Jan. 7, 1941. C. H. LITTLE ET AL 2,228,140

DRAFTING MACHINE

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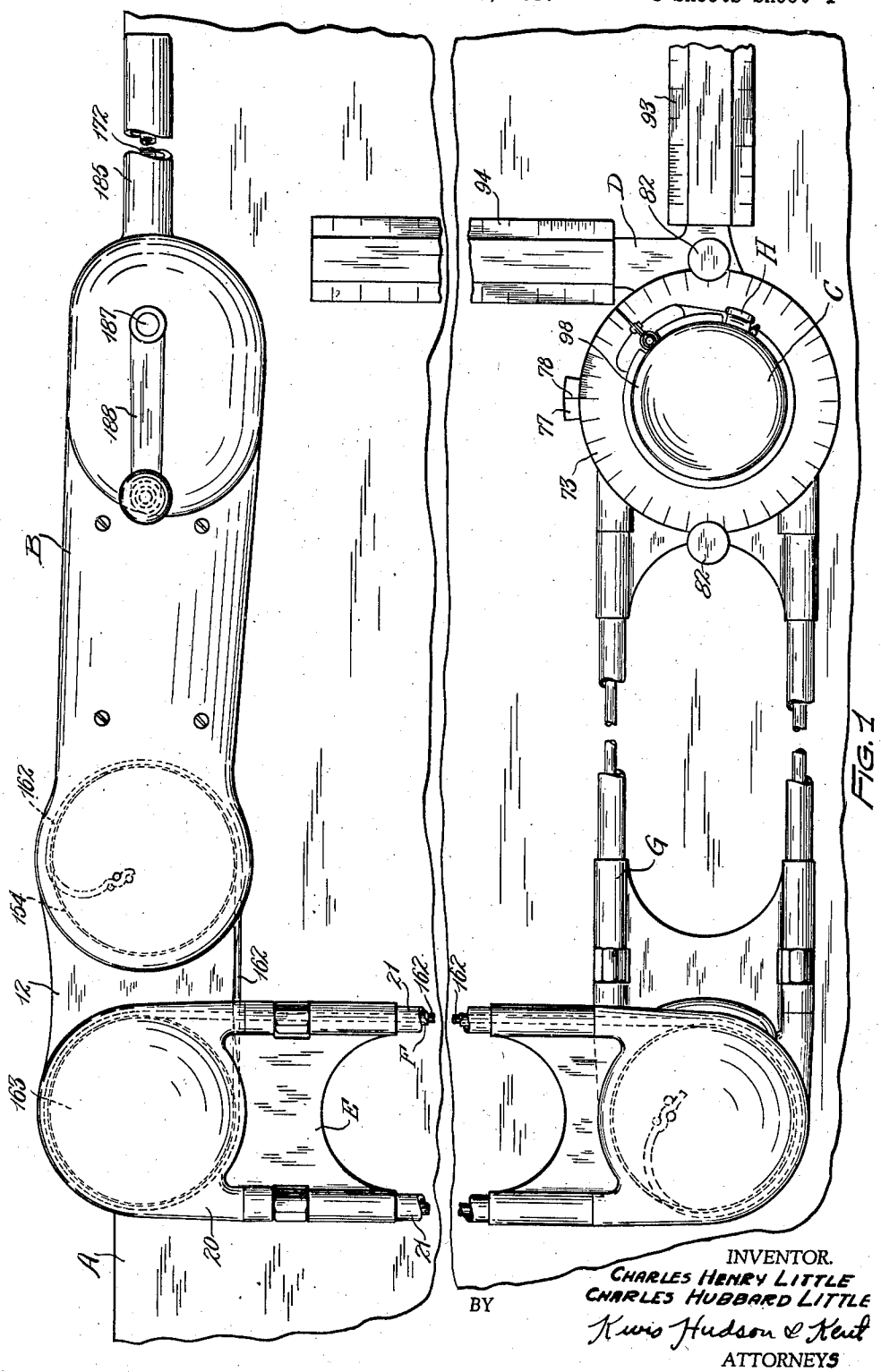


