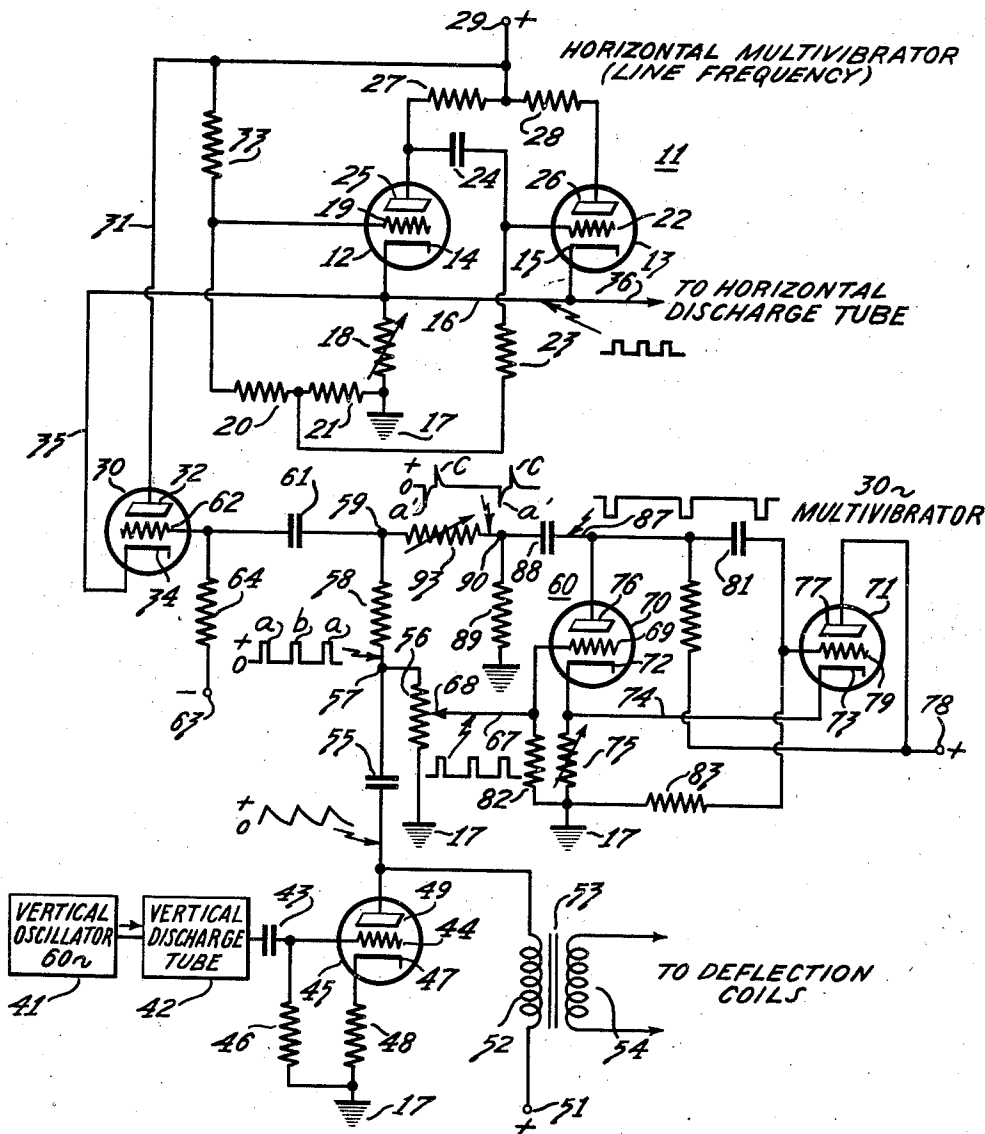


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INTERLACING SYSTEM

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INTERLACING SYSTEM

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This invention is directed to television apparatus, with particular emphasis being placed on a simplified form of arrangement whereby the interlaced patterns are obtained.

