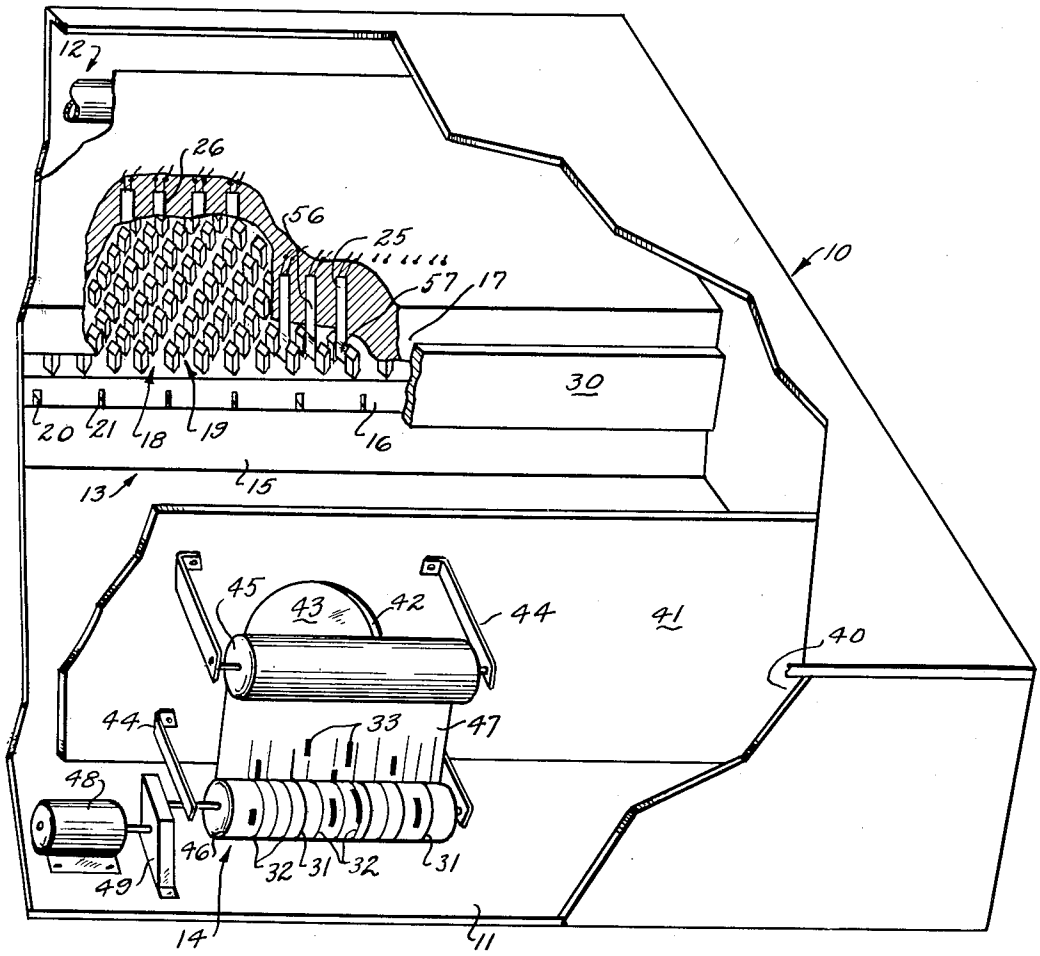
Oct. 25, 1955 F. VILBIG 2,721,782

MULTICHANNEL TIME RECORDING OF A PLURALITY OF EVENTS

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Fig. 1



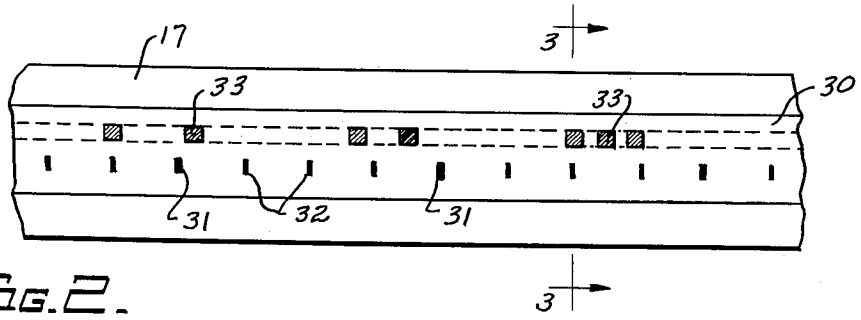


Fig. 2.

