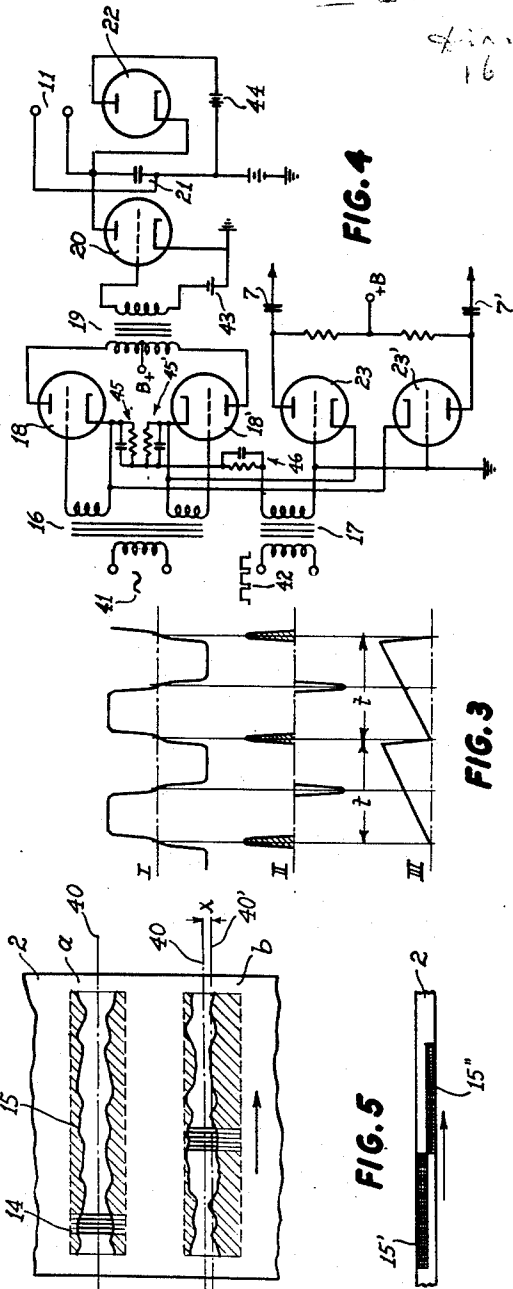
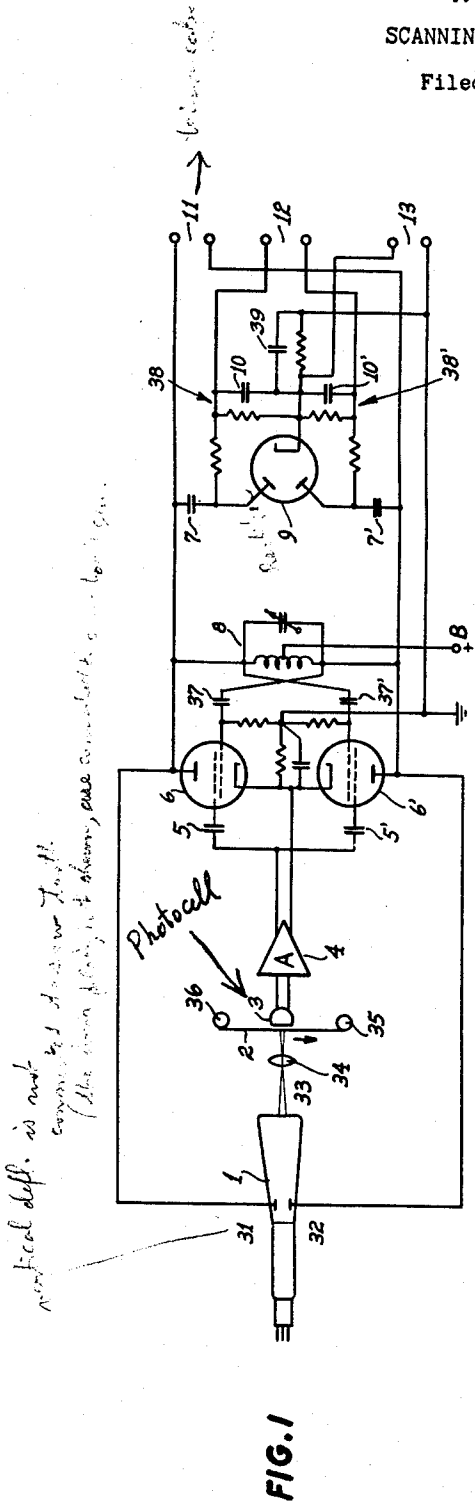


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SCANNING OF SOUND RECORDS

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SCANNING OF SOUND RECORDS

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The present invention relates to a method of and means for automatically controlling a scanning means, e. g. an electron beam, for the scanning of substantially linear objects or images such as sound records, pulse trains, reference lines and the like.

