PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Process for the Production of Cinematographic Effects in Colour and Means therefor.

I, DEMETRE DA PONTE, a Roumanian Subject, of The Engineer's Club, 39, Coventry Street, London, W. 1, 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:—

The present invention relates to means for the production of cinematographic films for showing colour effects of the kind wherein complementary colour images are taken simultaneously from the same point (aspect) of view and cast side-by-side on the film, with the width or horizontal lines of each picture running along or parallel to the length of the film, the images of the positive films obtained from the negatives thus produced being suited for projection on the screen through appropriate colour filters simultaneously in register with each other so that the spectator has not to rely upon persistance of vision for the blending of the colours.

The object of the present invention is to enable lenses of wide aperture and short focal length to be employed, a taking system according to this invention also enabling the images cast by the lenses to be free from the defects of parallax and aberration or substantially so and be of equal or substantially equal illumination and sharpness.

According to the present invention a taking system is provided comprising a light beam dividing prism system and co-operating lenses in which the beams are separated by such an amount, and/or inclined to each other at such an angle as will permit the use of lenses of large aperture, the separation of the beams being finally reduced and the beam re-directed by a single reflecting surface between the lens and the film at such an angle as will form the images side by side on the film at the required separation and permit the use of lenses of short focal length.

A positive film made from the negative film produced by the present system may be projected through colour filters by an ordinary projector provided with an optical system, conveniently the system claimed in our concurrent application No. 29,476/1930 (Serial No. 346,454), suited to superimpose and cast the corresponding pairs of images, turned to the normal position, or in correct orientation, in register upon the screen.

The images are taken through appropriate colour screens which may be in or on or travelling with the film itself or may be stationary or rotating screens in known or approved manner.

Means may be provided whereby the length of path of the divided beams may be controlled so as to obtain two substantially identical images capable of giving good registration of the corresponding positive images when these are superimposed on the screen.

In order that the present invention may be the more clearly understood reference is hereinafter made to the constructional examples illustrated in the accompanying drawings, in which:—

Figs. 1 and 2 are side elevations of known forms of combined lens and prism systems.

Fig. 3 is a side elevation of a combined prism and lens system constructed according to the present invention.

Fig. 4 is a side elevation of a modified form of Fig. 3.

Figs. 5, 6, and 7 are respectively plan, side, and front elevations of another modified form of combined prism and lens system under the invention.

Figs. 8, 9, 10, and 11 are respectively plan, side, front and rear elevations of another modification.

Figs. 12, 13 and 14 are respectively plan, side and front elevations of another construction.

Fig. 15 is a view of a piece of film showing how the images are formed alongside one another across the width of the film but disposed with their width along the end of the film.

Optical systems for cameras for colour photography or cinematography have been proposed as shown in Fig. 1 comprising a block consisting of two prisms A, B having partly transmitting and partly reflecting hypotenuses, and a reflecting prism C, the prisms being placed before

[Price 1/-]

lenses as to produce two images in the same plane, but this system has however the disadvantage that when the separation between the images on the film is small, as for instance it would be when two images are arranged side by side on film of standard width (35 mm.), only lenses of relatively small aperture can be used since the maximum diameter of lens mount is limited to a diameter of not more than the separation d between the centres of the images E, F and the maximum possible aperture of lens is limited by the cone of light received by the prism, and this cone of light cannot exceed at the point where the outside edges of the two cones meet, a width greater than the separation d of the two images.

In practice it is found difficult (using standard film 35 mm. wide) to use a lens of greater aperture ratio than f/3.5 with a short focus lens of $1\frac{1}{4}$ inches and a corresponding smaller aperture ratio with lenses of longer focus.

Further in colour cinematography in which an optical system is used to cast a pair of pictures alongside the same way round on the space usually occupied by the picture on normal sized film it is of importance to use not only lenses of large focal aperture but also lenses of such short focal length that the ratio of focus to picture size is approximately the same as the ratio of focus to picture size of a normal sized picture, or expressed in another way, the magnification is approximately the same as for pictures of normal size.