The many advantages of interlaced scanning are well known in the art, and the broad features thereof have already been set forth, for instance, in such prior art citations as the Ballard U. S. Patent No. 2,152,234, granted March 28, 1939, and in the Bedford U. S. Patent No. 2,178,218, granted October 31, 1939. In scanning systems of this type, the successive line traces of one scanned raster or image field fall halfway between the scanning lines of each of the preceding and succeeding rasters or image fields. The result is that the traced image or raster appears to have twice the number of lines that it actually has and the quality of the image resulting is considerably improved.

Various ways and means to achieve interlacing have already been proposed in the art and, broadly speaking, the results of interlacing are achieved by displacing the line scanings of successive fields by one-half line length for alternate image fields.

This effect is obtained by having a proper relationship in frequency between the horizontal and vertical or, in other words, between the line and the field scanings. With present standards, the image fields are repeated at the rate of 60 per second, with two fields forming one complete image frame, which frames occur at the rate of 30 per second. The horizontal or line scanings now occur at a rate of 15,750 line traces per second. It thus becomes apparent that within the time allotted to scan one raster or image field (now $\frac{1}{60}$ second), provisions are actually made for scanning only $262\frac{1}{2}$ lines; but with the $262\frac{1}{2}$ lines traced in the next succeeding raster or image field, a 525 line image raster is produced at the frame frequency, with the line traces of each field being placed intermediate those of the succeeding and preceding fields.

With apparatus of the prior art, the complexities of such pattern traces usually require that a complex sync signal generator be associated with the video or image signal producing equipment. One example of a form of sync generator for such a purpose has been exemplified by patents already granted to J. P. Smith, such as U. S. Patent Nos. 2,132,654 and 2,132,655, to name but two such patents by way of example. Further representations of this general form of apparatus may be found also by reference to the Seeley U. S. Patent No. 2,256,530, the Bedford U. S. Patent No. 2,258,943, and the Schlesinger U. S. Patent No. 2,350,536, granted June 6, 1944.

In the present invention, efforts have been made, however, to simplify very considerably the

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form of system used to provide the form of line frequency triggering pulse to assure uniform and satisfactory line trace interlacings. At the same time, provision is made by the invention whereby the instrumentalities used to develop the line sync pulses are keyed on to the control of the assumed 60-cycle field frequency pulses in such a way that any two successive image fields or rasters are scanned with one-half line time delay so that exact displacements between the lines of successive image fields are obtained, and an odd number of fields, for instance, trace the odd-numbered lines of the complete image frame, and even-numbered fields trace the even-numbered lines of the complete image frame.

Broadly speaking, these results are achieved through the utilization of an appropriate form of line frequency pulse generator which is keyed on and off completely under the control of the unit which brings about the field deflection, so that the line frequency sync pulse generator has its operation completely arrested for a very limited time period under the control of the field frequency pulse in order that it may be restarted to bring about the desired form of deflection control pulse. This procedure thus brings about a so-called synthetic, even though effective, interlacing method.

It, accordingly, becomes an object of this invention to provide a simplified form of system to bring about adequate and proper interlacing of successive scanned image rasters.

It is also an object of this invention to provide a form of scanning unit in greatly simplified form which overcomes one or more defects found to exist in presently used apparatus and, at the same time, to provide highly efficient units of economical construction.

Other objects and advantages will suggest themselves promptly to those skilled in the art to which the invention is directed when the invention is considered in the light of the accompanying drawings, of which the single figure, together with the diagrammatic representations of wave forms shown adjacent to significant portions thereof exemplify in one form a suitable and efficient arrangement to bring about the results above set forth.

Referring now to the drawing for a further understanding of this invention, line frequency output signals for triggering a suitable horizontal discharge tube (not shown) which is associated with cathode ray beam deflection control apparatus, for instance, are developed by a line frequency or horizontal multivibrator unit generally represented at 11.

