April 14, 1970 R. C. GEITZ 3,506,351

DRAFTING MACHINE

Filed July 26, 1967 4 Sheets-Sheet 1

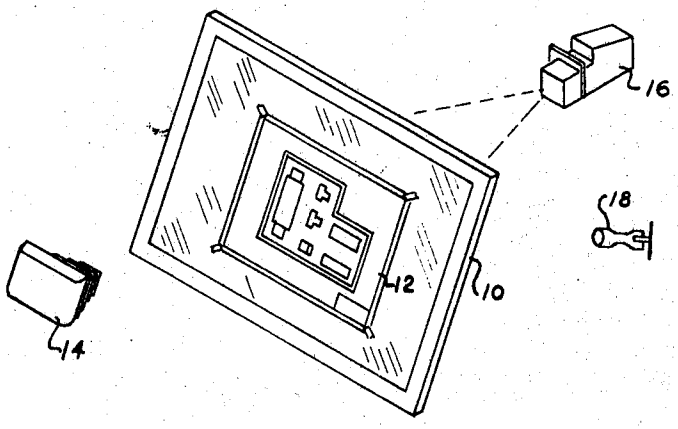


FIG. 1

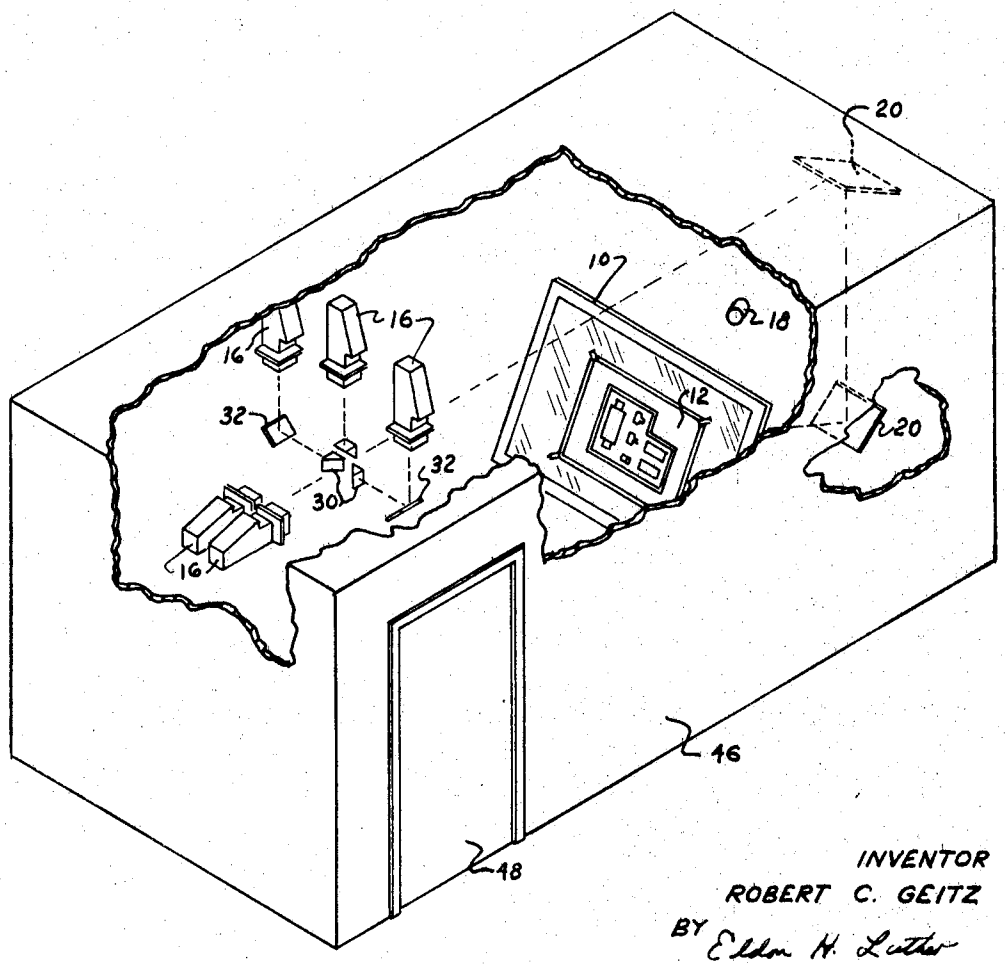


