N° 25,908 A.D. 1906

Date of Application, 16th Nov., 1906—Accepted, 4th July 1907

COMPLETE SPECIFICATION.

Improved Mirrorbox for Photography in Colours.

I Otto Pfenninger of 105 Hythe Road, Brighton, in the County of Sussex Photographer do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a box containing mirrors, which divide the lightrays from two centrally placed transparent reflectors, so that two or three photographic colour-records or ordinary photographic negative pictures can be taken simultaneously from one point of view, with the aid of two or three lenses, all pictures being of the same size and in the same plane or focusing distance; by reversing the lightrays through the positive colour records and the same instrument a picture in natural colours will be obtained.

F. E. Ives that master of knowledge in photographic reflection, the first who adapted Ducos du Hauron's ideas and indicated the means by which the lightrays could be divided for use in three-colour-selection, employed in his English Patent 3784[95]: one lens in front and three lenses at the back of the instrument and no correction or compensation for the defects caused by refraction is given or even suggested. My improvement dispenses with the lens in front and gives direction how to correct the defects caused by refraction.

Burghardt 23940[98] gives two front-mirrors, therefore pictures from different points of view. Selle 13666[99] has only one lens in front and none at the back, therefore two different focusing planes. Boult (du Hauron's) 15753[99] has in his main claim, one mirror on one side and all pictures reflected, the lens as ocular is optional; his secondary claim, with the ocular in the center and in front is not very clear but I deal with it later on. Davidson 13468[02] has only one lens at the back of the mirrors, so that the middle picture can never be rendered the same size as the other two. Abney 14623[05] adapts three lenses in front, or one lens separated into three parts, or one lens in which the light is divided by means of one stop with three openings; one point of view is therefore also an illusion for nearer objects.

There is annother class of one-exposure cameras in which an ocular throws the light simultaneously on two more or less separated reflectors, 17514[99] and 10795[00], or on two more or less separated double-reflecting-prisms 12181[00] and 24829[03], or two more or less separated wedge-prisms 3729[03], and 322[05]. In all these cases each separate picture shows only a panoramalike continuation to the other pictures, that is only part of the object photographed is formed on each separate photograph, and all three together complete the photograph as if the ocular had given the photographic rendering without the separation; therefore an apparatus constructed on such an optical illusion will never give three negatives of one identical view; it is only with an apparatus in which the full light cone from the ocular is repressented in each separation, that we succeed in gaining identical views.

First I refer to Fig. "1" where a preliminary explanation is given of lightrays passing through a refractive medium, and it seems to me that the above named patentees did not think the refractive interference as of any importance.

I give in "Fig. 1" one lightray "L" coming from a lens or optical center "O".

[*Price* 8*d*.]

and the ray is traversing two parallel and refracting surfaces, inclined at an angle of 45°, This lightray when passing the first medium is however not passing along "S", but as indicated by "D", and when passing through annother double surfaced and transparent refracting material, also inclined at 45° but in an opposite direction, that is at right angles to "P", the ray will return into the supposed first path, and that only after "P 2" If however I place "P 2" not at opposed angle but parallel to "P", then that central ray will be more displaced towards "D 4".

If a second ray from "O" passes to "D 2" and a third ray from "O" to "D 3" the refraction at "D 2" is not the same as at "D 3", one refraction will be longer and is the reason why, the resulting picture after having passed through "P" will be contracted, and still more so if these two rays pass also through "P 2" and it does not matter whatever if "P 2" is parallel or at opposed angle to "P", the picture-result is exactly the same, the one-sided contraction is the same.

If therefore in "Fig. 2" I split the lightray in two at the transparent reflecting screen "P" in light path "2" coming from "O 2.", then the transmitted halfray arriving at "O 2" in path "2" will be compressed, be narrower than the reflected halfray from "M" to "O 1" in lightpath "1", (—leaving the connection between "P" and "M" out of the question, about which we speak later—) because this reflected halfray has not been interfered with by refraction; we will now say, we are not able to widen the first halfray in lightpath "2" but we are able to narrow down the reflected ray in path "1" by interposing the necessary refractive medium say at "P 3". This refractive medium would simply be plain glass of same substance as "P".