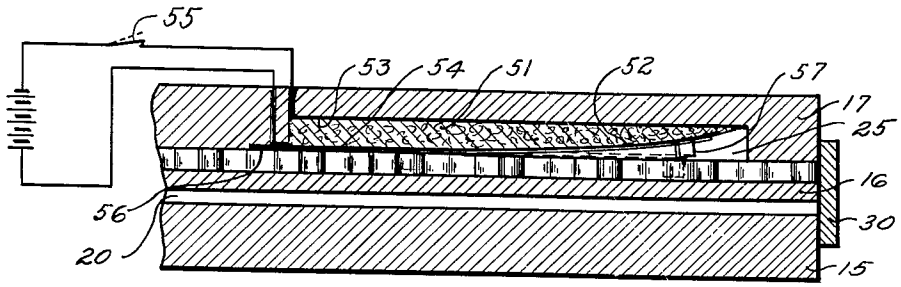
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MULTICHANNEL TIME RECORDING OF A PLURALITY OF EVENTS

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FIG. 3



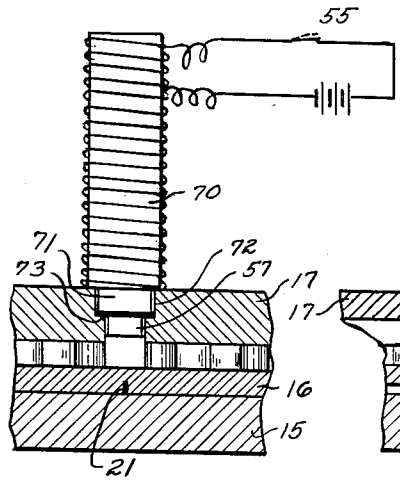


FIG. 4

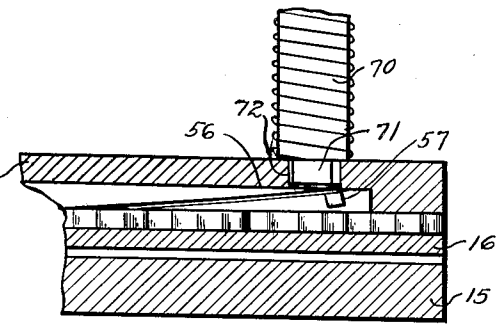


FIG. 5

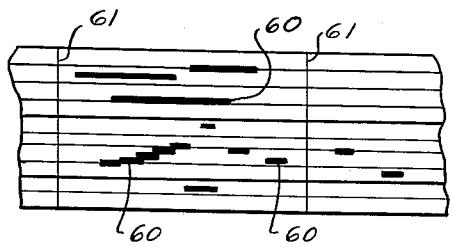


FIG. 6

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2,721,782

MULTICHANNEL TIME RECORDING OF A PLURALITY OF EVENTS

Friedrich Vilbig, Cambridge, Mass.

Application May 5, 1953, Serial No. 353,246

1 Claim. (Cl. 346—107)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to a multichannel light control recording device for recording the time duration and correlation of a plurality of different measurement events.

