

June 5, 1934.

W. A. MARRISON

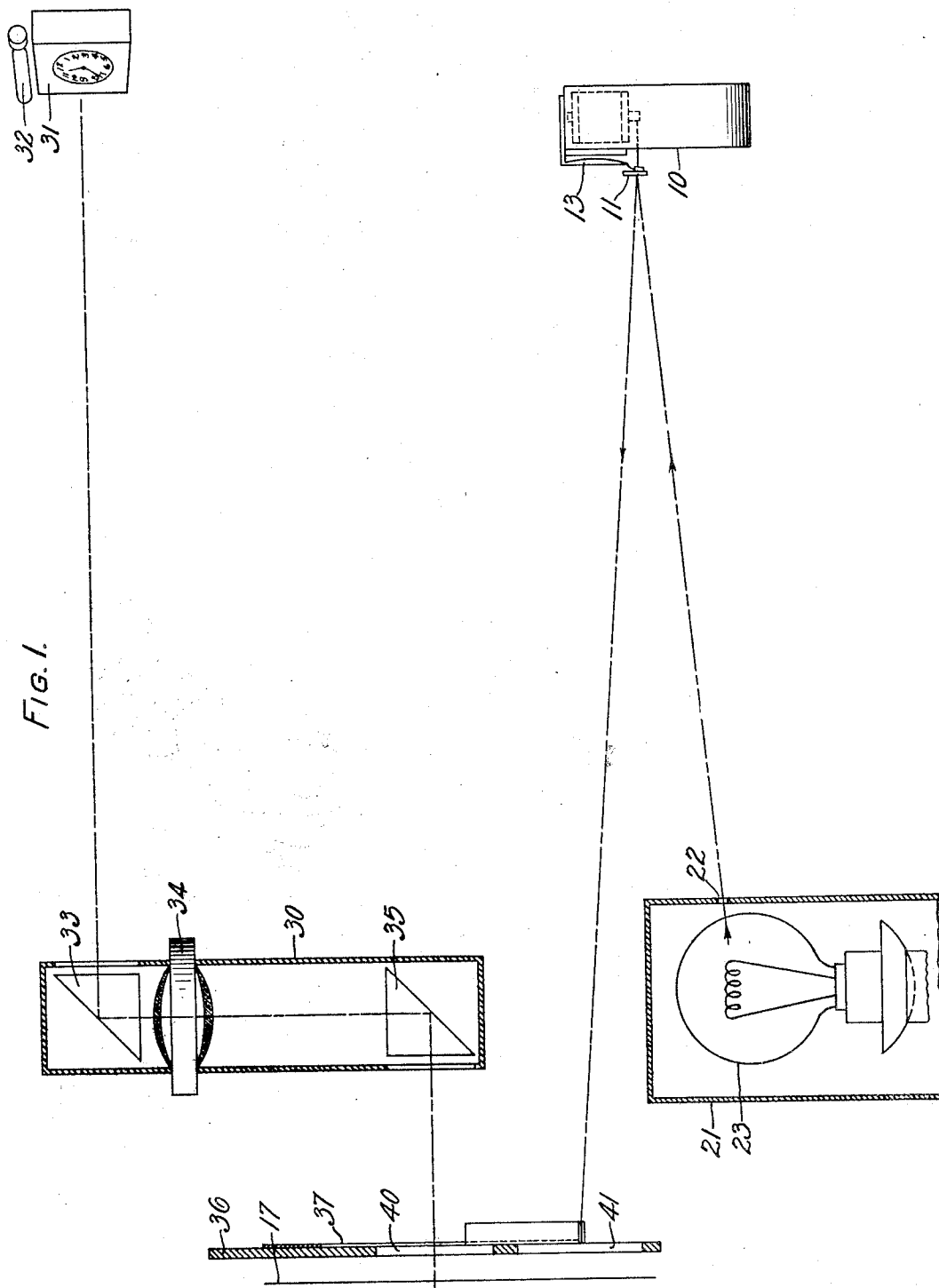
1,961,372

ELECTRICAL RECORDING

Filed Nov. 24, 1928

3 Sheets-Sheet 1

FIG. 1.



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FIG. 2.