FIG. 1

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DRAFTING MACHINE

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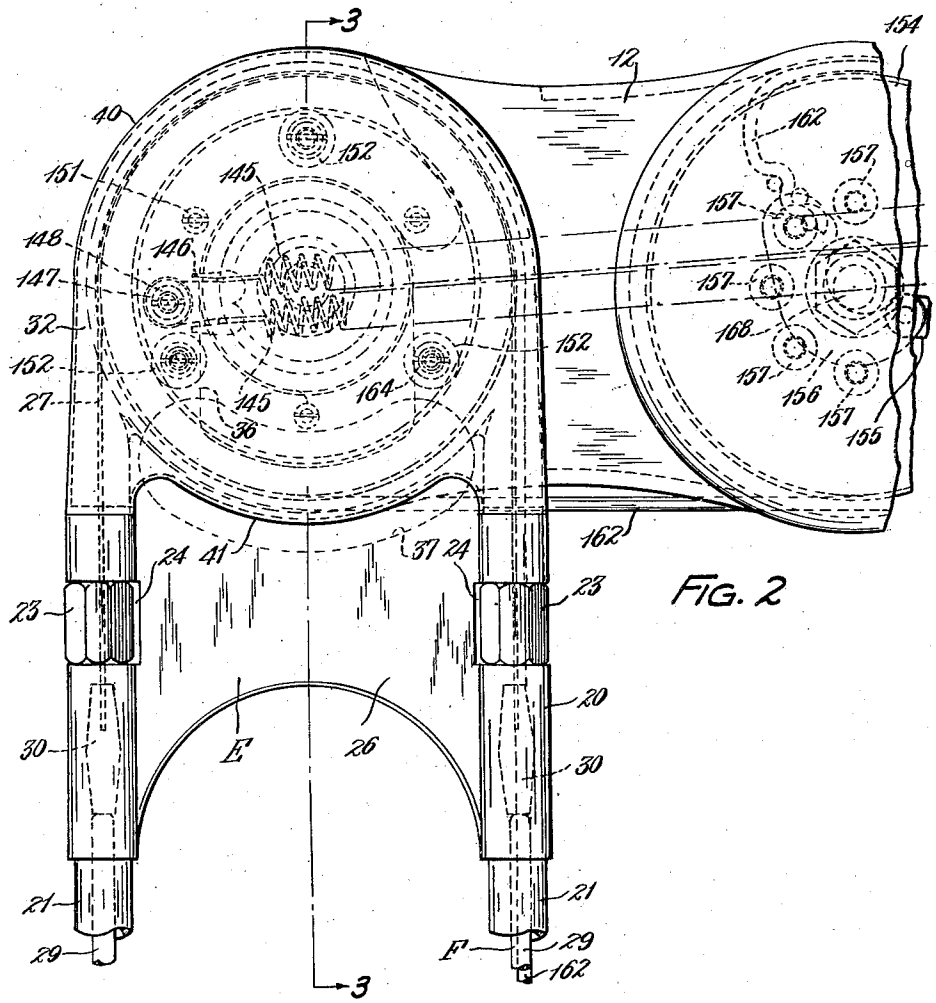


FIG. 2

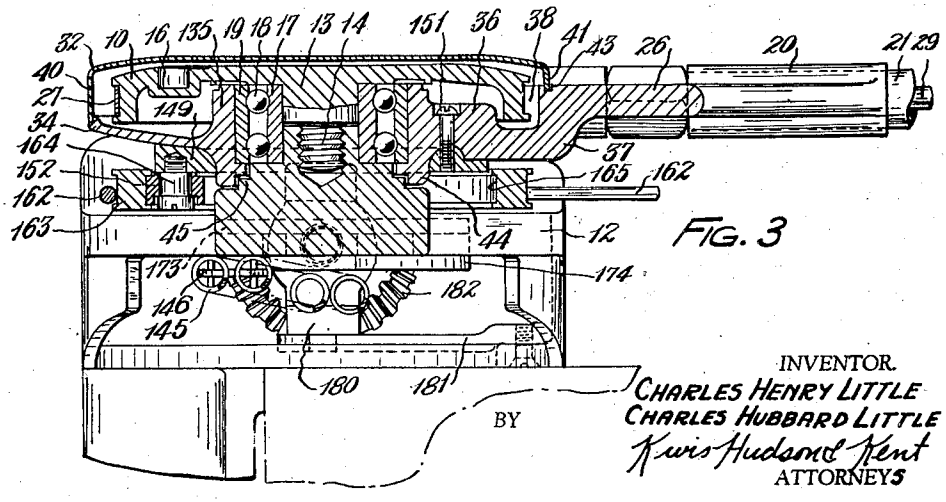


FIG. 3

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Jan. 7, 1941. C. H. LITTLE ET AL 2,228,140