This invention contemplates the recordation on film, or other record receiving memory device, of a plurality of events that may be happening simultaneously, alternately, successively, sequentially, or overlappingly, whether such events are happening periodically or randomly. This is accomplished by having a plurality of light passages closed by light shutters which passages terminate at the light outlet ends thereof on a ground glass plate. A light source is positioned at the inlet ends of the light passages whereupon the opening of any of the light passages by the light shutters will allow the light in those passages to fall on the ground glass plate at separate points at the ends of those open light passages. The images of those lighted points on the ground glass are brought to focus on a focal plane through an objective lens and, in the illustration of the invention herein, a film is slowly moved along the focal plane whereby the light points from the various light passages are exposed on the slowly moving film, it being understood that the entire structure hereinabove is sealed against exterior light. Each light shutter is operated by electrostatic or electromagnetic means in which the electric current therefor is switched by the event to be recorded for the time duration that the event continues, for example, the time that a door is open or that a key is depressed, etc. Each light passage image on the ground glass will focus at a different point on the film through the object lens so that if the film be made to travel normal to the plane of all the light passages, each light passage image would be able to expose and produce a separate line on the film and thus a comparison of the happening of all the events can be made.

Where it is desirable to put reference lines on the film, or other memory recording device, separate continuously open light passages may be used in combination with the shuttered light passages. This arrangement is quite useful where the invention is adapted for recording musical notes and the events come from a "musical writer."

In order to produce the light points on the ground glass plate in close relation such that, if all the light passages were open, a continuous light pattern or light band would be formed, the light passages are arranged in two angular series crossing each other such that the exits of all the light passages are adjacent or juxtaposed. In this manner a great number of light passages can concentrate their exit patterns in a substantially continuous light band whereby a great many events, for example a hundred or more, can be recorded with a relatively small piece of equipment. It is therefore a general object of this invention to provide a device for recording on film, or other memory recordation implement, the time duration and time correlation of a plurality of events which may happen together or separately, periodically or randomly.

These and other objects, advantages, features, and uses will become more apparent as the description proceeds when taken in view of the accompanying drawings, in which;

Fig. 1 is an isometric view of the invention with parts and portions sectioned to disclose constructional details;

Fig. 2 is a portion of the front face of the ground glass plate with examples of light passage patterns thereon;

Fig. 3 is a sectional view of the preferred form of the light shutter used;

Fig. 4 is a partial end sectional view of a modified form of light shutter;

Fig. 5 is a partial side sectional view of the modified light shutter shown in Fig. 4; and

Fig. 6 is a portion of the film, or memory recording device, showing the recorded events.

Referring more particularly to Fig. 1, the multichannel recording device is inclosed in a light impervious case **10** having a base **11**. Mounted on the base **11** within the case are a light source **12**, a light channeling unit **13**, and a film or other memory recording unit **14**.

The light channeling unit **13** consists of a block illustrated in three sections **15**, **16**, and **17** although this unit may be made in more or less sections where desirable and feasible. The lower section **15** provides a base and is substantially plain. On section **15** is mounted the second section **16** having a plurality of light channels therein in two parallel angular series **18** and **19**, each parallel series crossing the other parallel series. The two series of light channels **18** and **19** are cut completely across the top surface of the section **16**, each channel being substantially square in cross-sectional area, whereby light from the light source **12** may pass through the light channels. The exit ends of the light channels are adjacent such that light emitted will be alternate from one series of passages to the other. The underside of the section **16** has channels **20** and **21** of which **20** are of greater cross-sectional area than the channels **21** in order to trace a bolder line on the film or memory device, as will later be better understood. The cross-sectional size and spacing of the light channels **20** and **21** can be made for particular purposes in drawing reference lines on the recording tape or film, or may be omitted altogether, but are herein illustrated as having every fourth channel **20** and three intermediate channels **21** spaced such that they appear under every fifth light channel **18** or **19**, as will later appear feasible. The light channels **20** and **21** are cut completely across the undersurface of the section **16** and perpendicular to the light exit face to provide open light passages from the light source **12** to the exit face with sections **15** and **16** together as shown.

The top section **17** is positioned over the section **16** wherein the light channels **18** and **19** become light passages. In the under surface of the section **17** are elongated pockets **25** and **26** in two series, the series **25** being near the light exit face and the series **26** being near the back face. The pockets **25** and **26** house electrostatic shutters, soon to be described, which normally close the light passages **18** and **19**. While the light shutters and pockets are constructed exactly alike, for the purpose of explanation herein the light shutters in pocket series **25** control the light passage series **18** and the light shutters in pocket series **26** control the light passages **19**. The positioning of the light shutters in series as explained above is not necessary except insofar as required by space limitations.