This multivibrator unit 11 comprises essentially a pair of thermionic tubes 12 and 13 which are cathode coupled with the cathode elements 14 and 15 thereof being connected by a conductor

16 which connects to ground 17 by way of a variable cathode load resistor 18. The grid or control electrode 19 of the first tube 12 connects to ground 17 by way of the resistors 20 and 21. The grid or control electrode 22 of the second tube 13 connects through resistor 23 to the junction point of the resistor elements 20 and 21.

Likewise, through the well known coupling condenser 24, the output signals from the plate or anode 25 of the first tube 12 are supplied to the grid or control electrode 22 of the second tube 13. Each of these tubes 12 and 13 has the plate or anode element 25 and 26 thereof, respectively, supplied with a suitable positive voltage by way of resistors 27 and 28, respectively, which connect to a terminal point 29 whereat the positive terminal of a suitable source of voltage (not shown) is connected. This voltage source preferably has its negative terminal suitably grounded.

The same voltage source provides the plate voltage for a keying tube 30, later to be explained, by way of its connection through conductor 31 to the plate or anode 32 of such keying tube and the resistor element 33 forms a part of the plate load of the keying tube. The cathode element 34 of the keying tube 30 connects by way of the conductor 35 to each of the cathodes 14 and 15 of the multivibrator tubes 12 and 13 so that the tube 30 may serve, in a manner later to be explained, either to initiate or to interrupt operation of the multivibrator unit.

The output pulses from the multivibrator unit above explained are pulses which occur in accordance with circuit constants or parameters selected for the circuit of the multivibrator unit. These pulses are of short duration as compared to their interruption period and occur for presently proposed forms of standard apparatus at a repetition frequency of 15,750 pulses per second. The output pulses thus obtained are shown diagrammatically adjacent conductor 16 between the cathode elements 14 and 15 of the tubes 12 and 13. These same pulses are fed to the output conductor 36, for instance.

Simultaneously with the development of the pulses for controlling the horizontal discharge tube, other pulses known as the vertical or field frequency control pulses are developed from a completely separate oscillator unit, schematically represented at 41. The vertical pulses occur at a frequency of 60 per second, for instance. The vertical oscillator may be of any desired type and, for instance, might be a multivibrator of the general type above described for developing the line frequency pulses except that the circuit constants would be of considerably different values to provide the difference in frequency of the output from each of the multivibrator units.

Also, while a multivibrator unit has been shown above as developing the line frequency pulses, it will, nevertheless, be apparent that it is within the scope of this invention to utilize other forms of pulse generators, such as the well known blocking oscillator, for instance, to accomplish the end objectives obtained by the multivibrator.

The vertical pulses developed in the unit 41 are then fed through a vertical discharge tube of well known character, which is schematically represented at 42. The output from this vertical discharge tube is then supplied through a condenser 43 to the grid or control electrode 44 of a vertical output tube 45. This tube has its grid or control electrode 44 connected through the leak resistor 46 to ground 17. Its cathode 47 is

provided with bias through the cathode resistor 48 connecting to ground.

Output signals which appear at the plate or anode 49 of the output tube 45 may be generally of sawtooth wave formation as represented diagrammatically by the curve adjacent the output terminal. Suitable plate voltage for the output tube 45 is provided at a terminal point 51 to which a source of voltage (not shown) is connected in a manner similar to the connection specified at terminal point 29. This voltage feeds through the primary winding 52 of the output transformer 53. Any output signals corresponding to those indicated are then suitably fed into the transformer secondary 54 to be supplied to suitable deflection coils, for instance (not shown).

Also connected to the plate or anode 49 of the output tube 45 is a differentiating circuit comprising the serially connected capacitor 55 and the shunt connected resistor 56, having one terminal thereof connected to the side of the capacitor remote from the tube anode 49 and the other terminal thereof grounded at 17. Output signals of the indicated wave form are, therefore, differentiated by means of the differentiating network so that at the point 57, wave forms of generally short pulse character appear, as is indicated by the curve shown adjacent this point.

