May 17, 1949. F. WALLER ET AL 2,470,592

CONTROL BAND FOR GUNNERY TRAINING APPARATUS

Filed May 20, 1944 4 Sheets-Sheet 1

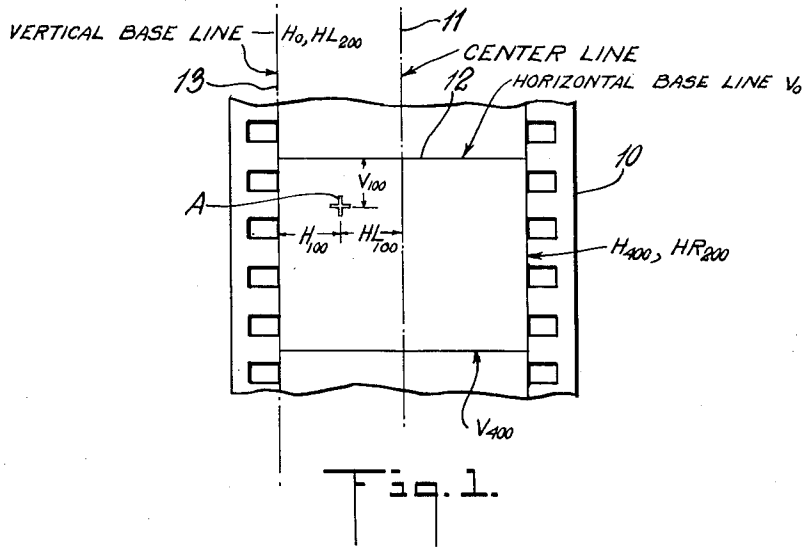

Fig. 1.

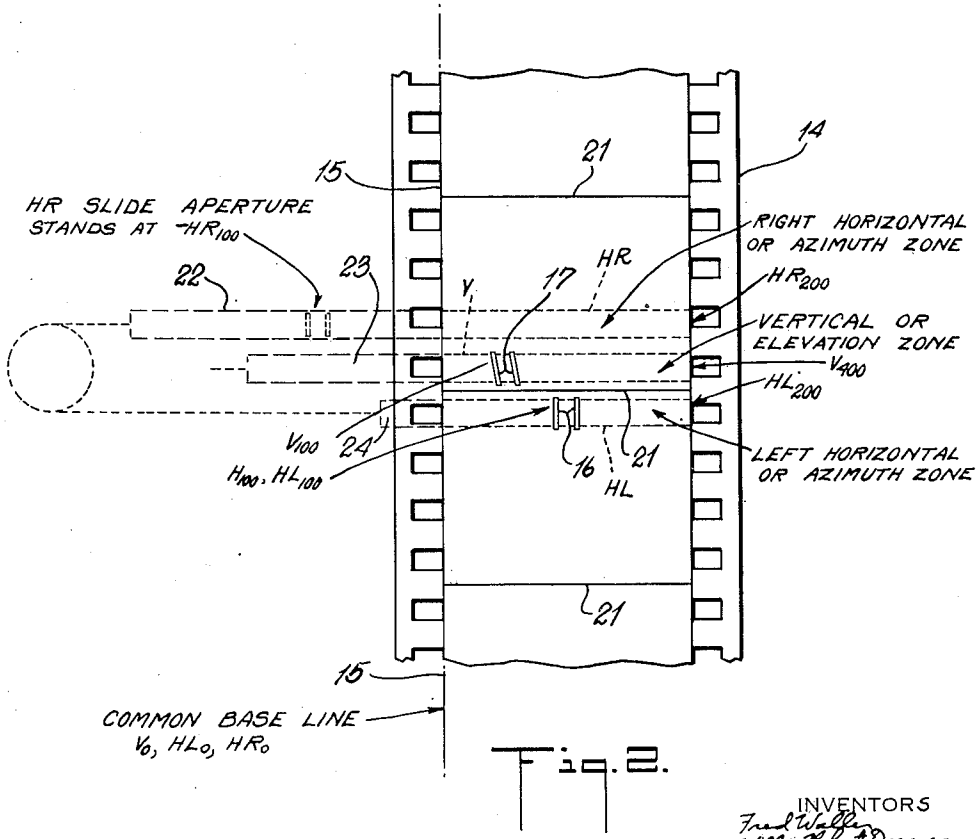

Fig. 2.

