Aug. 17, 1937. E. R. SWANSON 2,090,270

APPARATUS FOR MAKING MAPS FROM AERIAL PHOTOGRAPHS

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FIG. 1.

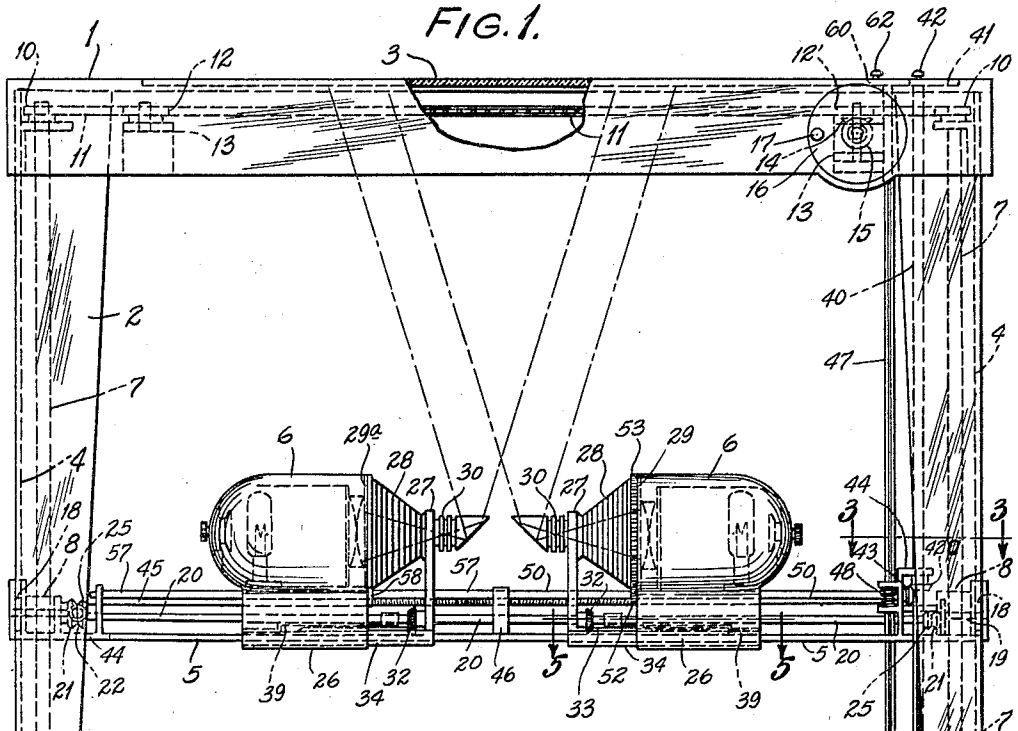
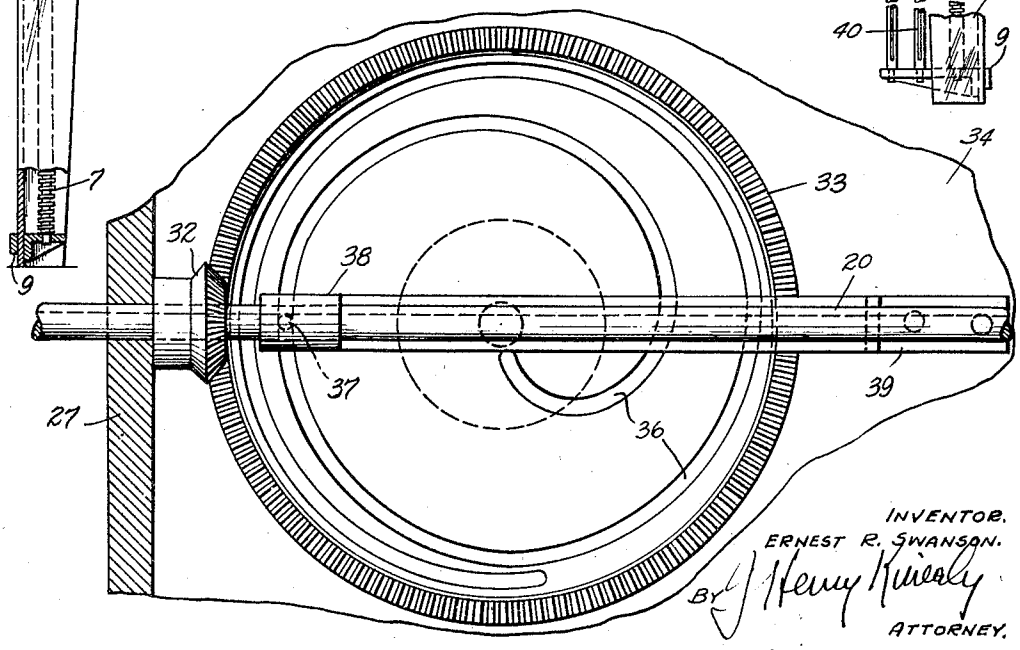


FIG. 5.



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FIG. 2.