In Fig. 2 which shows another known system means are provided whereby lenses of large aperture can be used but with such a system lenses of the desired short focus cannot be used. Referring to Fig. 2, A is the beam dividing prism, B and C are the lenses, of ordinary commercial type, E is a rhomb designed to bring the picture formed by lens B to the required separation from the picture formed by lens C, and G is a compensating block of glass of such thickness as to bring both pictures in the same focal plane. On account of the space occupied by the rhomb E and the considerable separation required between the centres of the lenses to provide room for the mounts it is not practical to use lenses of shorter focus than about 60 mm. and f/3 focal aperture for such focal length, whereas in practice it is desirable to use lenses of about 35 mm. focus and f/2 focal aperture which corresponds to a lens of about 50 mm. focus for a normal sized picture, which is common practice.

An additional difficulty is encountered with this system if the separation is further reduced, say by the use of specially made lenses, namely to prevent light passing directly through the rhomb E as shown by the ray H J K, and falling on to the picture, thus in effect allowing a second image to overlap the reflected image. In order to prevent such directly transmitted images from passing through the system it is obvious that the corner L of the rhomb must extend some distance outside the picture area, and it would therefore be impractical to further reduce the separation between the lenses to less than about two and a half picture widths. This difficulty can to some extent be overcome by the use of a long hood used outside of this system, but the rhomb cannot in any case be reduced so as to bring the lens centres within a distance exceeding two picture widths since the entrance face must be large enough to collect all the light from the lens aperture, and the exit face large enough to transmit all the light to the picture, and the aperture of a suitable lens would amount to approximately $1\frac{1}{4}$ picture widths.

The optical taking system designed in accordance with my invention overcomes these difficulties and enables lenses of ordinary commercial form, large aperture, and short focus to be used.

In referring to the various examples shown in the accompanying drawings the path of the main beam is represented by 1, *1a*, etc., and the path of the divided or branch beam is represented by 2, *2a*, etc., and where the path of the beam folds so as to continue at right angles to the plane of the paper such folded path is represented by a small spot representing the end on aspect of the path after so folding.

Fig. 3 shows one form of taking system according to the present invention which consists of a prism consisting of three components 3, 4 and 5 cemented together. The surface *3a* of prism 3 is arranged to reflect a certain proportion of the light received and transmit the remainder in a known manner, i.e., either by coating the surface with alternate silvered strips and clear spaces, or preferably by a uniform deposit of silver (or other reflecting agent) such as to reflect and transmit the light in the required proportion. The reflected or branch beam 2 passes on to the prism 5 where it is reflected by the surface *5a* in a direction *2a* parallel to the path 1 of the incident or main beam, and is received by the lens 6, which forms one of the pair of pictures. The main or transmitted beam passes on to the prism 4 and is reflected by the surface *4a* at an angle as required to obtain a proper correction for the system, as hereinafter described. The light then follows the path

1a and passes on to the lens 7 and is reflected along the path 1b which is conveniently parallel to 2a by a mirror or prism 8 (preferably a mirror) so placed as to give the required separation of the pair of pictures.

The dimensions of the prism are such that the optical path from the point (*d*) where the main beam is divided, to the lenses 6 and 7 is exactly equal in both beams i.e. the optical path length *a, d, c, e, f* is exactly equal to the optical path length *a, d, g, h, j, k*. In this way both lenses are in effect at exactly the same optical distance from the object being photographed, while at the same time both lenses 6 and 7 are so placed in conjunction with the mirror or prism 8 that they both form their respective images 9 and 10 in the same plane and at the required separation.

This condition may be expressed as follows: If μ_A is the mean refractive index of the prism 3 for the light required to be transmitted (i.e. for the wavelength corresponding to the mean transmission of the colour filter which will be used in the beam),

μ_B is the corresponding refractive index for the prism 4, and

μ_C is the corresponding refractive index for the prism 5, then the dimensions of the prisms must be such that:—

$$\frac{adg}{\mu_A} + \frac{ghj}{\mu_C} + jk = \frac{ad}{\mu_A} + \frac{dce}{\mu_B} + ef.$$

the distances *adg, dce* and *ghj* being the linear length of paths of the light in the respective prisms 3, 4 and 5 and the distances *jk* and *ef* being the distances from the prism to the first principal planes of the lenses 6 and 7.