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CONTROL BAND FOR GUNNERY TRAINING APPARATUS

Filed May 20, 1944 4 Sheets-Sheet 2

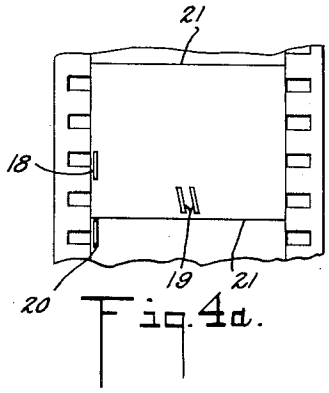

Fig. 4a.

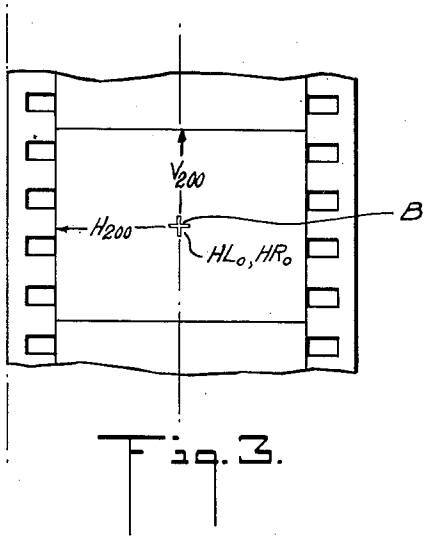

Fig. 3.

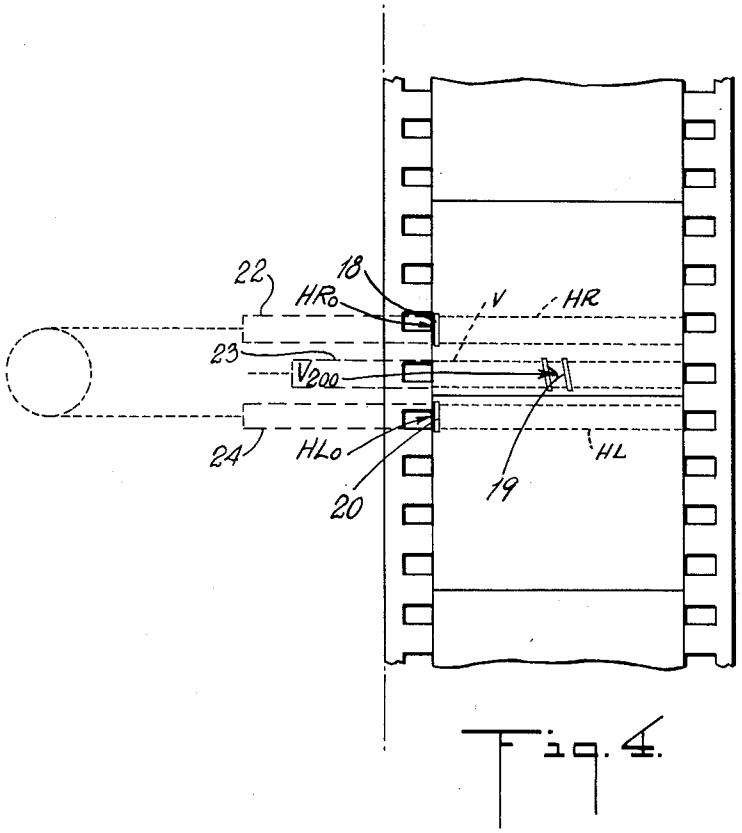

Fig. 4.