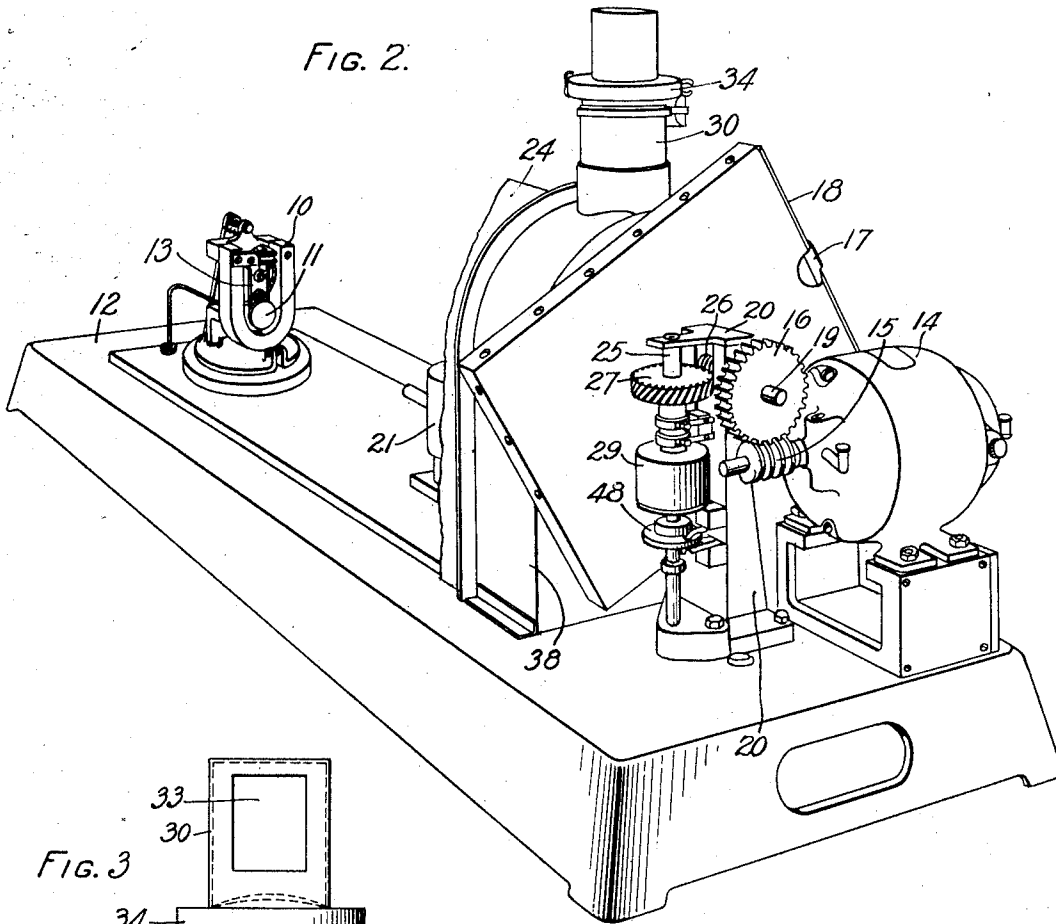


FIG. 3.

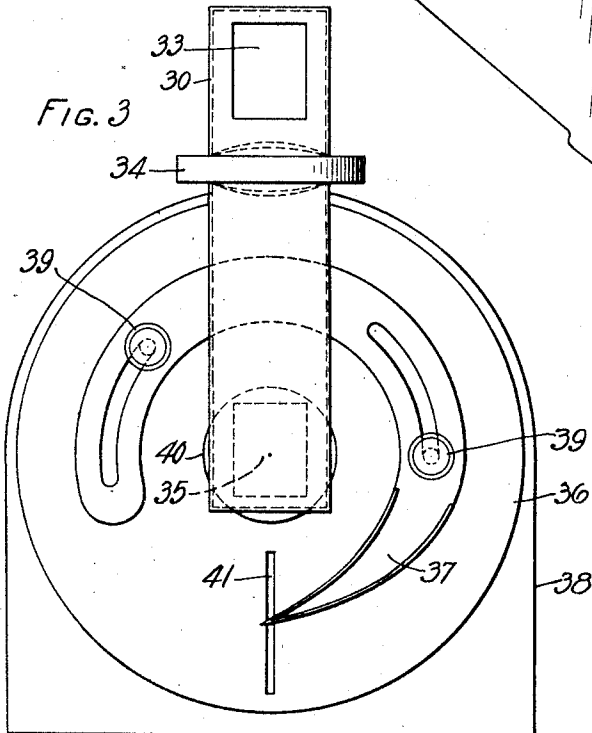
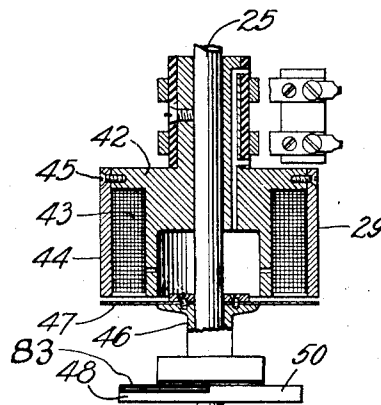


FIG. 4.