DRAFTING MACHINE

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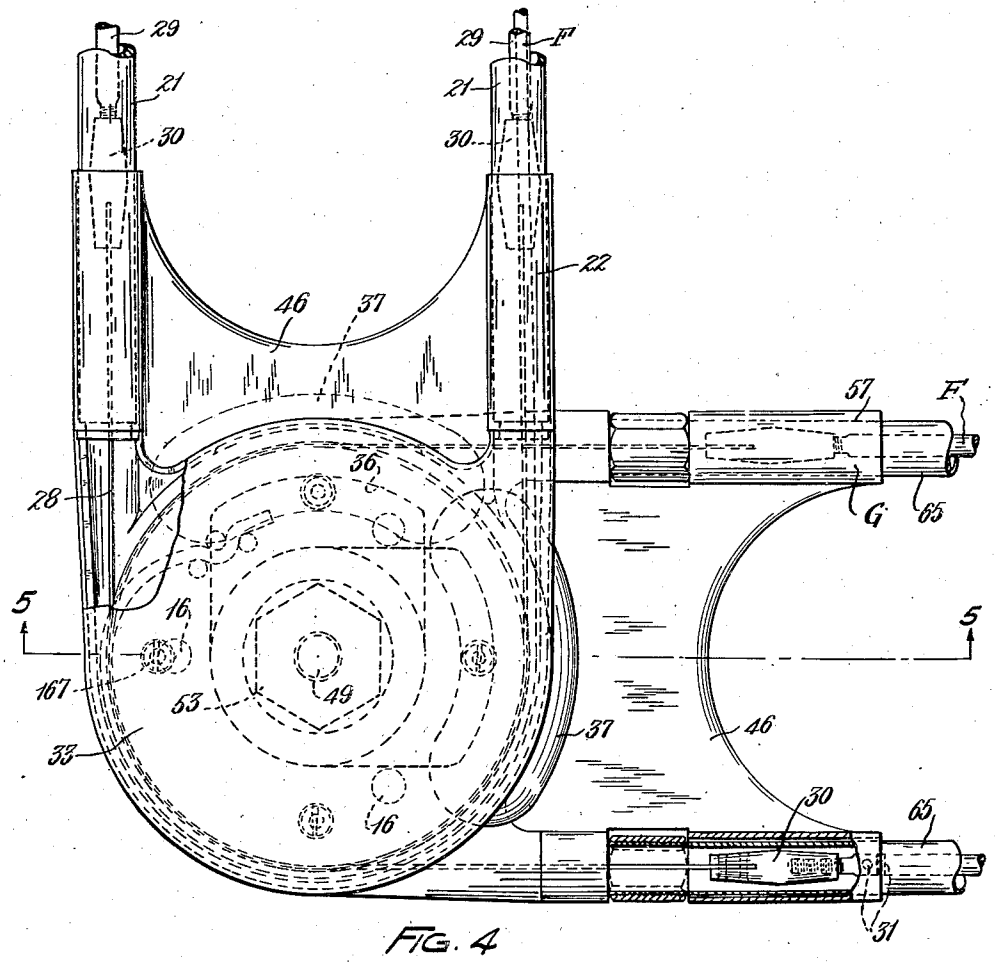