These pulses are supplied through the resistor 58 to the junction point 59 whereat they are mixed and combined with the differentiated output pulses from a 30 cycle multivibrator unit, generally designated as 60 and later to be described. The combined pulses will then be fed by way of the coupling condenser 61 to the grid or control electrode 62 of the keying tube 30, heretofore described, which is suitably biased by a source of negative potential connected at terminal 63 at the lower end of the grid resistor 64. This operation will later herein be described.

The pulse signal available at the point 57 is supplied in reduced amplitude through the conductor 67 which is adjustably connected to the resistor 56 in accordance with the position of its slider point 68 thereon. The signals thus supplied through conductor 67 then serve to trigger and suitably control the multivibrator unit 60 through application directly upon the grid or control electrode 69 of the first tube 70 of this multivibrator unit.

The multivibrator unit 60 is of essentially the same character device as the line frequency multivibrator 11 except for its circuit constants. It comprises a first tube 70 and a second tube 71. The cathode elements 72 and 73 are connected together through the conductor 74 and to ground 17 through the variable cathode resistor 75. The plate electrodes 76 and 77 receive plate voltage from a source (not shown) connected with the terminal point 77 in a manner similar to the above explained connection at terminal point 29. The output from the first tube 70 is fed from the plate 76 thereof to the input grid or control electrode 79 by way of the coupling condenser 81 in the manner already explained above. The grids or control electrodes of each of tubes 70 and 71 connect to ground, for instance, through resistors 82 and 83, respectively.

Output pulses from the multivibrator unit 60 will be developed under the influence and control of the keying pulses made available at point 68 by reason of the differentiating network 55, 56 so that pulse output signals repeating at 30 pulses per second may be made available from the unit

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60 where the circuit parameters are appropriately chosen so that the unit triggers once for every second pulse available at the point 57 or 68.

Pulse output at the 30 cycle frequency may be obtained in this manner in the conductor 87 and it will be of the general wave form indicated immediately thereabove. As these pulses are then supplied through a serially connected differentiating network comprising the capacitor 88 and the resistor 89 connecting to ground, as indicated, they will be differentiated and assume a wave form somewhat like that shown above the junction point 90. The wave form thus is an interrupted series of pulses which will be found to extend in both the negative and positive directions by reason of the differentiation of the wave appearing in conductor 89. The differentiated pulse may then be supplied by way of the mixing or combining resistor 93 to combine at the junction point 59 with the pulse output appearing at the point 57.

The complete signal series of the schematically indicated wave form is such that the portion *a'* of the differentiated output signal from the multivibrator unit 60 coincides substantially in its initiation with the commencement of the pulse portion *a* of the signal output available at the point 57. However, since the multivibrator unit 60 provides output pulses at 30 cycles, which is half the frequency at which the pulses available at point 57 occur, there will be no output signal from the multivibrator unit 60 available at the point 59 when the signal pulse *b* arrives at this point. The next pulse *a'* will, however, commence coincidentally with the next following pulse *a* which appears at point 57.

By adjusting the resistor 93, the amplitude of the pulses *a'* which are made available at the combining point 59 can be controlled. Accordingly, with an additive combination of the differentiated pulse series from the multivibrator unit 60 and the differentiated output pulses from the output tube 44, it will be appreciated that the negative portion *a'* of the output from the multivibrator unit 60 will tend to subtract from the pulse *a* so as to remove effectively the leading portion thereof. In this way, the effective time of commencement of the pulse *a* in the circuit beyond point 59 can be changed relative to the time of commencement of the pulse *b* so that by properly adjusting the resistor value 93, the leading edge of the pulses *a*, for instance, can be shifted in time relationship with respect to the pulses *b* by a time period which would coincide with the time allotted to exactly a one-half line scanning period, or to one-half the time represented by the separation of the output pulses of horizontal frequency available in the conductor 36.

