June 26, 1934. T. M. EDISON 1,964,198

PERSPECTIVE DRAWING MACHINE

Filed June 27, 1932 3 Sheets-Sheet 1

Fig.1

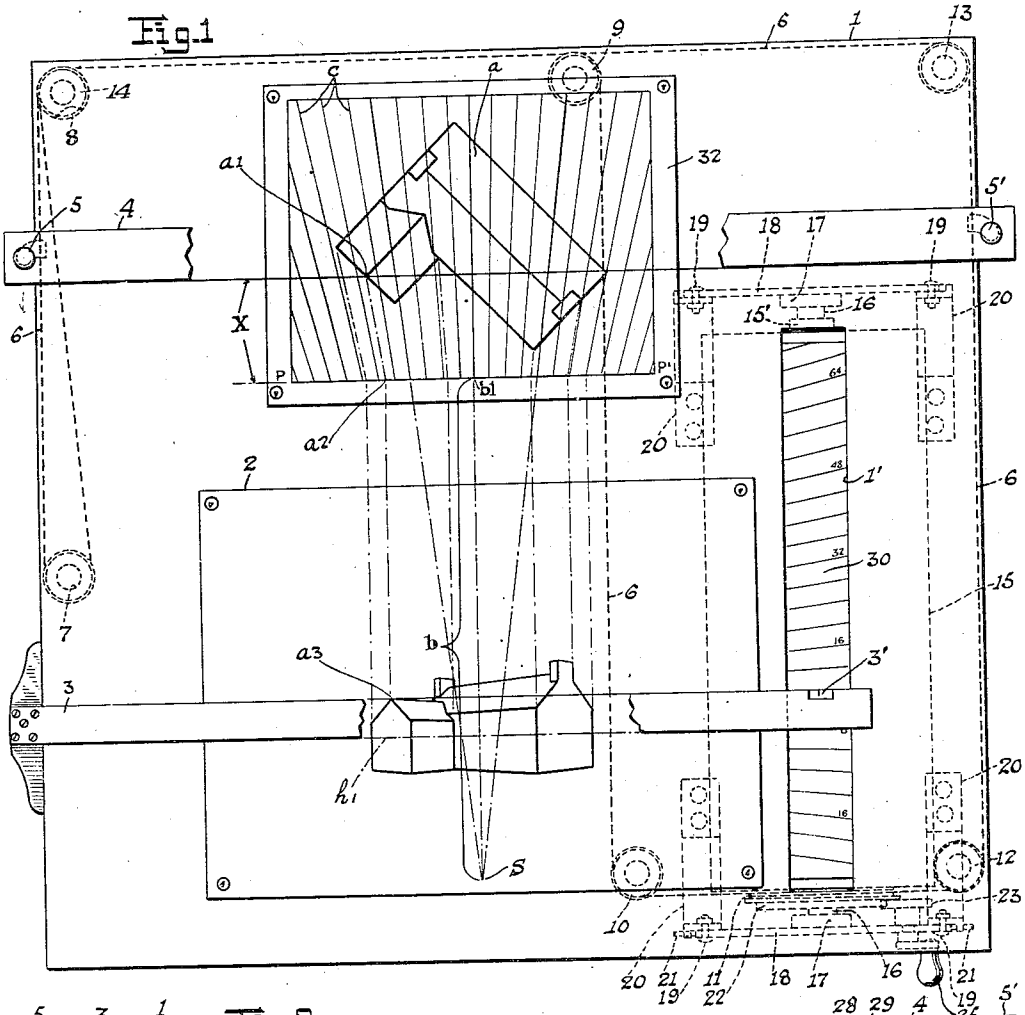
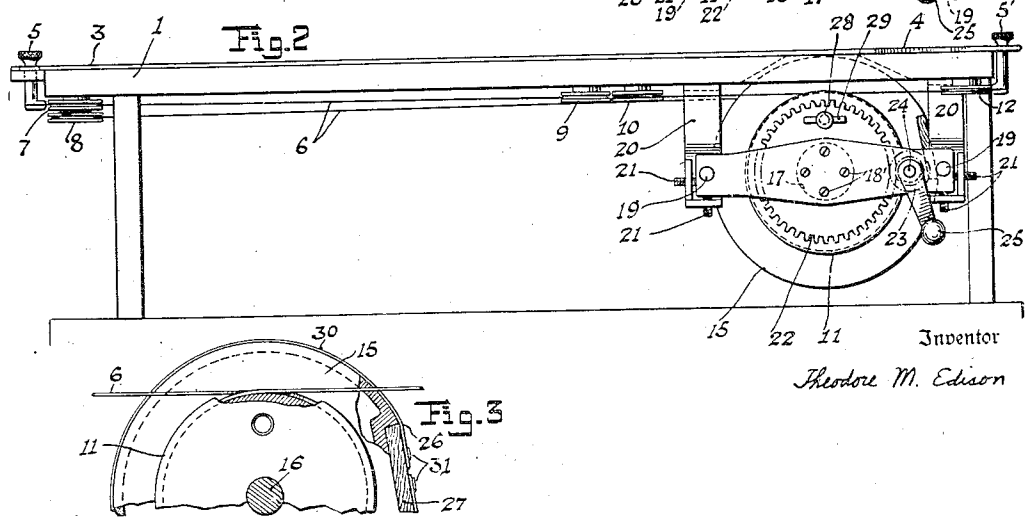


