May 12, 1959 F. S. BADGETT 2,885,786

DUPLICATING MACHINE

Filed Oct. 15, 1956 2 Sheets-Sheet 1

Fig. 1.

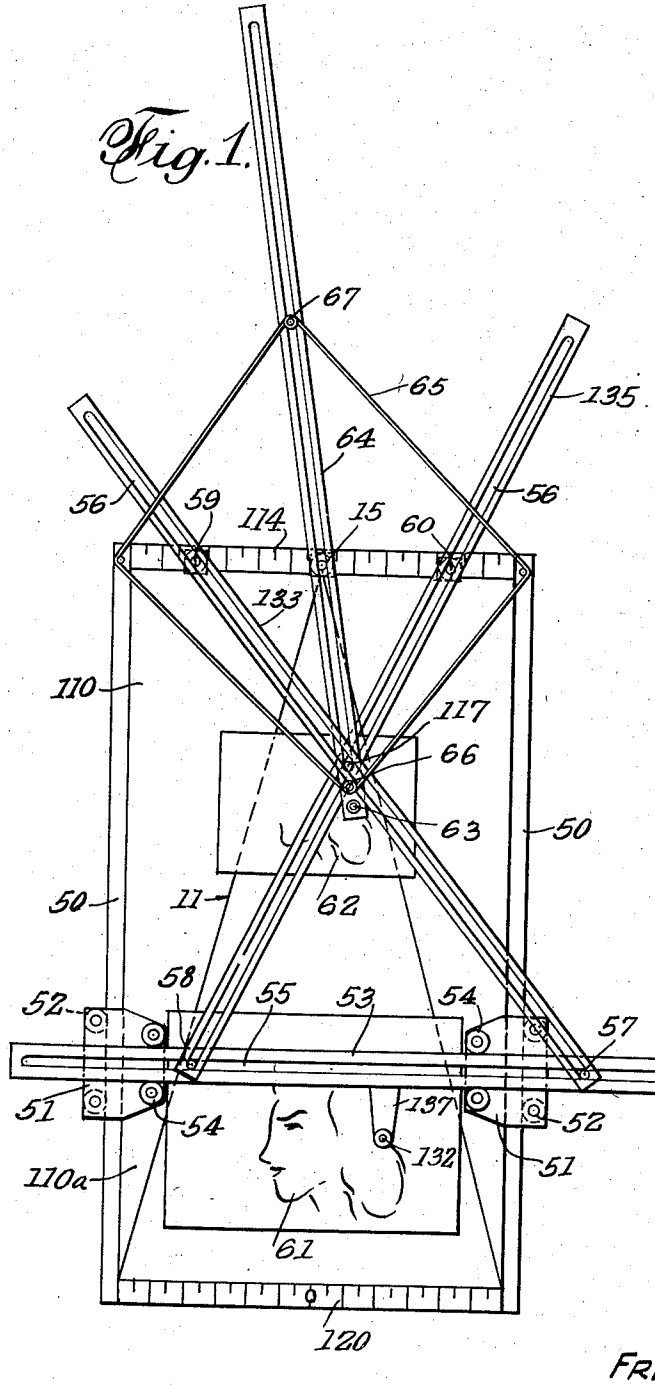
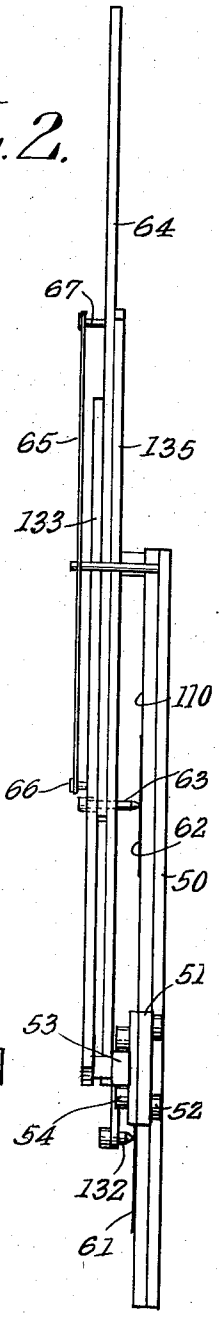


Fig. 2.



