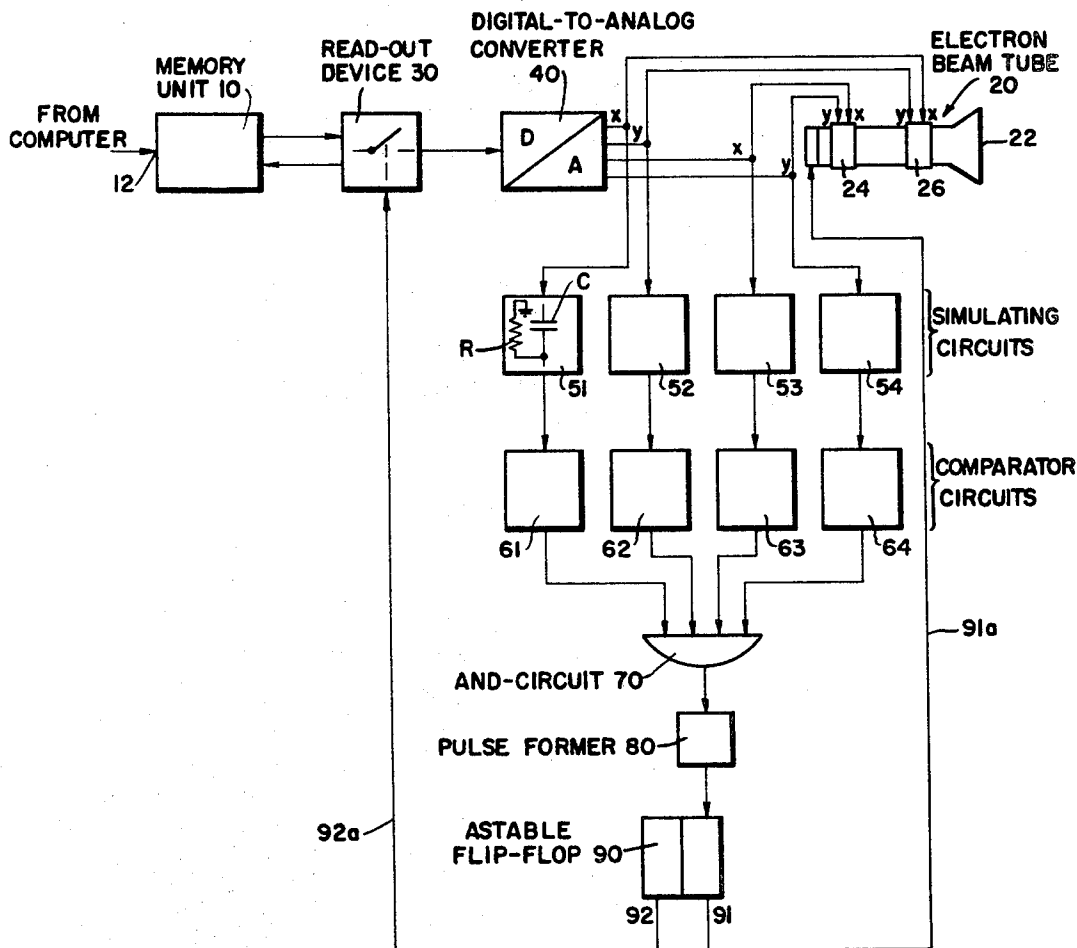


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CIRCUIT ARRANGEMENT FOR PRODUCING A PULSE SUBSEQUENT
TO A TRANSIENT SETTING OPERATION
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CIRCUIT ARRANGEMENT FOR PRODUCING A PULSE SUBSEQUENT TO A TRANSIENT SETTING OPERATION

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ABSTRACT OF THE DISCLOSURE

A circuit for producing a signal subsequent to a setting operation, in which the setting is brought about by an abrupt voltage change which brings the setting through a generally exponential transient condition toward a final value. The transient condition is simulated, for example, in a differentiating circuit which has the voltage change applied to it, there being a comparator connected to receive the output of the device which simulates the transient condition, the purpose of the comparator being to determine when the simulated transient condition approaches the final value upon the attainment of which the signal is to be produced. Finally, means are provided for deriving the signal from the output of the comparator.

The present invention relates to a circuit arrangement for producing a signal, e.g., a pulse which, after a setting which has undergone a transient condition, triggers a beam in an electron tube to high intensity.