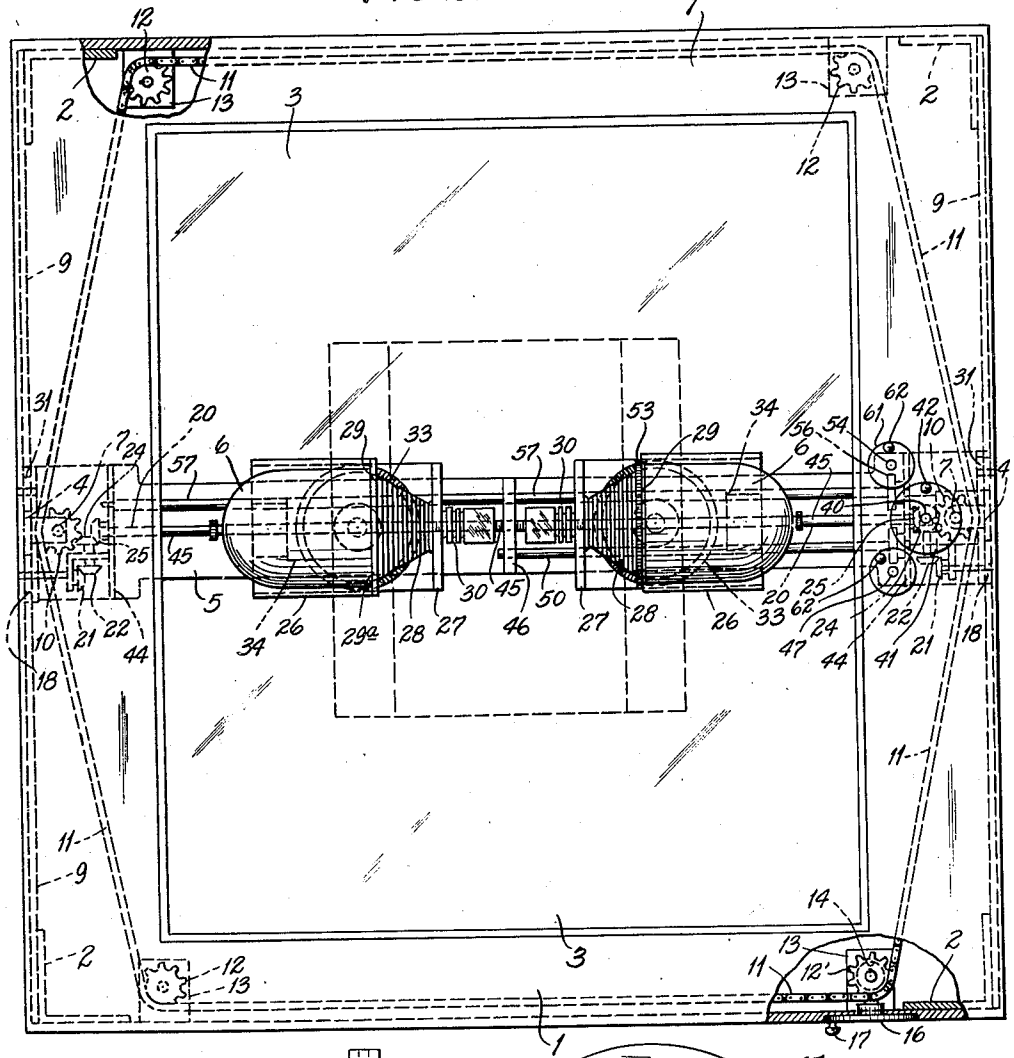


FIG. 13.

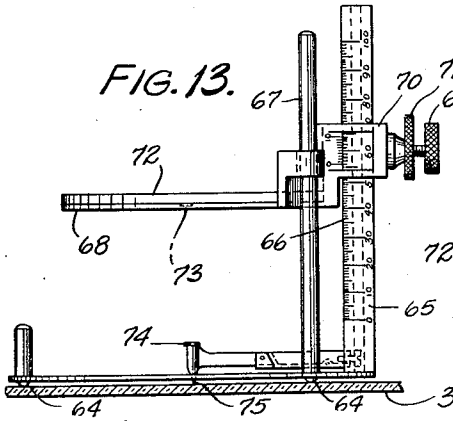
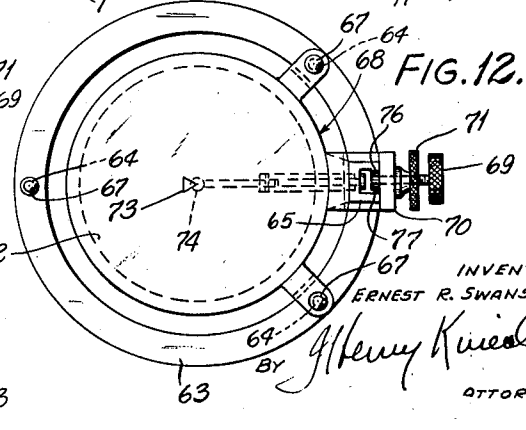


FIG. 12.