Heretofore it has been rather difficult to insure continuous and accurate alignment of the path of movement of the scanning means with the center of the line being scanned, particularly in the case of lines of relatively small width and great length, or in the case of such a line divided into closely spaced parallel segments which are to be scanned by simultaneous line scanning and transverse line feeding sweeps. Thus it has been impossible by the use of known arrangements to accomplish automatically the accurate positioning of an electron beam serving for the successive scanning of spaced parallel lines provided on a signal carrier which moves in a direction transverse to the lines; this is so because minor differences in timing between the (say, vertical) feeding movement and the (say, horizontal) scanning movement result after a relatively short interval in an inadmissible displacement of the scanning beam relative to the center (or zero axis) of the line which renders impossible the reproduction, for example, of sound records. Such deviations can be minimized only through the use of relatively expensive, highly accurately designed feeder mechanisms and equivalent scanning circuits; moreover, a considerable degree of similarity between the reproducing apparatus and the original recording apparatus is likewise essential. Even so it is possible to compensate for these differences only by constant manual adjustment. There exists, furthermore, the need for manually bringing the scanning medium into register with the line axis by special means at the beginning of the scanning operation, which is usually undesirable.

Similar difficulties arise with any arrangement for the scanning of linear objects where a positive mechanical coupling between the scanning and feeding movements is impractical.

It is, therefore, the general object of the present invention to provide a method of and means for automatically controlling a scanning means, such as an electron beam, in a manner which will avoid the above drawbacks.

More particularly, it is an object of this invention to provide a circuit arrangement adapted to be used in combination with a scanning beam or the like for the purpose of keeping said beam

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in substantial alignment with linear objects or images to be scanned.

Another object of my invention is to provide a method of producing a synchronizing or other signal by modifying the message being scanned in a manner detectable by special circuit means without noticeably affecting the character of the message.

A further object of the invention, allied with the preceding one, is to provide a circuit arrangement adapted to control a scanning means and also to detect a synchronizing or other signal of the character described.

In furtherance of the above and other objects, which will become apparent as the description proceeds, the invention utilizes a deflection of the scanning medium in a direction transverse to the line being scanned, this deflection being the result of a sinusoidal, linear or other suitable deflecting voltage super-imposed upon the normal scanning sweep. The invention further provides a pair of parallel transmission channels for the output of the scanning means which are differentially controlled so that positive half-cycles of the transverse sweep will make one channel more conductive than the other while negative half-cycles will have the opposite effect. A control voltage, serving to compensate for any deviation of the scan from the center line of the image being scanned (assuming the same to be of symmetrical configuration, such as a double-peak sound record), is derived from a comparison of the integrated outputs of the two channels, the sum of the two outputs being utilized at the same time to furnish the desired output signal corresponding to the message being scanned. The control voltage, according to another feature of the invention, may be used for the purpose of producing a single or periodic signal, e. g. for synchronization purposes, instead of or in addition to serving to compensate for deviations as stated above.

The invention will be more fully understood from the following detailed description, reference being had to the accompanying drawing in which:

Fig. 1 is an overall circuit diagram illustrating one embodiment of the invention;

Fig. 2 is a fragmentary view of a signal carrier, illustrating the scanning sweep according to the invention;

Fig. 3 is a set of graphs used in explaining the operation of a modified form of the invention;

Fig. 4 shows a partial modification of the cir-

cuit of Fig. 1, representing the embodiment to which Fig. 3 has reference; and

Fig. 5 is a schematical illustration of a scanning line adapted to produce a special control signal detectable by the circuit of Figs. 1 or 4.

