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ARRANGEMENT FOR PHOTOGRAPHICALLY RECORDING VARIABLE PROCESSES
Filed Dec. 13, 1939

Serial No.
309,053
2 Sheets-Sheet 1

Fig.1

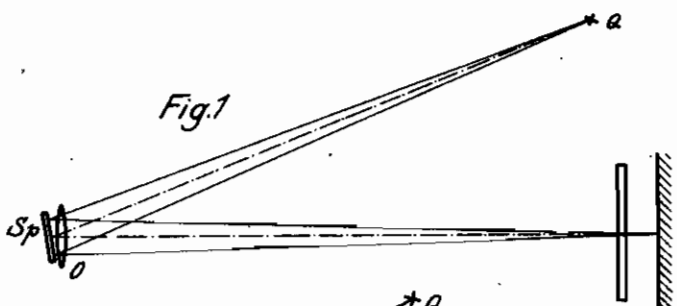

Fig.2

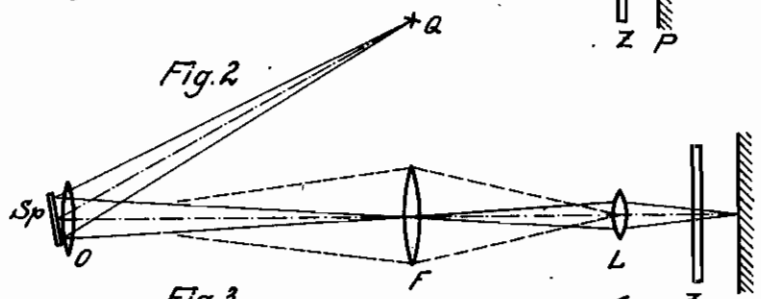

Fig.3

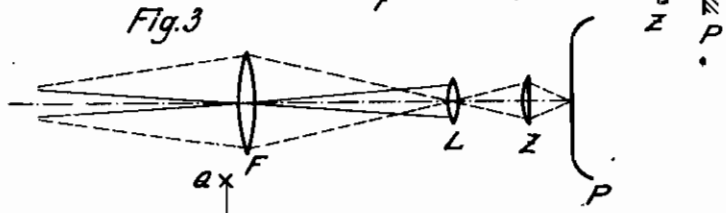

Fig.4

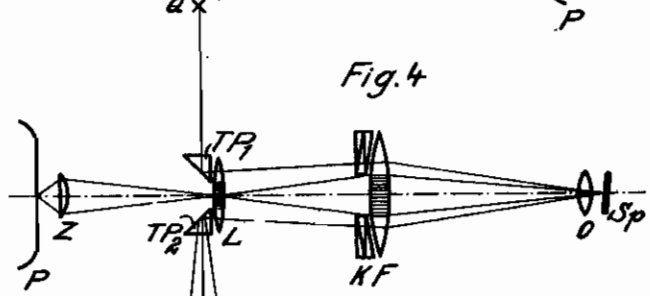

Fig.5

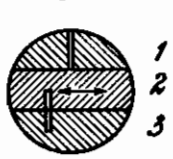

Fig.8

Fig.6

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Fig. 7

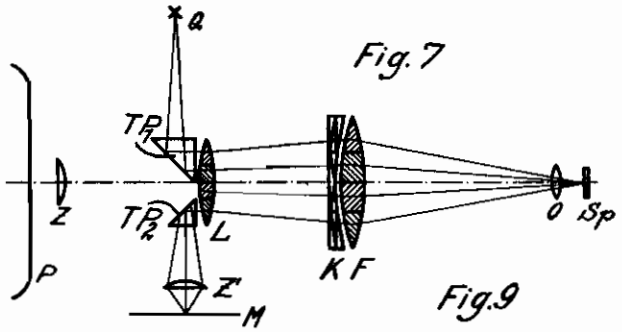


Fig. 9

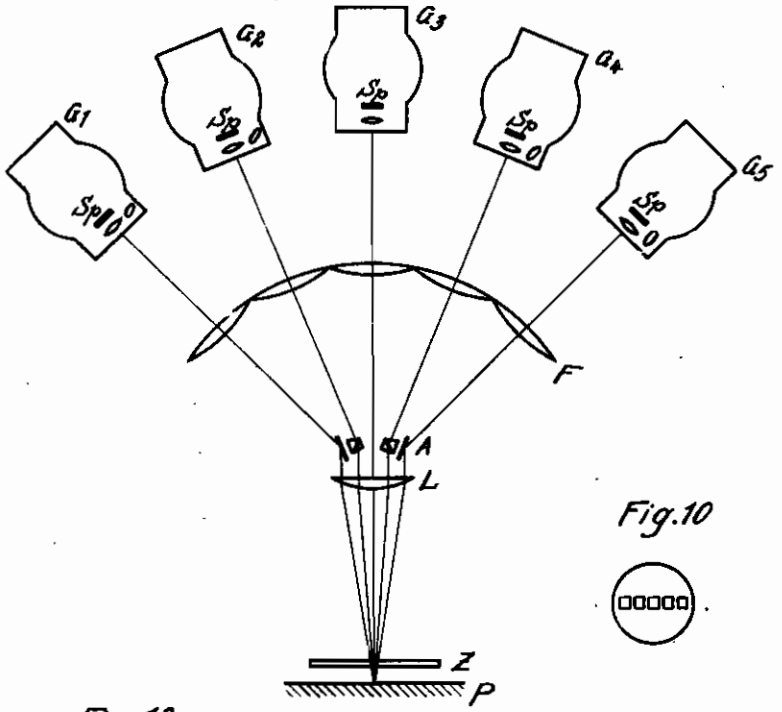


Fig. 10

Fig. 12

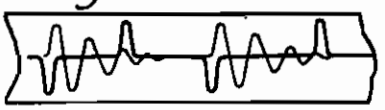


Fig. 13

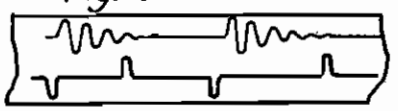
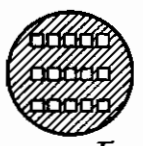


Fig. 11



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ALIEN PROPERTY CUSTODIAN

ARRANGEMENT FOR PHOTOGRAPHICALLY RECORDING VARIABLE PROCESSES

Heinrich Kaiser, Jena, Germany; vested in the Alien Property Custodian

Application filed December 13, 1939

This invention relates to an arrangement for photographically recording variable processes by means of a beam of light, in which case a light source, i. e., a filament of an incandescent lamp, a brightly illuminated slit or the like, is projected on a recording surface by means of an objective and an oscillating mirror controlled by the variable processes. This arrangement differs from the arrangements hitherto employed for the above-mentoined purpose in that the light source is projected by the objective first on a field lens which projects an image of the oscillating mirror on a further lens, i. e., the image lens, which in turn projects on the recording surface the image of the light source projected on the field lens. The essential feature of the invention is therefore the introduction of an intermediate projection of the light source or slit in such recording arrangements, whereby it is possible to bring about very important improvements in arrangements of the above-indicated character.

To obtain a distinct record also in the case of rapidly occurring processes, the light spot projected on the recording surface must be sufficiently bright. On the other hand, the diameter of the ray when recording must be very small, in order to enable a reading of the deflections and the corresponding periods with a certain accuracy. These requirements cannot be fulfilled in a satisfactory manner with the arrangements hitherto employed, whereas by means of the present invention it has been found that it is possible to shorten the effective length of the beam of light to such an extent as to attain a very distinct and sharp record.