Fig.2



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Fig.3

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PERSPECTIVE DRAWING MACHINE

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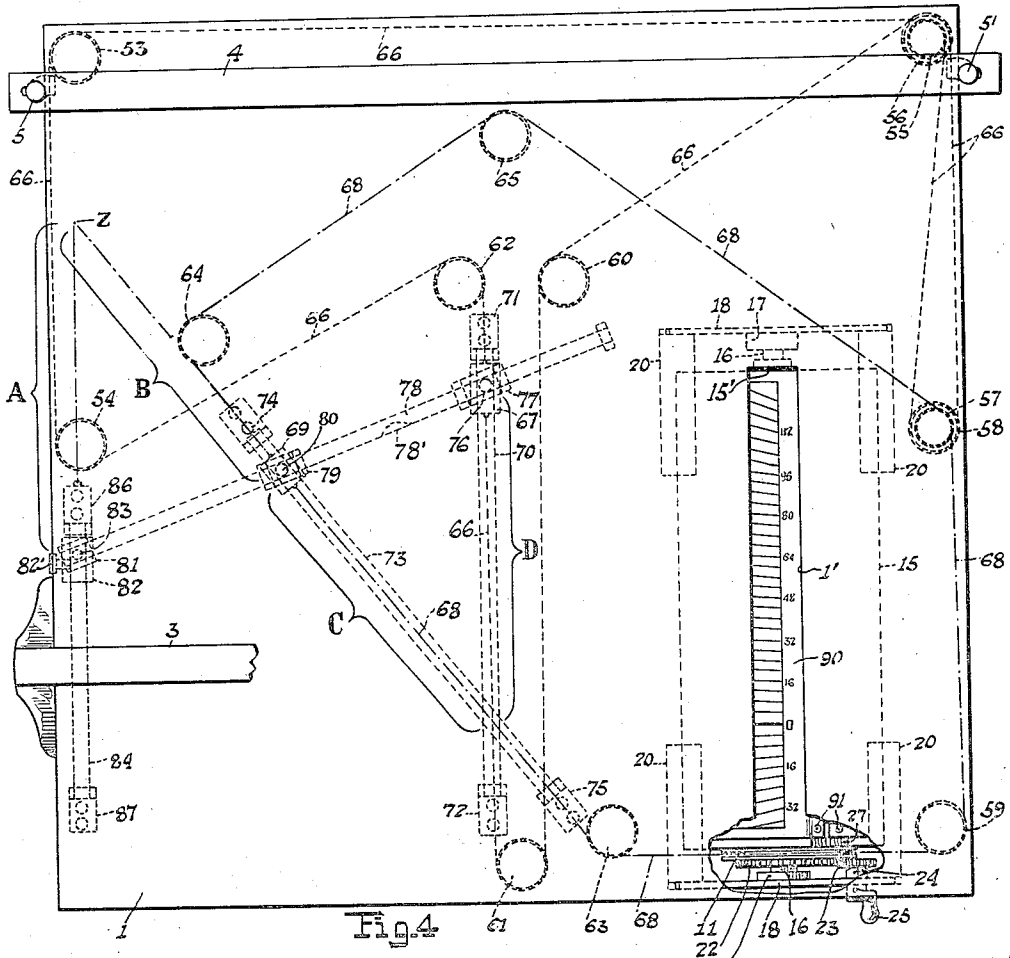


