and have particularly pointed out that in making electron distributors any number of balanced polyphase voltages may be used upon grids of proper design. Likewise, any reasonable number of plates may be used and there is no necessary relation between the number of control grids or the number of phases employed in controlling the grids and the number of segments employed in a single electron distributor. In practice, electron distributors with six grids controlled by three-phase voltage operating four segments have been successfully operated.

When the alternating current source 1 is put into operation there is impressed upon intermeshed grids of electron distributors 3 and 4 a three-phase voltage. In the absence of other influence, this will produce between the cathodes and the grid structure of the distributors an electric field which is essentially constant in amplitude and revolves synchronously, about the axis of the cathodes one revolution per cycle of the voltage source of 1.

Direct current plate supply, if applied to the plates collectively of such an electron distributor as shown in the accompanying drawing will cause the super-position of a radial field between the cathodes of the distributors and the cylindrical surface of the segments taken collectively. Such a distributor and circuit is shown in Fig. 3, my Patent 1,977,398. Relatively intense plate fields will have a tendency to spread the width of the electron beam, so that as the revolving beam falls upon the segments, with continuous direct current excitation, the beam width causes the current to start in one segment circuit, before it actually entirely leaves another. The reason for this spreading of the electron beam may be looked upon as due to the fact that such a tube as described would have a beam width of 360° with direct current on all the plates and, say, zero potential on all the grids. It is the differences in potentials applied to the grids that narrows down the width of the beam, hence a more intense radial plate field has the effect of spreading the width of the electron beam. This effect is of no importance in some cases and quite often may be biased out electrically, magnetically or

mechanically, but in many cases it is desirable to eliminate this effect.

Let us assume, for instance, that the electron distributor 3 operates under the effect of the three-phase voltage applied to its grids, that its cathode is emitting electrons, and that all of the segments are supplied with a proper value of continuous voltage if all the switches 11-16 are closed. Let us further assume that all of the switches, 11 to 16 inclusive are closed with the exception of say 12. Under these conditions the plate leads containing switches 11 and 13 have positive potential upon them as well as, of course, will leads 14, 15 and 16.

The electron distributor being a six-segment type, the line current under the conditions specified represented by the current in lead 32 should remain zero for exactly $\frac{1}{6}$ of the time required for the electron beam to make one complete revolution about the axis of the cathode 27. However, due to the width of the electron beam as it passes from, say the segment connected to switch 11 toward the segment connected to opened switch 12, some of the electron beam will still be falling upon the segment connected to switch 11 when, according to the time position of the electron beam, there should be no current in the lead including switch 11. A similar effect though reversed in order occurs as the electron beam passes in time position to that corresponding to the plate connected to switch 13.

This overlapping effect in electron distributors manifests itself also under various other conditions than those herein described. Clearly, this overlapping effect in an integral electron distributor is predominantly due to the existence of segment voltage during an interval of time when the particular segment is desired to be inactive. On account of the unilateral conductivity of the distributor and the narrowness of the electron beam, this overlapping segment edge effect never affects more than two segments at a time. This overlapping effect in distributors will be referred to hereinafter as a time-overlap because time division circuits are disclosed and claimed.

It will be clear then, that if a particular segment, occupying for a period of time an active position, is maintained positive and the two adjacent segments are maintained at a low positive potential or at a negative potential for the same period of time, the adjacent segments can receive no current during said period. Of course, if the segment occupying an active position is open-circuited, no current will flow to said segment during its active position.

The segments of the electron distributor generally opposite the active segment are inherently inactive because of the negative field of the control grids in that direction. Therefore, the potential of the segments opposite the active segment is not important during the period of activity of said active segment.

The character of segment potential necessary to produce this effect is determined by the fact that as the central sheet of the positive polarity of the revolving electric field turns continuously at a uniform rate about the axis of the cathode of the electron distributor, the positive segment potential must follow the revolving field in such a way that in the direction of rotation only one segment will be positive and only for an interval of time corresponding to the predetermined active period of that segment, and at the same time the two adjacent segments will be main-

tained at a potential sufficiently lower than that of the active segment, so that no undesired effects will be produced. In some cases the adjacent segments will be maintained at a negative potential as is the case in the herein described embodiment.

In electron distributor tubes having six segments the above described requirements are met by introducing a third harmonic of the grid control circuit in the segment circuits or their equivalent plate circuits. In a four-segment device, a second harmonic would be introduced; in an eight-segment device a 4th harmonic, etc. The action is somewhat like the effect produced by an interpole or commutating-pole in electromagnetic revolving machinery, in that the action is such as to produce zero field intensity in certain parts of the field where the field polarity undergoes changes in direction. In the specific embodiment herein described, employing six segments and a third harmonic of the grid potential in the segment circuits, the segments adjacent the active segment are maintained negative for the duration of one lobe of the third harmonic which is $\frac{1}{6}$ of the period of the grid potential, or exactly during $\frac{1}{6}$ of the time required for the electron beam to make one complete revolution about the axis of the cathode.