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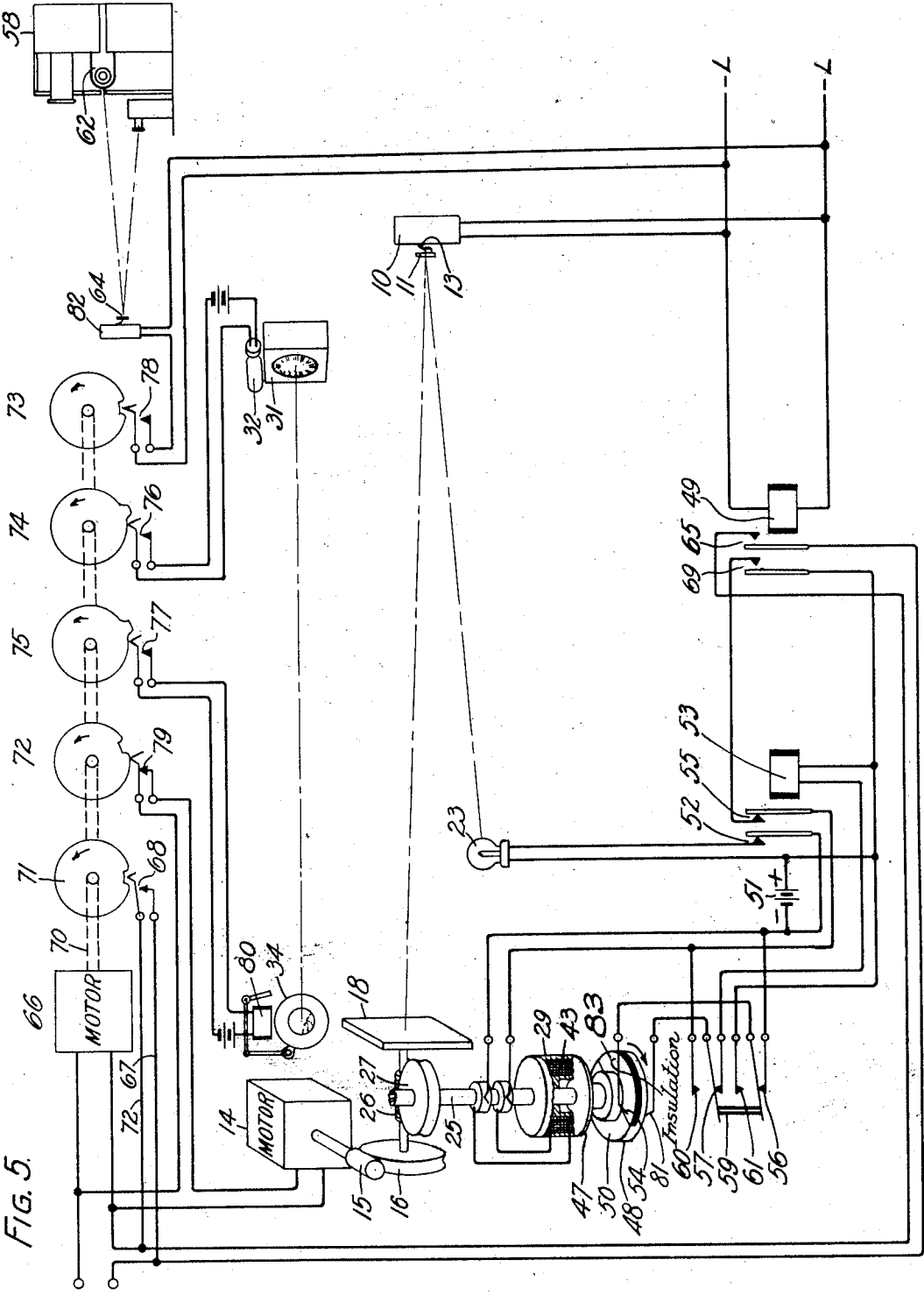


FIG. 5.