If now the combined pulse series which is available at junction point 59 is supplied to the grid or control electrode 62 of the keying tube 30, it will be appreciated that this tube immediately commences to draw plate current during each positive pulse portion. With the cathode output from the keying tube being derived across the cathode resistor 18 and with the cathode 34 of the keying tube 30 following the potential of the grid 62 any application of pulses of positive polarity on the grid 62 causes the cathode 34 immediately to assume a positive potential.

The connection of this cathode element 34 through conductor 35 to the cathodes 14 and 15 of the multivibrator tubes 12 and 13, completely arrests the operation of the multivibrator unit

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11 each time a positive pulse appears on the control grid 62 of the keying tube. Since successive pulses of positive polarity on the grid 62 of the keying tube 30 are shifted in time relationship with respect to each other, at a time period coinciding with one-half the period between successive line frequency pulses, it becomes apparent that for each successive vertical field, the line pulses are developed at different times. This, then provides an alternate start and interruption of the line frequency multivibrator in accordance with the control directly exercised thereon by the vertical oscillator 41 and causes the line of successive fields to be scanned one half line period apart so as synthetically to give the effect of interlacing the lines of successive fields and to cause each traced raster to have its lines uniformly displaced with respect to each preceding and succeeding raster.

In connection with the invention the broad feature of the control is that of keying the line frequency generator under the control of the field frequency pulses which are modified by the lower frequency pulses so as to start at different time periods relative to each other.

Having now described the invention what I claim is:

1. In a television circuit for developing signal pulses for controlling the linear deflection of a cathode ray beam utilized to trace a predetermined raster which comprises, in combination, a substantially stable oscillator means to generate line control pulses at a selected line frequency rate, means to develop supplemental control pulses occurring at substantially a desired raster field repetition rate, means for producing from the supplemental pulses a sequence of oscillator control pulses spaced in time relationship such that successive pulses occur at time periods which are unequally spaced from the preceding and succeeding pulses, and means responsive to the produced oscillator control pulses for rendering the line frequency pulse generator inoperative during periods at which the said control pulses are produced and for initiating an operation of the line frequency pulse generator during periods intervening between successive pulses.

2. In a television circuit for developing signal pulses for controlling the linear deflection of a cathode ray beam utilized to trace a predetermined raster which comprises, in combination, a substantially stable oscillator means to generate line control pulses at a selected line frequency rate, means to develop supplemental control pulses occurring at substantially a desired raster field repetition rate, means for producing from the supplemental pulses a sequence of oscillator control pulses spaced in time relationship such that successive pulses occur at time periods which are unequally spaced from the preceding and succeeding pulses, and a keying tube responsive to the produced oscillator control pulses for interrupting completely the operation of the line frequency pulse generator during periods at which the said control pulses are produced and for initiating an operation of the line frequency pulse generator immediately upon cessation of the control pulses and for time periods intervening between successive pulses.

3. In a television circuit for developing signal pulses for controlling the linear deflection of a cathode ray beam utilized to trace a predetermined raster which comprises, in combination, a substantially stable oscillator means to generate line control pulses at a selected line fre-

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quency rate, means to develop supplemental control pulses occurring at substantially a desired raster field repetition rate, means for producing from the supplemental pulses a sequence of oscillator control pulses spaced in time relationship such that successive pulses occur at time period which are unequally spaced from the preceding and succeeding pulses, and a keying tube having its input circuit connected to receive the produced oscillator control pulses and its output circuit connected to control the operation of the line frequency generator by rendering the line frequency pulse generator inoperative during periods at which the said control pulses are produced and by initiating an operation of the line frequency pulse generator during periods intervening between successive pulses.