If now the halfray in path "2" arrives at the transparent reflecting screen "P 2", a refraction interference has happened at "P" as explained, we have therefore for a moment not to interfere with this ray, part of which will arrive per reflection from "P 2" and "M 2" to "O 3", if however the remnant from the ray in lightpath "2" passes through "P 2" we have to add the same amount of refracting material in path "1" and in path "3" as this remnant of ray has passed at "P 2" With these corrections or compensations we have arrived of forming three pictures of the same size in the focusing plane, but having the defect of being slightly oblong where they should be square.

In all my drawings I have marked the refraction-compensation at opposed angles, but if I do not mind the displacement of the central-ray (as explained in Fig. 1 "D 4"), then I can add parallel plates as refraction-correctors, the result is the same; If in "path 2" I have two plates at 45° causing refraction, that is here one sided compression, then I have to add two plates also at 45° crossing the same refraction in "path 1", or one plate having double the thickness, but also at 45°, the material point is, that I have in all three path's equal refraction and if that is the case it matters not if near or distant objects are taken or projected; The necessity of equal refraction in the three light path's arises in our case by a convergent cone of light coming to an optical center or lens in each light path, and presupposing the three lenses having equal focus, then equal pictures must be the result.

This narrowing down of the three pictures or colour records—(that is what they will be if colourfilters are interposed)—may not be of much consequence, if they are used for cinematographic work, chromoscopic or ordinary printing works in colours, but if used for scientific work, we should be compelled to interpose some more refracting material, also slanting in a similar way, as those marked "P" and "P 2", but we have to insert this new material seemingly crossways, from the side to the first spocken of compensators, correctores, which latter are put in from the top or bottom; Fig. "3" will give a fair illustration of my meaning and so will also my other Patent of the same day:—No. 25907[06] apparatus for colour photography "T" and "T 2" in Fig. 8, of that specification.

Two reflectors at opposed angles and two correctors slanting in crossing

directions, as explained are also shown in Fig. "3" such a combination will narrow down together the pictures equally allround, rendering the pictures square but with the focusing plane in another place. If the focusing distance has to be further adjusted, then we can also insert an upright (that is at right angle to the central ray) corrector similar to those marked "Z". The upright corrector can have curved or parallel surfaces.

Up to the present we supposed that the lenses at the back of the path "1" path "2", path "3" would see the same in size, but that is only more or less the case, there is a crossover of the lightrays between "P" and "M" and also between "P 2" and "M 2", the lightrays travel from mirror to mirror, which latter are inclined at the necessary reflecting angles, the distance from "P" to "M" is such a small fraction of the distance from "P" to the object to be photographed (say 10 yards away) that we may say the rays travel parallel from mirror to mirror, but if the difference has to be corrected, an upright transparent plate or single lens, that is contracting material in the proximity of "Z" will shorten the rays allround in the lightpath and contracting, narrow the picture down in proportion to the stoutness and refracting power of the refracting material employed, in other words the focus-difference has to be adjusted.

If we do not balance all three pictures alike or only correct part of the refraction defects, then the apparatus can only be used in the additive method, because when projecting, the light has to travel the same lightpath backwards, to be reunited at the further end of "V"; if all the inside correctors are eliminated the apparatus comes to resemble Ives Patent 3784[95], but minus a lens in the front; instead of a lens-ocular my transparent reflecting screen "P" in lightpath "2" of Fig. "2" or Fig. "4" or Fig. "5" is the eye, the ocular of my mirrorbox.

We have another remedy, to correct the refraction-defects and that is by the use of prismatically inclined surfaces (glass-wedges) in place of the parallel surfaces of the transparent reflecting screen "P". In so doing we are able to arrange that the lightrays passing through "P" will be widened, not narrowed down, and we reach the fact of having pictures of equal or square size at "O 1" and "O 3" and if a contracting corrector is inserted at "F 1" or thereabout we shall have the pictures also of same size; the corrector can be a blue coloured screen. The remaining refraction defect caused by the light passing through "P 2" has now only to be accounted for and has to be corrected in a similar way, by parallel surfaces or glass-wedge as explained before.