FIG. 8

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DRAFTING MACHINE

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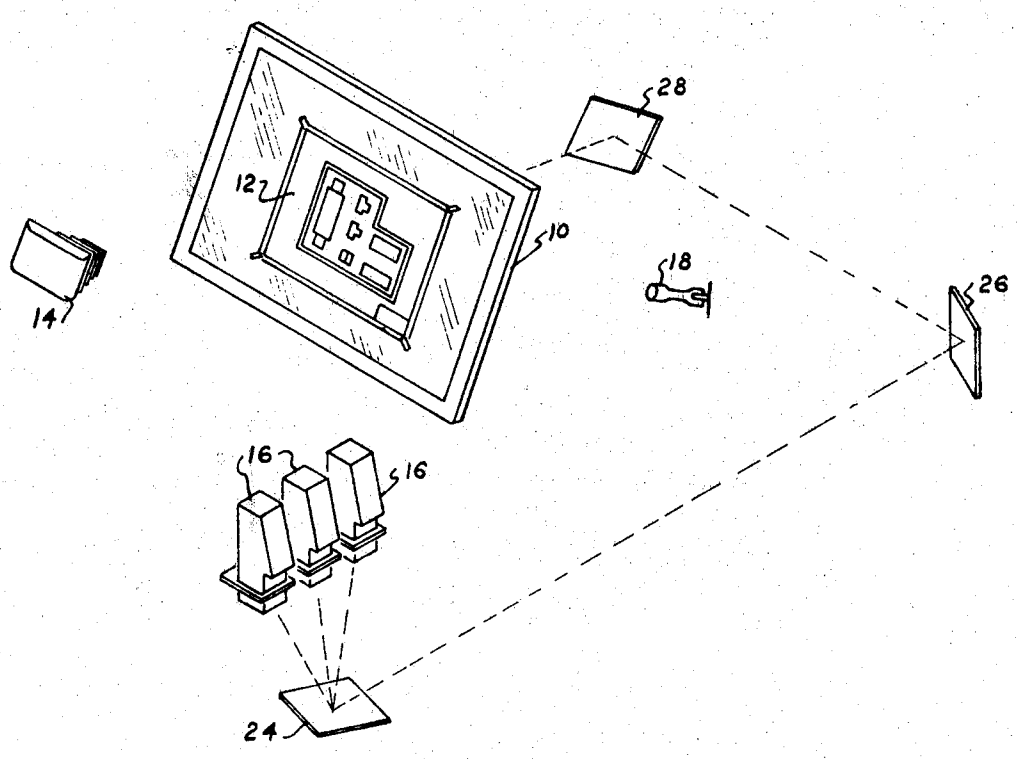