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2 Sheets-Sheet 2

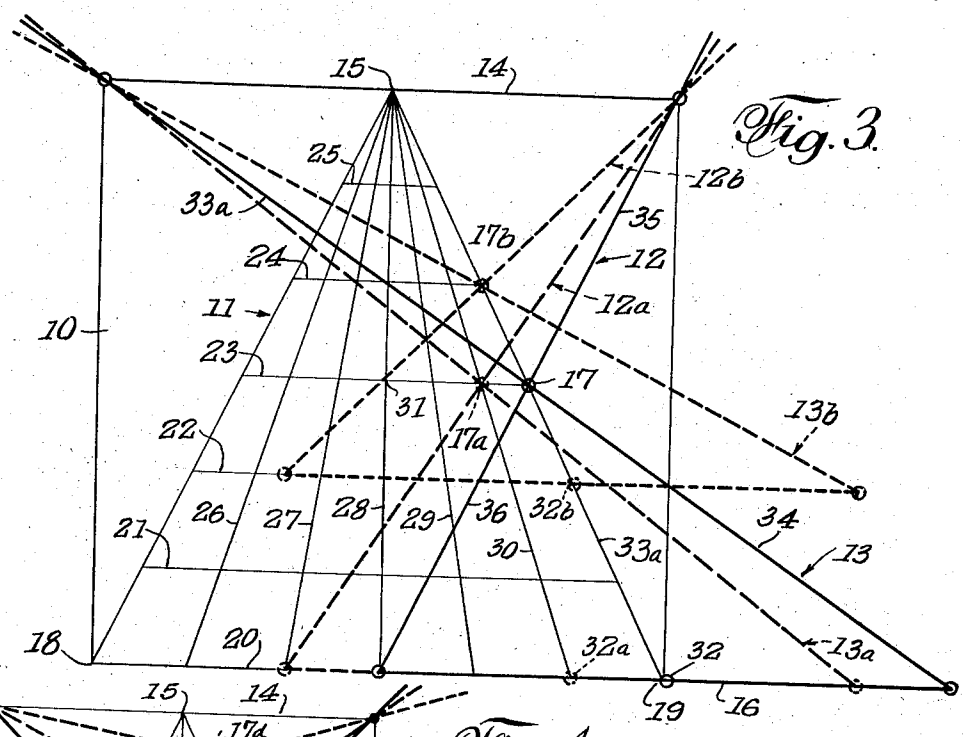


Fig. 3.

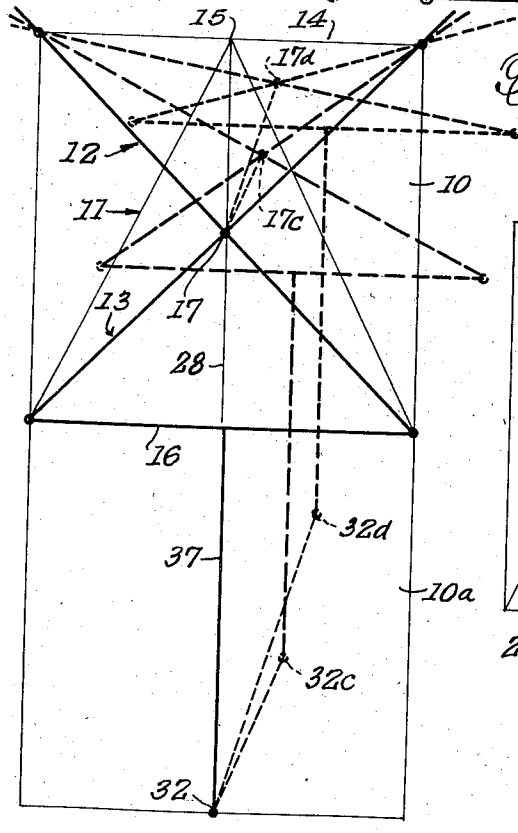


Fig. 4.

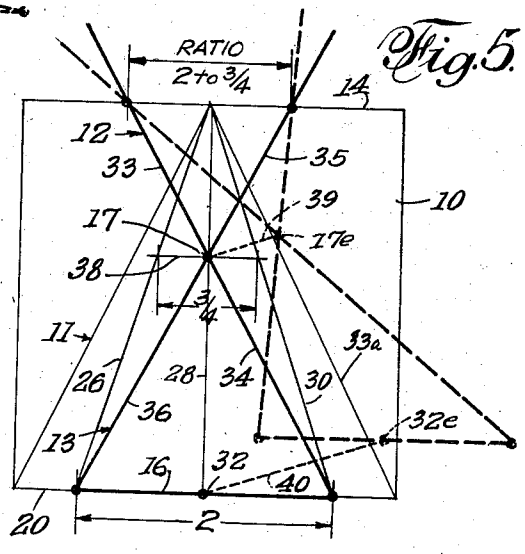


Fig. 5.