In all the above illustrations and in all the named patents, the angle of reflection was taken and given to be 45 degrees, but this is not necessarily so, I give the proof and solution of my contention in Fig. "6": "*i*" is the angle of incidence, "*r*" the angle of reflection and "*t*" the normal.

If I want to use or manufacture my mirrorbox, so as to secure two colour records, or two pictures only, I can leave out any part to arrive at that end, then I may use only "P" and "M" with or without the addition of the necessary refraction correction and colourfilters, or I may use "P", P 2" and "M 2" also with or without the necessary refraction-correction and colourfilters.

Having explained, what I understand by a refraction-correction here also called corrector or compensator, I will commence to explain some applications in a mirrorbox.

Fig. "5" is a rough sketch, showing the use of a wedge-reflector "P", to which is attached a yellow screen; the ordinary or blue light is received at "P" and reflected to mirror "M" and in turn by mirror "M" reflected down path "1" where it has to pass a blue light filter or screen at "F 1", further the lightrays passing through the reflector "P" holding a yellow screen will arrive in due course at "P 2" and "M 2" down path "3" to "F 3", which latter can be plain glass or a yellow or green screen. Fig. "5" is partly carrected with a wedge and partly with parallel surfaces, if using in "P 2" another wedge then the correctors "P 3" and "P 4" would be of no use, but the condensor "Z" had

to be stronger. The lightrays from "P" (in Fig. 5) pass also through "P 2" down to path "2", to "F 2"; "F 2" can also be plain glass or another colour-filter or corrector. "P 2" itself, if a wedge or two parallel surfaces has to be a colourfilter or carries a red colourscreen facing "F 2".

These are the interior positions of the reflecting and transparent surfaces in the apparatus, if the necessary refraction correctors are inserted, exact work can be done, if however the correctors are left out, then we can use the box only for cinomatography and kindred methods as explained before.

In "Fig. 4" we have exactly the same arrangement of mirrors and other surfaces as in Fig. "5" with the exception that the prismatically inclined surfaces are changed to parallel surfaces, and in this case if without any refraction compensation the apparatus is only useful for the additive methods and only if an apparatus of the same construction is used to recombine the three colour records, by the positive records into one picture. In an apparatus even of this simple form I should employ a condensor "Z" without which the focus-distance in the three lightpath's would not be in one plane; The secondary claim in Spec. 15753[99] (Hauron) does not compensate the focus difference, neither is such compensation put forward in Ives Spec. 3784[95] and this later apparatus can only work with a lens-ocular.

Here I may mention that faced mirrors, if such are employed for "M" and "M 2" are of very delaterious behaviour and right angle prisms "M 3" and "M 4" Fig. "8" can successfully take the place of "M" and "M 2", the long side is silvered from the back and the prism is then inserted so that from the two short sides which are at 90 degrees, one side will face the transparent-reflecting screen and the other side the lens. We could also use prisms with angles like 85 or 95 degrees if we like to calculate them for that purpose. The glass of the prisms being also made of refracting material, has also to be compensated in the middle lightpath "2" and will bring prism insertion within my claim. The refraction through a prism will be greatly influenced by the glass employed and according to the lighter or heavier substance of the glass, will the refraction cause more or less contraction of the passing lightrays and thereby form a smaller picture in the focusing-plane.

Fig. "2" shows nearly all positions of my corrector system mentioned in this specification. It shows the passage of the different rays, shows by the sprinkled parts what can be used in manufacturing my mirrorbox and in the shaded parts what must be filled up, it shows in "N" a sort of blind, dead surface best suitable behind the brillant surfaces of "P", the crossline "C" will ascertain if extraneous light from "V" the view- or eyepiece, "ocular" can arrive at "O" the optical centre or lens. The mirrors "M," and "M 2" should be faced mirrors, if not replaced by right-angle prisms. The lightrays are marked "R" for red, "Y" for yellow and "B" for blue. "Z" stands for upright, parallel plate, slanting or lenslike contracting corrector; "P 3", "P 4" and "P 5" for refraction-correctors; "S" for the borderray in the lightpath; "F" is the place for additional filters or screens and "X" is the crossing point of calculation for the three lightpaths.