The mirror 8 may be a surface silvered or metal reflector, in this case the linear distance from the lenses to the focal plane will be made exactly equal, but instead of a mirror a prism 11 may be used and in this case the linear distance of the lens 7 will be such that:—where *fn* is the distance from the second principal plane of the lens 7 to the surface of the prism, *nop* is the linear length of path through the prism and *pq* is the distance from the end or egress surface of the prism to the focal plane, and F is the distance from the second principal plane of the lens 6 to the focal plane.

$$fn+\frac{nop}{\mu_a}+pq=F_1$$

The prisms 3 and 4 must be material of the same refractive index, but the prisms 5 and 11 may be material of a similar or different refractive index as convenient to secure the required condition.

In the following examples the prisms would be suitably designed in accordance with the foregoing conditions and such designing will present no difficulty to the optical expert.

This form of prism may also be constructed so that the incident beam is received in the direction of the reflected beam *adgh* as shown in Fig. 4. The light falling normally on the face of admission enters the prism 12 and is incident on the reflecting surfaces 14 15 and 16, conveniently at an angle of 45°, being partially reflected and partially transmitted at 13 to give a folded path 1, 1a, 1b to the main beam and a folded path 2, 2a to the branch beam. The main beam is received by the lens 7 whence it passes on to the mirror 8 to be folder at the required separation parallel to the branch beam after it has been folded to pass through the lens 6.

Both these forms of prisms require that the film should travel in a horizontal direction instead of the usual vertical direction, but the prism may also be constructed so that the images are correctly disposed when the film is vertical and one such prism is shown in Fig. 5 in which a prism similar to Fig. 3 or Fig. 4 is used with the addition of an erecting prism of known form.

In the construction according to Figs. 5 to 7 prisms 12 and 13, lenses 6 and 7, and mirror 8 are employed similar to those in Fig. 3, and with these is combined an erecting prism 17 of known form such that the path of the main beam is:—1, 1a, 1b, 1c, 1d, and 1e to the focal plane, while the path of the branch beam after this is divided at the partially transmitting and partially reflecting surface 14 is 2 and 2a to the focal plane.

In Figs. 5 and 7, the spot indicated paths 1a in Fig. 5 and 1, 1c, and 2a in Fig. 6 are away from the observer, while those marked 1b and 1d in Fig. 7 are towards the observer.

In another form of prism, erection of the images is brought about in the construction of the prism and such a form is shown in Fig. 9, in which the prism-lens system consists of five components, four cemented together, viz., the rectangular prisms 18, 19 and the prism blocks 21, 22 and a spaced rectangular prism 20 which provide a partially transmitting and partially reflecting surface 23, and reflecting surfaces 24, 25, 26 and 28 such that the light falling on the face of admission 29 enters the prism 18 and is incident on the reflecting surfaces above referred to conveniently at an angle of 45°. It is partially reflected and partially transmitted at 23, the main beam being given a folded path 1, 1a, 1b, 1c through the lens 7 to the focal plane by the reflecting surfaces 25, 26 and 27, and the branch beam being given a folded path 2, 2*a*, 2*b*, through the lens 6 to the focal plane by the reflecting surfaces 23, 24 and 28.

In Figs. 8 to 10, the spot indicated paths 1*a* and 2 in Fig. 8, and 1, 1*b* and 2*b* in Fig. 10 are away from the observer, and those marked 2*a* and 1*a* in Fig. 9 are towards the observer.

Figs. 12, 13 and 14 show a modified form of prism constructed to bring about the erection of the images and consists of five components, four cemented together, viz., the rectangular prisms 30 and 31 and the prism blocks 32 and 33 and a spaced rectangular prism 34 which provide a partially transmitting and partially reflecting surface 35, and reflecting surfaces 36, 37, 38, 39 and 40 such that the light falling on the face of admission 41, enters the prism block 33 and is incident on the reflecting surfaces above referred to conveniently at an angle of 45°. It is partially reflected and partially transmitted at 35 so that the main beam has a folded path, 1, 1*a*, 1*b*, 1*c*, through the lens 7 to the focal plane by the reflecting surfaces 36, 39 and 40, and the branch beam has a folded path 2, 2*a* and 2*b* through the lens 6 to the focal plane by the reflecting surfaces 37 and 38.

