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METHOD AND APPARATUS FOR RECORDING VECTORCARDIOGRAPHS

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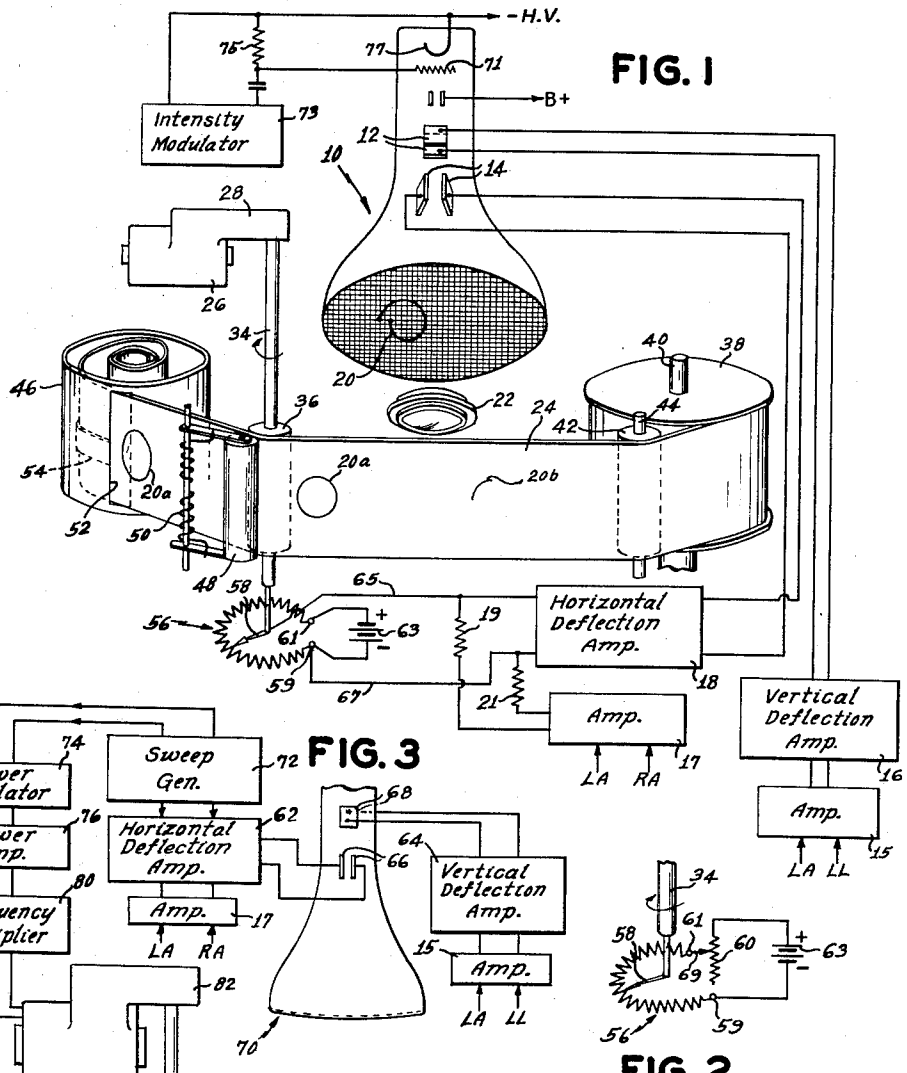
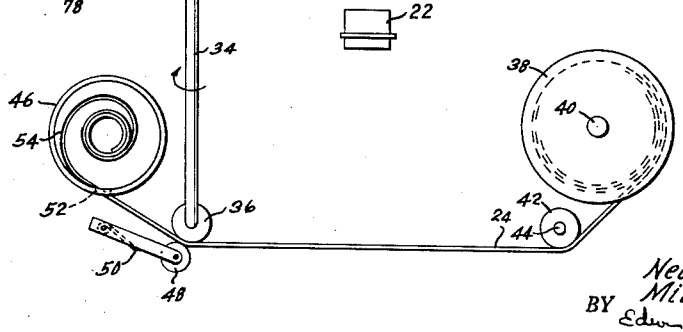


FIG. 1

FIG. 3

FIG. 2



INVENTORS
Nelson G. Kling
Milton H. Pelavin
BY Edwin Denson +
ATTORNEYS

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METHOD AND APPARATUS FOR RECORDING VECTORCARDIOGRAPHS

Nelson G. Kling, Roslyn, and Milton H. Pelavin, Brooklyn, N.Y., assignors, by mesne assignments, to Technicon Instruments Corporation, Chauncey, N.Y.