I may also mention here, that between two parallel surfaces, both surfaces reflect the light—(and so do all others of the correctores)—forming thereby what is called double pictures. This double reflection is greatly corrected by the use of glass coloured in the manufacture or by the action of the colourfilters or screens attached to the back-surface, the darker screen absorbing the back reflection completely, the lighter screen about fourfifths of it.

Ives in his Patent 3784[95] and in others suggests plain glass-wedges as a corrective against double reflection and I use wedges as compensators for refraction-defects and I have the wedges coloured in substance so that the glass wedges can also act at the same time as colourfilters, or I have the wedges surfaced with the colourfilters for the same purpose or for the purpose to increase the reflecting-power of the transparent reflectors.

To balance the light used for the exposures of the photographic and sensitive plate, I use different stops in each lens; if the reflected light for the blue record in "O 1" is too intense, then I put a smaller stop in the lens at "O 1", as I would in the lens at "O 2" or "O 3" if to much light passes those lenses. The red filtered light at "O 2" is the slowest of the three lights, and the lens aperture receiving it should therefore be the largest and the others balanced to it.

If my mirrorbox has to be adapted for cinematography, I press the necessary (paired) lenses more together, as shown in "Fig. 7" by cutting some of the sides away from the circular lenses, which enables me to use more powerful instruments, it would not matter if the central lens were kept larger than the other two, as long as the three axis of the lenses are in the optically correct places.

The mirrorbox can be connected attachable and detachable, or be in a fixed position in or without the connection of the lenses with or to an exposing box, photographic exposing camera, to which in turn the lenses are attachable or detachable, or camera, lens-attachement and mirrorbox may form one whole or set combination.

In this specification I say the pictures arrive in one plane, or on one plate, but two or three solid or flexible plates can be put side by side, so that each separate plate receives a separate picture, I may point out, that in this case I understand all three plates to represent only one plate, as each separate plate would only hold a separate part of the two or three parts that are necessary to form the forementioned records in or on one plate.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is.

1, A mirrorbox in which one central, transparent, and reflecting screen with two parallel or two prismatically inclined surfaces acts without the aid of a lens as an eyepiece and transmits the lightrays by reflection, transmission and filtration, through refraction-compensators, so that by the aid of three separate photographic lenses and colourfilters, three negative records in one plane on solid or flexible plate or plates,—all from one point of view with one exposure—are obtained, for the additive as well as the substractive methods of photography in colours and by the aid of the same mirrorbox as explained aforesaid, by reversing the action of the lightrays to render from the colour records in positive, one single picture again, the latter being in natural colours if the necessary colour screens are interposed in the propre places in the path of the lightrays.

2, A mirrorbox in which one central, transparent and reflecting screen with two parallel or two prismatically inclined surfaces acts without the aid of a lens as an eyepiece and with the aid of refraction-compensators consisting of compensating plates or wedge shaped plates ballances the light cone to same size for lenses placed at the back, substantially as herein described.

3, A mirrorbox in which the angle of reflection is larger or smaller than 45° or is 45°, substantially as herein described for the purpose specified.

4, A mirrorbox in which one central screen acts as eyepiece and transmits the lightrays in three lightpaths, one of which holds a focus-compensator, to three lenses to form three pictures at the back, substantially as herein described.

5, A mirrorbox in which one screen acts as eyepiece and transmits the lightrays in two lightpaths to two lenses to form two pictures at the back substantially as herein described.

Dated this 16th day of November 1906.

OTTO PFENNINGER.

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PFENNINGER'S COMPLETE SPECIFICATION.

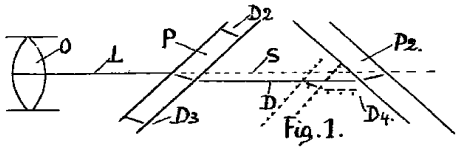


Fig. 1.