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UNITED STATES PATENT OFFICE

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ELECTRICAL RECORDING

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12 Claims. (Cl. 234—1.5)

The invention relates to electrical recording and more particularly to a device for automatically recording transients such as occur on transmission lines as a result of disturbances on neighboring power lines.

In order to study the effect that outside sources exert on telephone transmission lines it is desirable that a record be made of the transients which are induced thereon. Furthermore as these transients may occur at any time, it is desirable that the recording apparatus be arranged so that it will start recording at the very beginning of the disturbance on the line.

An object of this invention is to obtain a record of a disturbance on a transmission line which extends over a considerable period of time and which is complete as to what happens at the very beginning of the disturbance.

In accordance with one feature of this invention a polar oscillograph is connected across the line under observation and is run continuously, a shield being provided to render it insensitive to transients below a predetermined amplitude. The instant the transient exceeds the amplitude for which the shield is adjusted an oscillogram thereof is instantly recorded on a film or plate. In order to prevent overlapping of the record automatic means are provided to render the oscillograph inoperative after a predetermined time interval. This oscillograph is particularly valuable for giving complete information as to what happens during the first few cycles of a disturbance.

In accordance with another feature of this invention a second oscillograph, which is preferably of the motion picture film type, is also connected across the line under observation. The instant the disturbance exceeds the predetermined amplitude for which the variable shield in the polar oscillograph is adjusted, a sequence switch is operated which, among other functions, starts the second oscillograph in operation. As this oscillograph is put in operation by the transient, there will be slight interval between the time the disturbance begins and the time this second oscillograph starts recording. This second oscillograph preferably records on long strips of film and it is therefore obvious that a record of any desired length can be obtained.

In accordance with still another feature of this invention a camera is incorporated in each of the oscillographs by means of which identifying marks are photographed on the oscillograms.

When the two types of oscillographs are used in conjunction as described above, the records

obtained supplement each other, the information obtained being more complete than would be obtained by either instrument alone.

The invention may be more clearly understood by reference to the accompanying drawings in which Fig. 1 is a diagrammatic view of the optical system employed in the polar oscillograph; Fig. 2 is a view showing the arrangement of the parts of the polar oscillograph; Fig. 3 is a front view of the fixed and the variable shield employed therein; Fig. 4 is a cross-sectional view of the quick acting magnetic clutch; and Fig. 5 is a schematic view of the electrical circuits.

Referring to Figs. 1 and 2, a vibrator element 10 carrying a mirror 11 is attached to one end of base 12 of the polar oscillograph. This vibrator element may consist of a loud speaker driving mechanism such, for example, as disclosed in U. S. Patent 1,365,898, granted to H. C. Egerton on January 18, 1921 with the addition of mechanical means 13 to vibrate the mirror 11 about an axis in its plane at an amplitude proportional to the input current. A small constant speed motor 14 is attached at the opposite end of base 12 and by means of gears 15 and 16, rotates a light sensitive film or plate 17 in a plane parallel to the plane of mirror 11. This film is contained in film holder 18 which is attached to shaft 19 journaled in stanchion 20. A light tight compartment 21 in which lamp 23 is mounted directly behind pinhole 22 is also attached to base 12 intermediate mirror 11 and film 17 so that the mirror reflects the light from the pinhole to the moving light sensitive paper or film 17 a few inches from its center of rotation.

A quick acting magnetic clutch 29 is attached to shaft 25 and rotated by power supplied by motor 14 through gears 15, 16, 26 and 27, gear 27 being so designed that for each complete revolution of film holder 18 mounted on shaft 19, the magnetic clutch will only make one-half of a revolution.

A light tight cover 24 which is long enough to cover the vibrator element 10 and the optical system is also attached to base 12. In Fig. 2 this cover is shown broken away in order to better illustrate the essential elements of the device.

A camera 30 comprising a pair of right angle reflecting prisms, and a lens and shutter is mounted in the light tight cover 24 in such a way that the image of a clock 31 illuminated by a light 32 enters the right angle reflecting prism 33 and is reflected down through the lens and shutter 34 to prism 35 which in turn directs it toward the center of film 17.

A pair of shields 36 and 37 are inserted in the light path of the reflected beam and are attached to the rear wall 38 of the light tight enclosure 24, as shown more clearly by Fig. 3.