Fig. 4

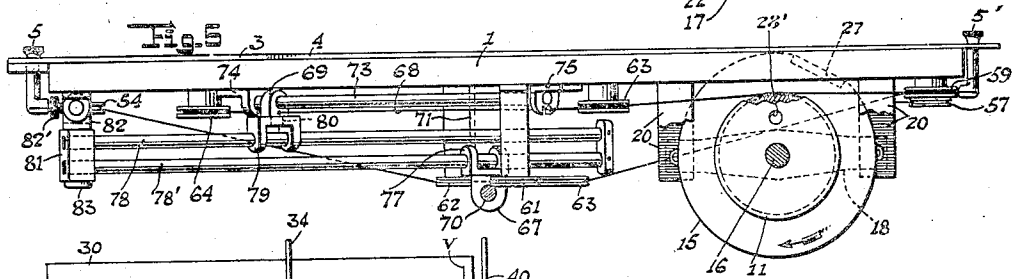


Fig. 5

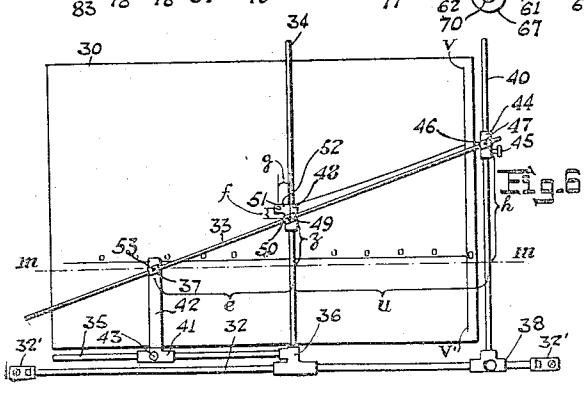


Fig. 6

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PERSPECTIVE DRAWING MACHINE

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Fig. 7

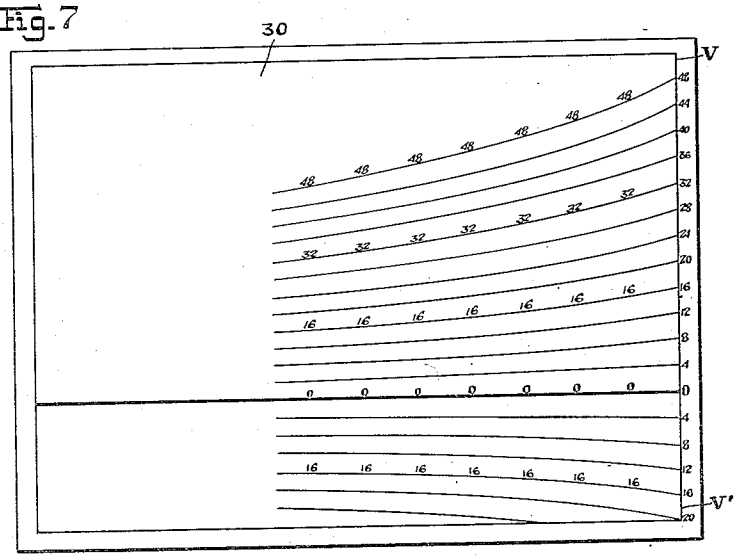
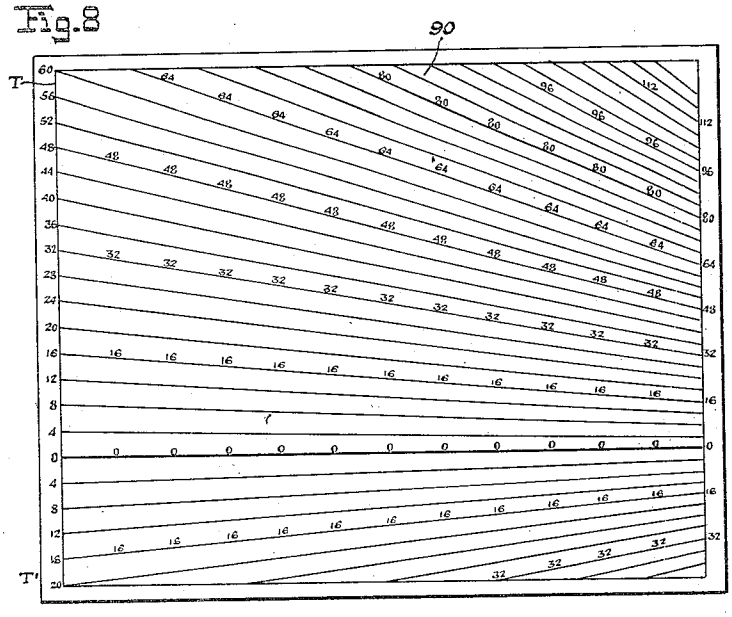


Fig. 8



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Patented June 26, 1934 1,964,198

UNITED STATES PATENT OFFICE

1,964,198

PERSPECTIVE DRAWING MACHINE

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Application June 27, 1932, Serial No. 619,440

11 Claims. (Cl. 33—77)

This invention relates to perspective drawing machines and more particularly to a machine for employing a method of making perspective drawings outlined in my co-pending application Serial No. 522,730, filed March 14, 1931. The machine described herein operates upon the principles set forth in the above mentioned application and greatly facilitates the process of making perspective representations as described therein.

One method to be used in constructing a perspective view of an object from plan and elevational views, as described in the above mentioned application is as follows. The desired relative location of the observer, the picture plane, and the object to be drawn is chosen. The plan view of the object is then placed on a suitable drawing board, and the picture plane located in its proper relative position as by a line indicating its trace on the drawing surface. Other planes, parallel to the picture plane and passing through the plan view of the object, are indicated. All distances lying in one of these planes may then be converted into the corresponding perspective distances by multiplying by a conversion factor. This conversion factor for each plane is derived by dividing the normal distance from the observer to the picture plane by the normal distance from the observer to the plane in which the distance to be converted, lies. The multiplication by the conversion factor may be accomplished either mathematically or graphically. This method of determining perspective distances is most useful in determining perspective heights relative to the chosen horizon.

It was further pointed out in the above mentioned application that the relative lateral positions of points in the object in the perspective view may be ascertained by indicating a field of radial lines converging on the point of view and then projecting such points from the plan view to the picture plane along such radial lines. By the combined use of these two methods, a perspective view may be rapidly developed without the involved construction required in the ordinary vanishing point method of making such drawings.

It is a purpose of this invention to provide a machine wherein the above two methods of finding perspective distances may be conveniently utilized to locate points in a perspective view of an object in their proper relative positions.

It is another object of this invention to provide a machine for making perspective drawings which is sufficiently simple in operation that the operator need not be familiar with the theory of perspective drawings.

It is another object of this invention to provide a combined drafting table and machine whereby perspective drawings may be made without the use of a large table and complex construction lines required by the ordinary vanishing point method of making such drawings.

Further objects and features of my invention will be described in the following specification and appended claims. For a clearer understanding of my invention, reference may be had to the drawings accompanying and forming parts of this specification wherein:

Figure 1 is a plan view of a drafting board equipped with one embodiment of my invention.

Fig. 2 is an elevational view of the apparatus in Fig. 1.

Fig. 3 is an elevation partly in section of a portion of the apparatus in Fig. 1.

Fig. 4 is a plan view of a drafting board equipped with another embodiment of my invention.

Fig. 5 is an elevational view of the apparatus of Fig. 4.

Fig. 6 is a schematic diagram of auxiliary apparatus to be used in making charts required in the embodiment of Fig. 1.

Fig. 7 is a diagram of a chart used in the embodiment of Fig. 1 for determining vertical perspective distances.

Fig. 8 is a diagram of a chart used in the embodiment of Fig. 4 for determining vertical perspective distances.