FIG. 5

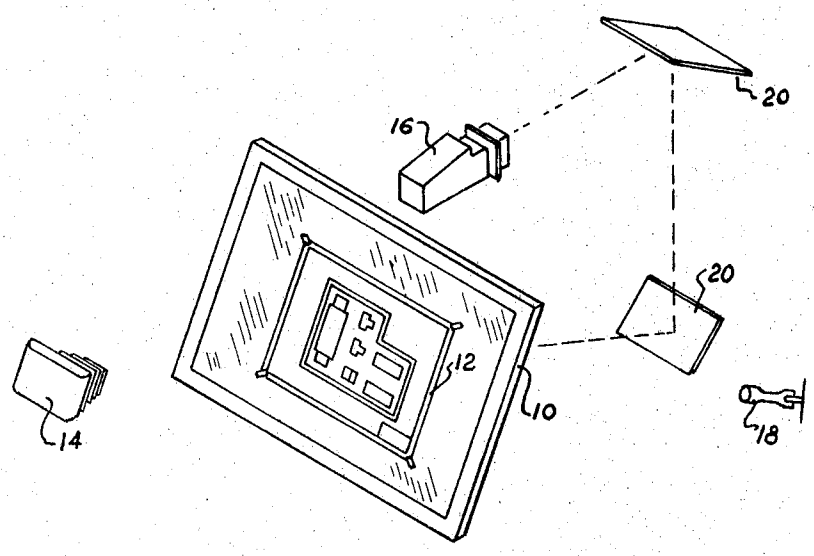


FIG. 2

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DRAFTING MACHINE

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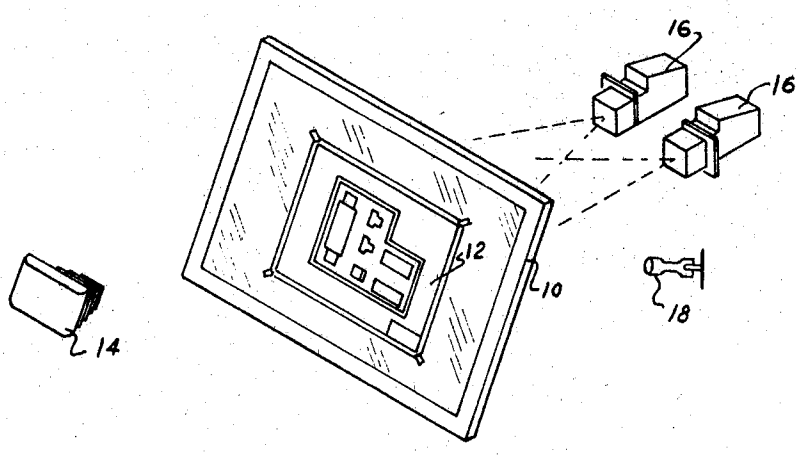