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CONTROL BAND FOR GUNNERY TRAINING APPARATUS

Filed May 20, 1944 4 Sheets-Sheet 3

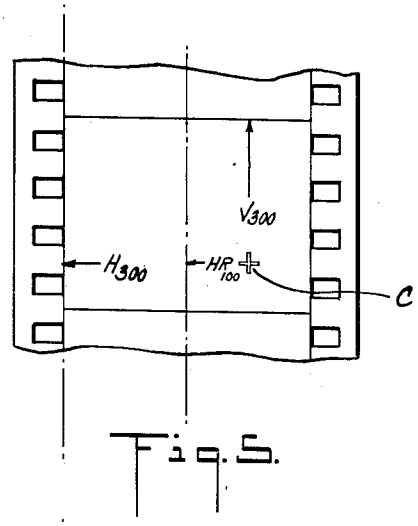

Fig. 5.

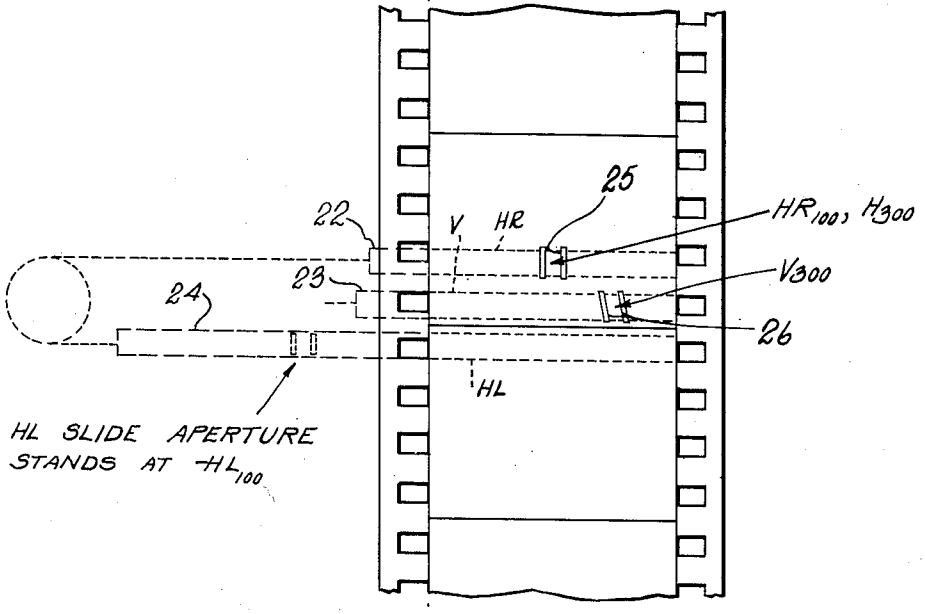

Fig. 6.