Referring to Figs. 1, 2, and 3, a drafting board or table 1 is provided for mounting the apparatus required and for carrying a sheet of drawing paper 2 on which the perspective representation of the object is to be drawn. A T-square 3 is arranged to co-operate with the left hand side of the board 1 in the usual manner. A movable straight-edge 4 is also provided extending across the board and fastened at its ends by clamps 5 and 5′ to an endless cord or belt 6. Cord 6 may be traced from the clamp 5 over a pulley 7, over a lower pulley 8 of a pair of pulleys, over a pulley 13, to clamp 5′, over a pulley 12, over a drum 11 which it completely encircles, over a pulley 10, over a pulley 9, over a pulley 14 which is directly above pulley 8, and back to the clamp 5. The pulleys 7, 8, 14, 9, 10, 12, and 13, are suitably mounted on the under side of table 1. This construction embodies the well known means of obtaining parallel motion of a straight edge across a board. As will be seen, downward movement of clamp 5 will cause cord 6 to move a corre-

sponding amount. Cord 6 moves downwardly and around pulley 7, upwardly and around pulley 8, around pulley 13 and downwardly to clamp 5'. Clamp 5' will therefore move downwardly at the same time and by the same amount as clamp 5 thereby imparting parallel motion to straight edge 4.

The drum 11 which the cord 6 encircles is mounted for free rotation on a shaft 16. As will be seen, the periphery of drum 11 is rotated with and moved the same distance as the straight-edge 4. Shaft 16 also passes axially through a large hollow metal cylinder 15. On its upper side, the cylinder 15 lies within an opening 1' in the board 1. The cylinder 15 has closed ends suitably drilled to receive the shaft 16 and is provided at one end with a hub 15' which has radially threaded holes for set screws (not shown) by which the cylinder 15 is secured to and turned with the shaft 16. The shaft 16 is journaled at either end in ball bearings confined within a casing 17, each of which is fastened to a plate 18 by screws 18'. Each of plates 18 is secured by means of bolts 19 to a pair of brackets 20, which are fastened to the under side of the board 1. The bolts 19 pass through laterally elongated holes in plate 18 and through vertically elongated holes in the brackets 20. Each of the brackets 20 is provided with two adjusting screws 21 co-operating with the plate 18 whereby the vertical and lateral position of shaft 16 and consequently of cylinder 15 may be adjusted. Screws 21 are normally adjusted so that the top surface of the cylinder 15 substantially coincides with the surface of the drawing board 1.

A gear wheel 22 is mounted on the shaft 16 adjacent drum 11 and is fastened to the shaft by set screws (not shown). Gear wheel 22 meshes with a smaller gear wheel 23 mounted on a shaft 24. The shaft 24 is journaled in the plate 18 and has a crank 25 pinned to its outer end. The gear wheel 22 is drilled to receive a pin 28 provided with a cross-pin 29 by which it may be grasped. The drum 11 which is freely rotatable on shaft 16 is also drilled in such a way that when the drum and gear wheel are relatively moved to the correct position, the holes will register and the pin 28 may be passed through both parts to lock them together. When this is done gear wheel 22, drum 11, and cylinder 15 move as a unit.

The cylinder 15 has a recess or inset portion 26 which is adapted to receive a strip of wood or similar material 27 extending the length of the cylinder. A suitable chart 30 is secured around the outside of the cylinder 15 and is held by thumb tacks 31 pressed into the strip 27. In securing the chart in place, pin 28 may be withdrawn to release drum 11 so that cylinder 15 is freely movable while straight edge 4 remains stationary. When the chart has been mounted, the pin 28 may be reinserted so that the movement of cylinder 15 will result in motion of the straight edge. The motion of the chart will be equal to the motion of the straight edge multiplied by

$$\frac{R}{r}$$

where R is the radius of cylinder 15 and r is the radius of drum 11.

Chart 30 carries a series of calibration lines as shown in Fig. 7. A horizon line is indicated on the chart by a straight line marked 0. At the right hand edge of the chart, a line VV' at right angles to the horizon is drawn. The T square 3 is provided with a mark 3' in the form of a line at right angles to its upper edge. This mark 3' falls approximately in the center of the opening 1'. As the T square is moved up and down the board, the mark 3' defines a line intersecting the calibration lines on the chart 30. The mark 3' therefore serves as an indicator to define a line intersecting the calibration lines and to form thereby a scale of varying calibration depending on the relative displacement of the chart and indicator, which scale may be used for measuring distances in the perspective view. It is obvious that in place of using an indicator in the form of the mark 3' on the T square, a cross hair or a straight edge could be permanently secured to the board at right angles to the straight line 0 of the chart. The use of the mark 3' however is much more desirable because of its simplicity and because it leaves the chart completely open to view. The chart is so located on cylinder 15 that when line VV' lies directly beneath the mark 3' on T-square 3, the straight edge 4 is near the lower extremity of its travel. In the example shown, the line VV' is calibrated to the same scale as the plan view is drawn and straight edge 4 then indicates the trace of the picture plane on the drawing surface. A plan view of an object a to be drawn is placed in the desired position relative to the picture plane which is indicated in Fig. 1 as PP'. The plan view may be drawn on a sheet 32 having a field of radial lines c representing lines of sight and converging on the point of view S. Alternatively a transparent chart having lines c and PP' inscribed thereon may be used over a previously prepared plan view, or the trace of the picture plane PP' only may be indicated and the lines of sight described when needed by a straight edge held against the point S.