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FIG. 3.

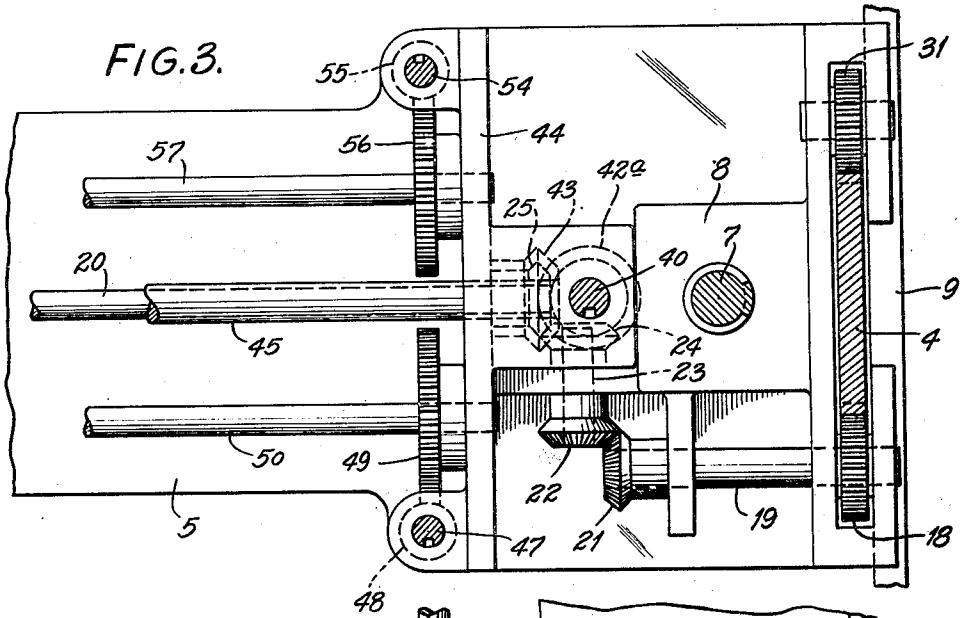


FIG. 4.

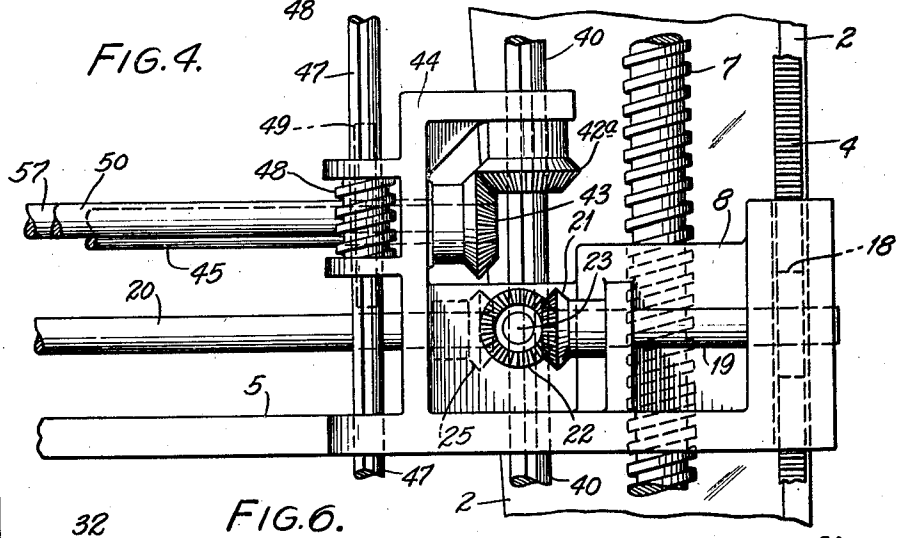
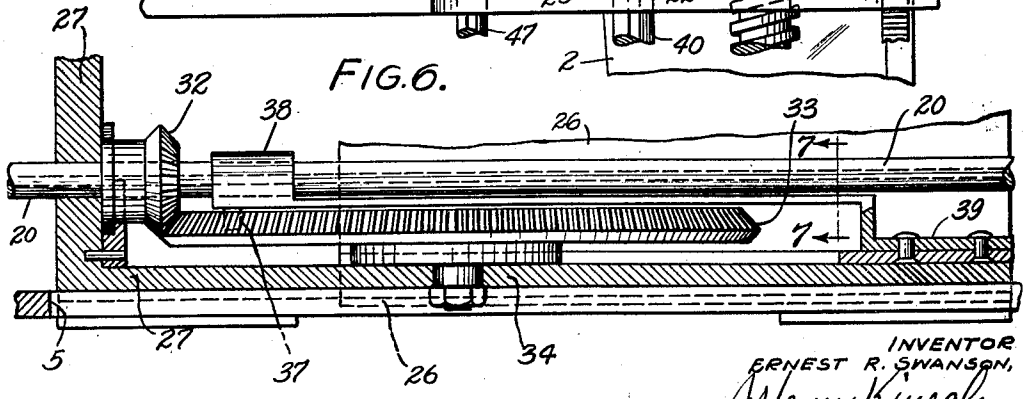


FIG. 6.