The invention is of particular importance for arrangements adapted to record various processes in the form of curves which overlap each other at certain points or are in spaced relation to each other on a relatively small recording surface. It has been found that the most favorable conditions as to brightness and sharpness of the image are obtained when employing lengths of the beam of light of about 50 to 100 mm. However, in this case it was not possible with the arrangement hitherto known to arrange various oscillograph loops in spaced relation to each other. With the introduction of an intermediate projection of the light source or an illuminated slip on a field lens according to the invention various processes may be recorded on a surface in a particularly convenient manner. In this case a particular field lens is allotted according to the invention to each oscillating mirror system, a common image lens being, however, provided for all systems. Furthermore, suitable deviating devices, by means of which the images of the different oscillating mirrors are arranged in spaced relation to one another, are allotted to the individual oscillating mirror systems and the fields of view within which move the images of the lighted slit are optically in alignment or approximately in alignment. To enable the employment of optical systems of the same type for the projection of the images of the oscillating mirrors on the field lens, all oscillating mirror systems are preferably arranged at the same distance from the image lens; i. e., on a circular arc or a spherical surface.

In arrangements according to the invention it is, furthermore, possible to employ the field lens for the multiple recording of a process; for instance, for the simultaneous observation and recording as well as for the illumination of the oscillating mirrors. This is accomplished by the fact that in the case of an oscillating mirror system, the free aperture of the cylindrical lens determines the length of the slit image and therefore the width of the field lens strip which is traversed by the rays when projecting the slit. This free aperture may be kept very small. Consequently, only a relatively narrow horizontal strip of the field lens is necessary. The portions of the field lens lying above and below this strip may then be employed for the multiple recording and illumination of the mirrors as will be seen from the forms of the invention hereinafter described.