As previously explained, the lower edge of straight edge 4 coincides with the picture plane when the line VV' lies under the mark 3' on T-square 3. Now if any portion of the object to be drawn lies in the picture plane, distances between points on the object lying in such plane would have values in the perspective representation equal to the true scale distances on the object. Since the line VV' is divided into a scale having the same proportions as the scale to which the plan view was drawn, this scale may be used to determine vertical heights relative to the horizon in the perspective view by moving T-square 3 until its upper edge coincides exactly at the indicating mark 3' with the scale line representing the height of the desired point relative to the horizon which may be determined from an elevational view of the object, if not otherwise known.

If crank 25 is now turned until the lower edge 4 has moved upwardly a distance x, chart 30 will have been moved a distance equal to

$$\frac{R}{r}x.$$

Straight edge 4 now defines a plane parallel to the picture plane. As previously explained, the perspective heights relative to the horizon of all points lying in such plane may be ascertained by multiplying the true heights by the conversion factor for such plane, which is

$$\frac{b}{b+x}$$

where b is the distance $\overline{Sb'}$, from the point S to the picture plane. Now under the mark 3' we

imagine a vertical line on chart 30 which is parallel to and spaced a distance

$$\frac{R}{r}\cdot x$$

from the line VV', such line could be divided into a scale having the proportion

$$\frac{b}{b+x}$$

to the scale of line VV'. This scale could be used in the same manner as described above to determine the perspective heights of points in the object lying in the plane indicated by the lower edge of straight edge 4. If a number of such scales were plotted for different positions of the straight edge 4, we could connect points for the same height and thus obtain a continuous line which for any position of the straight edge would have a height relative to the horizon line equal to the scale height multiplied by the conversion factor for the plane indicated by the straight edge. The equation for such a line representing a height h above the horizon is

$$y=h\cdot\frac{b}{b+\frac{r}{R}x_1} \qquad (1)$$

where y is the height of the line from the horizon line at a point on the chart 30 which falls beneath a vertical line defined by mark 3' when straight edge 4 is at distance x from the picture plane and where x_1 equals

$$\frac{R}{r}x$$

which represents the displacement from the line VV'. This is the equation for a hyperbola and Fig. 7 indicates a chart having a series of such height lines as used in the embodiment of Fig. 7. Chart 30 in conjunction with mark 3' on T-square 3 therefore constitutes an automatic variable scale, for determining vertical perspective distances, the variation in such scale being dependent upon the position of straight edge 4.

The method of making a perspective drawing with the apparatus described above is as follows. A plan view of a house, a, has been placed in the desired location relative to the picture plane. The correct lateral location of the roof peak (marked a_1 in the plan view) is ascertained in the perspective representation by projecting from a_1 along the field of radial lines c to the picture plane which is intersected at a_2 and then projecting vertically downward. As an example, assume that the roof peak is thirteen feet above ground, and the observer—and consequently the horizon—is located five feet above ground. The peak is therefore eight feet above the horizon. Straight edge 4 is then moved by turning crank 25 until its lower edge passes thru the point a_1 in the plan view. The chart 30 will then have been revolved until the calibration lines thereon in conjunction with the mark 3' on the T square 3 form a scale on which all lengths are equal to the scale length in the plan view multiplied by the conversion factor for a plane at x distance from the picture plane. The T square 3 is then moved until its upper edge coincides with the scale line for eight feet above the horizon on the chart 32, directly beneath mark 3'. The intersection, a_3, of the upper edge of T square 3 with the line a_2a_3, the vertical projection from a_2, gives the correct location of the roof peak in the perspective representation. All other points in the perspective representation may thus be located in a similar manner and the drawing completed by joining the various points so located.

If a radically different location of the observer as to height above ground is chosen over that described herein, the chart 30 of course will be altered and in some cases a zero line corresponding to the horizon line may not appear on the chart. Also if the objects to be drawn are represented by plans of different scales than that described in this case, a chart having different numbers on the lines will have to be used. However, many perspective drawings are made from plans of the same scale and with the same observer location and therefore in ordinary use the chart 30 will have to be changed but infrequently. For convenience, each line of chart 30 is numbered at several points along its length, the distance between the several numbers being somewhat less than the width of the slot 1' in table 1 through which the drum is visible. In consequence, there will always be at least one set of numbers visible through the slot 1' on the chart 30.

Fig. 6 indicates schematically a mechanism which may be utilized to conveniently make the chart 30 of Fig. 1 for any desired set of conditions. A suitable rod 32 is secured to a drawing board by supports 32'. Rod 32 carries a bushing 38 having a thumb screw 39 to clamp the bushing in any desired position along the rod. Another rod 40 is secured in bushing 38 at right angles to rod 32. Rod 32 also carries a slidable bushing 36 into which two rods, 34 and 35, are fixed. Rod 34 is held at right angles to rod 32 and rod 35 is parallel to rod 32. Rod 35 carries a bushing 41 having an upwardly extending arm 42 and a thumbscrew 43 whereby the bushing may be clamped to the rod in any desired position. Rod 40 carries a slidable bushing 44, having a thumb screw 45 to secure it in any desired position. A second bushing 46 is pivotally mounted on the upper side of bushing 44, the pivot being indicated schematically at 47. Similarly rod 34 carries a slidable bushing 48 to which is pivotally secured a second bushing 49, the pivot being indicated as 50. Bushing 48 has an arm 52 extending to the left and carrying a pen or other marking device 51. A third pivoted bushing, 37, is provided on arm 42 with the pivot indicated at 53. A rod 53 passes thru and aligns the bushings 46, 49, and 37. The rod is secured in bushing 46 but is free to slide thru bushings 49 and 37.