Shield 36 which is secured to the rear wall 38 consists of a disc that covers the whole area of film, that otherwise would be exposed, except a small space 40 in the center to enable the light reflected by prism 35 to pass through, and a slit aperture 41 just wide enough and long enough to pass the spot of light reflected from the mirror 11 on the vibrator element when it is vibrating at maximum amplitude. The other shield 37 is of variable width and by means of screws 39 it can be adjusted to cover a predetermined amount of the slit aperture 41. This shield is employed to prevent exposure of the film on the zero axis and also to prevent fogging due to disturbances of smaller amplitude than it is desired to record.

Referring to Fig. 4 the quick acting magnetic clutch 29, referred to above, comprises a core 42 which is preferably of soft iron and is fixedly attached to shaft 25, and is adapted to be magnetized by an energizing winding 43 which is located at the outer rim of the core. A thin outer shell 44 which forms a part of the magnetic circuit and which serves to protect the winding from mechanical injury is attached to the core by screws 45. The driven member of this clutch consists of a heavy hub portion 46 rotatably mounted on shaft 25 and a thin iron diaphragm portion 47 which is securely attached to hub portion 46. The faces of the driving and driven members are separated by a space of only a few thousandths of an inch and when winding 43 is excited, the outer rim of the diaphragm portion is attracted, causing it to flex upward thereby bringing the two members into frictional engagement. Since the diaphragm is very thin and is separated from the face of the electromagnet by only a very small air gap, it is obvious that the driving and driven members of the clutch are brought together quite rapidly upon the energization of the winding 43. Furthermore, due to the attractive force being at the extreme outer edge, maximum torque is obtained with this clutch for a given magnetic flux. A commutator 48 comprising an insulating segment 83 and a conducting segment 50 is also rotatably mounted on shaft 25 and forms an integral part of the driven member of the magnetic clutch 29.

By referring to Fig. 5 a clearer conception may be had of the operation of this device. The film 17 in film holder 18 is continuously rotated in its plane by motor 14 which is connected across a suitable power source and the mirror 11 on the vibrator element 10 which is connected across the line LL under observation reflects the beam of light coming from the lamp 23 through pinhole 22 (Fig. 1) toward a point on the film a few inches from its center of rotation. By adjusting the shield 37 as shown more clearly in Fig. 3 the beam is prevented from striking the rotating film when the current passing through the vibrator element 10 from the line LL is below a predetermined amplitude. The instant, however, that the current variations in the vibrator element exceed this predetermined amplitude a record thereof will be made on the film. In order to prevent overlapping of the record a relay 49, associated with the polar-oscillograph and connected across the line under observation in parallel with the vibrator element 10 is adjusted so that it operates the instant the current variations in the vibrator element exceed the ampli-

tude for which the variable shield 37 has been adjusted. When relay 49 operates it closes contact 69 which completes a circuit from the positive side of battery 51 through contact 69 of relay 49, contact 55 of relay 53, clutch winding 43 and back to the negative side of battery 51, thereby energizing clutch winding 43 which causes the operation of magnetic clutch 29, which in turn rotates commutator 48 in a clockwise direction. In its initial position, commutator brush 54 is in contact with the insulated segment 83 and lamp 23 is lit by power supplied from battery 51 through a circuit including contact 52 of relay 53. Lamp 23 remains lit during the time that brush 54 is in contact with the insulated segment 83 of commutator 48. The instant, however, that commutator 48 is rotated sufficiently so that commutator brush 54 makes contact with conducting segment 50 a circuit is completed from the negative side of battery 51, through contact 56, conducting segment 50, brush 81, contact 57, the winding of relay 53, and back to the positive side of the battery 51. Relay 53 is thus operated and in operating breaks the circuit through lamp 23 at contact 52 thereby extinguishing it and thus completing the record made by this oscillograph. Relay 53 when operated also breaks a circuit through the energizing winding 43 of magnetic clutch 29 at contact 55 and stops the rotation of commutator 48, thereby leaving the oscillograph in an operated position. It is thus seen that the commutator 48 makes only a half revolution after the variations in the line under observation exceed the amplitude for which shield 37 and relay 49 have been adjusted before lamp 23 is extinguished. It is evident therefore that the film makes one complete revolution after the beginning of the record before the polar-oscillograph is rendered inoperative. A slight overlap of the oscillogram may be eliminated by making the insulated segment less than 180°.