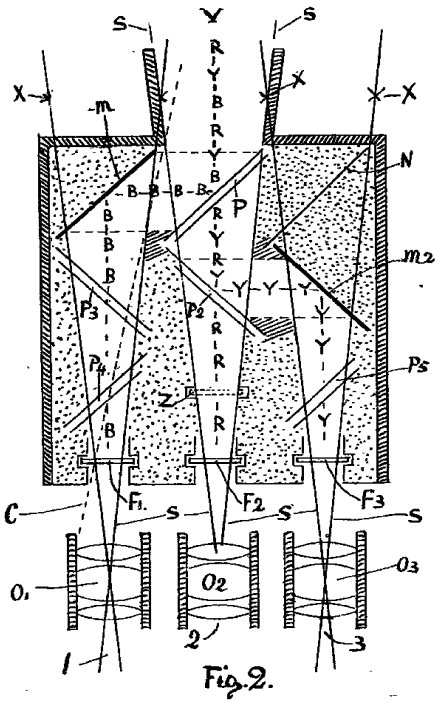


Fig. 2.

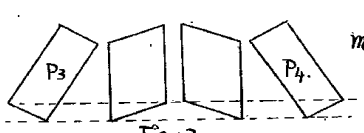


Fig. 3

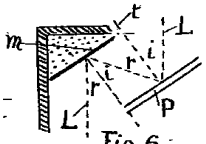


Fig. 6.

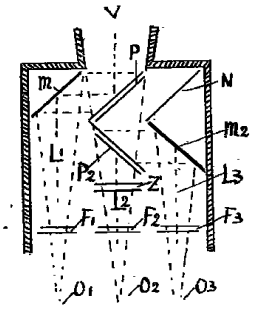


Fig. 4.

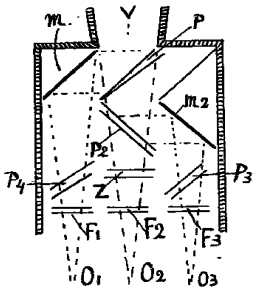


Fig. 5.

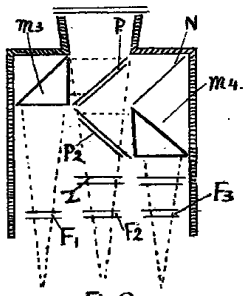


Fig. 8.

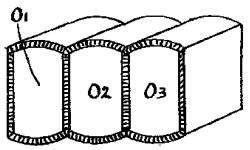
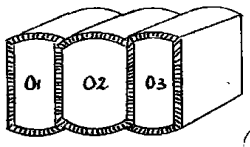


Fig. 7.



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PFENNINGER'S COMPLETE SPECIFICATION.

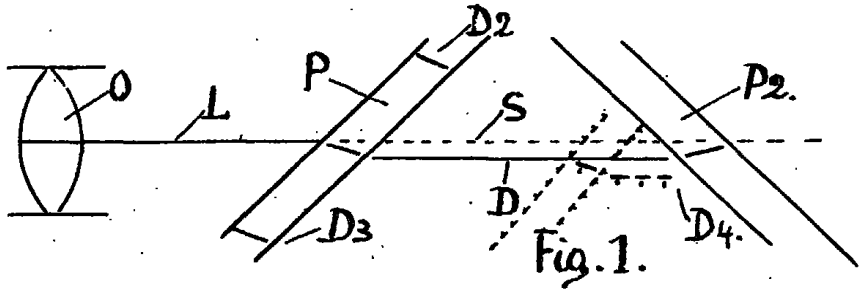


Fig. 1.