More particularly, the present invention concerns itself basically, with the solution of the following problem:

There exist electron beam tubes whose beam writes on the screen a large number of symbols, as, for example, figures, letters and markers of any desired configuration, which symbols are to be made visible simultaneously. Inasmuch as these tubes are capable of operating at high speeds, they are particularly suitable for visually indicating data put out by an electronic computer. One such arrangement, for example, operates as follows: a first deflecting system directs the electronic beam toward that place on a mask or template at which is profiled the symbol to be reproduced on the screen. The beam is then centered and, by means of a second deflecting system, is brought to that point on the screen at which the symbol is to appear. In order to allow a large number of symbols to be projected onto the screen of the electron beam tube, whereat they should appear as a steady image, the double deflections for the individual symbols follow one after another at a very high rate in a sequence and this sequence is repeated cyclically—this being the picture repetition frequency—while the signals needed to bring about the correct deflections of the beam, namely, the double positioning of the beam, first with respect to the template and second with respect to the screen of the electron tube, are derived, for example, from a digital memory unit which itself is suited for cyclic operation. The memory unit itself is connected to receive the output of the computer. After each posi-

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tioning of the beam, the same is unblanked for a short interval, that is pulsed to a greater intensity so as to appear brightly on the screen. Since the symbols projected on the screen must, at all times, be replaceable by other symbols, the screen has to have a short luminescence, and this, it will be appreciated, requires a relatively high cycle frequency in order to make the image on the screen appear as steady and free of flickering as possible. On the other hand, the arrangement should allow a great number of symbols to be displayed during each cycle, during which time the beam has to be unblanked after each positioning, as already mentioned.

The beam is positioned by means of control voltages which are applied to the deflection systems, which give rise to transient conditions that cause the beam to be brought, exponentially with respect to the deflection rate, to the desired angular deflection. That is to say, the application of the control voltages does not result in the immediate, instantaneous deflection of the beam to the desired position, but there is an inevitable time lag between the instant at which the control voltage is applied and the instant at which the beam has been swept in the desired direction. This is the well-known transient phenomenon common in many electrical circuits, and, as is also common, the transient frequently follows an exponential curve.

In conventional beam control circuits, the effect of the transient phenomenon is compensated for as follows: after the deflection voltage has been applied, the beam is unblanked only after the elapse of a predetermined, constant time interval which is sufficiently long to make certain that the beam will have reached the desired end position with the requisite degree of accuracy. This time interval is relatively long, in that it is so selected as to allow for maximum beam deflection. In other words, while a relatively short time delay might be sufficient insofar as small beam deflections are concerned, a long time delay is needed in order to take into consideration the case when the beam is subjected to maximum deflection. This, it will be appreciated, has the drawback that the time delay is selected in accordance with the most unfavorable of all possible circumstances, namely, the case where the transients last longest. This, in turn, limits the maximum number of symbols that can be represented per cycle.

It is, therefore, the primary object of the present invention to provide a circuit arrangement which overcomes the above drawbacks, and with this object in view, the present invention resides in a circuit for producing a signal subsequent to a setting operation wherein the setting is effected by an abrupt voltage change which brings the setting through a transient condition, generally exponential, toward a final value, this transient condition being a function of a time constant. According to the present invention, the circuit incorporates means for simulating the transient conditions, means for applying the voltage change to the simulating means, comparator means connected to receive the output of the simulating means for determining when the simulated voltage approaches the final voltage subsequent to the attainment of which the signal is to be produced, and means for deriving this signal from the output of the comparator means.

In the embodiment of the present invention to be described below, the signal in question is a pulse which triggers a beam in an electron tube to high intensity after the beam has been deflected in accordance with a setting derived from the input data.

In accordance with a further feature of the present invention, if the signal is to be produced subsequent to a multiple setting operation wherein the setting is effected by a plurality of abrupt voltage changes each of which brings its corresponding setting through a transient condition, a plurality of simulating means and a plurality of comparators are provided, the output signals of the latter being applied to a common coincidence circuit, such as an AND-circuit which puts out a signal only upon the appearance of a signal from each of the comparator means, in consequence of which a signal is produced at the output of the AND-circuit only after the appearance of the simulated voltage whose transient has the longest time delay. Such an arrangement is of significance where several deflection components, e.g., mutually perpendicular *x* and *y* deflections, are applied and/or where different deflection means are active.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawing in which the single figure is a schematic block diagram of a circuit arrangement in accordance with the present invention, the same being used in conjunction with an electron beam tube.

Referring now to the drawing, the same shows a memory unit 10 having an input 12 to which is applied the beam control data put out by a computer (not shown). The data coming from the computer is, as is conventional, in digital form suitable for controlling an electron beam tube 20 having a screen 22. The data for the symbols, i.e., the configuration of the symbols (numbers, letters, and so on) and the position of the symbols on the screen can be taken, sequentially and with cyclical repetition, from a read-out device 30 so as to obtain the over-all representation which is to appear on the screen 22. The output of the read-out device 30 is applied to the input of a digital-to-analog converter 40, which converts the digital signals applied to it into beam control voltages, the same being applied as abrupt voltage changes, i.e., as *x* and *y* voltage jumps to two deflection systems 24 and 26 of the tube 20. The deflection system 24 is, in the illustrated embodiment, the means which directs the electron beam to the proper place on the beam-shaping template or matrix and operates, for example, electrically. The transients of amplifiers connected ahead of the deflection system result in a corresponding transient of the beam deflection. Deflection system 26 is the means for directing the now-properly shaped beam to the correct point on the screen and may, for example, operate magnetically. The beam is deflected by an angle which depends on the amplitude of the voltage change, this deflection being subject to the transient, which itself is dependent on the essentially exponential building up of the magnetic field.