4. In a television circuit for developing signal pulses for controlling the linear deflection of a cathode ray beam utilized to trace a predetermined raster and to synthetically interlace successive rasters which comprises, in combination, a substantially stable line frequency oscillator means to generate line control pulses at a selected line frequency rate, a second substantially stable oscillator means to develop supplemental control pulses at a selected raster repetition rate, means for producing under the control of the supplemental control pulses a sequence of non-uniformly spaced line frequency oscillator control pulses so spaced in time relationship that successive pulses occur in time periods which are unequally spaced from the preceding and succeeding pulses, and a keying tube having its input connected to receive the combined series of pulses and its output connected to the line frequency generator, said keying tube means operating under the control of said last named pulses and being adapted to render the line frequency pulse generator inoperative during periods coinciding with oscillator control pulses and to initiate the stable operation of the line frequency pulse generator during periods intervening between successive oscillator control pulses.

5. In a television circuit for developing signal pulses for controlling the linear deflection of a cathode ray beam utilized to trace a predetermined raster and to synthetically interlace successive rasters which comprises, in combination, a substantially stable line frequency relaxation oscillator means to generate line control pulses at a selected line frequency rate, a second substantially stable oscillator means to develop supplemental control pulses at a selected raster repetition rate, means for producing under the control of the supplemental control pulses a sequence of non-uniformly spaced line frequency oscillator control pulses so spaced in time relationship that successive pulses occur in time periods which are unequally spaced from the preceding and succeeding pulses, and a keying tube having its input connected to receive the combined series of pulses and its output connected to the line frequency generator, means for energizing said keying tube under the control of said last named pulses and thereby applying a biasing voltage upon the line frequency pulse generator to render it inoperative during time periods coinciding with the duration of oscillator control pulses and for removing the biasing voltage and initiating stable operation of the line frequency pulse generator during periods intervening between successive oscillator control pulses.

6. In a television circuit for developing a plu-

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ality of signal pulses for controlling the deflection of a cathode ray beam to trace a predetermined raster which comprises, in combination, means to develop field frequency control pulses normally produced at a predetermined rate, means to generate line control pulses normally produced at a substantially constant rate, means to develop supplemental control pulses at a rate such that successive supplemental pulses occur coincidentally with substantially alternate field frequency control pulses, means for differentiating the field frequency and supplemental pulses and for combining the said pulses additively whereby the additive series comprises a sequence of pulses which are each non-uniformly spaced in time relationship with respect to the preceding and following pulse, and a keying tube having its input connected to receive the combined series of pulses and its output connected to the line frequency generator, said keying tube being adapted to render the line frequency pulse generator inoperative during periods coinciding with pulses of the combined series of pulses and to initiate an operation of the line frequency pulse generator during periods intervening between successive pulses of the combined series.

7. In a television circuit for developing a plurality of signal pulses for controlling the deflection of a cathode ray beam to trace a predetermined raster which comprises, in combination, means to develop field frequency control pulses normally produced at a predetermined rate, means to generate substantially constant frequency line control pulses at a frequency which is a selected non-integral multiple of the field frequency pulses, the non-integral relationship being such that line frequency pulses of a number corresponding to $n+m$ normally occur within the time period between each successive field frequency control pulse, where n is a whole number and m is a fraction of the order of one-half, means to develop supplemental control pulse energy at a rate such that one supplemental pulse is developed following a plurality of field frequency control pulses, means for differentiating each of the field frequency pulses and the supplemental pulses and for combining the said pulses additively whereby the additive series comprises a sequence of pulses non-uniformly spaced in time relationship with the variance in spacing between the successive pulses being of a time period corresponding substantially to the order of a fractional part of the time intervening between two successive line frequency pulses at the selected repetition frequency, and a keying tube having its input connected to receive the combined series of pulses and its output connected to the line frequency generator, said keying tube being adapted to render the line frequency pulse generator inoperative during periods coinciding with pulses of the combined series of field and supplemental pulses and to initiate an operation of the line frequency pulse generator during periods intervening between successive pulses of the combined series.

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