The translating devices 17-22 produce within the closed circuit a local overlapping with respect to time even though the impulse currents in the segment circuits do not overlap; in other words, local currents in individually closed circuits may be 100% overlapping and at the same time the channel feed current from the individual segments may not overlap at all. "Overlapping" in the present case means primarily overlapping of the segment current and not secondary effects produced thereby.

The operation of the system may be followed by considering the diagram as representing a time division, six-channel signaling system, the equipment above the element C being a six-channel transmitter and the equipment below the element C presenting a six-channel receiver.

Switches 11 to 16 may be ordinary Morse keys, and translating devices 17 to 22 ordinary Morse sounders shunted by a capacitor, the inductor of each translating device being the operating coil of a Morse sounder. If the frequency of alternating current source 1 is 60 cycles, the two sets of control grids of the two distributors 3 and 4 will be supplied with three phase voltage. A revolving electric field will be produced whose positive direction rotates synchronously in the two distributors and makes a complete revolution in $\frac{1}{60}$ of a second.

In cases where it is possible and desirable, circuit 2 may be a 60-cycle power line the segments of the two distributors are then supplied with 180 cycle alternating current (by means of frequency triplers A and A') poled up and orientated such that the positive segment polarity follows the direction of the positive grid voltage and for each passage of the electron beam across any segment of distributor 3, having its corresponding switch closed a corresponding impulse will be produced in the channel provided by the corresponding segment of distributor 4.

The value of the capacitance across the sounders constituting the translator circuits 17 to 22 must be properly fixed and the sounders and the keys 1-16 must be properly adjusted, at ordinary Morse sending speed of 25 words per minute, this circuit arrangement operates as a good six-

channel Morse circuit of high channel transmission fidelity where the telegraph lines present no frequency limitation.

If instead of the coupling C, radio transmission and reception be employed, the illustrated arrangement then becomes a six-channel communication circuit practically without channel frequency limitation, which obviously includes voice transmission in the individual channels. This time division channelization is self-orienting whether the grid control frequencies are electrically tied together or by radio transmission.

The term "self-orientating" is used herein with the conventional telegraph sense intended. Orientation, between a telegraph transmitting station and a receiving station employing a synchronous channelized operation over a single line, means the common trial and error method manual adjustment of the apparatus at one station or the other to cause the channels of the transmitting station to be received in the predetermined and intended receiving station channels. Reference may be had to the book "Printing Telegraph Systems and Mechanisms" by H. H. Harrison, 1923. This orientation process in synchronous telegraph systems corresponds to the "phasing" of polyphase power apparatus, and the "polarizing" of synchronous rectifiers of the X-ray art.

In the prior art systems of synchronous communication, radio, land line and cable, the relatively fixed synchronous positions of the transmitter and receiver are acquired and maintained by the signals themselves and only by trial and error can the channels of the transmitting station be directed into the corresponding proper channels of the receiving station (except by an occasional coincidence). This is well understood in the art to be due to the inability to distinguish one channel code signal from another.

In the present invention the channel orientation is not dependent upon the code signals themselves, but upon an independent signal (60-cycle power line voltage in the illustrated embodiment), which has a period equal in length to a complete sequence of channel signals. This independently controls the channel position and, like all polyphase apparatus, if once properly phased it always remains so.

The term "channel definition" as used herein means the quantity of channel signal current in one channel belonging to that channel compared to the quantity of signal current in that channel belonging to other channels.

The invention is not limited to the employment of a single electron distributor in the circuit arrangement but may include any number of tubes of any design, including any circuit arrangement which will produce an equivalent effect. Obviously, the present invention may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In an electron discharge tube system, an even number of anodes greater than two and an even number of control grids greater than two, means providing electron tube conductivity for said grids and anodes, a circuit for each grid, means providing polyphase alternating voltage excitation for the said grids, a circuit for each anode, and means in the anode circuit for rendering only one of said anode circuits practically operable at a time under grid excitation.

2. In an electron discharge tube system, an

even number of anodes greater than two and an even number of control grids greater than two, means providing electron tube conductivity for said grids and said anodes, a circuit for each grid, means providing polyphase alternating voltage excitation for the said grids, a circuit for each anode, means for applying to only half of the total number of anodes positive potential at a time and means for periodically alternating the group of anodes to which positive potential is applied, the alternation being at a frequency higher than that of the grid excitation alternating current.

3. In an electron discharge tube system, an even number of anodes greater than two and an even number of control grids greater than two, means providing electron tube conductivity for said grids and said anodes, a circuit for each grid, means providing polyphase alternating voltage excitation for the said grids, a circuit for each anode, and means for maintaining only half of the total number of anodes at positive potential for a time less than half the period of the alternating voltage applied to the said grids.