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FIG. 7.

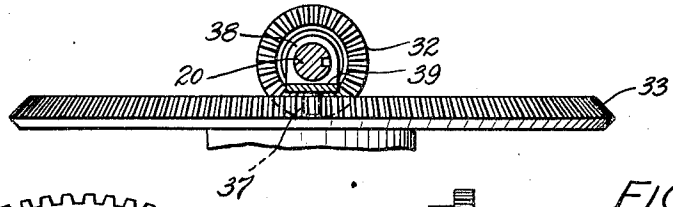


FIG. 8.

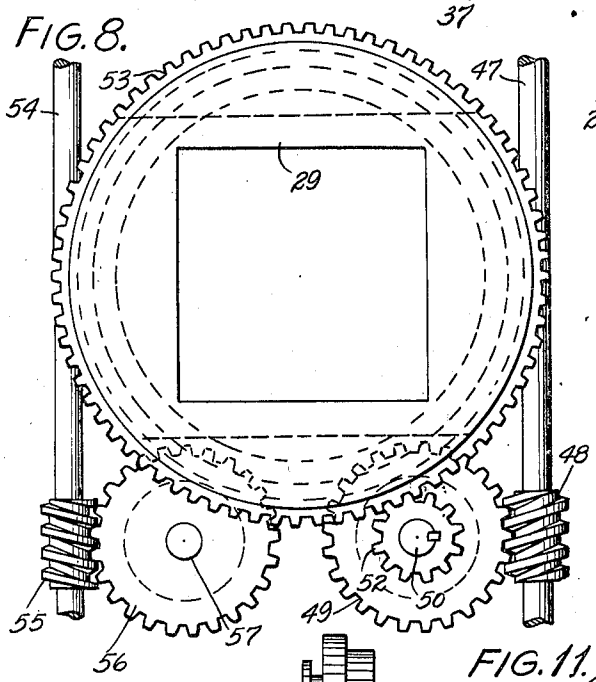


FIG. 9.

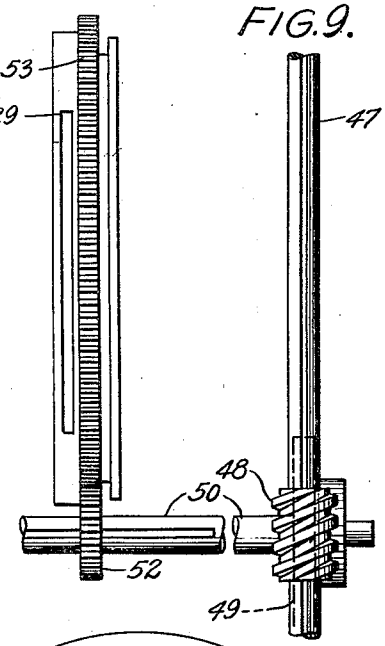


FIG. 10.

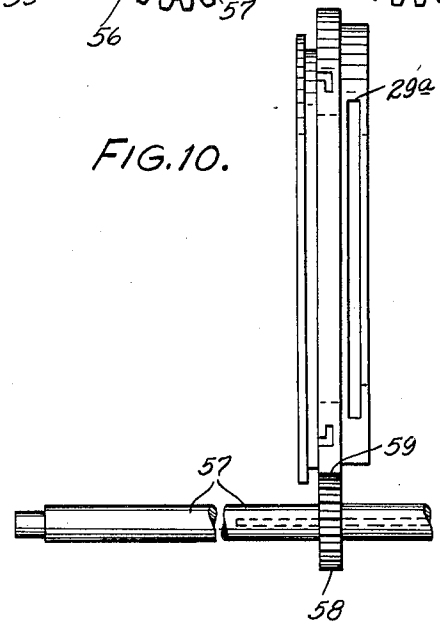
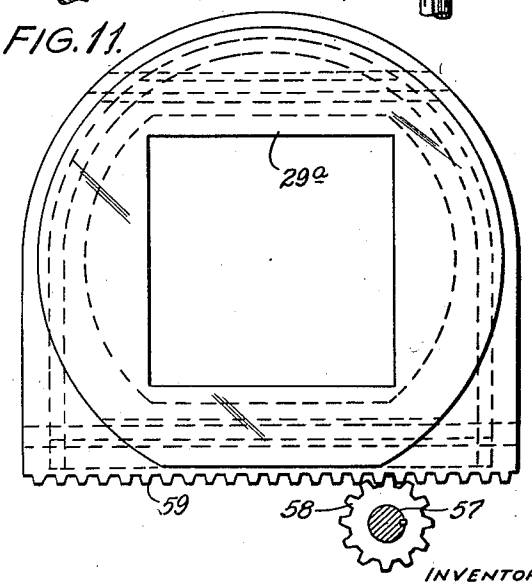


FIG. 11.