FIG. 4

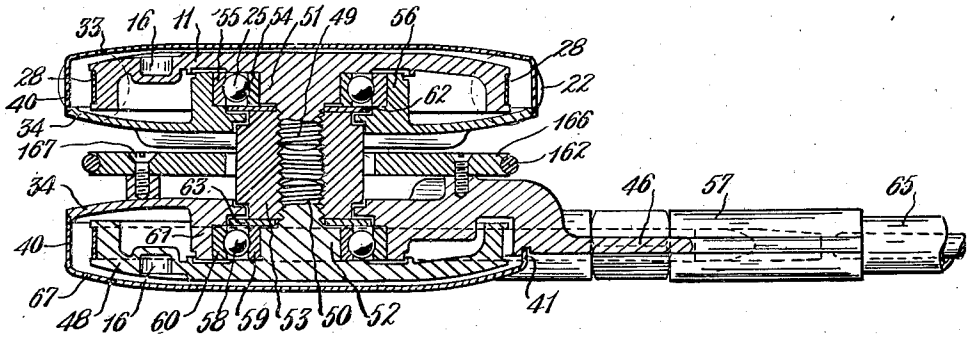


FIG. 5

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DRAFTING MACHINE

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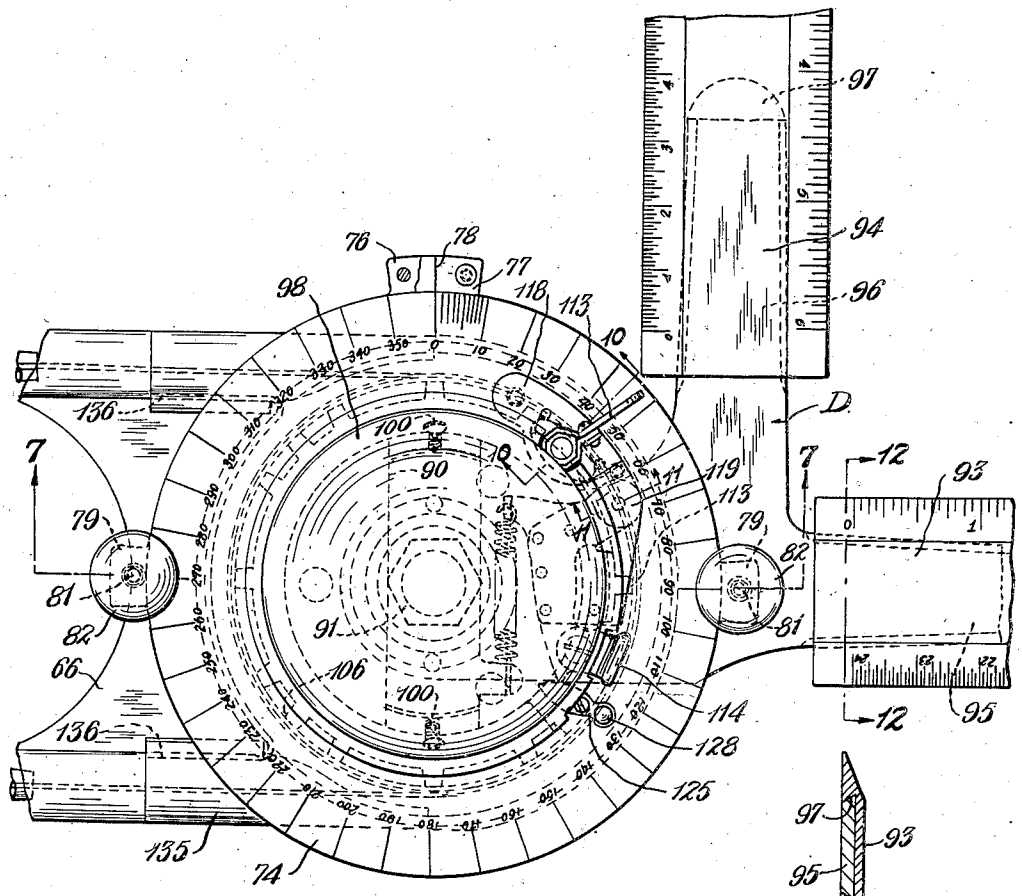