In order to restore the mechanism to its initial or non-operated position, key 59 is manually operated to close contacts 60 and 61 and to open contacts 56 and 57. Opening contacts 56 and 57 opens the winding circuit of relay 53, allowing contact 52 to return to its original position, thus completing a circuit from battery 51, through lamp 23, causing it to light. Closing contacts 60 and 61 completes a circuit from battery 51 through winding 43, contact 60, brush 81, conducting segment 50, brush 54, contact 61 back to battery, thereby energizing the magnetic clutch 29 which rotates commutator 48 until brush 54 is in contact with the insulated segment 83, at which time the circuit through winding 43 is broken and the rotation of the commutator 48 is again stopped due to the deenergization of clutch 29. The brush 54 is again on segment 83 which is in its normal or non-operated position. Key 59 is then manually restored to its original position and the entire oscillograph mechanism is again in its non-operated position.

While it is evident that a record produced by the oscillograph of the type just described will in most instances give the information desired, since it shows the characteristics of the disturbance at its very beginning, yet in many cases a record extending over a greater period of time is desirable. To accomplish this, a second oscillograph 58 recording on long strips of photographic film or paper is adapted to be put in operation within a very short time interval after the beginning of the disturbance and is employed in conjunction with the polar oscillograph, the polar

oscillograph being used to record the beginning of the disturbance and the second oscillograph being used to record the disturbances over an extended period. In the case of the second oscillograph the record is made either on a standard motion picture film, or on a bromide paper 62 of the same width and punched in the same fashion. The film 62 is contained in a standard magazine from which it is carried over a sprocket 10 driven by a motor through a suitable train of gears and is taken up in a second magazine. In this case the light from a source, similar to that used in the polar oscillograph, is reflected through a slit toward the film 62 by means of a mirror 15 64 mounted on the vibrator element 82 which is connected across the line LL under observation, both the mirror and the vibrator element being essentially the same as those used in the polar oscillograph.

20 When the two types of oscillographs are employed in the recording system the polar oscillograph is connected across the line under observation and is maintained in an operative position prior to the beginning of the transient, so as to instantly record the transient when it exceeds a certain predetermined amplitude, means being provided as explained above, for rendering the device insensitive after the recording film has made one complete revolution after the beginning of the transient. The motion picture film oscillograph, however, is maintained in a non-operative position prior to the beginning of the transient but is adapted to be put in operation during the first cycle of the disturbance so as 25 to start recording before the polar oscillograph is rendered non-operative. Once the motion picture film oscillograph is put in operation it continues recording until the entire length of the recording strip has been exhausted or until the device is shut off manually.

40 From the foregoing it is seen that there are a number of operations which must be performed automatically and in sequence in order to insure the proper operation of the system and for this reason a sequence switch is employed in conjunction with the oscillographs. This sequence switch consists of a motor 66 which is so geared to a shaft 70 that the shaft makes a predetermined number of revolutions per minute. Several cams 50 are mounted on the shaft and arranged to operate a number of contact combinations as shown in Fig. 8 in any desired order as the shaft rotates. As already pointed out relay 49 is operated during the first cycle of a disturbance in excess of a predetermined amplitude and in operating performs two functions by closing contacts 65 and 69. As already explained contact 69 in closing completes a circuit which renders the polar oscillograph insensitive to further variations after the film has made one complete revolution after the beginning of the record. Contact 65 in closing completes a circuit through the motor 66 of the sequence switch, thus causing the rotation of shaft 70 in a counter clockwise direction as indicated by the arrows. The instant 55 shaft 70 starts rotating cam 73 closes contact 78, thus connecting the motor element 82 across the line under observation. It also completes an energizing circuit (not shown) through the motor of the motion picture oscillograph which drives the film 62. This arrangement makes certain that the record on the motion picture oscillograph is started before the record on the polar oscillograph is completed. The instant shaft 70 starts rotating it also closes contact 68, on cam 70

71 thereby locking the energizing circuit through motor 66 during one complete revolution of the shaft 70. This insures the proper operation of the sequence switch in case the disturbance which operates relay 49 is not of sufficient duration to maintain this relay operated during such period. As the shaft continues to rotate cams 74 and 75 which are properly positioned thereon close contacts 76 and 77 respectively after the record on film 17 has been completed. By the closing of contact 76 a circuit is completed through the lamp 32 which illuminates the face of clock 31 and by the closing of contact 77 a circuit is completed through relay 80 which operates shutter 34 of camera 30, thereby automatically photographing the face of the clock on the film of the polar oscillograph immediately upon the completion of the record.