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Our invention relates to a method and apparatus for automatically recording transient phenomena, and more specifically to the recording of a vector summation of two simultaneous signals from such phenomena.

The making of photographic recordings of Lissajous figure traces formed on the screen of a cathode ray oscilloscope has presented a problem due to the superimposition of the recorded traces where the traces result from signal voltages which, though repetitive are non-identical. In making such a recording, the photographic film is subjected to the spot of light formed by the beam of electrons on the screen of the oscilloscope, the path of the rapidly moving light spot forming a figure trace, although at any given instant during the formation of the figure trace, the electron beam produces only a single light spot on the screen, the location of which is determined by the relationship of the signal voltages at that particular instant. Thus in the formation of a Lissajous figure, for example, a circle, what actually is happening is that a spot of light is moving at an extremely rapid rate in a circular path, the spot eventually returning to the starting point in order to complete the circular loop path. Thus, in order to take a picture of the complete trace, the film must be exposed during the entire movement of the beam of light in forming the complete trace.

Now, if a horizontal sweep voltage be applied during the formation of a circular Lissajous figure, in order to move the electron beam across the screen so that a succeeding trace, as recorded on the film, will not be superimposed upon a prior trace, as recorded thereon, it will be apparent that by the time the spot of light or the electron beam is to return to its starting point to complete the circular trace, the electron beam will have moved horizontally relative to its starting point, and thus the loop path will fail to close and the result will be a distorted trace rather than a true reproduction on the film of the resultant of the combined signal voltages. While a circular Lissajous figure is illustrated and described herein, in order to facilitate the description of the present invention, it will be understood, however, that in practice, Lissajous figures are extremely complex. For example, in the art of cardiology, a vectorcardiogram trace is a Lissajous figure, and reference is made to "Spatial Vectorcardiography," by Grishman and Scherlis, published by W. B. Sanders Company, Philadelphia and London, 1952, for illustrations of actual vectorcardiogram traces. Since the above mentioned distortion is a direct result of the additional voltage supplied to the horizontal deflection plates by the horizontal sweep means, neutralization of this additional voltage or horizontal component will eliminate said distortion. Thus, the basic concept of our present invention is to move a sensitized film, onto which the moving light spot is focused, in correlation with the rate of movement of the light spot across the screen of the oscilloscope so that the movement of the film will compensate for the horizontal movement of the trace formed by the light spot. Consequently, even though the path of movement of the

light spot on the screen of the oscilloscope will form or determine an incomplete and distorted Lissajous figure, the film will actually record the true, undistorted Lissajous figure representative of the signal voltages.

Therefore, in accordance with the foregoing, the primary object of the present invention is the provision of means for obtaining true or faithful reproductions of successive resultants of separate signal voltages which resultants are non-identical and repetitive in character.

Another object of the invention is the provision of a method of and apparatus for photographically recording transient phenomena. In this connection, a more specific object of our invention is to provide a method and apparatus for the automatic photographic recording of a trace appearing on a cathode ray oscilloscope, which trace is the resultant of simultaneous signals supplied to the oscoilloscope by the transient phenomena under investigation.

Another object of our invention is the provision of automatic photographic recording means having a continuously moving film, and means for correlating the movement of the film with the movement of the electron beam across the screen of an oscilloscope.

Another object of our invention is the provision of an automatic photographic recording method and apparatus which is especially advantageous in recording varying vectors, for example, vectorcardiograms, as well as other biological voltages, and which is also useful for other purposes.

The above and other objects, features and advantages of the invention will be fully understood from the following description considered with reference to the accompanying illustrative drawings.

In the drawings, which illustrate the best mode presently contemplated by us of carrying out our invention:

Fig. 1 is a more or less diagrammatic and schematic representation of the preferred form of our invention;

Fig. 2 is a schematic view of a variable resistor connected to the potentiometer employed in the preferred form of our invention; and

Fig. 3 is a more or less diagrammatic and schematic representation of a modified form of our invention.