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DUPLICATING MACHINE

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Application October 15, 1956, Serial No. 615,788

11 Claims. (Cl. 33—23)

This invention relates to machines or devices for duplicating or reproducing pictures, charts, maps, diagrams, etc. to a different scale than an original, and has for its primary object to provide a reproducing machine that is not only inexpensive to manufacture, but is efficient in operation and of such simple construction as to greatly facilitate set-up.

Another object of the invention is to provide a duplicating machine that can be quickly set to provide a desired size ratio between an original picture and a picture to be reproduced therefrom, the machine having basis on proportional triangles that join at their apices, in which one base side is fixed and the other base side movable in a plane in which the first base side resides, and in which, due to changes in size resulting from such movement but not in proportion of the two other sides of each triangle, the common apex of the two triangles moves proportionally to any point of the movable base side.

A further object of the invention is to provide a duplicating machine, as above indicated, in which the proportional adjustment of the machine is guided by a triangular configuration or perspective triangle, the same being disposed in the mentioned plane of movement.

A further object of the invention is to provide a ratio reproducer based on the proportional triangles above indicated and in which elastic and self-adjusting means is provided for retaining the device in operative condition under control of an operator.

The invention also has for its objects to provide such means that are positive in operation, convenient in use, easily installed in a working position and easily disconnected therefrom, economical of manufacture, relatively simple, and of general superiority and serviceability.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show, and the following description merely describes, preferred embodiments of the present invention, which are given by way of illustration or example only.

In the drawings, like reference characters designate similar parts in the several views.

Fig. 1 is a top plan view of a duplicating machine embodying the features of the present invention.

Fig. 2 is a side view thereof in the position of the parts as in Fig. 1.

Fig. 3 is a diagrammatic view illustrating the principles of the present invention.

Fig. 4 is a similar diagrammatic view showing an alternative arrangement in which tracing and reproducing areas are more readily kept from overlapping.

Fig. 5 is still another diagrammatic view, the same more clearly showing the method employed for producing a desired ratio between tracing and reproducing areas.

Reference is first made to the diagram shown in Fig. 3, in which a rectangular plane **10** is provided with a perspective triangle **11**, and in which are shown proportional triangles **12** and **13**, one having a base leg **14** disposed on an edge of plane **10** and on which one apex **15** of triangle **11** resides, the other having a base leg **16**, and the two triangles **12** and **13** meeting on a common apex **17** opposite to their respective base legs **14** and **16**.

In addition to apex **15**, the perspective triangle **11** has its two other apices **18** and **19** coincidental with the corners of the plane **10** that are opposite to plane edge **14**. Said triangle **11** may be uniformly divided between its apex **15** and its base **20** by a series of lines **21**, **22**, **23**, **24** and **25**, for instance, and by a series of lines **26**, **27**, **28**, **29** and **30** that extend between apex **15** and uniformly spaced points along said base **20**.

In the case of plane **10** being a square, as shown, line **23** will be half as long as base **20** and each of the parallel dividing lines **21**, **22**, **24** and **25** will be proportional to said base according to their respective locations. Thus, line **21** is five-sixths of base **20**, line **22** is two-thirds of said base, line **24** is one-third, and line **25** is one-sixth. Consequently, each part of each of said lines that is intercepted between the lines **26—30** is proportional according to the foregoing ratios.

If it is assumed that the base leg **16** of triangle **13** is coincident with the base **20** of the perspective triangle **11**, then it will be obvious that the two triangles **12** and **13** will be isosceles and that their common apex **17** will fall on a point **31** which is the intersection of divider lines **23** and **28**. It will also be obvious that triangles **12** and **13** are equal.

By moving the base leg **16** along the line **20**, the middle point **32** of said line **16** will be moved a distance that is twice the distance that apex **17** is moved. This is clearly demonstrated because line **23** is half as long as base **20** and points **32** and **17** fall on the side **33***a* of perspective triangle **11** when the triangles **12** and **13** are moved to the full-line position shown. This ratio of movement is further demonstrated by moving the triangles **12** and **13** to the respective dash-line positions **12***a* and **13***a* in which case the middle point **32** falls at **32***a* and the apex point **17** falls at **17***a*. It will be noted that points **32***a* and **17***a* both fall on divider line **30** in two-to-one ratio, as before. By inspecting dotted-line triangles **12***b* and **13***b* and the points **32***b* and **17***b*, the proportional movement will again be demonstrated.