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UNITED STATES PATENT OFFICE

2,090,270

APPARATUS FOR MAKING MAPS FROM AERIAL PHOTOGRAPHS

Ernest R. Swanson, St. Louis, Mo.

Application June 10, 1935, Serial No. 25,802

12 Claims. (Cl. 88—24)

My invention relates to apparatus for making maps from aerial photographs and more particularly to such apparatus wherein an image of the photograph is projected onto a plane surface to be traced so that a map of the area included in the photograph may be produced on such tracing.

Heretofore, attempts have been made to produce an apparatus of this type which would be efficient, compact, accurate and simple in operation, but such devices as have been manufactured and used have been intricate, bulky, inefficient and expensive in design. Also, such apparatus as has been used did not allow accuracy in the maps produced therewith because contours of the terrain represented in the aerial photograph could not be included in the map without involved manipulation and computation. Furthermore, the projected flat image made for errors and resultant distortion which necessitated adjustments and computations to rectify partly these conditions.

In an apparatus of this type as heretofore used the image was projected downwardly upon the work table so that the draftsman tracing the projected image, as described above, cast his own shadow on the work table and the tracing was accomplished with great difficulty and high possibility of error. In some devices the image was projected into a vertical plane and as a result the draftsman worked in an unnatural and uncomfortable position.

Having in mind the deficiencies of the prior used devices the objects of my invention are to provide an apparatus and method of using such apparatus for making maps from aerial photographs whereby results of great accuracy will be obtained; to provide such apparatus which is simple and cheap in manufacture and operation; to provide an apparatus which allows the draftsman to work in comfort; and to provide an apparatus whereby the resultant map will accurately show the contour of the terrain photographed without necessitating intricate adjustments and computations.

In the accompanying drawings wherein similar characters are used to designate similar parts, my invention is shown embodied in an apparatus of the dual projection type wherein a pair of projectors are used to project a fused image from aerial photographs of overlapping sections of country. In the drawings, Fig. 1 shows the apparatus in elevation; Fig. 2 is a plan view of the apparatus as shown in Fig. 1; Figs. 3 and 4 show the arrangement for driving the various shafts which operate adjustments of the parts; Figs. 5, 6 and 7 are details of the mechanical parts for effecting automatic focus of the projectors, all as described fully hereinafter in the specification; Figs. 8, 9, 10 and 11 show the means used to complete fusion of the images from the projectors; and Figs. 12 and 13 show a contouring device which when used with the other parts of the apparatus assures production of an accurate topographic map.

Referring to the figures in the embodiment shown, the supporting frame for the various parts of the device includes a top 1 carried by legs 2. The top has the center portion thereof cut out and otherwise adapted to receive a transparent plate 3 upon which the dual image from the projectors is focused and which provides a flatwork surface arranged at the proper height for tracing the image, all as shown in Figs. 1 and 2 and for the purposes more fully hereinafter described. At each end of the device and preferably midway between the sides thereof is arranged a vertically extending guide 4 upon which the carriage 5 for the projectors 6 is raised and lowered. Preferably, the side edges of the guide 4 are provided with teeth to form a rack, for the purpose hereinafter mentioned. Arranged inwardly from each of the guides 4 is a shaft 7 threaded in a boss 8 at an end of the carriage 5 so that the carriage may be raised or lowered by rotation of the shafts 7. The lower ends of the shafts 7 and guides 4 may be maintained in predetermined position by the stringers 9 extending between the legs.

At the upper ends of the shafts 7 are fixed sprockets 10 adapted to engage a chain 11 which extends inside of the frame of the top 1 and runs over sprockets 12 carried on brackets 13 near the corners of the table. However, one of said sprockets as at 12' is driven through beveled gears 14 and shaft 15 by a hand wheel 16, preferably, set flush in the side frame of the top 1 and having a knob 17 to facilitate rotation. It will be understood clearly that rotation of the wheel 16 in either direction will move the chain 11 and, in turn, rotate the shafts 7 to raise or lower the carriage 5 on the guides 4 and, thereby, to increase or decrease the size of the image projected on the transparent plate 3 by the projector 6.

However, to obtain best results in using my device it is desirable that as the carriage 5 is raised or lowered by the means shown or by any other suitable expedient that the projectors 6 be maintained automatically in the proper focus for any particular adjustment of the car-

riage. To this end, I provide, as shown in detail in Figs. 3 and 4, at each end of the carriage 5 a gear 18 arranged to engage the rack formed on the edge of the guide 4. The gears 18 are each fixed on a stub shaft 19 and are arranged so that when the carriage is raised or lowered on the guides 4 the gears 18 and stub shafts 19 will be rotated to drive a focusing shaft 20 through complementary gearing, including beveled gears 21 and 22, stub 23 and beveled gears 24 and 25. The gears 18 at opposite ends of the carriage 5 are arranged on the same side of the guides 4 so that the shaft 20, of course, will be driven in the same direction by both driving means. Idler gears 31 may be included to balance the movement along the guides 4.