Because of the utility of the invention in the art of cardiology, and also for the sake of convenience and to facilitate the description thereof, our invention has been illustrated and will de described in connection with its application to the field of cardiology, and more specifically, to vectorcardiography. However, while the use of our invention in vectorcardiography constitutes an application of primary importance, it is to be understood that the basic concept thereof can be applied to the recording of various other transient phenomena such as, for example, but without limitation, various biological voltages, the monitoring of line voltages, phase shifts, etc. By transient phenomena, reference is made to phenomena that emit re-occurring but non-identical signals.

In the practice of vectorcardiology, the resultant of two simultaneous voltages across different parts, respectively, of the subject's body is observed. For example, in taking a vectorcardiograph in the so-called frontal plane, one pair of electrodes may be applied to the patient's left arm and left leg and another pair may be applied to the patient's left arm and right arm. The two voltages thus obtained may then be supplied to a cathode ray oscilloscope, after being suitably amplified. For example, the left arm-left leg may be supplied to the vertical deflecting plates of the oscilloscope while the left arm-right arm may be supplied to the horizontal deflecting plates. When the two voltages thus obtained are out of phase, the resulting trace on the scope will be in the form of a closed loop, known in the art as a Lissajous figure,

which will represent a vector sum of the aforelisted components, but it is to be emphasized that this is an instantaneous vector and represents the resultant of the forces of the heart measured for only one cardiac cycle. Since the forces of the heart for each cardiac cycle are different, it follows that the vector for each cardiac cycle will be different as well, this being an example of transient phenomena. The problem which presents itself is that of recording this constantly changing vector as it is presented on the oscilloscope, and it is this problem with which the present invention deals.

Referring now to the drawings, and more particularly to Fig. 1 which represents the preferred form of our invention, reference numeral **10** generally designates a cathode ray oscilloscope having vertical-deflecting plates **12** and horizontal-deflecting plates **14**. The electrode applied, for example, to the subject's left arm, designated at LA and the electrode applied to the left leg of the subject and designated at LL supply a signal voltage to the vertical-deflecting plates **12** of the cathode ray oscilloscope, which voltage represents the vertical component of the vector being obtained. Before being applied to the vertical deflecting plates **12** this voltage is amplified by an amplifier **15** from which it is fed to the vertical-deflection amplifier **16** of the oscilloscope. The horizontal component represents, for example, a voltage across the left arm LA of the subject and the right arm of the subject, designated at RA, which is applied as a signal voltage to the horizontal-deflecting plates **14** of the cathode ray oscilloscope. Before reaching the horizontal-deflecting plates, this signal voltage is amplified by amplifier **17**, and fed through resistors **19** and **21**, for reasons to be later set forth, to the horizontal-deflection amplifier **18**, of the oscilloscope. It will be understood that since both pairs of electrodes are in contact with the subject, both the horizontal signal voltage and the vertical signal voltage are transmitted simultaneously from the subject to the cathode ray oscilloscope. It will further be understood that the trace formed on the cathode ray tube, as the result of the simultaneous horizontal and vertical signals being supplied thereto, will represent a vector or resultant of said horizontal and vertical signals, as is well known to those skilled in the art.

The means for automatically recording the above described transient phenomena will now be described. Photographic means comprising a spherical convex objective lens assembly **22** and a continuously moving sensitized film **24**, positioned therebehind, are provided. The basic concept of the instant invention is to continuously drive the film **24** so that the linear rate of travel of the film is the same as the linear rate of travel of the light spot image, as focused thereon. With a magnification ratio of 1:1 for the lens assembly **22**, the film is moved at precisely the same speed as the rate of linear travel of the light spot across the oscillosope screen. With a magnification ratio other than 1:1, suitable compensation is made in the rate of linear travel of the film to provide that the image of the light spot, as focused thereon, is moved at the same linear rate as the film. If this relation between the linear movement of the film **24** and the linear movement of the image focused thereon is accurately maintained, a complete and undistorted photographic recording of the trace will be obtained. On the other hand, if this relationship is not accurately maintained, the resulting picture of the tract will be blurred and distorted. Thus it is highly desirable to eliminate relative linear movement between the image as projected on film **24** and the film. The manner in which this is accomplished pursuant to out invention, will now be described.