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CONTROL BAND FOR GUNNERY TRAINING APPARATUS

Filed May 20, 1944 4 Sheets-Sheet 4

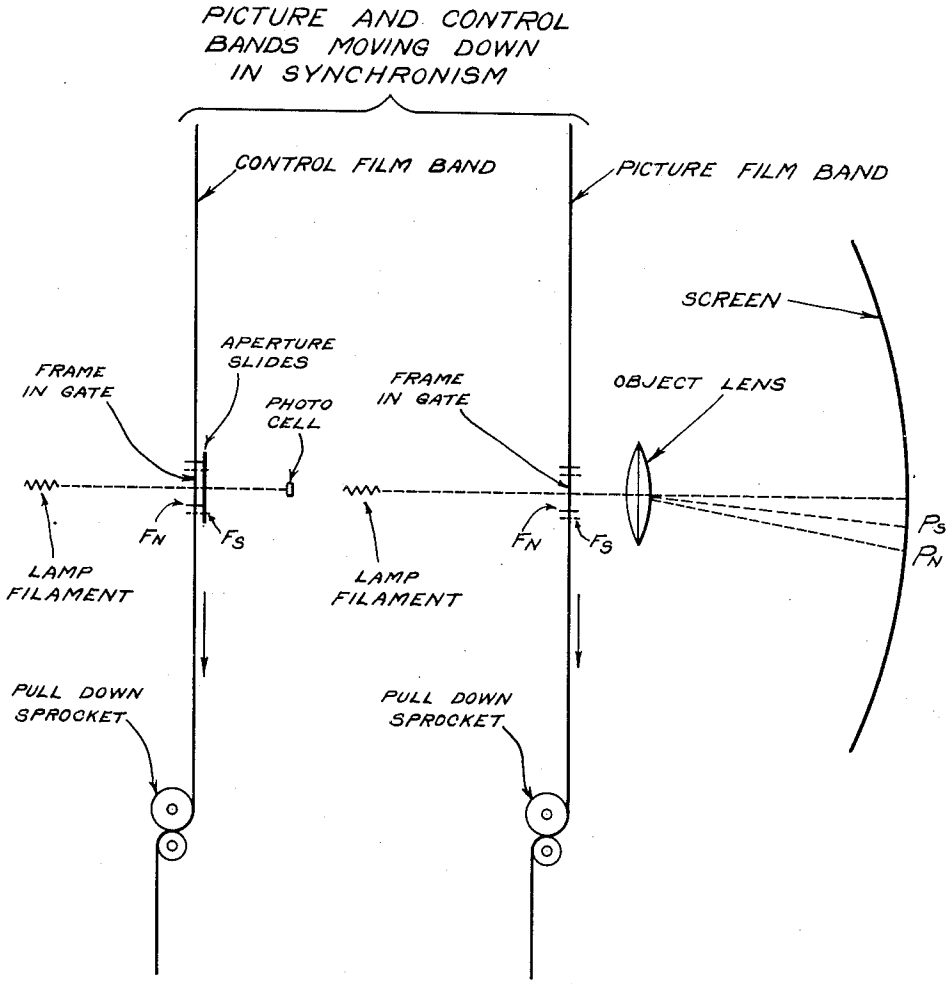

Fig. 2.

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Patented May 17, 1949

2,470,592

UNITED STATES PATENT OFFICE

2,470,592

CONTROL BAND FOR GUNNERY TRAINING APPARATUS

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Application May 20, 1944, Serial No. 536,578

7 Claims. (Cl. 88—19.5)

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This invention relates to gunnery training, particularly to gunnery training which involves the projection of target images on a screen while a dummy gun is aimed and fired at the target and the accuracy of aim is indicated with the aid of a control frame or band operatively associated with the dummy gun and the image projector; and has for an object the provision of improvements in this art. This invention relates particularly to a control band adapted to be used in a gunnery trainer. Reference is made to the copending application of Fred Waller, Willis Robert Dresser and Henry Martyn Baker, Serial No. 415,374, filed October 17, 1941, now Patent 2,406,574, issued August 27, 1946 for a complete disclosure of a gunnery trainer of this type.

In the aforementioned Waller et al. application, there is disclosed a form of apparatus wherein a motion picture film band is run in a projector to cast moving images of a target on a screen. The motion pictures having previously been taken by a camera from the same position as that normally occupied by an actual gun and the dummy gun being located during projection in approximately the same relative position as was the camera, there is a realistic reproduction of the conditions of actual gunnery. In the preferred form disclosed in that application, a number of projectors occupying the same positions formerly occupied by a like number of cameras which made the pictures, project a mosaic of matching pictures on a concave curved and preferably spherical screen. A control band is run in synchronism with the picture projection band or bands, either being made integral with the picture band or as a separate band. This control band is provided with apertures which represent the position of the target on the projection frame; or more accurately, the position which the target would occupy when the projectile reached it (taking account of target distance and target and projectile speeds); or still more accurately, the hit or impact spot of the projectile in the plane or surface of target movement (taking additional account of gravity, windage and other factors which might throw the point of aim off the future image of the target at the time of the hit). The dummy gun is operatively associated with a coordinately movable slide provided with an aperture to indicate the point of aim, and the slide is positionally associated with the control band in such manner as to furnish an indication of a hit when the apertures in the slide and in the control band are in registry. By way of illustration, this hit indicating registry is announced by

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the passage of a beam of light from a light source through the registering apertures to a light sensitive cell.