Referring for the present to Fig. 1, there is shown a cathode ray tube 1 having a pair of vertical deflecting electrodes 31, 32 as well as horizontal deflecting electrodes, not shown, the latter being connected to a suitable sweep circuit (not shown) for the purpose of horizontally displacing the beam of the tube; light rays 33 from the luminous spot produced on the screen of the cathode ray tube are focused by a lens 34 upon the photocell 3 by way of the signal carrier or film 2, the latter being vertically displaced by mechanism schematically indicated at 35, 36.

The output of photocell 3 passes through the amplifier 4 and is then applied in parallel, by way of condensers 5, 5', to the control grids (shown here as the second grids) of two push-pull connected vacuum tubes 6, 6'. These tubes also form part of an oscillator comprising a tuned circuit 8 which determines the frequency of the transverse deflecting voltage to be applied to the plates 31, 32. The tuned circuit 8 is connected across the plates of the tubes 6, 6' and feeds back energy to the first grids thereof by way of condensers 37, 37'. The oscillator output is also available at the terminals 11 whence it may be applied, for example, to an indicator (not shown). It will also be possible to use the terminals 11 for injecting an externally generated deflecting voltage into the system.

Connected across the terminals 11 is a rectifier tube 9 to the twin anodes of which the output of tubes 6, 6' is applied by way of condensers 7, 7'. The two rectification paths are shunted by respective integration networks 38, 38' across the condensers 10, 10' of which there are developed D.-C. voltages proportional to the mean value of the outputs of tubes 6 and 6', respectively. A control voltage corresponding to the difference between the two condenser voltages is available at the terminals 12. A third rectification network, 39, is connected in the cathode circuit of rectifier tube 9 and serves to develop a signal voltage corresponding to the envelope of the combined outputs of the two amplifier tubes 6 and 6', this signal voltage being available at terminals 13.

In describing the mode of operation of the arrangement of Fig. 1, reference is made to Fig. 2 which shows the film 2 carrying sound records 15, these records being symmetrical about an axis 40. The transverse sweep of the beam 33, due to the oscillator voltage applied to the deflecting electrodes 31, 32, is indicated at 14. As long as the axis 40 of the image 15 coincides with the axis of this sweep, as is the case in Fig. 2(a), the outputs of the two tubes 6, 6' will be similarly modulated and no difference or control voltage will appear at the terminals 12. (The portions of the sweep 14 in which light effectively impinges on the photocell 3, giving rise to signal impulses, have been indicated by heavier lines.)

Should, however, as shown in Fig. 2(b), a deviation x exist between the axis 40 of the image and the axis 40' of the sweep, then the mean conductivity of, say, tube 6 will be greater than that of its companion tube 6', so that the voltage developed across the condenser 10 will exceed that developed across the condenser 10' and a difference voltage will be present at termi-

nals 12. (If the deviation of the two axes had been in the opposite direction, the polarity of this difference voltage would have been reversed.)

This difference or control voltage may now be used to restore the alignment of the scan with the image in any number of ways known per se; thus it may act upon the transverse sweep itself by increasing the deflection in the proper direction, it may exercise a sustained or a temporary retarding or accelerating effect upon the horizontal scanning motion of the beam, it may alter the synchronizing frequency of the line scanning sweep, or it may affect the operation of the feed mechanism 35, 36.

It will be noted that in the arrangement just described the tubes 6, 6' act simultaneously as generators of the transverse deflecting frequency and as amplifiers for the output of photocell 3. The transverse deflecting voltage produced by the circuit is sinusoidal, which is satisfactory for many purposes, and is identical with the voltage which periodically varies the conductivity of the tubes 6, 6'. In some instances, however, it is desirable to use different wave forms for these voltages, as for the purpose of insuring adequate separation between the positive and the negative half-cycles of the deflecting sweep even where the width of a signal pulse (the spacing between the upper and the lower limit of the image 15 in Fig. 2) is relatively small. Such an arrangement, using a linear deflecting voltage and a rectangular channel blocking voltage, is shown in Fig. 4 and will be described with reference to Fig. 3.

Referring to Fig. 4, a sinusoidal voltage 41 is applied to the primary of a first input transformer 16 while the output of amplifier 4 (Fig. 1), shown as a pulse train 42, is applied to the primary of a second input transformer 17. Transformer 16 has two secondaries connected across the inputs of a pair of overdriven tubes 18, 18' working into the primary of an output transformer 19. The secondary of the latter is connected to the grid of a triode 20 which is normally maintained non-conductive by means of a biasing battery 43. The plate-cathode circuit of tube 20 forms a discharge path for a condenser 21 adapted to be charged from a source of direct current 44 through a suitable charging impedance, shown here as a diode 22.