The film **24** is driven by a synchronous motor **26** having suitable reduction gearing, generally indicated at **28**, for driving shaft **34** which has fixedly mounted thereon a film feed roller **36**. The film **24** is fed from a supply roll or spool **38** rotatably mounted on spindle **40** and is directed over guide roller **42**, rotatably mounted on shaft **44**, and continues across the front of the oscilloscope screen and the objective lens assembly **22** to the feed roller **36** and then on to cassette **46**. A pressure roller **48** is urged by spring **50** against the film in engagement with feed roller **36** thereby insuring that the film makes sufficient frictional contact with said feed roller so as to be driven thereby. It will be understood that a drag may be applied to the feed roll **38** by any suitable means (not shown) in order to prevent overrunning of the film thereby maintaining the film taut during its travel to the feed roller. Cassette **46** is an open top cylindrical enclosure having an elongated cut-out portion **52** disposed vertically on its side surface and receiving the film therein. A suitable flat spring **54** may be disposed within the cassette to insure proper rerolling of the film. The arm or tap **58** of a potentiometer, designated generally at **56**, is mounted near the lower end of shaft **34** and is utilized to provide a horizontal sweep voltage for the horizontal-deflection plates **14** of the cathode ray oscilloscope. As here shown, the potentiometer terminals **59** and **61** are connected to the terminals of battery supply **63**, terminal **59** being connected by lead **67** to the horizontal deflection amplifier **18**, and tap **58** being connected thereto by lead **65**. The resistors **19** and **21** serve to isolate the sweep voltage and the body voltage from the LA–RA electrodes so as to provide for the proper addition of the voltages in the horizontal deflection amplifier to assure the amplification of the additive total thereof by said amplifier. The potentiometer arm **58** being secured to the lower end of shaft **34** for rotation therewith, it will be seen that the speed of shaft **34** directly controls the sweep voltage supplied by the potentiometer to the horizontal deflecting plates **14**. As arm **58** is rotated by the shaft **34** from terminal **59** to terminal **61** a sweep voltage cycle will be supplied to the horizontal deflecting plates **14**, the sweep voltage cycle terminating when the arm travels from terminal **61** to terminal **59** to again initiate the sweep voltage signal when the arm again contacts the terminal **59**. The potentiometer **56** is connected to the oscilloscope in place of the horizontal sweep generator usually employed in an oscilloscope for regulating the horizontal linear movement of the trace across the oscilloscope, and it will be understood that said sweep generator is not used. Since, as described, the potentiometer tap is directly coupled to the shaft **34** which controls the feed of the film, it will be obvious that the linear rate at which the trace moves across the scope can be correlated with the rate at which the film is fed so that the image, as projected on the film, will move at the same rate as the film. This arrangement is particularly advantageous because of the fact that any unforeseen variations in the film feed will result in corresponding variations in the movement of the trace across the scope. The maximum voltage supplied to the horizontal-deflecting plates **14** by potentiometer **56** will determine the limits of the travel of trace **20** across the scope. Accordingly, if it be desired to vary the limits of linear movement of said trace, a variable resistor **60** may be coupled in series with the potentiometer as shown in Fig. 2 thereby varying the maximum voltage supplied thereby. More specifically, the rheostat **60** is connected in series with the battery supply **63**, and with the potentiometer **56**. Consequently, the setting of tap **69** of rheostat **60** will determine the distance of linear travel of the trace **20** across the screen of the oscilloscope. It may also be desirable to vary the speed at which film **24** is fed in order to adjust for the frequency or rate of heartbeats in different patients. This is important since, where a subject has a rapid heart beat, relatively slow feed of the film and correspondingly slow movement of the trace could conceivably result in superimposition of succeeding traces on the film. This variation in speed may be obtained by changing the reduction gears **28** al-

though it will be understood, of course, that any suitable variable speed transmission may be used.

As is well known to those skilled in the art, the sweep voltage which is ordinarily applied to the horizontal deflection plates also provides a time base which can be utilized for determining the time required to complete a trace formed on the screen of the oscilloscope by a signal applied to the vertical deflection plates. However, since in the present invention a signal voltage is additionally provided on the horizontal deflection plates to form a Lissajous figure, some other timing means must be provided for determining the time required to form the complete trace. For this purpose, provision may be made for intensity modulation of the control grid **71** of the cathode ray tube with a signal of predetermined frequency from a suitable intensity modulator of known type, such as indicated at **73**, the output of which is developed across a control grid bias resistor **75** between control grid **71** and the cathode **77** which is connected to a negative high voltage (—H.V.) source, as is well known to those skilled in the art. When a sine wave signal is used for intensity modulation of the control grid, the time required to form the complete trace may be readily determined by counting the number of high intensity portions of the trace and comparing said number with the known frequency of the modulated signal. Under certain circumstances, it may be desirable to determine the general direction of movement of the electron beam in forming the trace, for example, whether the beam is moving generally clockwise or generally counterclockwise during the formation of a Lissajous figure. In this connection, an intensity modulator which provides a saw tooth voltage may be used, in lieu of the sine wave voltage, and the high intensity portions of the trace will then have a generally tear drop outline, the beam traveling in the direction from the substantially pointed narrow end of the tear drop to the wider arcuate end thereof.