Each projector includes a housing 26 slidably mounted on suitably arranged parts of the carriage 5 and the projector also includes a lens support 27 for the front end of a bellows 28 extending between a plate holder 29 or 29a at the front end of a housing 26 and a lens mounting 30. In the form of device shown, the lens are used in conjunction with a prism so that the image is projected at a right angle to the axis of the projector.

The mechanism for automatically focusing each projector by means of the shaft 20 is shown in detail in Figs. 5, 6 and 7. Keyed onto the shaft 20 so as to be slidable along the shaft, but to be rotated thereby is a beveled gear 32 which is maintained in mesh with a ring gear 33 carried on the bottom plate 34 fixed to the lens support 27. The gear 32 is maintained in predetermined position relative to the ring gear 33 by the support 27. The bottom plate 34 is slidably mounted relative to the main housing 26 of the projector. On the upper face of the ring gear 33 is arranged an eccentric groove 36 adapted to receive a pin 37 fixed in the collar 38. Extending from the collar 38 and secured thereto is a link 39 which has its end opposite the end fixed to the collar secured to the lower part of the housing 26. The groove 36 is shaped and the speed of rotation of the ring gear 33 is adjusted so that as the carriage 5 is raised or lowered, in the manner described above, the ring gear 33 will be rotated and the grove 36 will move the collar 38 along the shaft 20 and the co-action of the pin 37 in the groove 36 will cause the projector housing 26 and lens support 27 to be moved relative to one another so that the focus of the projectors will be varied. By careful adjustment of the parts the device may be arranged so that the projectors will be properly focused for any vertical adjustment of the carriage. When the carriage 5 is raised or lowered to increase or decrease the size of the image cast on the plate 3 it is necessary that the images from the two projectors be properly merged or fused one into the other. To this end, it is necessary that the distance between the projector 6 be varied. To accomplish this, I provide a shaft 40 extending vertically and adapted to be rotated by a wheel 41, preferably, set flush in the top 1 and having thereon a knob 42. Keyed on the shaft 40 so as to be slidable thereabout but to be rotated thereby, is a beveled gear 42a maintained in mesh with the beveled gear 43 by a bracket 44 carried by the carriage 5. The beveled gear 43 is fixed to the shaft 45 which is supported at the center of the carriage 5 by a block 46. The shaft is threaded in opposite directions on each side of the center block so that each threaded portion of the shaft passes through and is threaded in the lens support 27 of a projector. When the shaft 40 is rotated by the hand wheel 41 the projectors 6 will be moved towards or away from one another according to the direction of rotation of shaft 40 and, in turn, shaft 45.

It is sometimes necessary for complete fusion of the images that the plates containing the aerial views be shifted in the projectors and, therefore, I provide mechanism as shown in detail in Figs. 8, 9, 10 and 11, whereby the plate holder 29 for one projector may be rotated with its contained plate and the plate holder 29a for the other projector may be moved in a path at right angles to the axis of the projector. The plate holder 29 is moved by a vertical shaft 47 through a worm wheel 48 keyed thereon, pinion 49, shaft 50, and gear 52 in mesh with ring gear 53 associated with the plate holder 29. The gear 52 is keyed on the shaft 50.

The plate holder 29a is moved at right angles to the axis of the projector by the shaft 54, worm wheel 55 keyed thereon and meshing with pinion 56 fixed to the shaft 57, pinion 58 keyed on shaft 57 and in mesh with rack 59 associated with plate holder 29a.

The shafts 47 and 54 are rotated in a direction to effect the proper movement of the plate holders 29 and 29a by hand wheels 60 and 61, respectively. These hand wheels are preferably set flush in the top 1 and are provided with knobs 62.

If the parts of the device are arranged as shown the operator or draftsman will have easy access to the means for making the various adjustments to the parts and work will be facilitated to a great extent.

In a dual projection apparatus of the type described and shown herein adjacent or simultaneous aerial photographs reproduced on the plates positioned in the plate holders 29 and 29a may be projected with the fusion of images outlined above into a relief map or model of the ground by projecting the two images with rays of different complementary colors and by causing the rays to intersect in space and the images to be focused and fused on a given surface. This composite projection is then viewed stereoscopically through filter spectacles of the same density and complementary colors as used in the projection filters, thereby rendering the area plastically visible to the operator and permitting direct interpretation and generation of a map by the tracing of the topographic features and terrain as disclosed by the viewed image.

Therefore, the lens of the projectors 6 are provided with filter screens of different colors so that the rays will be projected in different complementary colors. The filter spectacles by which the fused image is viewed are not shown.

When my new and improved device in the embodiment shown is to be used to produce a topographic map a sheet of tracing cloth or paper is fastened onto the top 1 to register with the transparent plate 3. Plates of overlapping aerial views of the terrain to be mapped are inserted in the plate holders 29 and 29a and the projector carriage 5 is raised or lowered by manipulation of the hand wheel 16 until the image cast upon the transparent plate 3 and visible through the tracing material is of the desired size. By the term "plate" as used herein, I mean a translucent reproduction or any other form of print which may be projected by a suitable device.