FIG. 6

FIG. 12

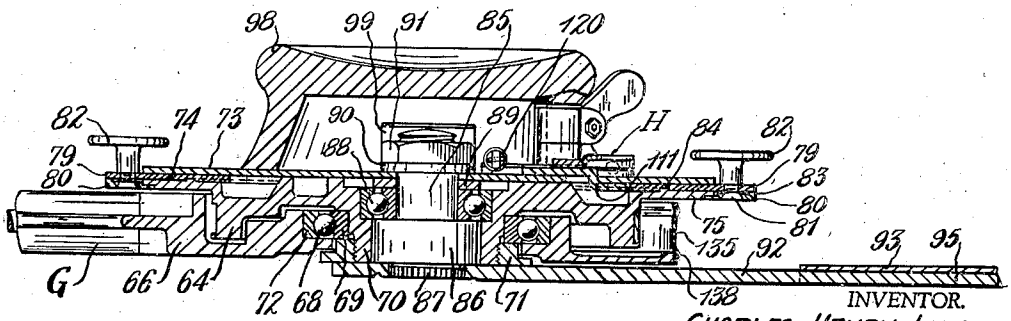


FIG. 7

BY

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DRAFTING MACHINE

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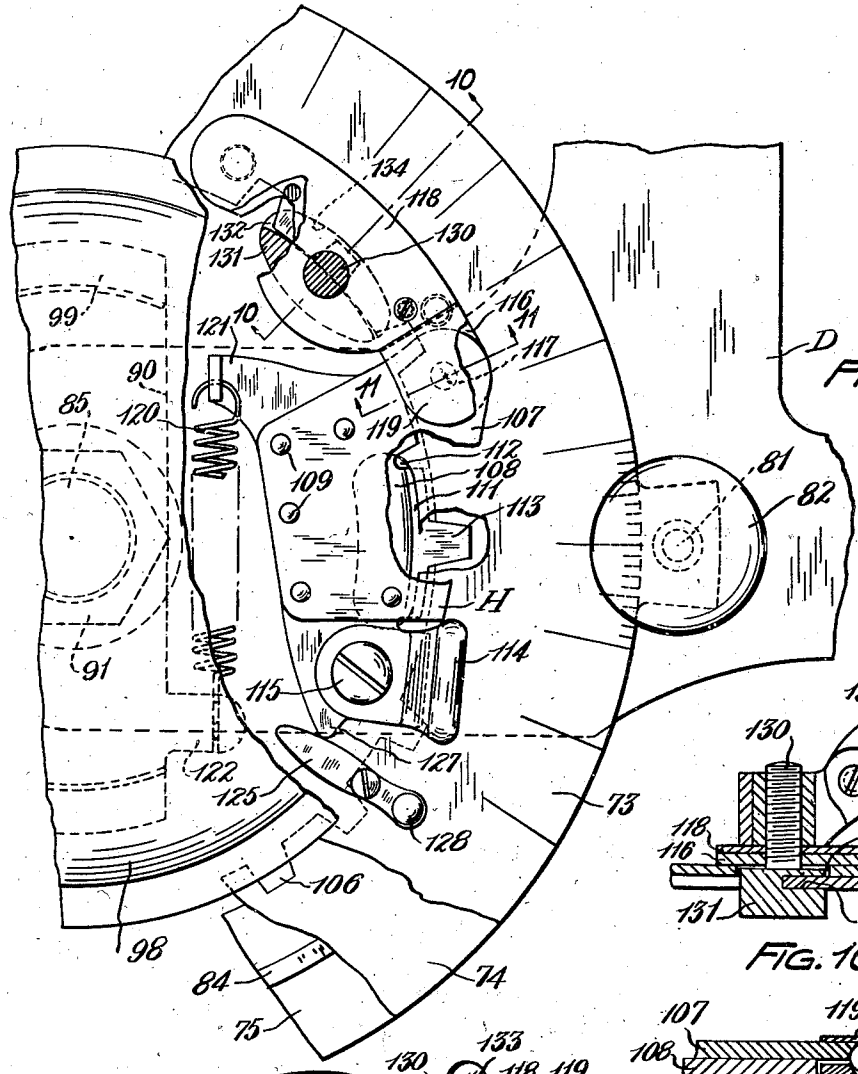