The setting components which form the voltage jumps are additionally applied to the four differentiating circuits 51, 52, 53, 54, the differentiating characteristics being represented, in the case of circuit 51, by the RC (resistor-capacitor) combination. The differentiating elements have resistors and capacitors of such values that the deflection control signal is differentiated with a time constant which is the same as that of the transient of the deflection system. In the same manner, the circuits 52, 53, 54 imitate, i.e., simulate the transients for the other components of the deflection voltage.

The output of each differentiating circuit is connected to the input of a respective comparator 61, 62, 63, 64. Each of the comparators determines when the output voltage of the respective differentiating circuit, which represents a simulation of the deflection current, and ap-

proaches exponentially the quiescent value, has attained a sufficiently accurate approximation of this quiescent value. This, in practice, may occur when the differentiated voltage has disappeared. The comparators may be constituted, for example, by amplifiers which are controlled by the positive or negative differentiated voltages and whose amplified output signals are subjected to full-wave rectification. Of course, any other suitable comparator circuit arrangement may be used, provided they are accurate enough.

The output signals of the comparators 61, 62, 63, 64, which after the simulated voltages have decayed, remain quiescent and constitute the signal voltages, are applied to the inputs of a coincidence circuit, such as an AND-circuit 70 which puts out an output signal only when the quiescent voltage is applied to all of the inputs. This will be the case only after the beam deflection process having the longest transient conditions has been completed. The output of AND-circuit 70 is applied to the input of a pulse former 80 which, when the AND-circuit 70 puts out a signal, differentiates the incoming signal thereby to form a pulse. This pulse, in turn, is applied to the input of a monostable trigger circuit of flip-flop 90 which is thereby made to assume its astable state. So long as the flip-flop 90 is in its astable state, there will appear at output 91 a signal voltage which is applied, via line 91a, to the electron tube 20 to bring about an increase in the beam intensity, i.e., a brightening of the image projected onto the screen 22. The duration of this unblanking pulse is determined by the duration of the interval during which the flip-flop remains in its astable state, i.e., the time interval between the instant at which the flip-flop is first moved from its stable to its astable state until the instant at which the flip-flop by itself returns from its astable to its stable state. In practice, the flip-flop is so constructed as to allow this time interval to be adjusted.

When the flip-flop 90 returns to its stable state, a pulse is put out at output 92 which is applied, via line 92a, to the read-out device 30, such that the deflection data for the next symbol is taken out of the memory unit 10.

It will be seen from the above that, thanks to the present invention, the beam will be unblanked as soon as the beam has been deflected into its nominal position with the requisite accuracy. Thus, the over-all duration of the deflection plus unblanking operation is, for each symbol equal to the time needed properly to position, by deflecting, the beam plus the time during which the beam is intensified. This over-all time will thus depend on the deflection of the beam and this means that when the beam is deflected only little, the over-all total time required will be less than when the beam is subjected to a deflection which will write the symbol to an extreme end or corner of the screen. In short, the total time is no longer always equal to the time delay which would have to be provided to allow for proper operation at all deflection angles, instead, the operation can proceed more rapidly for small deflections than for large deflections. Consequently, the number of symbols which can be accommodated during one cycle is increased, or, if the number of symbols is not increased, the quality of the image presented on the screen is improved thanks to the higher cycle frequency which can now be used.

Also, it will be seen that, in case more than one deflection voltage is used, namely, the two *x* and *y* deflections for the two deflection means, the high-intensity pulsing is held off until the deflection which undergoes the most time-consuming transient has been completed. This insures that the high-intensity pulsing is not brought about prematurely.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims. For example, it is not absolutely essential that the output of the single compara-

tor, if there be only one such comparator, or the output of the coincidence circuit, be applied directly, as, for example, via the pulse former and the flip-flop. Instead, the output of a single comparator, or of the coincidence circuit in the event there are more than one comparator, can be subjected to a time delay after which the unblanking pulse is applied to the electron gun of the tube.