The grids of another pair of vacuum tubes, 23 and 23', are connected in parallel to one terminal of the secondary of input transformer 17 and are connected to the negative pole of a source of plate potential, which may be ground. The cathodes of tubes 18 and 23' are connected to the other terminal of this secondary by way of a biasing network 45, and the cathodes of tubes 18' and 23 are connected to the same terminal by way of a similar network 45', a third network 46 being inserted between this secondary and the network 45, 45'. The tubes 23, 23', which represent the two transmission channels connecting the photocell 3 to the output terminals 13, are connected to coupling condensers 7, 7' in similar manner to the tubes 6, 6' in Fig. 1, the remainder of the two circuits being identical.

Fig. 3(I) shows the wave form of the output of tubes 18 and 18' as it appears in the primary of transformer 19. The flat tops of the pulses shown correspond to saturation current in one tube, the conductivity of the other tube at the same time being zero. The leading and trailing edges of these pulses give rise to positive and negative pulses in the secondary of transformer

19, these pulses being shown in Fig. 3(II). Only the positive pulses, shown hatched in the drawing, have any effect upon the conductivity of tube 20 and serve to bring about a quick discharge of the condenser 21. There will thus appear across this condenser a sawtooth voltage as shown in Fig. 3(III), having a period t , this voltage being available at terminals 11 for application to the deflecting electrodes 31, 32 of cathode ray tube 1 (Fig. 1).

The voltage drop alternately appearing across the networks 45 and 45' alternately blocks the tubes 23, 23' during respective halves of the scanning sweep shown in Fig. 3(III); in this arrangement, too, a control voltage will thus appear across the terminals 12 (cf. Fig. 1) only if the transverse sweep lies unsymmetrically with respect to the image being scanned.

In addition to being utilized in one of the ways previously set forth, or in lieu thereof, the control voltage from these terminals may be applied to a suitable indicator e. g. of the "magic eye" type; the provision of such an indicator will also allow for the manual re-alignment of the scan with the film, if it be desired to substitute adjustment by hand for automatic control. Other compensating means known per se, e. g. of an optical nature, may be employed in combination with one or more of the control methods suggested above; also, the application of the control voltage to a particular correcting device may take place with or without delay, as needed. It will further be possible, particularly in the case of a movable signal carrier, to make use of a peak rider for making continuing corrections in response to the maximum values of the control voltage, whereby considerable stabilization of the system will be obtained.

The invention also provides for the generation of special control signals, e. g. in the form of trigger or synchronizing pulses, by the artificial creation of unsymmetrical line formations. Thus it is possible, for example, to create such lack of symmetry by causing minor deviations of the lines from a normal position or by making the upper and lower halves of the line dissimilar. This is illustrated in Fig. 5 where the position of the line portion 15' is offset with respect to that of line portion 15'', whereby a discontinuity is produced which will give rise to a sudden inversion of the control voltage at the terminals 12, this inversion being in turn translatable into a sharp pulse for switching purposes or the like. This may be of value, for instance, where it is desired to switch on the sound reproducing means, the apparatus having been roughly pre-adjusted to the selected film portion with the aid of some external mark. Also, the discontinuities may be of a periodic character or spaced according to a predetermined law, whereby several frequency-dependent or otherwise timed switching operations may be carried out independently of one another.

The principles of the invention are also applicable to line scanning systems other than those using the luminous spot produced by an electron beam. In one known system, for example, the image projected by optical means upon the cathode of a photocell is converted into an electron image (e. g. by an arrangement similar to a Farnsworth tube) which is then scanned through an apertured anode, the electron image being bodily displaced in front of the anode aperture. The transverse scanning movements according to the invention are in this case likewise

carried out by the entire electron image, and the control voltages resulting from a displacement of the sweep axis with respect to the aperture center may be used for compensation purposes in any of the manners previously described. The invention may thus be advantageously applied to a device as illustrated in Fig. 1 of my co-pending application Ser. No. 117,058, filed on even date herewith.