If bushing 36 is moved along rod 32, the points 50 and 53 will also move and the point 50 will describe a hyperbola. An asymptote which such hyperbola approaches will be a line mm which passes thru point 53 and is parallel to rod 32. The equation of the curve is

$$z=h\frac{e}{e+u} \qquad (2)$$

where e is the horizontal distance between the center of rod 34 and point 53 and is constant; z is the height of point 50 above the line mm; u is the dstance between centers of rods 34 and 40; and h is the vertical distance from line mm to point 47. Remembering Equation (1) given above, if we set the distance

$$e=b\frac{R}{r}$$

and let

$$u=\frac{R}{r}\cdot x,$$

then z will be equal to y for values of h corre-

sponding to those in Equation (1) and the curves described will be correct for use. Any other distance from observer to picture plane may be used by resetting the bushing 41 and thereby changing the distance e by the required amount.

It will be observed, that if the directions given above are followed, u cannot become negative or even approach zero, without causing an interference. This interference may be avoided by adding an arbitrary constant length, e_1, to u; subtracting this same constant length, e_1, from e; and replacing h by

$$\frac{e}{e-e_1} \cdot h.$$

(e_1 may have either a positive value or a relatively large negative value).

The pen 51 is set a distance f above point 50 and a distance g to the left. In making a chart 30 for use on the machine a verticle line VV' is drawn on a suitable sheet to indicate the line on which true scale distances occur or on which the conversion factor is unity. A line 00 is also drawn at right angles to line VV' to indicate the desired horizon. The drawing sheet is then secured with line VV' a distance g to the left of the center of rod 40, and the line 00 a distance f above line mm. Since pen 51 is offset by the same amounts, it will describe a curve of the proper relation to the vertical and horizontal axes. To make the chart, the bushing 44 is successively set at various scale heights and clamped. The bushing 36 is then moved along rod 32 and pen 51 describes the desired curves. This mechanism is intended to be merely illustrative and may obviously be modified in many ways.

In order to avoid the necessity for hyperbolic or curved lines on the chart 30, I have shown a modification of my invention in Figs. 4, 5 and 8. This mechanism operates on the same general principles as the device of Fig. 1 but it is so arranged that the ratio of motion between the straight-edge 4 and the chart fastened on the surface of the cylinder varies through their travel in an amount determined by the change in the conversion factor whereby the lines inscribed upon the chart become straight lines as shown in Fig. 8.

In the apparatus shown in Fig. 4 those parts of similar construction having like functions to the parts of the embodiment shown in Fig. 1 are given the same numbers. The apparatus is mounted on a drawing board 1 having an opening 1' and equipped with a movable straight-edge 4 fastened to a cord 66 by clamps 5 and 5'. A T-square 3 is provided to co-operate with the left hand edge of the board 1. The cord 66 indicated by a dashed line may be traced from the clamp 5 over a pulley 54, over a pulley 62, to a sliding member 67 to which one end is secured. The other end of the cord 66 is fastened to the opposite end of the member 67 and passes over a pulley 61, over a pulley 60, over an upper pulley 56 of a pair of pulleys, to clamp 5', over an upper pulley 58 of a pair of pulleys, over a lower pulley 55 directly beneath pulley 56, over a pulley 53 and to the clamp 5. By this means it is obvious that as the cord 66 is moved both of the clamps 5 and 5' will be moved in the same direction and by the same amount in the well known manner.

A cylinder 15 is mounted on a through shaft 16 and journaled in ball bearings 17 fastened to a pair of plates 18 mounted on brackets 20 secured to the under side of table 1. A drum 11 is mounted for free rotation on the shaft 16 adjacent one end of cylinder 15. A gear wheel 22 is fastened to the shaft 16 and meshes with a smaller gear wheel 23. A crank 25 is provided to turn the gear wheel 23 and thus impart rotation to the cylinder 15. A pin (not shown) which is designed to pass through a pair of registering holes 28' in the gear wheel 22 and the drum 11 locks these parts together so that when such pin is in place the drum 11 moves with the cylinder 15. A second cord 68 indicated by dash and dot lines encircles the drum 11 and may be traced over a pulley 59, over a lower pulley 57 of a pair of pulleys, over a pulley 65, over a pulley 64, to a sliding member 69 to which one end of the cord is secured. The other end of the cord 68 is secured to the opposite end of the member 69 and passes over a pulley 63 and back to the drum 11.

The member 67 is suitably drilled to receive a rod 70. Rod 70 is fastened in a pair of brackets 71 and 72 which are secured to the under side of table 1. Member 69 is likewise suitably drilled to receive a rod 73 which is mounted in a pair of brackets 74 and 75 secured to the under side of table 1. On the upper side of member 67, a lug 77 which is suitably drilled to receive a rod 78', is pivotally mounted by means of a pin 76. The member 69 carries a similar downwardly extending lug 79 pivotally mounted by a pin 80. Lug 79 is drilled to receive a rod 78 parallel to and located directly above rod 78'. At their left hand ends, the rods 78 and 78' are secured in a lug 81 pivoted by means of a pin 83 on a slidable member 82. The member 82 is suitably drilled to receive a rod 84 which is held in place by a pair of brackets 86 and 87 secured to the under side of table 1. The member 82 may be provided with a suitable clamp screw 82', to secure it in any desired position along the rod 84. If it is desired, some suitable indicating pointer may also be attached to the member 82 and may extend around the edge of the drawing board 1 and co-operate with a scale on the upper side of the board 1 whereby the exact position of the member 82 may be noted.