The operation of the above described apparatus for practicing our method is thought to be obvious from the foregoing, but a brief summary thereof will now be given. By supplying the vertical signal to the vertical-deflecting plates **12** of the cathode ray oscilloscope and by supplying the horizontal signal to the horizontal deflecting plates **14**, a resultant trace will be formed which trace represents the vector of the two signals being supplied simultaneously to the oscilloscope. A sweep voltage is additionally supplied to the horizontal plates **14** for effecting the linear movement of the trace horizontally across the screen. This sweep voltage is developed by potentiometer **56** which in turn is controlled by the speed of shaft **34**. Thus, a direct relation is established between the linear movement of the trace across the screen and the speed of shaft **34**, which, of course, controls the rate of feed of the film **24**. It will be understood that successive images, on the film, indicated at **20***a* and **20***b*, of the traces as they appear in succession on the screen of the oscilloscope will be spaced from each other longitudinally of the film according to the distance of the horizontal travel of the individual traces on the screen of the oscilloscope, subject to any magnification by lens **22**. Although other means could be employed for moving the film **24** in correlation with the linear movement of trace **20** across the screen, as regulated by a conventional horizontal sweep generator, the method herein described is highly desirable because it obviates the possibility of linear movement of the film and trace image, as projected thereon, in relation to each other which might otherwise occur under circumstances which cause a variation in speed of the film, so that said film feed would no longer retain its proper relation with respect to the rate of the linear movement of the trace. In the instant invention, however, since there is a tie-in between the rate of film feed and the linear movement of the trace any variations in the former will automatically be compensated for and the proper relationship will at all times be maintained, and a clear, undistorted image will be recorded.

Fig. 3 represents a modified form of our invention which will now be described. The basic concept of this form is similar to that of my preferred embodiment in that the speed of the film feed is related to the linear movement of the trace across the screen of the oscilloscope. Instead of having the film feed regulate the linear movement of the trace, however, the movement of the film is controlled in accordance with said linear movement. This is accomplished in the following manner. The horizontal and vertical signals are supplied to horizontal and vertical deflection amplifiers **62** and **64**, respectively, and then to the horizontal and vertical deflection plates **66** and **68**, respectively, of cathode ray oscilloscope **70** in a manner identical to that described in connection with my preferred embodiment. Horizontal linear movement of the resultant trace is effected by sweep generator **72** in a conventional manner. The sweep generator is additionally connected to a power oscillator **74** to operate the latter in synchronism with the rate of horizontal deflection of the trace, the oscillator providing a signal output of higher frequency than the sweep generator. The oscillator output signal is amplified by power amplifier **76** and then multiplied by the frequency multiplier **80** to a frequency level required for efficient operation of the motor **78** which requires voltage of a much higher frequency than that provided by the sweep generator **72**. Suitable reduction gearing, as at **82**, is then provided so that the shaft **34** may be driven by the motor **78** at the rate required for movement of the film in correlation with the linear movement of the trace across the screen. The film mounting and feed means are identical to that described in the preferred embodiment and accordingly no further description pertaining thereto will be given. It will be understood, however, that the potentiometer employed in the preferred embodiment is not utilized in the modification, just as the sweep generator of the modified form is not utilized in the preferred form. It will be further understood that the intensity modulating means, as previously described in connection with the preferred embodiment, may be similarly utilized in connection with the present embodiment.

Therefore, it will be apparent from the foregoing that although the frequency of the sweep generator output may be quite low, for example, and not by way of limitation, sixty cycles per minute, it can be used to drive a high speed motor, for example, and not by way of limitation, a motor operating in a range from 1800–3000 r.p.m. to provide desired efficiency, and then reduce the frequency of the motor output to drive a film feed efficiently and in synchronism or in correlation with the movement of the trace across the screen.