FIG. 8

FIG. 10

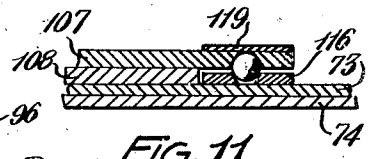


FIG. 11

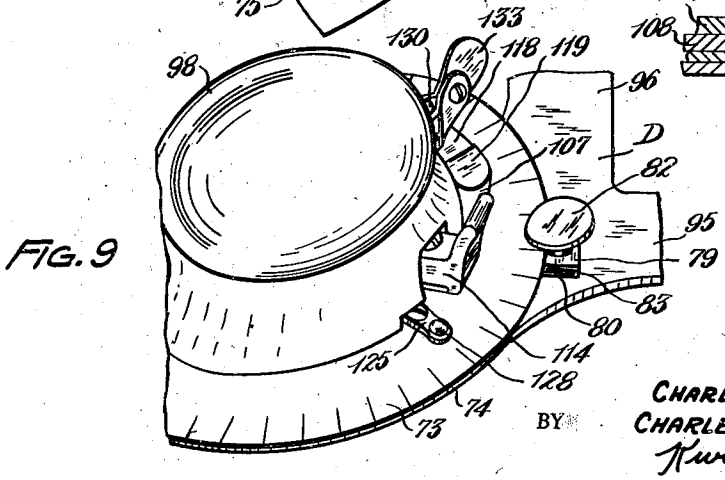


FIG. 9

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DRAFTING MACHINE

Filed Dec. 27, 1937 8 Sheets-Sheet 6

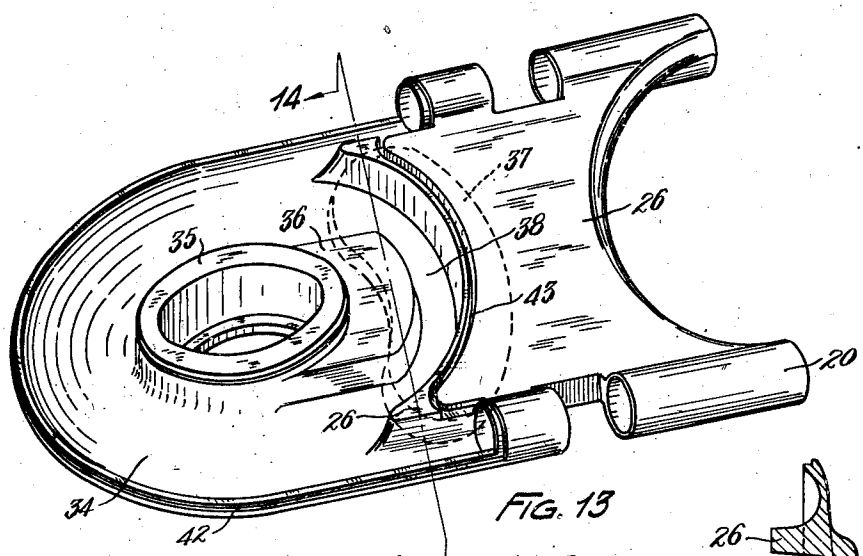


FIG. 13

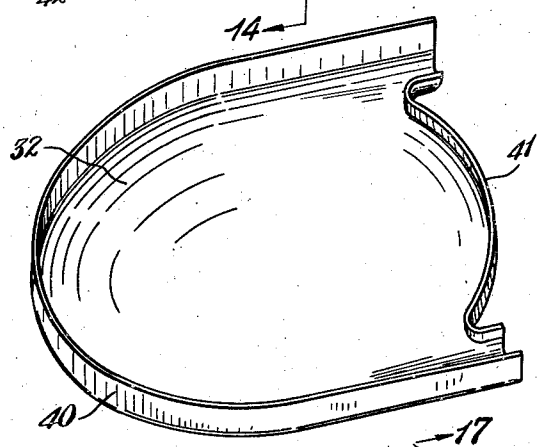


FIG. 15

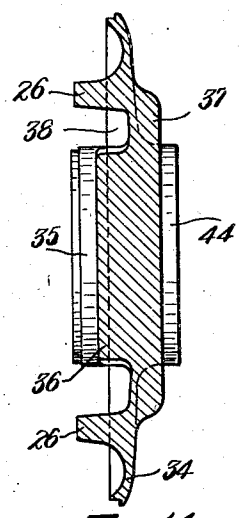


FIG. 14

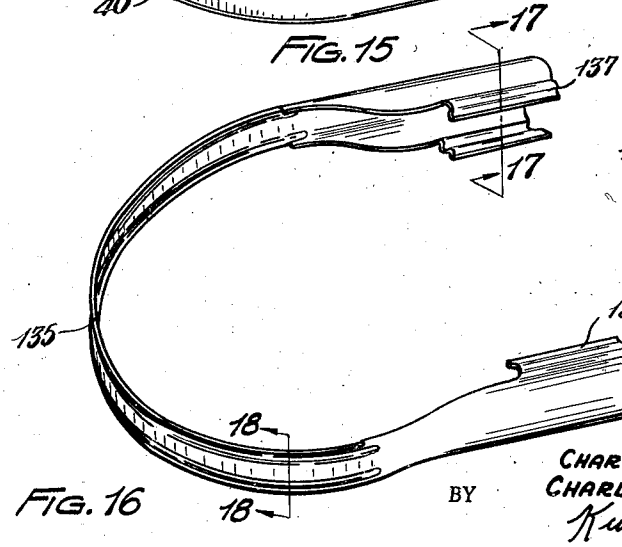