Now as the crank 25 is turned it will result in rotation of the drum 11 and in movement of the cord 68. Such movement of cord 68 will cause the member 69 to slide along the rod 73. It will also carry the pivoted lug 79 along and thus move the rod 78. Since the rod 78 is pivoted on the pin 83, it will execute a swinging motion about the pin 83 and in consequence the member 77 will also move. Movement of the lug 77 will result in motion of the member 67 along the rod 70. Such movement of the member 67 will cause movement of the cord 66. Assuming a clockwise motion of the drum 11, the members 69 and 67 would be drawn downwardly. This would result in drawing the cord 66 where it is secured to the member 67 downwardly also and would thereby cause a downward parallel motion of the straight-edge 4. It will be seen, however, that the motion of the straight-edge 4 will no longer be directly proportional to the motion of the surface of the cylinder 15.

In order to explain the motion more clearly the center lines of the rods 84 and 73 have been carried upwardly until they intersect at a point Z. Now in order to explain the relative motion of the drum and straight edge we will call the distance from the center of pin 83 to the point Z, A; the distance from the center of pin 80 to the point Z, B; the distance from the center of pin 80 to the intersection of the center line of

rods 73 and 70, C; and the distance from the center of pin 76 to the intersection of the center lines of rods 73 and 70, D. It is obvious, if rods 84 and 70 are parallel, that the triangle formed by the sides A and B with the intervening portion of the rod 78, and the triangle formed by the distances C and D and the intervening portion of the rod 78 will be similar in any position of rod 78. We may therefore write the following relation:

$$C/D=B/A \quad (3)$$

The distance A always remains fixed and the sum of the distances B and C always remains fixed. Now if we let the distance C plus B equal K which is constant and solve the relation given above for C, we will obtain the relation.

$$C=\frac{KD}{A+D} \quad (4)$$

This then gives the relative travel of the cords 68 and 66 and consequently of the straight-edge 4 and the periphery of the drum 11.

The motion of the periphery of cylinder 15 will be

$$\frac{R}{r}$$

times the motion of drum 11 where R is the radius of the cylinder and r is the radius of the drum. D is made equal to x, the distance from the picture plane to the straight edge 4, so we may replace D by x in Formula 4. The displacement, w, of the periphery of cylinder 15 is then given by

$$w=\frac{R}{r}\cdot\frac{Kx}{A+x} \quad (5)$$

from which

$$x=\frac{w\cdot A}{\frac{R}{r}\cdot K-w} \quad (6)$$

I have shown hereinbefore that the perspective value of any distance h lying in a plane parallel to the picture plane and at a distance x therefrom is

$$y=h\cdot\frac{b}{b+x} \quad (7)$$

where h is the true scale distance and b is the scale distance from the observer to the picture plane.

The distance A is made equal to distance b by properly positioning member 82.

Substituting the value of x from Equation (6) into Equation (7), we obtain

$$y=h\cdot\frac{\frac{R}{r}K-w}{\frac{R}{r}K}$$

This defines the shape of the various scale lines to be used on the chart, and such lines are straight lines. It will also be noted that they are independent of the distance from the observer to the picture plane, this being taken care of by the proper setting of member 82 which may be adjusted to any desired point.

A chart 90 shown in detail in Fig. 8 is now applied to the surface of cylinder 15 and is held in place by means of thumb tacks 91 in the wood strip 27. As explained hereinbefore, in order to properly secure the paper in place upon the cylinder 15, the pin 28 which passes through the gear wheel 22 and the drum 11 may be withdrawn so that the cylinder 15 may be freely turned without causing motion of the straight-edge 4. The straight-edge 4 is brought to the approximate location in which it is desired to place the picture plane relative to the drawing to be made. The chart 90 is then applied to the cylinder 15 with its line TT' having true scale distances marked thereon approximately on the indicating line 3' on T-square 3. When the chart 90 is secured in place, the gear wheel 22 may be rotated until the hole therein registers with the hole in the drum 11 and the pin may thereupon be replaced so that the two parts drive as a unit. The cylinder 15 is then rotated until the line TT' which in this case is divided in true scale distances coincides with the indicating line 3' of the T-square 3.

A chart as shown in Fig. 1 having radial lines converging upon the picture plane is then placed with the line PP' coinciding with the lower edge of the straight-edge 4. A plan view is positioned in the location desired relative to the picture plane.

As explained hereinbefore the relative lateral position of points in the object may be obtained in the perspective view by projecting such points from the plan view along the field of radial lines to the picture plane and then projecting them vertically to the surface on which the perspective representation is to be drawn. In order to obtain the various perspective heights of such points, the same general method as used hereinbefore is again supplied. The straight-edge 4 is used to delineate planes parallel to the picture plane and the motion of the cylinder 15 co-operative with the motion of the straight-edge 4 always serves to locate a scale, including the necessary conversion factor, opposite the indicating line 3' on the T-square 3.

By the use of this compensating mechanism, comprising the various rods and sliding members, the process of making the charts required for different horizon lines or for different scales is much simplified since all of the lines in such charts are true straight lines. If an indicator is provided on the member 82 extending above the top of the drawing board 1 and co-operating with a scale, the mechanism may be quickly adjusted for any ordinary distance from the observer to the picture plane required. The chief advantages of the apparatus shown in Fig. 4 are that cheaper and more accurate charts may be easily produced and that one chart for the cylinder 15 may be used for different distances between the observer and the picture plane. For most perspective drawing work, the scale of the plans used, the distance between the observer and the picture plane, and the approximate location of the horizon line may be fairly well standardized, in which case the apparatus of Fig. 1 is probably the more desirable type because of its extreme simplicity.