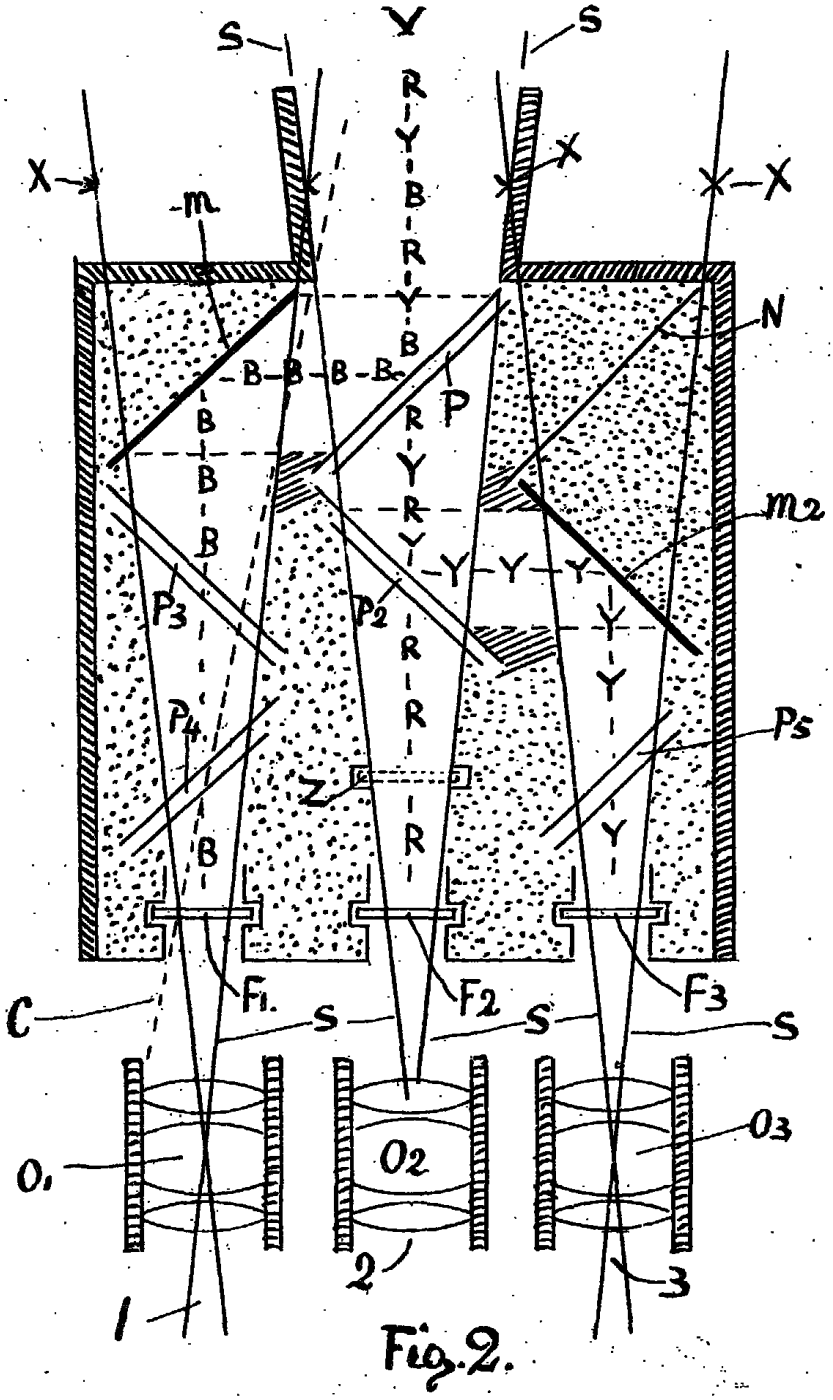


Fig. 2.

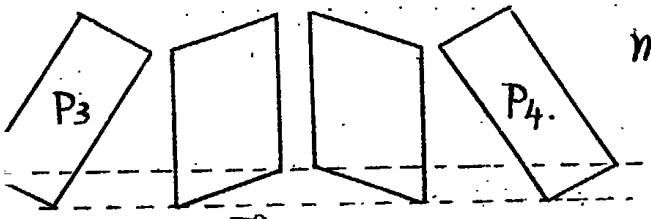


Fig. 3

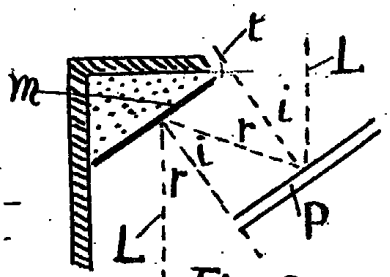


Fig. 6.