FIG. 3

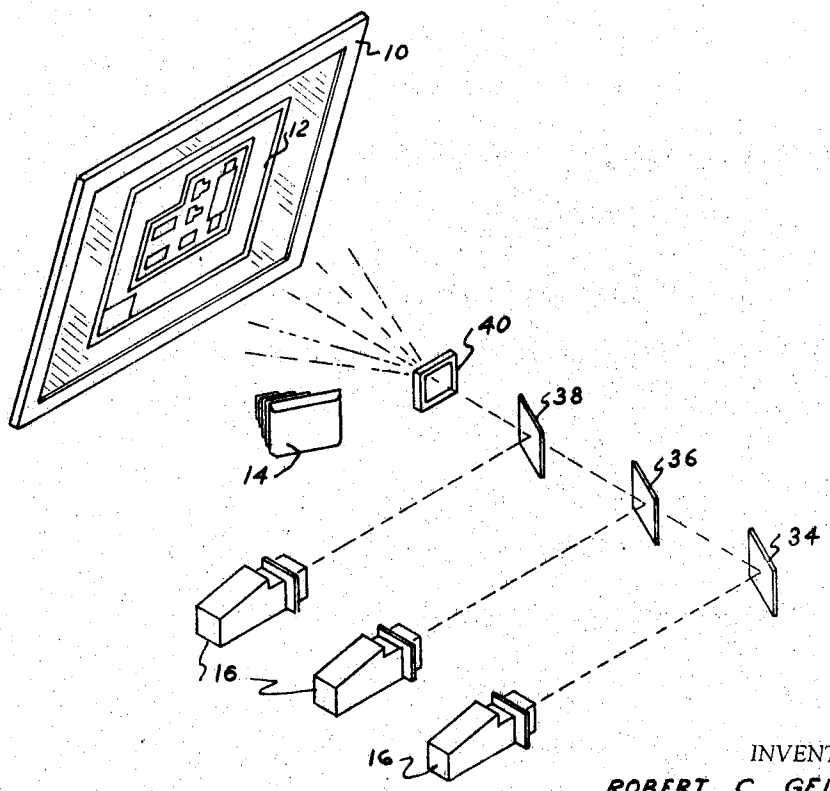


FIG. 4

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DRAFTING MACHINE

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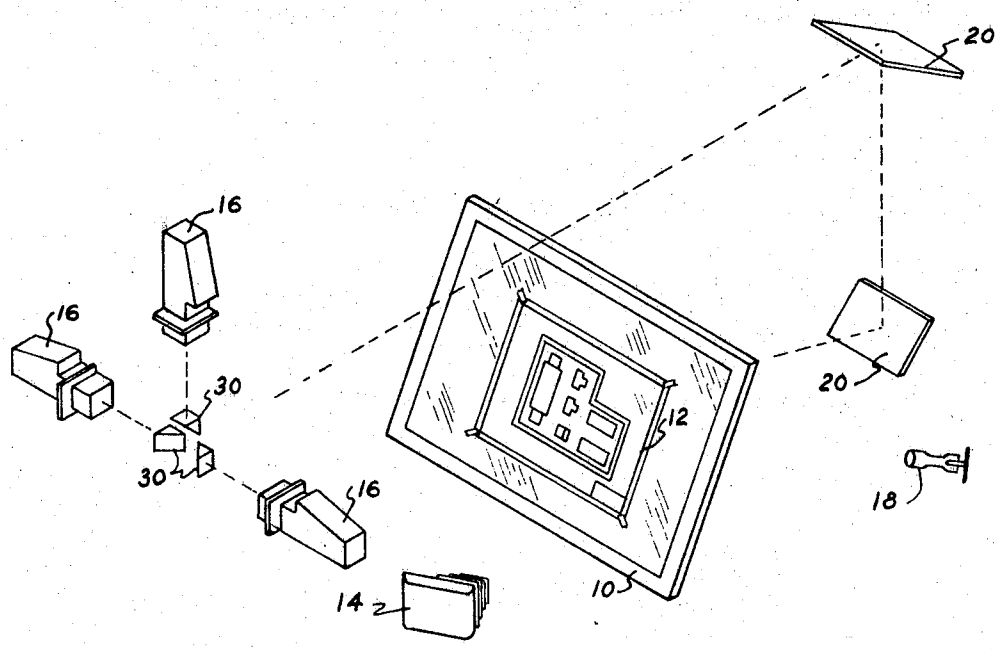