Other control bands, zones, apertures or indicia are disclosed in the Waller et al. application; but it is the aim-registering control band zone, aperture, or indicia with which the present invention is concerned.

One of the first considerations which underlies the present invention is the fact that the coordinate representation of the aim spot (which might be the hit spot or the target image location) requires a large amount of control band or film; and this is particularly true because it proved advantageous to double the vertical dimension of a frame of the control band for greater accuracy of response and to provide space for various control indicia. Film strip material is expensive and an undue amount is troublesome to handle and store. Moreover, there is considerable shrinkage in film strip of the usual transparent type and this is particularly troublesome when it occurs longitudinally of the strip. Keeping in mind that the pull-down mechanism of a projector, such as the intermittent sprocket or claw, is spaced by a distance of several frames away from the frame which stands in the projection aperture at the gate, it will be realized that the effects of longitudinal shrinkage are magnified to throw the target image higher on the screen than it was located originally before shrinkage occurred. Correspondingly, the aim spot on the control band will be altered, because the control band is made of the same material as the picture band and shrinks in the same sense and by about the same amount between its projection pull-down mechanism and the exposure aperture.

According to the present invention the disadvantages of vertical shrinkage in the picture and control bands are substantially eliminated by converting the vertical coordinate to a horizontal coordinate. The film shrinkage is substantially compensated for by forming the aperture which represents the vertical coordinate at an inclination to the vertical. And accuracy is obtained by using a longitudinal line at one edge of the film as a guide or zero index line from which the length of a coordinate is measured. Inasmuch as the edge of the film, or a line parallel to the edge within the line of sprocket holes, is the normal zero index line for the horizontal coordinate, it thus becomes a multifunction index base; that is, instead of having two index lines or reference bases, vertical and horizontal, there will

be only one index line, vertical. Hence the condition is established where the horizontal and vertical coordinates, which define the location of an aim spot for a frame, are placed in adjacent horizontal zones and are measured from the same base line.

There is another difficulty which is caused by film shrinkage and other factors. The major factor, aside from shrinkage, is that the central portion of the frame where the target most often appears is not the region of greatest aim accuracy when the horizontal coordinate is measured from one edge of the picture frame. The present invention largely eliminates the error here involved by taking the longitudinal median line of the picture film as the line from which the horizontal or azimuth movement is measured in each direction. It is here assumed that a single picture band projects the whole picture on the screen instead of using a number of bands to project a mosaic picture. More accurately, the screen center line should be referred to. Thus there are obtained two azimuth zones instead of one. These two zones are laid out on the control band as parallel horizontal zones which are also parallel to the horizontal zone for the vertical coordinate of elevation just discussed above, and measured from the same longitudinal edge or base line. Hence the condition is now established where there are three parallel horizontal zones which are employed to define the coordinate location of the aim spot for a frame. Normally, of course, only one of the azimuth zones will be used at a time because the target or aim spot will be located on only one side of the median line of the film at any given time. In the case where it is located on the median line, both azimuth areas will be used at one time, each with a partial effect. An incidental advantage derived from the present scheme is that each horizontal zone is allotted the full width of the film, hence is increased in length, whereby greater accuracy is obtained. In the present example the azimuth distance is doubled but there may be other degrees of change. One of the principal advantages of the invention is that it permits the use of very much simplified mechanism with the control band.

The objects and advantages of the invention will be more apparent from the following description of an exemplary embodiment of the invention, reference being made to the accompanying drawings wherein:

Figures 1, 3 and 5 represent three illustrative frames of target film which respectively show three target aim apertures, one in each view, together with a vertical median line and the locational coordinates of each spot;

Figures 2, 4 and 6 are views of a control band according to the present invention, together with associated mechanism, not a part of the invention, shown in dotted lines, showing how the three aim spots are represented;

Fig. 4*a* is a view of the control strip of Fig. 4 shown apart from the associated mechanism, and

Figure 7 is a schematic view with legends to explain the application of the invention.