4. The combination defined in claim 3, an electron discharge tube, and means for periodically alternating with one another the two groups of anodes to which positive potential is applied.

5. In an electron discharge tube system, an even number of anodes greater than two and an even number of control grids greater than two, means providing electron tube conductivity for said grids and said anodes, a circuit for each grid, means providing polyphase alternating voltage excitation for the said grids, a circuit for each anode, means for applying to only half of the total number of anodes positive potential at a time, and means for periodically alternating with one another the two groups of anodes to which positive potential is applied, the alternation being at an anode impulse cathode direct current frequency determined numerically by the arithmetic product of said grid frequency and the total number of anodes.

6. In an electron discharge tube system, an even number of anodes greater than two and an even number of control grids greater than two, means providing electron tube conductivity for said grids and said anodes, a circuit for each grid, means providing polyphase alternating voltage excitation for the said grids, a circuit for each anode, means for applying to only half of the total number of anodes positive potential at a time, and means for periodically alternating the group of anodes to which positive potential is applied, the alternation being at an anode impulse frequency numerically equal to a higher harmonic of the grid frequency.

7. In combination, an electron discharge tube having an even number of anodes greater than two and an even number of control grids greater than two, a circuit for each grid, a circuit for each anode, means for providing electron conductivity for said grids and said anodes, means providing polyphase alternating current excitation for said grid circuits, and means for providing single phase alternating current for said anode circuits.

8. In combination, an electron discharge tube having an even number of anodes greater than two and an even number of control grids greater than two, a circuit for each grid, a circuit for each anode, means for providing electron conductivity for said grids and said anodes, means for providing polyphase alternating current excitation of a given frequency for said grid circuits, and means

for providing single phase alternating current of a higher frequency for said anode circuits.

9. The combination defined in claim 8 and in which the single phase alternating current is of a frequency equal to a higher harmonic of the grid frequency.

10. The combination defined in claim 8 and in which the single phase alternating current for said anode circuits has a frequency determined numerically by the arithmetic product of said grid frequency and half the total number of the anodes.

11. In an electron discharge tube system of electric circuits channeled by time division and having a plurality of cathode-grid circuits and a plurality of cathode-plate circuits, said cathode-plate circuits comprising the channels of said system, means providing time-phased potential impulse excitation to said grid circuits causing the electron stream to be directed to a group of said plates, and electrical means in the plate circuits for causing one and only one plate of the said group to receive a discharge at a time.

12. An electron discharge tube system of electric circuits channeled by time division and having a plurality of cathode-grid circuits and a plurality of cathode-plate circuits, said cathode-plate circuits comprising the channels of said system, means providing time-phased potential impulse excitation to said grid circuits causing periodic time division of the cathode current in said plate circuits, and electrical means in said plate circuits preventing the flow of current in two plate circuits simultaneously.

13. In combination, an electron tube discharge apparatus, means for establishing through said apparatus channeled plate circuits by time division of the cathode current, and electrical means in said plate circuits preventing time-overlap in the flow of current therein.

14. In a combination, an electron discharge tube apparatus comprising channeled plate circuits by time-division of the cathode current, means providing pulsating grid potentials, means providing pulsating plate potentials, and means for synchronizing and relatively evaluating said grid and plate potentials to prevent the flow of current in two plate circuits simultaneously.

15. In a system of channeled electric circuits, an electron discharge device having a plurality of plates and circuits therefor, each circuit comprising a channel of the said system, said plates being disposed in a circuitous formation with respect to a cathode in the said device, a plurality of control grids electrically excited by polyphase alternating current directing the electron stream between the cathode and said plates to the plates in sequence periodically, said stream transversing the plates, and means for applying positive potential only to each alternate plate at a time.

16. In the system defined in claim 15, means for charging the application of positive potential from each alternate plate aforesaid to the remaining plates of the two groups of plates.

17. In the system defined in claim 15, means for providing alternating plate potential for the channeled circuits causing increase in the channel definition.

18. In a system of channeled electrical communication by time division of a circuit, a transmitting station and a receiving station, means for communicating between said stations by signaling currents each having the same period, a plurality of terminals at each station for signal transmitting and receiving instruments, a dis-

tributor of each station periodically traversing said terminals always in the same direction, means common to the two distributors for producing current impulses of a predetermined timing and each impulse having a period different from the period of the signaling current and the same as the sum of the periods of the signaling currents.

19. In a system of channeled electrical communication by time division of a circuit, a transmitting station and a receiving station, means for communicating between said stations by signaling currents each having the same period, a

plurality of terminals at each station for signal transmitting and receiving instruments, a distributor at each station periodically traversing said terminals always in the same direction, means common to the two distributors for producing current impulses of a predetermined timing and each impulse having a period different from the period of the signaling current and the same as the sum of the periods of the signaling currents, said impulse having a polarity causing correct orientation in the receiving station terminals.

MONTFORD MORRISON.