FIG. 6

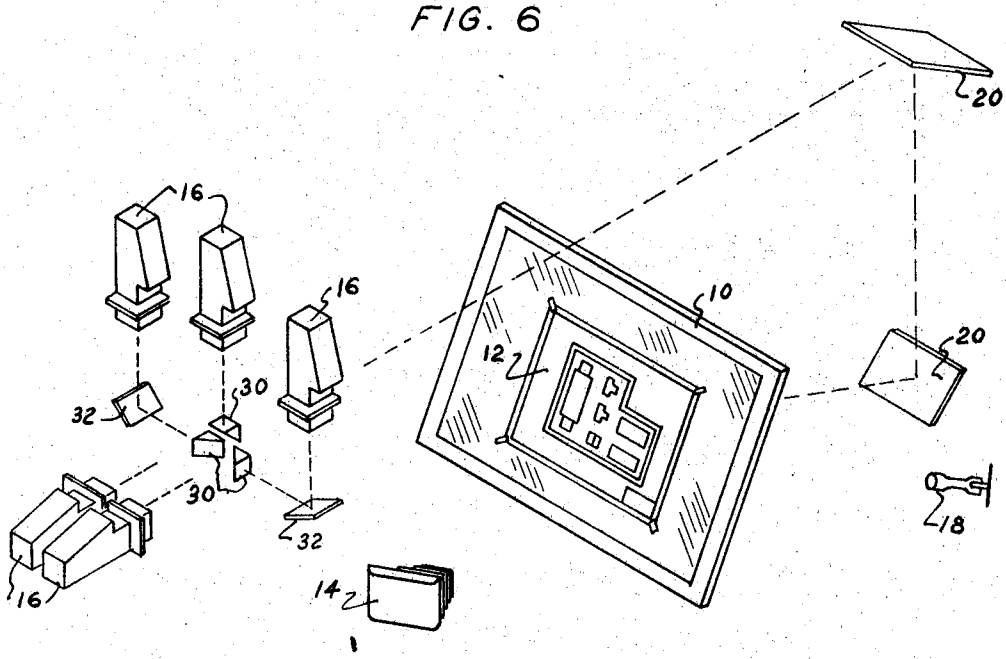


FIG. 7

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United States Patent Office 3,506,351
Patented Apr. 14, 1970

3,506,351

DRAFTING MACHINE

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Filed July 26, 1967, Ser. No. 656,272
Int. Cl. G03b 27/70
U.S. Cl. 355—43 5 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and method for producing engineering drawings and the like wherein an image of a drawing is produced on a light collecting member by projection from the rear of the member and this image is modified either by drafting techniques applied from the front of the member or by light projecting techniques including superimposing on this image one or more additional images. Photographs are taken of the thus produced and modified image at any desired stage of its development with the photographs rendering additional images that may be stored, projected or reproduced as desired.

BACKGROUND AND SUMMARY OF THE INVENTION

This invention generally concerns an improved method and apparatus for producing engineering, architectural and other drawings and has particular relation to such an improved method and apparatus wherein the step by step development of a drawing may be readily and easily recorded and wherein the space and facilities required for drawing storage are greatly reduced over that heretofore required and wherein reproduction of drawings may be readily accomplished.

In the development of engineering and architectural plans and designs there are frequently many choices, for example of arrangement, which must be evaluated. By present methods of producing drawings this is such a tedious and clumsy procedure that usually only a few of the possibilities are considered, and of these few, seldom are any but the ultimate solution recorded. Further, once a particular line of design is well under way it becomes an accretion of lines which are very difficult to change or correct without complete redrawing. My invention provides an easy and rapid means both of evaluating and recording many different design routes and of correcting or revising completed or partially completed designs.

In accordance with the invention there is provided a drawing table arrangement oriented conveniently for a draftsman to work on the front side thereof. This drawing table may be transparent or semi-transparent and will preferably carry on its front face a light collecting membrane upon which or directly over which there may be inscribed opaque lines by the draftsman. A projecting system is utilized for projecting an image or images onto the drawing table from the reverse side thereof and a camera is mounted in front of the drawing table to take photographs of the image produced on the table to thus produce images which may be used in the projection system. With this arrangement the image projected onto the drawing table may be altered by the draftsman and by photographing the changes a step by step record may be made as the drawing progresses. Several images may be projected onto the drawing board simultaneously through the use of one or several projectors and thus a composite drawing of the combination of these images produced. The image bearing members utilized in the projection system are preferably small transparencies which may readily be stored for future use and reference.

Accordingly, it is an object of this invention to provide

an improved drafting device for producing engineering, architectural and other drawings and which permits the rapid production and evaluation of various design changes and alternatives.

Another object of the invention is to provide an improved method for producing drawings wherein the time and labor necessary to evaluate different designs and/or different arrangements is greatly reduced over that heretofore required.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, fragmentary in nature, showing the various elements of the organization of the invention in their operative relationship in accordance with one embodiment of the invention;

FIGS. 2, 3, 4, 5, 6 and 7 are views similar to that of FIGURE 1 but showing different embodiments of the invention; and