In the operation of a system of this type it is possible by the addition of cams on the sequence switch to substitute another polar oscillograph in place of the operated polar oscillograph to record the beginning of a subsequent disturbance which may take place on the line before the operated polar oscillograph is manually returned to its non-operated position.

While the invention has been described with particular reference to telephone transmission lines, it is to be understood that it is applicable to the study of vibratory disturbances in other systems.

What is claimed is:

1. The method of recording a transient on a line which consists in maintaining an oscillograph in operative condition to record the transient the instant said transient exceeds a predetermined amplitude directing a beam of light from said oscillograph to the recording means and screening said recording means to prevent the recording by said beam of light of transients below the predetermined amplitude.

2. The method of recording a transient on a line which consists in rendering one of a plurality of oscillographs connected across the line unresponsive to variations below a predetermined amplitude, maintaining said oscillograph in an operative condition to record the transient the instant said transient exceeds the predetermined amplitude, automatically rendering said oscillograph inoperative a given time interval after said transient has exceeded said predetermined amplitude and rendering another of said oscillographs operative before said first mentioned oscillograph is rendered inoperative.

3. A system for recording transients comprising an oscillograph having its vibrator element connected directly across the line under observation and maintained in an operative condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude, means for recording said transient when said transient exceeds said predetermined amplitude, and means for automatically rendering said oscillograph inoperative a given time interval after said transient has exceeded said predetermined amplitude.

4. A system for recording transients comprising an oscillograph connected across the line under observation and maintained in an operative condition, means comprising a variable shield for rendering said oscillograph unresponsive to transients below a predetermined amplitude, and means for automatically rendering said oscillograph inoperative a given time interval after said

transient has exceeded said predetermined amplitude.

5 5. A system for recording transients comprising an oscillograph having its vibrator element connected directly across the line under observation and maintained in an operative condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude, and means controlled by said transients
10 for rendering said oscillograph inoperative a given time interval after said transients have exceeded said amplitude.

6. A system for recording transients comprising an oscillograph connected across the line
15 under observation and maintained in an operative condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude, and means comprising a quick acting magnetic clutch for rendering said oscillograph
20 inoperative a given time interval after said transients have exceeded said amplitudes.

7. A system for recording transients comprising an oscillograph connected across the line under observation and maintained in an operative
25 condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude, and means comprising a quick acting magnetic clutch, the action of which is controlled by transients above the predetermined
30 amplitude for rendering said oscillograph inoperative a given time interval after said transients have exceeded said amplitudes.

8. A system for recording transients comprising an oscillograph connected across the line
35 under observation and maintained in an operative condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude and means controlled by said transients for rendering said oscillograph
40 inoperative a given time interval after said transients have exceeded said amplitudes and for automatically recording identifying marks on the oscillograph film the instant said oscillograph is rendered inoperative.

45 9. A system for recording transients comprising an oscillograph connected across the line

under observation and maintained in an operative condition, means for rendering said oscillograph unresponsive to transients below a predetermined amplitude and means controlled by said transients for rendering said oscillograph inoperative a given time interval after said transients have exceeded said amplitudes and for automatically illuminating an indicating device to produce a record thereof on the oscillograph film after said oscillograph has been rendered inoperative.

10. A system for recording transients comprising a plurality of oscillographs connected across the line under observation, one of said oscillographs being adapted to start recording a transient impressed upon the line at the instant the transient exceeds a predetermined amplitude and to be rendered inoperative after a predetermined length of time, and another of said oscillographs being adapted to start recording said transient before said first mentioned oscillograph is rendered inoperative.

11. A system for recording transients comprising a plurality of oscillographs connected across the line under observation, means for rendering one of said oscillographs unresponsive to transients below a predetermined amplitude, means for rendering said oscillograph inoperative a given time interval after said transient exceeds said amplitude, and means for rendering another of said oscillographs operative before said first mentioned oscillograph is rendered inoperative.

12. A system for recording transients comprising a plurality of oscillographs connected across the line under observation, means comprising a variable shield for rendering one of said oscillographs unresponsive to transients below a predetermined amplitude, means controlled by said transients for rendering said oscillograph inoperative a given time interval after said transients exceed said amplitude, and means for automatically rendering another of said oscillographs operative before said first mentioned oscillograph is rendered inoperative.

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