On the light exit face of the composite sections **15**, **16**, and **17** is a ground glass plate **30** which is of a size to completely cover all the light passage exits. The light source **12** is preferably a tube type known as the "Soffitt" lamp which is an elongated cylindrical frosted tube having a tungsten filament extending lengthwise thereof. Light

along the tube **12** is sealed out of all the case except through the light passages. Light from the source **12** will pass through all open light passages to form light patterns on the ground glass plate **30** as shown in Fig. 2 of which **31** are examples of light coming through light passages **20, 32** are examples of light coming through light passages **21**, and **33** are examples of light coming through light passages **18** and **19** where the respective light shutters are open.

The film recording unit **14**, illustrated herein for explanation although other light sensitive memory recording devices may be used, is housed in a separate compartment **40** of the case **10** divided off by a wall **41**. The wall **44** has a single opening **42** in which is mounted an objective lens **43**. Brackets **44** support two film reels or rollers **45** and **46** which will support a film **47** thereon in the focal plane of the lens **43**. The unexposed film is on reel **45** and reeled onto the roller **46**, the reel **46** being driven slowly by a motor **48** through a gear reduction means **49**. By way of illustration the exposed portion of the film **47** shows the bold and secondary reference lines formed by the open light passages **20** and **21**, respectively, and the exposed patterns resulting from corresponding open light passages **18** and **19**. Reference characters show the corresponding light patterns on the glass plate of Fig. 2 which illustrates the film exposure resulting from the camera effect of imaging the light patterns of the ground glass plate **30** on the film **47**.

Referring now more particularly to Fig. 3 where a longitudinal cross-section of one of the electrostatic light shutters is shown, the "pocket" **25** referred to above in the section **17** is identified as **25** in this view and is representative of the "pocket" portion **26** as well. In this pocket is a semiconducting slate slab **51** having an upwardly curved lower face **52** toward the light exit face on which the ground glass plate **30** is mounted. On the upper and lower surfaces of the slate slab **51** are metal plates **53** and **54** which are connected in circuit through an electric switch **55** to a voltage source of some 200 to 300 volts. Attached on the underside of section **17** in back of the pocket **25** is a metallic shutter strip **56** as of Phosphor bronze having a depending lip **57** on the forward end thereof that normally rests across a light passage **18** or **19**. As may be seen in the view of Fig. 1, the depending lip **57** rests in a plane angularly of the plane perpendicularly through the longitudinal centerline of the strip in order to be positioned in a plane perpendicular to the side walls of the light passage. Upon the closing of the switch **55** the shutter strip **56** will be lifted from the dotted line position to the position shown opening the light passage. Opening of the switch **55** will immediately return the shutter to the dotted line position by its inherent resiliency. This electrostatic means is known as the Johnson-Rahbek effect and is accomplished in the following manner. The upper and lower surfaces of the slate slab **51** are of microscopic roughness in the order of 10^{-5} to 10^{-7} centimeters. The metal plates **53** and **54** contact the slate slab **51** only at specific points. At other points practically the full potential exists between the metal plate and the slate surface which forms a kind of a condenser in which the slate surface and the metal plate are the two condenser plates and have a distance $d=10^{-5}$ to 10^{-7} centimeters. Because of the high potential and the small distance a large force is produced,

$$F=\frac{AE^2}{8\pi d^2}$$

where A is the area and E is the voltage. The force depends on the squares of the slope **52** for lifting the shutter **56—57** but for the slope represented the force is sufficient to provide a fast acting shutter. While the voltage source for the light shutters is illustrated in Fig. 3 as a battery, it is to be understood that an alternating voltage may be used with frequencies up to 5 or 6 megacycles.