FIG. 8 shows the various interrelated elements of the system of the invention mounted within a suitable housing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference characters are used throughout to designate like elements, there is disclosed in FIG. 1 the simplest form of the invention which includes a drafting table or plate **10** which preferably takes the form of a piece of flat plate glass that is transparent although semi-transparent glass or plastic may be utilized. The glass **10** is arranged at an angle to the vertical convenient for a draftsman to work on the front or upwardly directed face of the glass. Placed over this glass is a light collecting membrane such as a sheet of paper **12** and upon which the draftsman may draw by inscribing opaque lines. A camera **14** is mounted in a position on the front or membrane side of and perpendicular to the plate **10**. The camera is so positioned and has a focal length so as to give some standard fixed reduction of image, say from 48" to 4" or from 48" to 1½". A projector **16** is mounted and positioned to project perpendicular to the under or rear face of plate **10**. This projector is positioned with relation to plate **10** and has a focal length to give the exact same enlargement as the camera gives reduction so that if a series of lines are drawn on the paper **12** and a photographic transparency is made using the camera and an image is then projected onto the back of the paper **12** by means of the transparency and projector **16** the image and the original lines will exactly coincide.

Once a photographic transparency of a series of lines or a drawing has been made by this method, the drawing or lines can then be projected at will onto a blank screen (consisting of the plate of glass and an unmarked sheet of paper) by means of the transparency and the projector. It is then possible to modify the original drawing without going back to the drawing itself by drawing lines on the light collecting membrane (paper) and photographing the combination of the original image and the new lines. Furthermore, it is possible to erase portions of the original image by projecting spots of light by means of another projector **18** onto the image collecting membrane covering the portions to be erased. This can be done quite sharply

by projecting the image erasing light through suitable slits or apertures of appropriate size and orientation.

In addition to modifying the image projected on the light collecting membrane by means of a draftsman inscribing lines on or over this membrane, the image may be modified by simultaneously projecting another image on the membrane in a manner similar to the original image. With the organization and method of the invention this may be done with precision, and many different overlays, for example, may be projected onto a basic drawing or plan. For example, the foundation or floor plan of a house or building may be projected upon a plot plan on which the house is to be built; or machinery may be located on the floor plan of a factory; or a motor may be mounted on machinery; or the piping, electrical, heating, and ventilating arrangements may be projected on the same basic floor plan or architectural drawing permitting the checking of the layout and the determining of the existence of physical interference.

This simultaneous projection of the plurality of images on the light collecting member can be accomplished in a number of ways. The simplest, although not necessarily the most convenient and desirable method for all purposes, is depicted in the FIG. 1 organization wherein the image bearing transparencies are disposed in the projector in juxtaposition. For instance, one of the transparencies may contain an image of the plot of land upon which a building is to be built and the other contain the floor plan of the building. The transparencies are mounted in the projector in such a manner that they may be moved and maintained in any desirable position laterally of the axis of the projector, i.e., they may be moved sideways and vertically. Thus the floor plan of the house may be moved with relation to the plot plan as desired with the image produced on the light collecting member **12** showing the combination of these superimposed images. With this arrangement of the invention there will be some optical aberration because of the thickness of the film itself since both transparencies cannot be in the focal plane of the projector. Furthermore it will be impossible to block out a portion of the image of one of the transparencies with relation to that of the other. For instance, in the plot plan-floor plan combination it would be desirable to block out the portion of the plot plan which is occupied by the floor plan in the combination that is projected onto the light collecting membrane **10** since the information contained on the plot plan will tend to confuse the illustration of the floor plan of the building.

In lieu of mounting the projector **16** to the rear of the drawing table, it will generally be preferable to mount it in front thereof so that it is readily accessible to the draftsman. Such an arrangement is disclosed in FIG. 2 and with this arrangement it is necessary to employ reflecting means **20** to reflect the beam of light from the projector **16** first downwardly and then back toward the rear face of the drawing table normal to this table. These reflecting means may take any desirable form satisfactory for the purpose with front faced mirrors being one desirable form.