Referring to Figure 1, there is shown a frame of an illustrative target film band **10** on which an aim spot or cross according to the former scheme is shown, this spot being designated as A. The vertical center line is shown in dotted lines and referred to by the numeral **11**. Measured from the left vertical base line **13** and the upper edge **12** of the frame, the coordinates of the point A are respectively V—**100**, H—**100**. Measured from the upper edge and the vertical center line the coordinates are V—**100**, HL—**100**.

In Figure 2 the aim spot A of Fig. 1 is represented (although not shown as a point) on a control band **14** according to the present invention. The base reference line or index line at the left is designated as **15**. The three horizontal bands or zones in which apertures are to be placed to represent the coordinates of aim spots are indicated by dotted lines and designated from top to bottom as HR (horizontal or azimuth to right of center line, on picture film frame or projection screen), V (vertical or elevation), and HL (horizontal or azimuth to left of center line). The indicia of horizontal distance to the left of the vertical center line **11** of Fig. 1, here represented by the two apertures **16** in the zone HL, is shown and its value designated as HL—**100**. Also its value H—**100** is given. The indicia of vertical distance downward from the base line Vo of Fig. 1, here represented by the two apertures **17** in the zone V, is shown and its value designated as V—**100**. All the indicia connected with any given aim spot may be said to be located in a single frame, though multiple projection means may be used for each pause of the film band. The transverse boundaries of a frame may, however, be difficult to locate. A horizontal register line **21** for each frame is shown but this is for positional registry principally.

In Figures 3 and 4 for aim spot B, V—**200**, H—**200** or V—**200**, HL—**0**, HR—**0**, the zones are indicated as before and the indicia of horizontal distance to the right of the vertical center line of Fig. 3, here represented by a single aperture **18** in zone HR is shown and its value designated as HR—**0**; the vertical indicia represented by two apertures **19** in zone V is shown and its value designated as V—**200**; and a single aperture **20** in zone HL is shown and its value designated as HL—**0**. It will be noted that when the aim spot falls on the center line, as here, there will be apertures in all three zones, but the apertures for the horizontal coordinate or azimuth (**18** and **20** here) appear only in half size, the two half apertures together passing the same amount of light as one whole aperture, and together with the vertical coordinate aperture or apertures, passing enough light to register a hit if the apertures of the gun actuated slides **22**, **23** and **24**, indicated in dotted lines, are properly located. The slides **22** and **24** for horizontal coordinate or azimuth are shown to be connected for movement in opposite directions. The travel of each is twice the width of the film strip, the apertures moving between minus 200 and plus 200.

In Figures 5 and 6 for aim spot C, V—**300**, H—**300** or V—**300**, HR—**100**, the horizontal zones are against indicated as before, and the dual or compound aperture **25** in zone HR is shown and its value designated as HR—**100**, and the dual aperture **26** in zone V is shown and its value designated as V—**300**.

The apertures in the control band vary in width to accommodate for different degrees of accuracy in aim for different distances from the target, the apertures in the slides, of course, remaining the same, viz. the size of the smallest film apertures.

The control film apertures in zone V are inclined to the left at the top, hence if the control film shrinks the apertures will be drawn down toward the sprocket and toward the left index line in the vertical zone V in which the cooper-

ating inclined slide aperture moves. The inclination of both film and slide apertures may be, for example, about 10 degrees. The apertures in the control band are longer than the width of the zone V, here chosen to be equal in width to the length of the apertures in the slide **23** for the vertical component of the aim spot, so that they still span the zone even though they are pulled down by shrinkage. But the gunner will aim high because the picture band has also shrunk in length from its pull-down sprocket toward the exposure position or gate by substantially the same amount, being the same kind of film and made at about the same time. This means that the target image is nearer the horizontal base line at the top of the projection screen than it was made to be and when the gunner aims high the vertical slide aperture will be positioned nearer the common base line **15**. It is therefore in proper position to register with the shrinkage-displaced control band aperture and to give an indication of a hit.