Finally it should be remarked that the invention is not limited to electronic scanning beams; it may be used, for example, in connection with directional electromagnetic radiation, infrared rays, visible light or rays of still shorter wave length for the purpose of scanning linear objects, or with sonic or ultrasonic waves forming part of some such scanning system. It is also applicable to electro-mechanical line scanning systems in which useful impulses are produced by mechanical deflecting movements or periodical electric field displacements occurring in a direction perpendicular to that of the main sweep.

It should furthermore be noted that many departures from the circuit arrangements specifically disclosed and illustrated are possible without departing from the spirit and scope of the invention; for example, the amplifiers shown may be of the multistage type, or the rectifiers employed may be of the dry-contact type. It is therefore intended that all such modifications and adaptations, which in part have been specifically pointed out hereinabove and in part will be obvious to those skilled in the art, be included within the scope of the appended claims unless specifically limited otherwise.

I claim:

1. A system for scanning linear objects comprising scanning means, sweep means adapted to displace said scanning means relative to an object to be scanned, parallel to the main direction of said object, deflecting means adapted to displace said scanning means periodically relative to said object in a direction transverse thereto and at a rate which is high relative to the rate of displacement by said sweep means, signal generating means responsive to the output of said scanning means, a first and a second transmission channel connected in parallel to the output of said signal generating means, transmission control means synchronized with said deflecting means for improving the transmission characteristics of said first relative to said second transmission channel during odd half-cycles and of said second relative to said first transmission channel during even half-cycles of the periodic transverse displacement of said scanning means, and unbalance determining means adapted to compare the mean outputs of said transmission channels so as to provide a measure of any displacement between the scanning means and the axis of the object being scanned.

2. A system for scanning linear objects comprising scanning means, sweep means adapted to displace said scanning means relative to an object to be scanned, parallel to the main direction of said object, deflecting means including a source of electric oscillations adapted to displace said scanning means periodically relative to said object in a direction transverse thereto and at a rate which is high relative to the rate of displacement by said sweep means, impulse generating means controlled by said scanning means to produce an impulse whenever said scanning means sweeps over said object, a first and a sec-

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ond transmission channel connected in parallel to the output of said impulse generating means, transmission control means connected to said source of oscillations for improving the transmission characteristics of said first relative to said second transmission channel during odd half-cycles and of said second relative to said first transmission channel during even half-cycles of said oscillations, first circuit means for separately integrating the outputs of said two channels over periods which are large relative to the period of said oscillations and for deriving a control voltage from the difference, if any, of said integrated outputs, and second circuit means for demodulating the combined outputs of said two channels to produce a signal representative of the object being scanned.

3. A system according to claim 2 wherein said scanning means comprises a cathode ray tube.

4. A system according to claim 3 wherein said impulse generating means comprises a photoelectric cell positioned for illumination by a luminous spot of said tube across the object to be scanned.

5. A system according to claim 2 wherein said first circuit means is connected to said sweep means for modifying the displacement of said scanning means in the direction of the object being scanned.

6. A system according to claim 2 wherein said first circuit means is connected to said deflecting means for modifying the displacement of said scanning means in the direction transverse to the object being scanned.

7. A system according to claim 2 comprising mechanism for displacing a carrier of linear objects in a direction transverse to said objects, said first circuit means being connected to said mechanism for modifying the speed of displacement of said carrier.

8. A system according to claim 2 wherein said first circuit means includes a peak riding circuit.

9. A system according to claim 2 wherein each of said channels includes a respective variable im-

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pedance adapted to be varied by said transmission control means.

10. A system according to claim 9 wherein said variable impedance is an amplifier tube forming part of said source of electric oscillations.

11. A system according to claim 2 comprising photosensitive means adapted to convert an optical image into an electron image, said scanning means including an anode having a stationary aperture, said electron image being displaceable relative to said aperture by said sweep and deflecting means.

12. A system according to claim 2 wherein said transmission control means comprises a source of substantially rectangular blocking pulses.

13. A system according to claim 12 wherein said source of oscillations is a substantially linear sawtooth wave generator adapted to be triggered by said rectangular blocking pulses.

14. A system according to claim 2, comprising switch means adapted to be operated by said first circuit means in response to a discontinuity of said control voltage.

15. The combination, with a system according to claim 14, of a carrier of linear objects to be scanned, certain of said objects having successive portions in relative disalignment so as to produce a discontinuity of said control voltage.

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