In Figs. 12 to 14, the spot indicated paths 1*b* and 2*a* in Fig. 12, and 1 and 2*b* in Fig. 14 are away from the observer, while those marked 1*a* and 2 in Fig. 13 and 1*c* in Fig. 14 are towards the observer.

It is to be observed that all reflecting surfaces are silvered when the critical angle is exceeded.

Where I speak of prism components cemented together it is to be understood that where practical any two or more components may be constituted by one piece.

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 beam dividing taking prism and lens system receiving images from the same aspect for casting images side by side on the film, preferably normal sized film, with the width or horizontal lines of each picture running along or parallel to the length of the film comprising a light beam dividing prism system and co-operating lenses in which the beams are separated by such an amount, and/or inclined to each other at such an angle as will permit the use of lenses of large aperture, the separation of the beams being finally reduced and one or each of the beams redirected by a single reflecting surface between one or each lens and the film at such an angle as will form the images side by side on the film at the required separation, and permit the use of lenses of short focal length.

2. A beam dividing taking prism and lens system as in claim 1 constructed so as itself before the lens to turn the images so that they appear in the required orientation on the film and permit the camera to be used in the upright position.

3. A beam dividing taking system according to claim 1 or 2, wherein the images are cast the same way up on the film.

4. A beam dividing taking system according to any of the preceding claims wherein the lengths of the paths of the main and branch beams through the prisms to the lenses and the refractive indices of the prisms are so proportioned that the lengths of the paths of the two beams from the point where the main beam is divided to the lenses are optically equal.

5. A taking system according to claim 1 or 4 in which a mirror is used between the lens and the film and the correction of the optical lengths of the paths of the beams is effected before the lens.

6. A beam dividing taking system substantially as herein described with reference to Fig. 3 of the accompanying drawings.

7. A beam dividing taking system substantially as herein described with reference to Fig. 4 of the accompanying drawings.

8. A beam dividing taking system substantially as herein described with reference to Figs. 5, 6 and 7 of the accompanying drawings.

9. A beam dividing taking system substantially as herein described with reference to Figs. 8, 9, 10, and 11 of the accompanying drawings.

10. A beam dividing taking system substantially as herein described with reference to Figs. 12, 13 and 14 of the accompanying drawings.

Dated this 9th day of January, 1930.

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Patent Agents for the Applicant.

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Fig. 1.

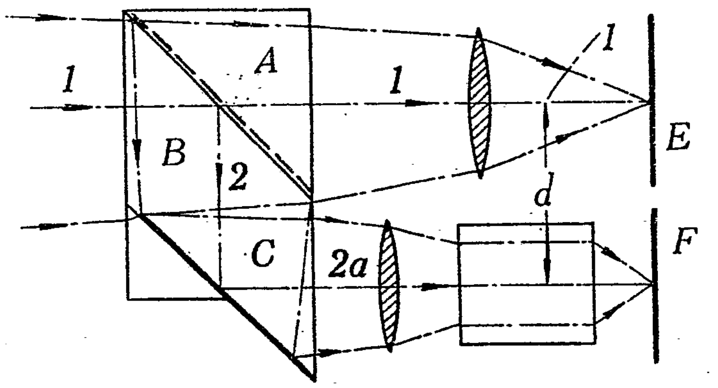


Fig. 3.