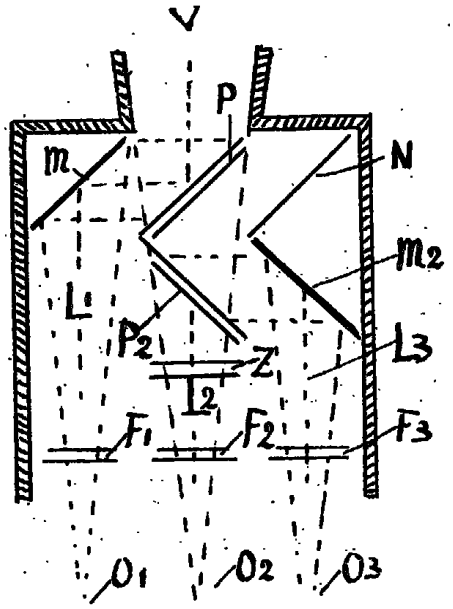


Fig. 4.

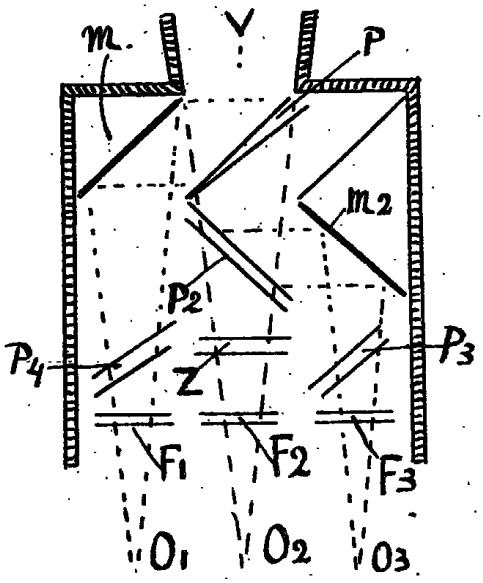


Fig. 5.

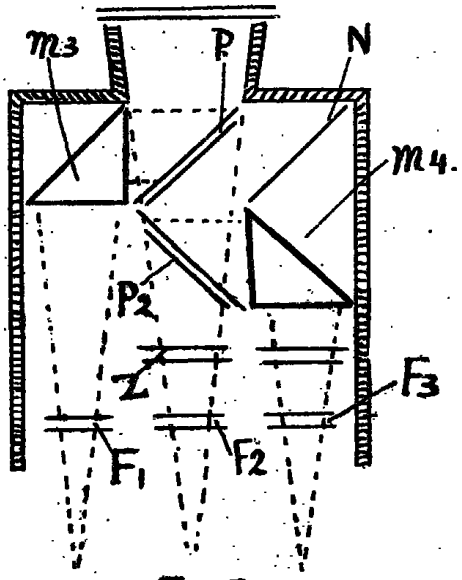


Fig. 8.

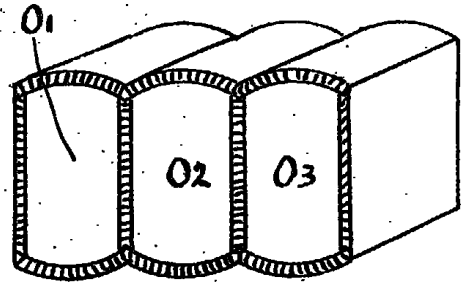
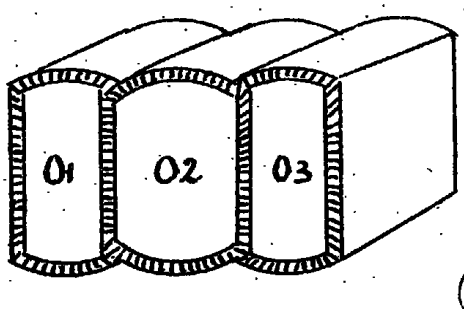


Fig. 7.



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