When triangles **12** and **13** were in their initial position with base leg **16** coincidental with base **20**, the leg **33** of triangle **12** was equal to the leg **34** of triangle **13**, and the leg **35** of triangle **12** was equal to leg **36** of triangle **13**. It will be noted that this proportion is maintained during all movements, as above. Whether lengthening or shortening, legs **33** and **34** are always equal, as are legs **35** and **36**. Hence, triangles **12** and **13** remain proportional irrespective of the variations of movement of said triangles.

By inspecting the pattern defined by points **32**, **32***a* and **32***b*, and comparing it with the pattern defined by points **17**, **17***a* and **17***b*, it becomes readily apparent that the movement of point **17** is one-half that of point **32** or, for that matter, any point along line **16**, providing said line is retained parallel to side **14**.

It will be seen, however, that there may be overlap between the patterns of points **32** and **17** since point **32** may, at times, be moved to a position nearer side **14** than was point **17** at an earlier position. Therefore, as can be seen from Fig. 4, the point **32** may be placed on an extension **37** of base leg **16** in a direction away from side **14**. The plane **10** may be extended to include the area **10***a*, accordingly.

Now, it will be seen that the pattern defined by point **32**, for instance, **32**, **32***c* and **32***d*, is sufficiently remote from the pattern of point **17**, as shown by **17**, **17***c* and **17***d*

so that overlap is obviated. In other respects, the showing of Fig. 4 is similar to that of Fig. 3.

The two-to-one ratio demonstrated above may be varied, as desired, by shifting the apex point **17** to an appropriate location between base **20** and side **14**. Referring now to Fig. 5, it is assumed that base leg **16** of triangle **13** may be as long as plane base **20** or shorter than said base, as shown. In this instance, base leg **16** is shown as two units long and the ends thereof will fall at the intersections of divider lines **26** and **30** with base **20**.

If it is desired that apex point **17** move in the ratio of three-quarters-to-two of any point on base leg **16**, three-quarters of a unit is measured between divider lines **26** and **30** and the point **17** is placed on such line **38** where the same intersects divider line **31**. The triangles **12** and **13** that are formed by extending sides **33—34** and **35—36** through point **17** from the ends of base leg **16** to and through edge **14** of plane **10** will be unequal, but proportional. With this ratio setting of two-to-three-quarters, the point **17** will move three-quarters of a unit for each two units of movement of point **32**.

Inspection of the dash-line position of triangles **12** and **13** will show that line **39** between initial point **17** and new point **17***e*, and line **40** between initial point **32** and new point **32***e*, are in a three-quarters-to-two ratio.

From the foregoing, it will be realized that any desired ratio of movement may be obtained. Also, it will be clear that the base line for triangle **12** may be longer than base line **16** for triangle **13**, thereby enabling ratios that approach one-to-one.

For the purposes of this disclosure, the edge **14** may be defined as a reducing scale, the base **20** as an enlarging scale, the point **15** as a vanishing point, the point **17** as a reducing point, the point **32** as an enlarging point, and the triangle **11** as a perspective triangle.

Reference is now made to Figs. 1 and 2, wherein a duplicator embodying the principles of analytical geometry above set forth is illustrated.

The areas **110** and **110***a* are shown as a board comparable to planes **10** and **10***a*. In this instance, said board is provided with side rails or the equivalent **50**, the same extending between the reducing scale **114** and the enlarging scale **120** at opposite ends of the board.

The board mounts a pair of similar carriages **51** that ride the rails **50** as by means of rollers **52**. Said carriages slidingly mount a platform **53** that is the counterpart of base leg **16**, said platform being maintained transverse by the carriages **51** and guided for transverse movement by rollers **54**. A longitudinal slot **55** is provided in said platform.

In the present device, the bar **133** is the counterpart of triangle legs **33—34** and the bar **135** is the counterpart of legs **35—36**. Each said bar is provided with a longitudinal slot **56**. Said bars **133** and **135** are pivotally joined at **57** and **58**, respectively, to platform **53**, the same thereby including the equivalent of base leg **16** therebetween. In this instance, the platform is shown with an extension **137** on which is mounted tracing point **132**, the counterpart of point **32**.