Shrinkage of the control band also draws the horizontal or azimuth apertures down but as they are made over-length they still span the zone of movement of the azimuth slide apertures. But the horizontal shrinkage of the picture band is very small and even less from the vertical center line, hence no adjustment for shrinkage is needed in the azimuth registration.

Figure 7 shows schematically how the picture and control bands run in unison; how shrinkage of the picture band moves the object image up on the screen from P*n*, or normal, to P*s*, the shrink position; and how the control band shrinks correspondingly to move down relative to the aperture slides. Legends are applied to Figure 7 throughout so no detailed description of parts by reference characters here is deemed necessary.

It is thus seen that by changing from one aperture to a plurality of separately functioning apertures, by transferring the elevational coordinate from vertical to horizontal; and by inclining the elevational apertures, very material advantages in operation are obtained and simpler associated mechanism is permitted to be used. The azimuth coordinate is multiplied by the factor two by using two horizontal zones instead of one and with them two apertured slides which move in opposite directions. It may be multiplied by different factors by different aperture and slide arrangements. For example, there may be three horizontal zones instead of two and for this a single slide having three vertically and horizontally spaced apertures to cooperate with apertures in three horizontal zones of the control band may be used. Or one slide with two apertures and an oppositely moving slide with one aperture may be used with the three control band zones. Other arrangements are possible. The vertical coordinate or elevation is lengthened by turning it horizontally. It may be further increased by increasing the number of apertures, as for the azimuth. It will be understood that according to the former system the vertical coordinate required a considerable length of film and if the sensitivity was increased by increasing the length of the vertical coordinate, much more film was required. By the present system in which all indicia are placed in horizontal bands much film is saved and space is left for a number of other control indicia.

Horizontal shrinkage is compensated for by using one edge of the control band as a reference or zero line which may be run along an accurate fixed or adjustable edge guide. The center of the film where greatest accuracy is needed is now transposed in effect to the edge where greatest accuracy is obtainable.

Vertical shrinkage is further compensated for by taking the initial reference from the top of the picture band or projection image frame. Previously elevation was measured from the bottom of the frame to obtain a true reference location on a frame for the single aperture or set of apertures which represented the aim spot or target location.

While one embodiment has been described it is to be understood that the invention may have various embodiments within the limits of the prior art and the scope of the subjoined claims.

We claim as our invention:

1. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components in all of said zones together defining the position of a single aim spot or target on the corresponding picture frame, the indicia components of azimuth being defined by vertical lines and the indicia of elevation being defined by lines which are inclined to the vertical to compensate for shrinkage of the band.

2. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components of all of said zones together defining the position of a single aim spot or target on the corresponding picture frame, the indicia components being defined by generally vertical lines of a predetermined length required by their normal function plus an allowance for film band shrinkage.

3. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components in all of said zones together defining the position of a single aim spot or target on the corresponding picture frame.

4. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components in all of said zones together defining the position of a single aim spot or target on the corresponding picture frame, the value of each indicia component being measured by its

distance from a common vertical base line extending across all of said zones.

5. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components in all of said zones together defining the position of a single aim spot or target on the corresponding picture frame, the indicia components of two or said zones representing azimuth and another indicia component representing elevation, the value of each indicia component being measured by its distance from a common vertical base line extending across all of said zones.

6. As an article of manufacture, a control band having a plurality of frames adapted to be used in connection with a picture band having a plurality of corresponding frames carrying the image of a target to be fired upon, a frame of said control band being formed with indicia components such as apertures in one or more of a plurality of separately allotted parallel horizontal zones respectively representing azimuth and elevation, the indicia components in all of said zones together defining the position of a single aim spot or target on the corresponding picture frame, the indicia components of two of said zones when present representing respectively azimuth on opposite sides of a target frame center line and being

defined by vertical lines on the control band, and the indicia in a third or elevation zone representing distance downward from the top of a target frame and being defined by lines which are generally vertical but inclined slightly from the vertical, all distances being measured in the horizontal zones from a base line extending across the ends of the zones at one edge of the band.

7. A control band as set forth in claim 6, further characterized by the fact that the zone of elevation is located between the zones of azimuth.

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