In the arrangement according to the invention it may be so arranged that the field lens on which is reproduced the intermediate image of the illuminated slit be subdivided into individual strip-shaped zones which run in parallel relation to the direction of movement of the beam of light and that particular deviating devices are provided which allot a particular pupil to each field; i. e., a particular image of the mirror, so that auxiliary paths of ray are formed for the further utilization of the field lens and image lens besides the main path of ray provided for the photographic record. Achromatic wedges may be employed as suitable deviating devices; also the arrangement of lenses whose centers are displaced with respect to one another may be employed as deviating devices; or the field lens may be combined with the deviating devices by dividing the field lens itself into individual lens sections whose centers are displaced with respect to one another; in this manner the achromatic wedges are dispensed with. In this case, the auxiliary paths

of ray caused by the deviating devices may be employed according to the invention to produce at the same time, for instance, by means of an oscillating mirror the photographic record in the main path of rays and various records of the same process or also a visual observation of the oscillogram. Furthermore, the oscillating mirror may be illuminated by the single light source with the aid of the auxiliary paths of ray brought about by the deviating devices by employing at the same time the main and auxiliary paths of ray for the different purposes. In this case the width of the slit for the path of ray for the visual observation may be made larger than the width of the slit for recording. This may be accomplished by arranging the slits on the field lens; i. e., by covering the portion of the field lens, provided for the illumination of the oscillating mirror, in the corresponding auxiliary path of ray so as to form two slits of different width lying one below the other.

In this manner in arrangements having a plurality of oscillating mirror systems, all mirrors may be illuminated by a single light source by producing as already mentioned above, auxiliary paths of ray with the aid of deviating devices arranged in front of the field lenses and by causing the illuminated slit to be brought to the point where the image lens in the corresponding path of ray projects the common image of the field lenses. A luminous slit image is there produced on each field lens and acts as a light source for the corresponding mirror. If the portion of the lenses symmetrical to the axis of symmetry thereof is utilized as the main path of ray, the perpendicular to the mirror is inclined by a small amount with respect to the axis of symmetry so that the image of the slit reflected by the mirror and projected by the objective is produced on the central portion of the field lens.

For the corresponding paths of ray of each individual oscillating mirror system, extending one above or below the other, the same deviating devices may be employed in front of the image lens which are used to arrange the images of the mirrors close to one another.

For a better distinction, the luminous rays which come from the different oscillating mirror systems and which serve for the visual observation may in addition be differently colored, in which case color filters are employed, arranged in front of the portions of the field lenses which serve as light sources for the visual observation.

Further details of the invention will be apparent from the following description taken in connection with the accompanying drawings, in which

Fig. 1 shows the beam of light recording arrangement hitherto employed.

Fig. 2 is a plan view of an arrangement according to the invention as applied to a single-loop oscillograph.

Fig. 3 is a part lateral view of the arrangement shown in Fig. 2.

Fig. 4 shows one form of the arrangement according to the invention with one main path of ray and two auxiliary paths of ray.

Fig. 5 shows a view of the field lens shown in Fig. 4.

Fig. 6 shows a field lens which combines the effect of a simple field lens with the effect of the deviating devices and which may be employed in the arrangement shown in Fig. 4.

Fig. 7 shows an arrangement according to the invention with one main path of ray and three auxiliary paths of ray.

Fig. 8 shows a view of the field lens shown in Fig. 7.

Fig. 9 shows the arrangement according to the invention as applied to a multiple-loop oscillograph.

Fig. 10 shows a view of the pupil field on the image lens shown in Fig. 9.

Fig. 11 shows a view of the pupil field on the image lens of a multiple-loop oscillograph arrangement with a main path of ray and two auxiliary paths of ray.

Fig. 12 shows a portion of a photographic record of two variable processes which are recorded one upon the other and

Fig. 13 shows the same processes which are recorded in spaced relation to each other.

In Fig. 1, Q denotes an illuminated slit or the filament of a single-filament lamp. This slit is sharply projected on the paper P by means of the oscillating mirror Sp and an objective O arranged in front of the mirror. In front of the paper is disposed a cylindrical lens Z which is ineffective in the cross-sectional view shown but projects the aperture of the objective O on the paper in a sectional plane perpendicular to the first plane.

The arrangement according to the invention is shown in principle in Figs. 2 and 3 in which the light source Q which is preferably represented by an illuminated slit is not directly projected on the paper but first on a field lens F. The slit image reproduced in F is sharply projected on the paper P by a further lens L. However, the field lens projects the oscillating mirror Sp on the lens L. In the sectional plane shown in Fig. 3 perpendicular to the sectional plane shown in Fig. 2 the aperture of the lens L, i. e. the image of the oscillating mirror Sp produced there is projected on the paper P by the cylindrical lens Z.

The images to be projected according to the arrangements shown in Figs. 2 and 3 may be magnified or reduced at will. Thus, for instance, the distance OF may be made very great in order to remove the spacious difficulties, for instance, when adjusting the optical arrangement. A deciding factor for the light intensity and the diffusion at the image fringes influencing the sharpness of the image is only the aperture ratio of the image lens L, since the image of the oscillating mirror is projected on this lens.