The bars **133** and **135** are slidingly connected at **117** (comparable to point **17**) and the same are slidingly connected to the reducing scale **114**, as at respective adjustable points **59** and **60**.

It will be seen that platform **53** and bars **133** and **135** are provided with excess length so that any desired ratio adjustment within the range of the board area may be made, so that a pictorial representation **61** may be duplicated at **62** in any desired ratio.

Since points **117** and **59** and **60** are sliding ones, the present device includes means to keep the reducing point **63** in place, said latter point being provided on a guide bar **64** that is pivoted at the vanishing point **15** and connects with the pivot **117**. By providing an endless elastic band **65** that through the medium of an adjusted fixed point **67** over which said band is trained, opposed resilient forces are produced on spaced points **66** and **67** of said guide bar **64**, the reducing point **63** thereof is better controlled.

The pin **67** can be fixed at any point along the slot in bar **64** to adjust the tension of the elastic band **65**. Motion of the bar **64** and the pin **67** is proportional to the motion of the reducing point **63** when the pin **67** is set equidistant or the same distance from point **15** as from point **66**. But, since the point **67** is located on the opposite side of the sliding pivotal clamp **15**, the motion is reversed but the same causes an equalized tension to be exerted against the reducing point when it is moved to different positions. The bar **64** is slidingly pivotal at the point **15** and points **66** and **67** are fixed on bar **64**. The pin **67** is adjustable to reduce or increase the tension on the elastic band points **66** and **67** which are always equidistant regardless of the position of the reducing point **63** with respect to the area **62**. Changes in the position of point **63** causes variations in the parallelogram shape of the elastic band, but the tension remains approximately the same and holds the point **66** to the crotch where the arms **133** and **135** cross and always toward the point **15** of the base leg 14. This is due to the fact that the tension is directed in a straight line along the points **66**, **15**, and **67**.

The point or pin **66** is used to hold the elastic band **65** on guide bar-supporting-reducing point **63**. The purpose of the elastic band is not for balancing the reducing point but rather to hold the reducing point in position where the arms **133** and **135** intersect, and, when the elastic band is properly adjusted, it will hold all the moving assembly in a steady rather than a loose or wavering position, thus permitting the operator to trace a drawing with desired accuracy.

The scales **114** and **120** may be marked as finely or as coarsely as desired. Desired power advantage will dictate whether the settings of the machine will be based on the full width of the board or on a narrower width (see Fig. 5).

While the foregoing has illustrated and described what are now contemplated to be the best modes of carrying out my invention, the constructions are, of course, subject to modification without departing from the spirit and scope of the invention. It is, therefore, not desired to restrict the invention to the particular forms of construction illustrated and described, but to cover all modifications that may fall within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A reproducing device comprising a plane rectangular board, carriages on opposite edges of said board to move therealong, a transverse member mounted to slide between said carriages transversely to the direction of motion of said carriages relative to the plane board and movable along said surface during the mentioned movement of the carriages, a pair of similar arms pivotally connected to spaced points of the transverse member and in crossed relationship to define a triangle having its three corners at the point of such crossing and the mentioned pivot connections, a pivot at said point of crossing and slidable along each of said arms, said arms having extensions beyond said pivot, a sliding pivotal connection between each extension and an edge of said board that spans between the two mentioned edges, and a tracer point at the crossed connection between the arms and a tracer point fixedly carried by the transverse member and movable in all directions in the plane of the board while the pivotal connections of the extensions with the edge of said board slide to proportionally move the tracer point at the crossed connection of the arms in the same direction.

2. A reproducing device comprising a plane rectangular board, carriages on opposite edges of said board to move therealong, a transverse member mounted to slide

between said carriages transversely to the direction of motion of said carriages relative to the plane board and movable along said surface during the mentioned movement of the carriages, a pair of similar arms pivotally connected to spaced points of the transverse member and in crossed relationship to define a triangle having its three corners at the point of such crossing and the mentioned pivot connections, a pivot at said point of crossing and slidable along each of said arms, said arms having extensions beyond said pivot, a sliding pivotal connection between each extension and an edge of said board that spans between the two mentioned edges, and a tracer point at the crossed connection between the arms and a tracer point fixedly carried by the transverse member and movable in all directions in the plane of the board while the pivotal connections of the extensions with the edge of said board slide to proportionally move the tracer point at the crossed connection of the arms in the same direction, said arm extensions and the board edge between the last-mentioned pivotal connections defining a triangle proportional to the previously mentioned triangle, and means carried by the plane board to guide the placement of the pivotal connections for the arm extensions and, thereby, to provide the desired proportion between said two triangles.