The disadvantages encountered in using a single projector wherein it is desired to simultaneously project a plurality of images onto the light collecting membrane may be overcome by utilizing a plurality of projectors. Such an arrangement is disclosed in FIGS. 3 through 7. In these arrangements a different projector may be utilized for each transparency which bears an image that it is desirable to simultaneously project on the light collecting membrane or alternatively one or more of the projectors may be provided with a plurality of transparencies in juxtaposed relation.

FIGURE 3 discloses the simple form of utilizing a plurality of projectors. In this arrangement there are two projectors **16** which are in side by side relation mounted to the rear of the drawing table and in relation to the table to project onto the rear of the table in perpendicular relation to the table.

In this embodiment of the invention the projectors are spaced so that their light cones overlap and the images thus produced will overlap as desired. For instance if the projectors are projecting a 48" wide image the projected cones of light can be arranged to each be 54" wide with 48" of overlap and perfact coincidence obtained by offsetting each transparency ¼" each with 4" wide transparencies.

FIGS. 5, 6 and 7 also disclose arrangements wherein several projectors are utilized with the projectors being effectively in side-by-side relation. In FIG. 5 there are three projectors **16** used with these projectors being vertically arranged so as to project their light beams downwardly and with there being three reflecting means utilized to reflect the light onto the back of the drawing table. The projectors are mounted to one side of the drawing table in this embodiment and they first impinge their light upon the reflecting means **24** with it thence being reflected from the reflectors **26** and **28** on to the drawing table **10**.

The embodiments of FIGS. 6 and 7 are generally similar with that of FIG. 6 utilizing three projectors **16** while the arrangement of FIG. 7 utilizes five projectors **16**. In the FIG. 6 arrangement the projectors are arranged as disclosed to initially reflect their light beams from individual prisms **30** which are arranged so as to produce three light beams generally in side-by-side relation. These projectors are mounted above and in front of the drawing table **10** with the light being reflected via the reflectors **20** in the manner of the embodiment of FIG. 2. The FIG. 7 embodiment is similar to that of FIG. 6 except that the three projectors that project their light onto the prims **30** are all arranged in a vertical position with the outer two first reflecting their light from the reflectors **32** and then onto the prims **30**. In addition there are two more horizontally mounted projectors **16** in this FIGURE 7 embodiment so that there are five beams of light that are combined and reflected from the reflectors **20** onto the back of the drawing table **10**.

Another way of combining two or more images for projecting onto the back of the drawing table **10** is by the use of light splitters, such as half silvered mirrors. FIG. 4 discloses an embodiment of the invention utilizing this means and in this embodiment three projectors **16** are arranged in side by side spaced relation and direct their beams of light generally horizontally. The reflecting means **34** for the outermost of the projector **16** may be a front faced mirror while the reflecting means **36** and **38** for the two inner projectors will be half silvered mirrors such that the parallel light emerging from the reflector **38** and directed toward the drawing table **10** will be a composite of the light from each of the projectors. This light will then pass through a suitable lens system **40** so that a desired enlarged image will appear on the light collecting membrane at the front of the drawing table.

While several arrangements of projectors and reflecting means have been disclosed in the various embodiments, it is apparent that the disposition of these elements may take numerous and varied forms depending upon the number of projectors, the most convenient projector location with respect to the light collecting membrane, the geometric configuration and the degree of compactness desired.

In each of the embodiments of the invention the camera **14** is mounted normal to the plane of the light collecting membrane so as to take a photograph of the image appearing on the membrane as described hereinbefore. In general it is desirable to provide a hood about the light collecting membrane which can be made reasonably light tight for the taking of photographs. This hood or enclosure may be utilized to provide structural support for mounting the camera and the projectors and also if desired the drawing table itself. FIG. 8 illustrates one form of hood or enclosure where there is provided a box-like enclosure **46** provided with a door **48** with this enclosure being sufficient to contain all the elements of the inven-

tion and permit a draftsman to work within the enclosure. In FIG. 8 the embodiment of FIG. 7 is shown mounted in an enclosure.