Also, the present invention is not limited in application to use with electron tubes. Instead, the principle underlying the present invention is equally applicable to other equipment in which a change of voltage is to effect a setting, after the attainment of which a signal is to be put out. One such example would be a solenoid in which an armature is to be drawn into a coil, against the force of a spring, to a certain depth, whereafter an operating signal, of any type is to be put out. Thus, the invention relates generally to cases where a signal is to be produced after a setting step has taken place, in which the extent of the setting, i.e., the setting itself, is a function of the applied signal, or of the change in applied voltage, which, after the passage of a given time interval, produces the setting, the latter reaching its final value after a transient, particularly an exponential transient. In this way, the time delay is no longer equal, at all times, to the longest time delay which can possibly occur.

Nor is the present invention limited to situations in which the transient is a monotonous function leading to the final value, so that even in cases where the transient is in the nature of a damped oscillation, i.e., in cases where the final, nominal value is reached after having undergone a progressively smaller oscillation, a simulating circuit can be used—preferably one which puts out an amplified copy of the actual transient conditions. The instant at which a value sufficiently close to the nominal value is reached can then be determined, whereupon the operating signal will be put out.

What is claimed is:

1. In a circuit for producing a signal subsequent to a multiple setting operation wherein the setting is effected by a plurality of abrupt voltage changes each of which brings its corresponding setting through a generally exponential transient condition toward its respective final value, each transient condition being a function of a time constant, the combination which comprises:

- (a) a plurality of circuit means each for simulating a corresponding one of said transient conditions;
- (b) means for applying the voltage changes to the respective circuit means;
- (c) a plurality of comparator means each connected to receive the output of a respective one of said circuit means for determining when the respective simulated voltage approaches the respective final value subsequent to the attainment of which said signal is to be produced;
- (d) coincidence circuit means connected to receive the output signals of all of said comparator means for putting out a signal only upon the appearance of a signal from each of said comparator means, in consequence of which a signal is produced at the output of said coincidence circuit means only after the appearance of the simulated voltage whose transient has the longest time delay; and
- (e) means for deriving the final signal from the output of said coincidence circuit means.

2. The combination defined in claim 1 wherein each of said simulating means comprises means for differentiating the respective applied voltage change with a time constant equal to the time constant of the respective transient condition.

3. In a circuit for producing a pulse which triggers the beam in an electron beam tube to high intensity after said beam has been deflected in accordance with a setting derived from input data, wherein the setting is effected by an abrupt voltage change which brings the deflection through a transient condition toward a final value, said

transient condition being a function of a time constant, the combination which comprises:

- (a) differentiating means having said time constant for simulating the transient condition;
- (b) means for applying the voltage change to said differentiating means;
- (c) comparator means connected to receive the output of said differentiating means for determining when the simulated voltage approaches the final value subsequent to the attainment of which said pulse is to be produced; and
- (d) means for deriving said pulse from the output of said comparator means.

4. A circuit arrangement comprising, in combination:

- (1) a memory unit connectible to receive digital data from a computer;
- (2) a read-out device connected to said memory unit to receive data therefrom;
- (3) a digital-to-analog converter connected to receive digital data from said read-out device for putting out electrical voltage signals corresponding to the digital data and constituting deflection voltages;
- (4) an electron beam tube having deflection means connected to receive the deflection voltages from said converter, said deflection means deflecting an electron beam through transient condition, in accordance with a time constant, toward a final deflected position;
- (5) a plurality of differentiating circuits connected to receive the same voltages which are applied to said deflection means, said differentiating means having said time constant, thereby to simulate the transient condition;
- (6) a plurality of comparator circuits each connected to receive the output of a respective one of said differentiating circuits for determining when the respective simulated voltage approaches the respective deflected position subsequent to the attainment of which there is to be produced a pulse which intensifies the beam of said tube;
- (7) an AND-circuit having a plurality of inputs each connected to the output of a respective one of said comparator circuits;
- (8) a pulse former connected to the output of said AND-circuit;
- (9) an astable flip-flop connected to the output of said pulse former to assume, upon the appearance of a pulse, its astable state, said flip-flop having a first output at which appears a signal when said flip-flop is in its astable state and a second output at which appears a signal when said flip-flop returns to its stable state;
- (10) means connecting said first output of said flip-flop to said tube for intensifying the beam thereof upon the appearance of a signal at said first output; and
- (11) means connecting said second output of said flip-flop to said read-out device for applying thereto a command which causes said read-out device to take out of said memory unit the deflection data for the next line to be swept.

5. In a circuit for producing a pulse which triggers the beam in an electron beam tube to high intensity after said beam has been deflected in accordance with a setting derived from input data, wherein the setting is effected by an abrupt voltage change which brings the deflection through a transient condition toward a final value, said transient condition being a function of a time constant, the combination which comprises:

- (a) means for simulating said transient condition;
- (b) means for applying the voltage change to said simulating means;
- (c) comparator means connected to receive the output of said simulating means for determining when the simulated voltage approaches the final value sub-

sequent to the attainment of which said pulse is to be produced; and
(d) means for deriving said pulse from the output of said comparator means.

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