3. A reproducing device according to claim 1 in which the mentioned board is provided with a scale along an edge that is opposite to the edge with which the arm extensions are connected, the scale being centered between the board edges to guide the location of the arm pivots on the transverse member when the latter is centered with respect to said board edges.

4. A reproducing device according to claim 2 in which the last-mentioned means comprises a triangular representation on said board, the angles of the same being disposed at the corners where the side edges of the board meet the edge thereof that is opposite the edge where the arm extensions are connected and at the middle of the latter edge.

5. A reproducing device according to claim 1 in which means engaged with the arms at the point of crossing thereof is provided for maintaining uniformity of tension on the sliding pivotal connection where the arms are crossed.

6. A reproducing device according to claim 1 in which means is provided for maintaining uniformity of tension on the sliding pivotal connection where the arms are crossed, said means comprising a slotted guide bar having sliding pivotal connection with said board and pivotal connection with the two arms where the latter cross, and elastic means encircling two spaced points of said guide bar and transversely spaced points on the board and biasing the guide bar to a balanced position relative to the crossed arms.

7. A reproducing device according to claim 2 in which means engaged with the arms at the point of crossing thereof is provided for maintaining uniformity of tension on the sliding pivotal connection where the arms are crossed.

8. A reproducing device according to claim 2 in which means is provided for maintaining uniformity of tension on the sliding pivotal connection where the arms are crossed, said means comprising a slotted guide bar having sliding pivotal connection with said board and pivotal connection with the two arms where the latter cross, and elastic means encircling two spaced points of said guide bar and transversely spaced points on the board and biasing the guide bar to a balanced position relative to the crossed arms.

9. A reproducing device comprising a pair of crossed arms, a member having a pivotal connection with one end of each arm, a rectangular base board having sliding pivotal connection with portions of said arms that are intermediate the opposite ends of the arms and the point of crossing of said arms, a sliding pivotal connection where the arms cross, means to guide said member for universal movement over the surface of the base board and to retain the member parallel to the opposite ends of said board, said sliding connection and the cross pivotal connection adjusting according to the position of the member, the triangles defined by said arms, member and board being proportional, a tracer point fixedly carried by the member, and a tracer point carried at the crossing of the arms, said tracer points moving in a ratio that conforms to the proportions of said triangles.

10. A reproducing device according to claim 9 in which the opposite sides of the board are provided with guides, carriages are mounted to move along said guides, and the carriages are provided with means to guide said member for movement transversely to the movement of the carriages.

11. A reproducing device comprising a plane board provided with opposite parallel side edges, a carriage engaged with each said edge and movable therealong, each carriage being provided with guide means, a transverse member engaged between the guide means of the two carriages and extending transversely to and beyond the side edges of the plane board and movable in said guide means transversely to said edges, a pair of similar longitudinally slotted arms pivotally connected at one of their ends to spaced points of said transverse member and in crossed relationship to define a triangle having its three corners at the point of said crossing and the mentioned pivotal connections with the transverse member, a sliding pivot at the point of crossing of said pair of arms and passing through the slots in each arm, extensions on said arms beyond said sliding pivotal connection, a sliding pivot connecting each arm extension and a transverse edge of said board that spans between the mentioned side edges, and the mentioned sliding pivot between said arms extending through the slots in the arms where the same cross, a slotted bar having one end connected to said sliding pivotal connection between the arms and extending in the angle defined between the arm extensions in a direction toward and beyond the mentioned transverse edge, a projection carried by said slotted member and engaged with the crotch defined between the mentioned crossed pair of arms, a longitudinally spaced and adjustable member on said slotted bar, a member encircling the mentioned projection on the bar and the adjustable member thereof and transversely spaced points on the board to bias the mentioned projection into the crotch of the crossed arms, a tracing point on the transversely movable member and a tracing point on the mentioned slotted bar, both points being movable universally over the board in proportion to the relative size of the mentioned triangle and the triangle defined within said crossed point of the crossed arms and the points where said arm extensions pass over the transverse edge of the plane board.

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