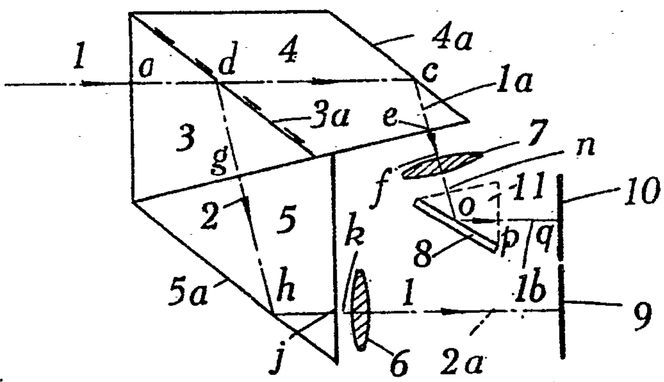
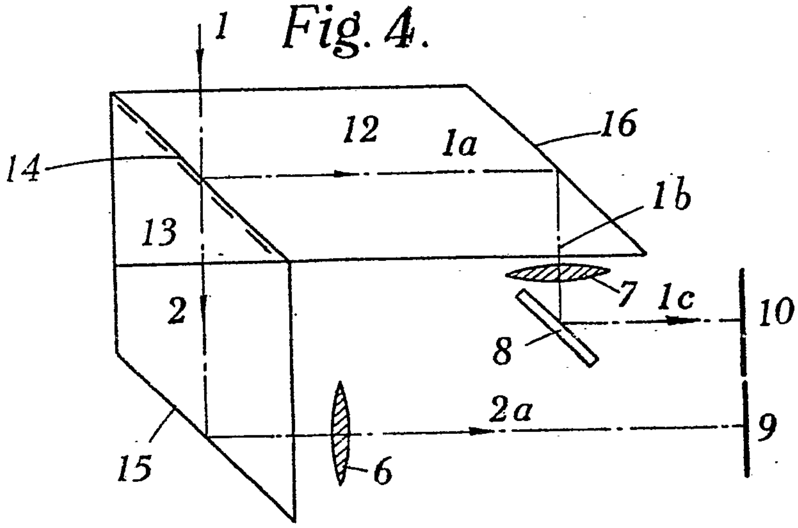


Fig. 4.



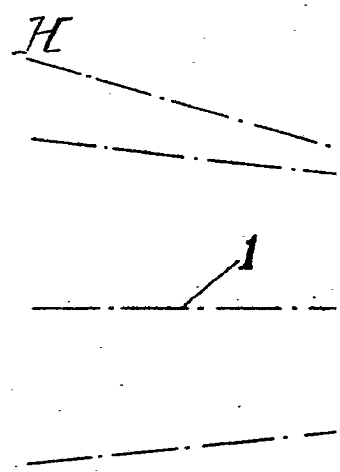


Fig. 2.