In the mechanism shown in Fig. 4, the possibility of a mechanism interference, in the region where x has a very small or slightly negative value, is avoided mechanically. This interference could also be avoided by multiplying all the ordinates of the chart by the factor

$$\frac{b}{b-e_2};$$

using a value $A-e_2$ in place of A; and letting D equal $x+e_2$ instead of x, where e_2 is an arbitrary constant length. However, in this case the chart is no longer independent of the value b. (If the substitutions just mentioned are made C and D may be kept positive for all desired values of x).

The embodiments of my invention described herein are intended to be illustrative of the ap-

plication on the principle of applying the methods of conversion factors and of projecting lines along a field of radial lines convergent upon a picture plane in a machine for making perspective drawings. It is obvious that my invention could be applied in many other ways than those shown without departing from the spirit thereof.

Having thus described my invention, I claim:

1. A machine for making perspective drawings from an orthogonal projection of an object to be drawn comprising a scale comprising a member movable to a plurality of positions, said scale presenting a different calibration for each of said positions, indicating means cooperative with said plan view and indicating planes passing through the object to be drawn, and means interconnecting said movable member and indicating means for moving them synchronously whereby said member presents the correct calibration for perspective distances lying in the plane indicated.

2. A machine for making perspective drawings from an orthogonal projection of an object to be drawn comprising a scale comprising a member movable to a plurality of positions, said scale presenting for use a different calibration for each of said positions, indicating means cooperative with said plan view and movable to a plurality of positions in each of which positions it indicates a plane passing thru the object to be drawn, and connecting means between said movable member and said indicating means.

3. A machine for making perspective drawings from an orthogonal projection of an object to be drawn and a trace of a picture plane, said machine comprising a variable scale for measuring distances in the perspective view, said scale comprising a surface having marked thereon a series of hyperbolae having a common asymptote, said surface being movable; movable means cooperative with said plan view to indicate planes passing thru said object and parallel to said picture plane; and connecting means between said scale and said movable means to displace said movable means in direct proportion to the displacement of the surface.

4. A machine for making perspective drawings from an orthogonal projection of an object to be drawn and a trace of a picture plane, said machine comprising a scale having a member movable to a plurality of positions in each of which said scale presents for use a different calibration, indicating means co-operative with said plan view and movable to define any one of a plurality of planes passing thru said object and parallel to said picture plane, and connecting means between said member and said indicating means, said connecting means maintaining said movable member in a position in which the correct calibration is presented by said scale for use in measuring distances in the perspective view corresponding to distances on the object lying in the plane defined by said indicating means.

5. In a machine for making perspective drawings, from an orthogonal projection of an object to be drawn and the trace of a picture plane, a movable straight edge for indicating planes passing thru the object to be drawn, means to confine said straight edge to parallel motion, a scale comprising a member movable to a plurality of positions in each of which said scale presents for use a different calibration, the motion of said member being controlled by said means.

6. In a machine for making perspective drawings from an orthogonal projection of an object and a trace of a picture plane, movable indicating means cooperative with said plan view to define any one of a plurality of planes passing thru the object and parallel to the picture plane, a scale having a calibration changing member movable to a plurality of positions in each of which the scale has a calibration presented for use in measuring perspective distances corresponding to actual distances on the object lying in one plane defined by said indicating means, and driving means controlled by said member to move said indicating means.

7. In combination, a drawing board, a straight edge mounted for parallel motion across said board, a scale having a member movable to a plurality of positions in each of which said scale presents for use a different calibration, and connecting means between said member and said straight edge whereby said straight edge is moved coincidentally with said member.

8. In a machine for making perspective drawings, a scale for measuring perspective distances comprising a chart having marked thereon a series of converging lines having the equation

$$y = h \cdot \frac{b}{b + \frac{r}{R} x_1}$$

9. A machine for making perspective drawings from an orthogonal projection of an object to be drawn and a trace of a picture plane, said machine having a variable scale for measuring distances in the perspective view, said scale comprising a surface having marked thereon a field of converging straight lines and an indicator defining a line intersecting said converging lines and thereby forming a scale, said indicator and said surface being relatively movable to vary the calibration of said scale; movable means cooperative with said plan view to indicate planes passing thru said object and parallel to the picture plane; and connecting means between said surface and said movable means including a compensating mechanism for maintaining the calibration of the scale correct for the measurement of perspective distances corresponding to actual distances lying in the plane defined by the movable means.

10. In a machine for making perspective drawings, a movable device for indicating planes parallel to the picture plane, a plurality of scales movable into and out of a position wherein they may be used for measuring perspective heights, each of said scales having a calibration for measuring perspective heights corresponding to heights lying in a single plane defined by said movable device, and means to synchronize the movements of said device and said scales whereby the scale which is in operative position is that scale having a calibration corresponding to the plane indicated by the device.

11. A machine for making perspective drawings having a variable scale for measuring distances in the perspective view, said scale comprising a surface whereon are marked a series of hyperbolae having a common asymptote, and an indicator, said indicator and said surface being relatively movable at right angles to said asymptote to define a line on which said scale is formed by intersection with said hyperbolae, said indicator and said surface also being relatively movable in the direction of said asymptote whereby the calibration of said scale may be changed.

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