In the preferred forms of my invention the transparencies are firmly held between glass plates which are free to move up and down, sideways or rotationally in the focal plane of the projector. The image from each projector can then be positioned on the light collecting screen as desired.

Another feature of my invention is the provision for a light screen in each projector. This consists of a means of supporting an opaque screen or portion thereof parallel to the image containing transparency in the parallel light passing through the transparency. This is used as follows: for example, where the image of a house plan is being projected from one projector onto the image of a plot plan from a second projector, the portion of the plot plan under the house plan can be blotted out by positioning parallel to the plot plan transparency a portion of opaque material corresponding in size and shape to the area of the house. As a refinement to balance out light intensity, a complementary screen, blotting out all of the light but that producing the image of the house itself may be inserted in the projector transmitting the house image. This procedure can be carried out rapidly and precisely using photographic techniques as follows: When the house has been located with respect to the plot plan on the image collecting screen, the plot plan projector is turned off and a plastic or paper overlay is laid over the house image. The outline of the house is traced onto the overlay which is then used as a template for cutting out an opaque overlay. The opaque overlay is then laid over the house image on the image collecting screen. The house image projector is turned off and a photograph of the opaque overlay in position is made using light projected through a blank transparency. Positive and negative transparencies are made of the opaque house overlay. The positive transparency is used in the plot plan projector to blot out the plot plan underlying the house and the negative transparency is used in the house projector to blot out all but the house image.

With the apparatus and method of the invention a library of transparencies of standard parts can be built up which can in turn be readily combined into numerous diverse combinations as required without the necessity of laborious, detailed drafting. Furthermore, with the invention no work is done directly on the drawing of record itself (the transparency): no erasures or corrections, etc.; so there is no deterioration. Erasures and corrections produce entirely new drawings as recorded by the camera. Obviously also, storage of drawings is compact and convenient since the films are 1/12 or less the size of the screen image.

Conventional blue prints or white prints can be conveniently made from a transparency by exposing film directly on the image collecting screen by means of light projected through the transparency by one of the projectors. The exposed film is developed and then used in conjunction with a blue print machine or ozalid type machine to produce conventional blue prints or white prints.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing

from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What is claimed is:

1. A drafting machine comprising an enclosure means, a drawing table disposed in said means having a generally upwardly directed surface, said surface having a substantially transparent area and adapted to contain on its upwardly directed side a light collecting sheet, means projecting an image onto that sheet from the back side thereof and comprising a projector positioned in an area accessible to a draftsman working on the upwardly directed side of the table and reflecting means reflecting the image from the projector up onto the rear face of said light collecting sheet whereby an image will appear on said sheet and may be modified by a draftsman working from the front of the table, and camera means mounted accessible to the draftsman for taking a picture of the thus modified image with a size ratio the same as that of the projector as projected onto the rear of the light collecting sheet, said projecting means and camera means being mounted within and supported by said enclosure means.

2. The drafting machine of claim 1 wherein the camera means is mounted in front of said drawing table.

3. The drafting machine of claim 1 wherein there are a plurality of projecting means disposed to simultaneously project images on said sheet in overlying relation.

4. The drafting machine of claim 1 including means operative to project intensified light onto said sheet to effectively blot out a part of said image projected thereon by said projecting means.

5. A drafting machine comprising a drawing table disposed so that it has a generally upwardly directed surface, said surface having a substantially transparent area and adapted to contain on its upwrdly directed side a light collecting sheet, means projecting an image onto that sheet from the back side thereof and comprising a projector positioned in an area accessible to a draftsman working on the upwardly directed side of the table and reflecting means reflecting the image from the projector up onto the rear face of said light collecting sheet whereby an image will appear on said sheet and may be modified by a draftsman working from the front of the table, and camera means mounted accessible to the draftsman for taking a picture of the thus modified image with the size ratio the same as that of the projector as projected onto the rear of the light collecting sheet.

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353—37, 44; 355—45