In Fig. 4 is shown a form of an arrangement according to the invention for the multiple utilization of the field lens. The portion of the field lens necessary for the main record is shown shaded. In front of the other portions of the field lens are arranged achromatic wedges K, the purpose of which is to allot to each field a particular pupil; i. e., a particular image of the mirror. The rays coming from the light source Q are caused by the total reflection prism TP_1 to be deflected towards the field lens F and illuminate the oscillating mirror and serve both for the projection in the main path of ray and for the observation of the oscillating processes in the auxiliary path of ray, since they are caused by a further total reflection prism TP_2 to be deviated towards a further cylindrical lens Z' and are projected on a ground glass M.

Fig. 5 shows the pupils for the three different paths of ray on the field lens. The rays passing in the upper path of ray 1 through the lens L do not change their position, whereas the central beam of rays 3 is a narrow luminous band for the photographic record and the lower beam of rays

4 is also a narrow luminous band for the visual observation.

Fig. 6 shows a field lens made of three lens sections which may be employed in an arrangement according to Fig. 4 instead of the simple field lens F and the achromatic wedges K. The center of the central lens section lies on the main axis, whereas the centers of the two outer sections are displaced in the outward direction.

In Fig. 7 is shown a path of ray divided into four parts, in which case both the illumination and the attainment of different slit widths is made possible from one and the same light source Q. To this end, the upper half of the field lens F is covered with the exception of two differently wide strips and is therefore designed as a double light slit as shown in Fig. 8 in the paths of ray 1 and 2. Fig. 8 shows in turn the pupils on the field lens F. The deviation is effected according to Fig. 7 by a wedge strip K which has a different deviating angle for every path of ray. As shown in Fig. 8 the slit images projected by the oscillating mirror Sp are reproduced on the lower half of the field lens F. The wide slit image 1 reproduced on the upper fourth portion of the field lens is again projected through the cylindrical lens Z' on the ground glass M by the lowest fourth portion 4 when reflected by the oscillating mirror and serves for the visual observation. On the upper inner fourth portion of the field lens is reproduced the narrow illumination slit image 2 for the photographic record. On the lower inner fourth portion of the field lens is reproduced the narrower slit image 3 reflected by the oscillating mirror and which is then projected on the photographic paper by the lens L.

Fig. 9 shows an arrangement according to the invention as applied to a multiple-loop oscillograph. The individual casings G_1, G_2, G_3, G_4 and G_5 contain the different measuring loops as well as mirrors Sp secured to the latter and objectives O arranged in the casings as lens windows. A field lens F is allotted to each measuring loop. The individual systems are so arranged that the images of the mirrors projected by F coincide with one another. Short of the point where the image is produced are arranged, however, deviating devices A, by means of which the images of the different oscillating mirrors are brought close to one another and the fields of view in which move the images of the light sources or the slit images are brought into alignment or approximately into alignment by the same devices. In Fig. 9 are shown mirrors as deviating devices for the two outer oscillating mirror systems. Here reflection prisms are preferably employed. Achromatic wedges are shown for the two next following inner systems. The purpose of the deviating device consists in that the arrangement of a further image lens L for each of the individual systems may be dispensed with and in that the five slit images reproduced on the field lenses F are projected simultaneously on a single lens for all five systems. Fig. 10 shows how the images of the five oscillating mirrors lie on the lens L when viewed from the paper. In the arrangement shown in Fig. 9 the individual oscillating mirror systems are arranged on a circular arc at the same distance from the image lens L in order to enable the use of the same optical systems. The individual systems may also be arranged on a spherical surface. On the other hand, the images to be projected may also be magnified or reduced at will in order to be independent of the choice of the distance of the systems from the lens L. Also the pupils, i. e., the images of the oscillating mirrors may be arranged side by side in any suitable manner.

Fig. 11 shows on the lens L the rows of pupils for three different paths of ray, for instance, according to Fig. 4 when using at the same time a plurality of oscillating mirror systems as shown in Fig. 9, to which is applied the principle according to the invention. In this case, the row 1 of pupils corresponds to the auxiliary path of ray for the illumination of all oscillating mirror systems from one light source, whereas the row 2 corresponds to the main path of ray for the photographic record and the row 3 corresponds to the auxiliary path of ray for the visual observation. Fig. 4 shows a side elevational view of such an arrangement.

Figs. 12 and 13 show the result of the photographic record of a double-loop oscillograph. In this case the images of two variable processes as shown in Fig. 12 lie one upon the other, whereas those in Fig. 13 are shown in spaced relation to each other. The last record is obtained when selecting a somewhat greater deflecting angle of the deflecting devices A shown in Fig. 9.

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