It may be readily understood from the above description that a plurality of different events can all be recorded on the film **47** by arranging the switch of each electrostatic light shutter to be actuated by the event to be recorded, as for example, movements of measuring probes, multi-channel telegraphy, radio telemetering, musical notes, etc. With the individual switches **55** so arranged and the motor **48** operating to move the film at a fixed speed, the events will be recorded as illustrated on the film **47**, Fig. 1, and in Fig. 6. As a practical example of one of the many uses of the invention the switches **55** may each be positioned to be actuated by individual keys of a piano or a similar musical keyboard with the key and switch corresponding to the proper note to be produced on the film. For a simple construction the ordinary note types cannot be used where time will be given by different shapes of the single note heads. Instead the length of these different notes wil produce corresponding lengths of lines but it is not possible to write half notes by using the standard signs of the sharp and flat. This is avoided by indicating the notes not only on the lines and in the spaces but also indicating half tones on the bottom third and on the top third of the spaces as shown by **60** in Fig. 6. By playing the piano or the musical keyboard the notes are "written" on the film **47**. The musical bars **61** may be produced on the film by actuating a master switch in any well known manner (not shown) to place all the light shutters in circuit simultaneously for an instant, or by closing a condenser circuit which, upon discharge, will produce an instantaneous voltage in all the light shutter circuits. Indications of volume (*p, pp, mf, f,* and *ff*) can be produced by special keys which give light signals that can be recorded on the film.

As shown in Figs. 4 and 5 the operation of the light shutters may be carried out in other ways. In the modification shown herein the shutter strip may be attracted to open position by an electromagnet **70** in which a pole end **71** may extend into an opening **72** in the section **17** just above the shutter depending portion **57** of the light shutter strip **56**. The clearance between the pole end **71** and the shutter strip **56** need be only sufficient in the deenergized condition to permit sufficient lift of the shutter to clear the light passage in the energized condition of the electromagnet. The openings **72** are made sufficiently larger than the light passage to provide a shoulder therein on which a brass or plastic disc **73** is placed to prevent sticking of the strip **56** to the pole end **71** as a result of residual magnetism. Each electromagnet **70** is individually connected through a switch **55** to a voltage source as in the modification of the electrostatic shutters except that low voltage may be used. The operation of the multi-channel recording device using electromagnetic operated light shutters is the same as the operation of the device using the electrostatically operated light shutters.

There may be uses of this invention where it would be desirable to have actual time printed on the film, or other recording implement, for reference purposes. A time clock unit could be installed in the compartment **40** in any well known manner as shown in the patent to F. E. Garbutt issued on January 6, 1931, and bearing the Patent No. 1,787,940, to print the time at intervals along the film **47**.

It is to be understood that many modifications, changes, relation of parts, and proportions of the elements may be made in the illustrated forms of the invention to adapt it for various uses, whether mentioned herein or not, without departing from the spirit and scope of the invention and I desire to be limited only by the scope of the appended claim.

I claim:

A multichannel recording device for recording the time duration of a plurality of data comprising a housing, a first chamber at one end of said housing containing a light source extending thereacross, a second chamber positioned at the opposite end of said housing and having mounted therein a film recorder, a ground glass image

receiving screen and a condensing lens for forming an image of the light pattern on the screen in the plane of the recording film, and means for transmitting light from said first chamber to said second chamber to form illuminated areas on said ground glass screen representative of respective events to be recorded comprising a first set of parallel light transmitting channels extending from said first to said second chamber and inclined in a horizontal plane in one direction with respect to the longitudinal axis of said housing, a second set of parallel light transmitting channels extending between said first and said second chambers in a common plane with said first set of channels and inclined in the opposite sense from the longitudinal axis of the housing to intersect said first set of channels, intersecting pairs of light transmitting channels having common light inlets in the first

chamber and common light outlets in the recording chamber and adapted to form juxtaposed light spots on the ground glass screen when both channels of a pair of channels intersecting at the outlet are opened for light transmission, a shutter in each recording channel and adapted to be open for the duration of the event to be recorded in the corresponding channel, and electrical means for selectively operating the shutters.

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