As set forth above, when the carriage 5 is raised

or lowered the projector 6 will be focused automatically at all times and for all vertical adjustments of the carriage 5 the dual images will be clear cut as projected into the plane of the transparent plate 3.

However, for best results and for the reasons described above there should be perfect fusion of the two projected images and, such fusion may be easily secured by moving the projectors 6 and the images projected therefrom towards or away from one another by manipulation of the hand wheel 41. Exact fusion then may be obtained by moving the plate holders 29 and 29a and their carried plates by manipulation of the hand wheels 60 and 61. The two images in rays of complementary colors upon proper manipulation and adjustment of the parts will be in perfect fusion and the resultant dual or fused image when viewed through filter spectacles quickly and easily may be traced on the tracing material so that the topography of the pictured terrain will be accurately shown.

I have found that it is necessary that a topographic map should include indications of varying elevations of the terrain and, although the variances may be computed from field notes this is a long and tedious procedure. As the contour of the country is generated fully by the projection method described above I have found that elevation indicia may be placed upon the tracing if a contouring device, one embodiment of which is shown in Figs. 12 and 13, is used in conjunction with the mapping apparatus described herein.

In the embodiment shown the contouring device includes a foot 63 supported on smooth knobs 64. Extending upwardly from and fixed to the foot 63 is a standard 65 graduated as at 66. Slidably mounted along guide posts 67 and the standard 65 is a frame 68 which may be moved into any desired adjusted position by rotating the thumb screw 69 carried by the yoke 70 and having at its inner end a small gear 77 in mesh with the rack 76 formed on the standard 65. The thumb screw 69 may be held in adjusted position by a lock nut 71 associated therewith. The frame 68 supports a transparent plate indicated at 72. This plate has, preferably in the center thereof, a floating ground mark 73. Carried at the bottom of the device is a holder 74 for a pencil 75 which pencil is adapted to bear and mark upon the tracing material on the transparent plate 3. When the contouring device is placed on the tracing material and when the image is viewed through the filter spectacles, as fully set forth above, by raising or lowering the frame 68 the floating ground mark 73 will appear to be above, below or on the ground as generated by the fused image from the projectors. The floating ground mark 73 is fixed on a point of known elevation and the graduation at which the frame is set is noted. As the contouring device is moved over the tracing if the ground mark 73 appears to be above the ground the operator knows that at that point the elevation is less than that at the known point for which the contouring device has been set. If the ground mark 73 appears below the ground, in turn, it is known that the elevation at that point is higher than the point for which the mark has been set. If the elevation for two points is known after the ground mark 73 has been set to register with the two known points the difference in graduations at which the ground mark registers with the two known elevations may be calibrated into hundreds or thousands of feet and the elevation of any part of the terrain may be determined quickly by registering the floating mark 73 therewith and then computing the relative elevations on the calibrations 66.

In the accompanying drawings and in the above description, I have shown one embodiment of my invention, but it should be understood that apparatus made according to my ideas may take many forms without deviating from the spirit of my invention as included in the appended claims.

What I claim as new and desire to secure by Letters Patent, is:—

1. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported to be movable away from or toward said work surface, a projector mounted on said carriage and arranged to project onto said work surface an image from a plate adjusted therein, means for moving said carriage relative to said work surface, said projector including a lens and said plate, a cam plate having an eccentric groove formed therein, a link having a pin associated in said groove, power transmitting mechanism whereby said cam plate will be rotated when said carriage is raised or lowered, and said cam and said link being positioned and arranged whereby when said cam is rotated said lens and said plate will be moved relative to each other whereby the projected image will be focused automatically on said work surface at any adjusted position of said carriage.

2. In an apparatus of the class described, the combination of a supporting frame including a transparent panel, a pair of guides arranged at substantially right angles to said panel and extending downwardly therefrom, a projector carriage slidably mounted on said guides whereby said carriage may be adjusted away from or toward said panel, a projector mounted on said carriage and arranged to project onto said panel an image from a plate adjusted therein, said projector including a lens and said plate, one of said guides having a rack formed along an edge thereof, a gear mounted on said carriage and in mesh with said rack whereby said gear will be rotated when said carriage is raised or lowered, a shaft fixed to said gear and adapted to rotate a cam plate, a link having a pin associated with said cam plate, and said cam plate and said link being positioned and arranged whereby when said cam is rotated by raising or lowering said carriage said lens and said plate will be moved relative to each other whereby the projected image will be focused automatically on said panel at any adjusted position of said carriage.

3. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported relative to said work surface, a pair of projectors mounted to be movable relative to one another on said carriage and each arranged to project onto said work surface an image from a plate adjusted therein, means for moving said carriage away from or toward said work surface, and a unitary manually operable means connecting the pair of projectors for effecting vertical and horizontal adjustments of said projectors whereby the images therefrom as projected on said work surface may be fused.

4. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported relative to said work surface, a pair of projectors mounted on said carriage and each arranged to project onto said work surface

an image from a plate adjusted therein, each of said projectors including a plate holder for said plate and a lens, means for moving said carriage away from or toward said work surface, and manually operable means for effecting adjustments of said projectors relative to each other and of said plate holders whereby the images as projected on said work surface may be fused.

5. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported to be movable away from or toward said work surface, a pair of projectors mounted on said carriage and each arranged to project onto said work surface an image from a plate adjusted therein, each of said projectors including a plate holder for said plate and a lens, the plate holder of one of said projectors being arranged to be rotated in a plane substantially at right angles to the axis of said projector, the plate holder of the other of said projectors being arranged to be moved transversely of the axis of said projector, and means operable from said work surface for moving said plate holders whereby the images as projected on said work surface may be fused.

6. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported to be movable away from or toward said work surface, a pair of projectors mounted on said carriage so as to be movable relative to each other and each arranged to project onto said work surface an image from a plate adjusted therein, means for moving said carriage relative to said work surface, each of said projectors including a plate holder for said plate and a lens, the plate holder of one of said projectors being arranged to be rotated in a plane substantially at right angles to the axis of said projector, the plate holder of the other of said projectors being arranged to be moved transversely of the axis of said projector, and means operable from said work surface for moving said projectors relative to each other and for moving said plate holders whereby the images as projected on said work surface may be fused.

7. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported to be movable away from or toward said work surface, a pair of projectors mounted on said carriage and each arranged to project onto said work surface an image from a plate adjusted therein, each of said projectors including a plate holder for said plate and a lens, the plate holder of one of said projectors being arranged to be rotated in a plane substantially at right angles to the axis of said projector, the plate holder of the other of said projectors being arranged to be moved transversely of the axis of said projector, and means operable from said work surface for moving said plate holders whereby the images as projected on said work surface may be fused, and means operating automatically upon adjustment of said carriage for focusing the projected fused image on said work surface whereby said projectors will be focused automatically at any adjusted position of said carriage.

8. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported to be movable away from or toward said work surface, a pair of projectors mounted on said carriage so as to be movable relative to each other and each arranged to project onto said work surface an image from a plate adjusted therein, means for moving said carriage relative to said work surface, each of said projectors including a plate holder for said plate and a lens, the plate holder of one of said projectors being arranged to be rotated in a plane substantially at right angles to the axis of said projector, the plate holder of the other of said projectors being arranged to be moved transversely of the axis of said projector, and means operable from said work surface for moving said projectors relative to each other and for moving said plate holders whereby the images as projected on said work surface may be fused, and means operating automatically upon adjustment of said carriage for focusing the projected fused image on said work surface whereby said projectors will be focused automatically at any adjusted position of said carriage.

9. In an apparatus of the class described, the combination of a supporting frame including a transparent panel, a pair of guides extending vertically downwardly below said panel, a projector carriage adjustably mounted on said guides so as to be movable away from or toward said panel, a pair of projectors mounted on said carriage so as to be movable relative to each other and each arranged to project onto said panel an image from a plate adjusted therein, a plate holder for each of said projectors, and manually operable means for moving said carriage relative to said work surface and means for effecting adjustments of said projectors relative to each other and of said plate holders whereby the images as projected on said work surface may be fused.

10. In an apparatus of the class described, the combination of a supporting frame including a transparent panel, a pair of guides extending vertically downwardly below said panel, a projector carriage adjustably mounted on said guides so as to be movable away from or toward said panel, a pair of projectors mounted on said carriage so as to be movable relative to each other and each arranged to project onto said panel an image from a plate adjusted therein, a plate holder for each of said projectors, manually operable means for moving said carriage relative to said work surface and means for effecting adjustments of said projectors relative to each other and of said plate holders whereby the images as projected on said work surface may be fused, and means operating automatically upon adjustment of said carriage for focusing the projected fused image on said panel whereby said projectors will be focused automatically at any adjusted position of said carriage.

11. In an apparatus of the class described, the combination of a supporting frame including a flat work surface, a projector carriage adjustably supported relative to said work surface, a pair of projector housings mounted on said carriage to be movable therealong relative to one another, each of said housings including a projector arranged to project onto the same area of said work surface an image from a plate adjusted therein and said housing also including a single operating means controlled by the movement of said carriage for automatically focusing and fusing the image from said projectors on said surface at any adjusted position of said carriage relative to said work surface.

12. In an apparatus of the kind described, the combination of a supporting frame including a

flat work surface, a projector carriage mounted on said supporting frame so as to be movable away from or toward said work surface, a pair of projector housings mounted on said carriage to be movable therealong relative to one another, a single manually operable means for moving said housings toward and away from each other on said carriage and for moving said carriage relative to said work surface, each of said housings including a projector arranged to project onto the same area of said work surface an image from a plate adjusted therein, a shaft mounted on said carriage and arranged to be rotated by movement of said carriage away from or toward said work surface and for moving said housings and each of said housings including focusing means controlled by rotation of said shaft whereby the image from each of said projectors will be focused automatically and fused on the same area of said work surface in any adjusted position of said carriage.

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