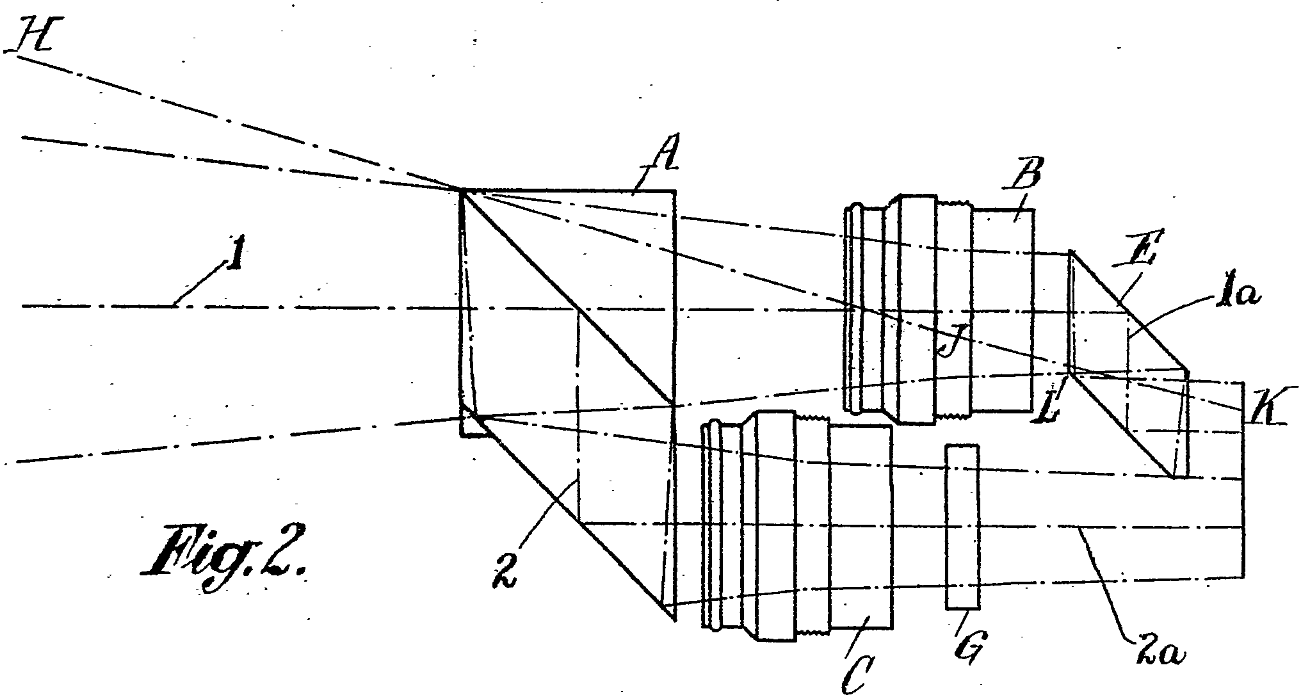


Fig.2.

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Fig. 1.

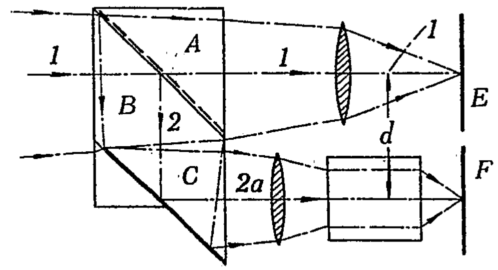


Fig. 3.

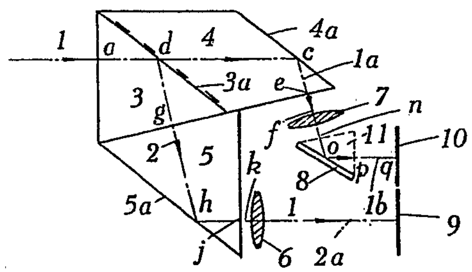
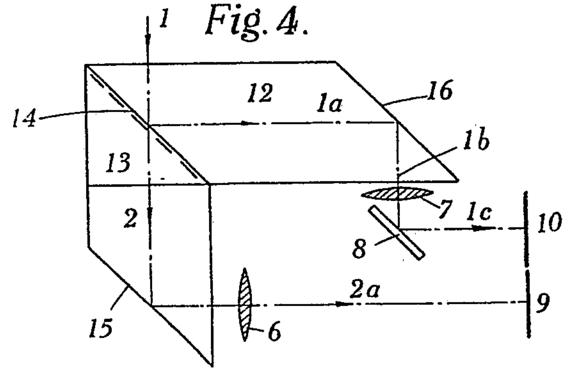


Fig. 4.



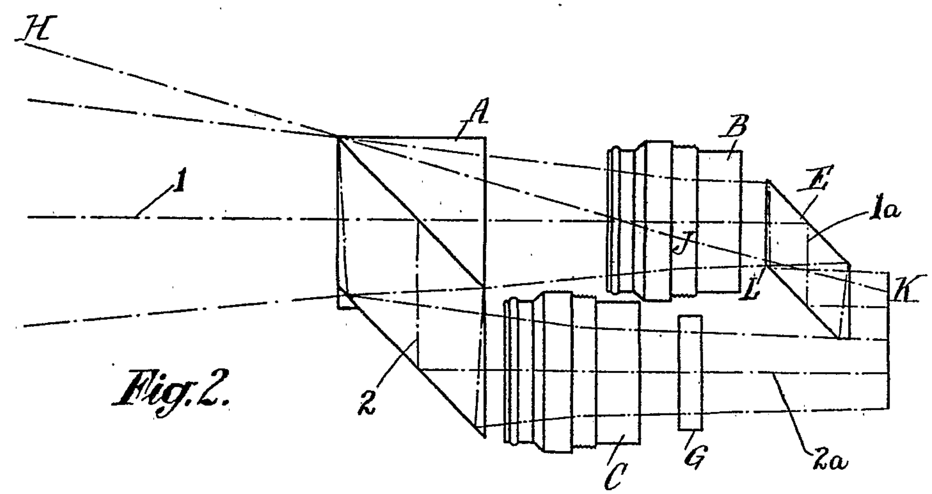


Fig. 2.

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