From the foregoing, it will be apparent, that in the constructions illustrated in Figs. 1 and 3, and utilizing signal voltages which, for example would normally from a circular trace in the absence of a sweep voltage, the light beam follows a non-circular path, as illustrated at **20**, in Fig. 1, due to the fact that the electron beam is subjected to the horizontal sweep voltage. However, the continuous horizontal movement of the film **24** neutralizes the effect of the horizontal sweep voltage so that the trace which is recorded on the film is a circular trace, as illustrated at **20***a*. In this connection it will be understood that since the lens **22** is a reversing lens, the movement of the film from the supply roll **38** to the cassette **46** is in a direction opposite to the direction of the horizontal deflection of the electron beam by the sweep voltage. While **20***a* illustrates a completely recorded trace, **20***b* illustrates a partially recorded trace, it being understood that trace **20***b* will form a complete circle when the electron beam has completed a trace **20**.

It will be understood also that, in the movement of the film at a uniform speed in front of the screen of the oscilloscope, the film is continuously exposed in succes-

sion to the light of each of the traces while each trace is being formed on said screen, and in this connection it will be understood further that no shutter is required in view of the continuous exposure of the film to the trace-forming light on the screen pursuant to the present invention.

Although the present invention is primarily and especially useful and beneficial in the automatic recording of vectors or Lissajous figures of transient phenomena, it can be utilized also in connection with ordinary electrocardiographs or other phenomena wherein one signal of varying amplitude is recorded with respect to time or some other variable. Pursuant to the accomplishment of this function, the potentiometer of my preferred embodiment is disconnected and no sweep signal at all is supplied to the horizontal deflecting plates. A signal voltage from the electrodes attached to the patient will be supplied to the vertical-deflecting plates and will be recorded on the horizontally moving film **24**, the movement of the film, in effect, serving the same function as a sweep voltage. Consequently, as to this aspect of the invention both the sweep generator and the horizontal deflecting plates may be omitted from the oscilloscope.

It will be understood that the film and its supply and take-up devices are arranged in a suitable cabinet or housing (not shown) so as to exclude all light except that of the trace on the oscilloscope screen; alternatively, the apparatus may be disposed in a dark room.

While we have shown and described the preferred embodiments of our invention, it will be understood that various changes may be made in the idea or principles of the invention within the scope of the appended claims.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously applying first and second repetitive signal voltages to the horizontal and vertical deflecting plates, respectively, of said oscilloscope whereby to form a series of traces in succession on said screen of said oscilloscope, sweep means connected to one of said pairs of deflecting plates for effecting movement of said traces during formation thereof, whereby to prevent successive traces on the screen from overlapping or being superimposed on each other, continuously moving recording means sensitive to said traces and disposed in operative relation to said screen, means for moving said recording means in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, and means for synchronizing the rate of movement of said recording means with the rate of movement of said traces, said recording means being moved parallel to the movement of said traces and in synchronization therewith to form undistorted reproductions of said traces.

2. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously applying first and second repetitive signal voltages to the horizontal and vertical deflecting plates, respectively, of said oscilloscope whereby to form a series of traces in succession on said screen of said oscilloscope, sweep means connected to one of said pairs of deflecting plates for effecting movement of said traces during formation thereof, photographic means for recording said traces individually in succession as they are formed on said screen, said photographic means being positioned in operative relation to said screen and having a continuously moving film, means for moving said recording means in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, and means for synchronizing the rate of movement of said film with the rate of movement of said traces, the movement of said film being parallel to the movement of said traces and in synchronization therewith to form undistorted reproductions of said traces on said film.

3. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously supplying first and second out of phase signal voltages to the horizontal and vertical deflection plates, respectively of said oscilloscope, so as to form a series of non-identical traces on said screen of said oscilloscope, sweep means for effecting movement of said traces during formation thereof, photographic means for continuously recording said traces, said photographic means being positioned in operative relation to said screen and having a continuously moving film, drive means for feeding said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, and means for operating said sweep means at a rate governed by the rate of operation of said drive means whereby the rate of feed of the film may be synchronized with the rate of movement of the traces across the screen of the oscilloscope, the movement of said traces being parallel to the movement of said film and in synchronization therewith to form undistorted reproductions of said traces on said film.

4. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously applying first and second out of phase signal voltages to the horizontal and vertical deflecting plates, respectively, of said oscilloscope, so as to form a series of non-identical traces on said screen of said oscilloscope, sweep means for effecting movement of said traces during formation thereof, photographic means for continuously recording said traces, said photographic means being positioned in operative relation to said screen and having a continuously moving film, drive means for feeding said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, and means for operating said drive means at a rate governed by the rate of operation for said sweep means whereby the movement of the traces across the screen of the oscilloscope may be synchronized with the rate of feed of the film, the movement of said film being parallel to the movement of said traces and in synchronization therewith to form undistorted reproduction of said traces on said film.

5. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously applying first and second out of phase signal voltages to the horizontal and vertical deflecting plates, respectively, of said oscilloscope, so as to form a series of non-identical traces on said screen of said oscilloscope, sweep means for effecting movement of said traces during formation thereof, photographic means for continuously recording said traces, said photographic means being positioned in operative relation to said screen and having a continuously moving film, drive means for moving said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, said drive means comprising a driven shaft and a feed roller operated thereby, and means for operating said sweep means at a rate governed by the rate of operation of said shaft whereby the rate of feed of the film may be synchronized with the rate of movement of the traces across the screen of the oscilloscope, the movement of said traces being parallel to the movement of said film and in synchronization therewith to form undistorted reproductions of said traces on said film.

6. Apparatus of the character described comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneous-

ly applying first and second out of phase signal voltages to the horizontal and vertical deflection plates, respectively, of said oscilloscope, so as to form a series of non-identical traces on said screen of said oscilloscope, sweep means for effecting movement of said traces during formation thereof, photographic means for continuously recording said traces, said photographic means being positioned in operative relation to said screen and having a continuously moving film, drive means for moving said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, said drive means comprising a driven shaft, a feed roller operated by said shaft, a motor for driving said shaft, and means responsive to the rate of operation of said sweep means for controlling the speed of said motor whereby the rate of movement of the traces across screen of said oscilloscope may be synchronized with the rate of feed of the film, the movement of said film being parallel to the movement of said traces.

7. Apparatus for taking vectorcardiographs comprising an oscilloscope provided with a screen and pairs of horizontal and vertical deflecting plates, means for simultaneously applying a first and a second body voltage to the horizontal and vertical deflecting plates, respectively, of said oscilloscope whereby to form a series of traces in succession on said screen of said oscilloscope, photographic means for recording said traces individually in succession as they are formed on the screen comprising a movable film, feed means for moving said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen, said drive means comprising a driven shaft, a feed roller operated by said shaft, a potentiometer in circuit with one of the pairs of deflecting plates in said oscilloscope so as to apply a sweep voltage thereto, the arm of said potentiometer being secured to said driven shaft for rotation therewith whereby the rate of operation of said feed means controls the rate of movement of said trace across the screen of the oscilloscope, the movement of said traces being parallel to the movement of said film and in synchronization therewith to form undistorted reproductions of said traces on said film.

8. Apparatus of the character described comprising a cathode ray tube having a screen, vertical deflecting means and horizontal deflecting means, means to apply first signal voltages to said vertical deflecting means and means to apply second signal voltages to said horizontal deflecting means to form a series of successive figure traces on said screen, means to generate sweep voltages and to apply said sweep voltages to one of said deflecting means during the formation of said figure traces with the other of said deflecting means being free of sweep voltages, whereby each figure trace is moved over said screen during the formation thereof to clear the screen for the formation of the next succeeding trace, and means to move a sensitized film past said screen parallel to the movement of said traces in a direction such that the direction of movement of the recorded image on said film is opposite to the direction of trace movement on said screen and at a rate in synchronism with the rate of said movement of the figure traces to form undistorted reproductions of said figure traces on said film.

9. Apparatus for recording vectorcardiographs comprising an oscilloscope having a screen and a pair of horizontal beam deflecting plates and a pair of vertical beam deflecting plates, means for simultaneously applying a first and a second body voltage to said horizontal and vertical deflecting plates, respectively, of said oscilloscope so as to form a series of traces in succession on said screen of said oscilloscope, sweep means connected to said pair of horizontal deflecting plates for effecting horizontal movement of said traces over said screen during the formation thereof, photographic means for recording said traces individually in succession as they are formed on said screen, said photographic means being positioned in operative relation to said screen and having a continuous sensitive film moving horizontally and parallel to the horizontal movement of said traces, means for moving said film in a direction such that the direction of movement of the recorded image is opposite to the direction of trace movement on said screen and means for synchronizing the rate of movement of said film with the rate of movement of said traces so as to form undistorted reproductions of said traces on said film.

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