FIG. 16

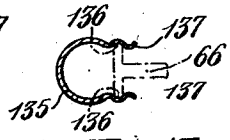


FIG. 17



FIG. 18

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DRAFTING MACHINE

Filed Dec. 27, 1937 8 Sheets-Sheet 7

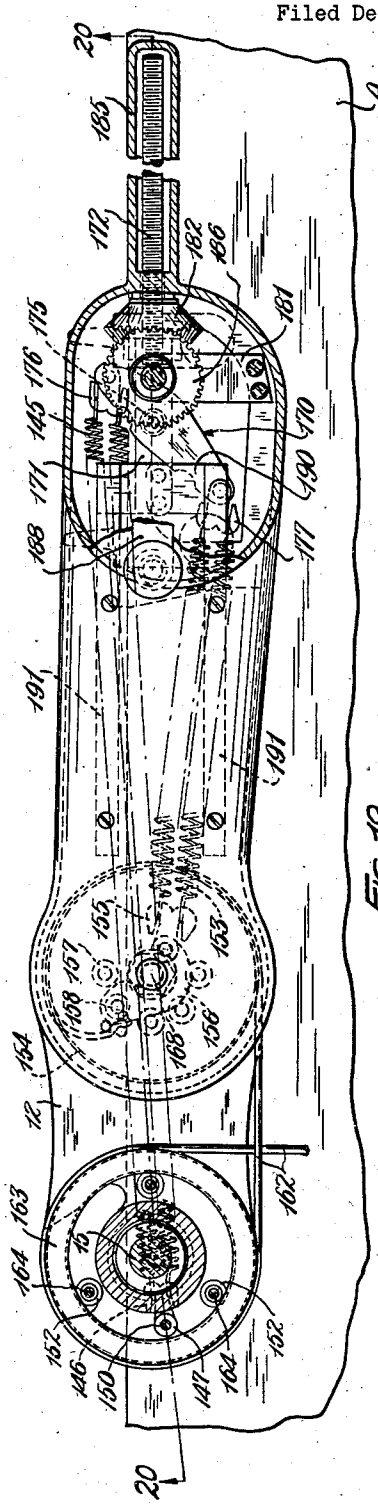


FIG. 19

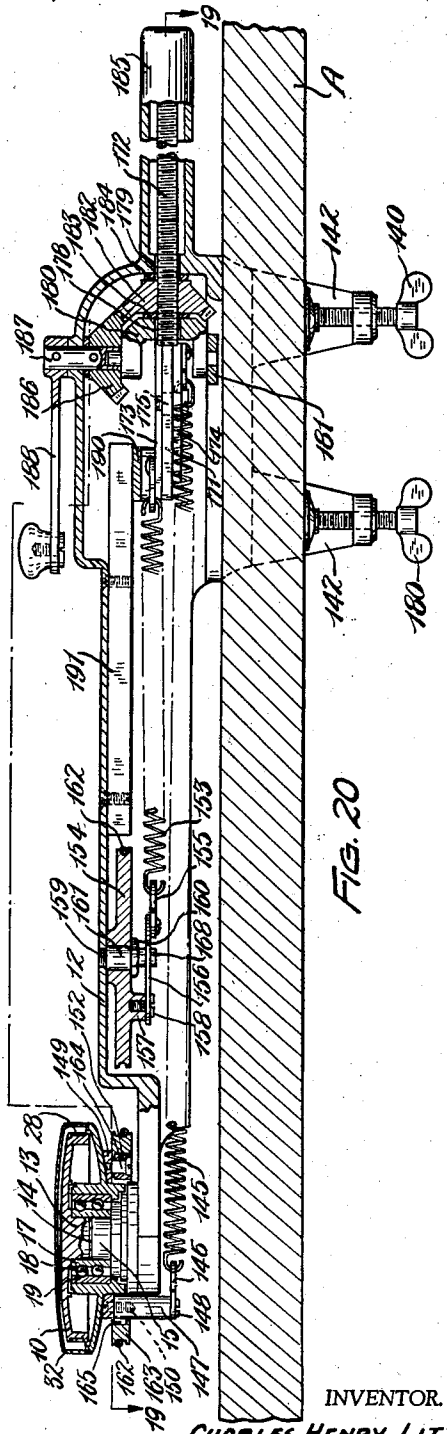


FIG. 20

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DRAFTING MACHINE

Filed Dec. 27, 1937 8 Sheets-Sheet 8

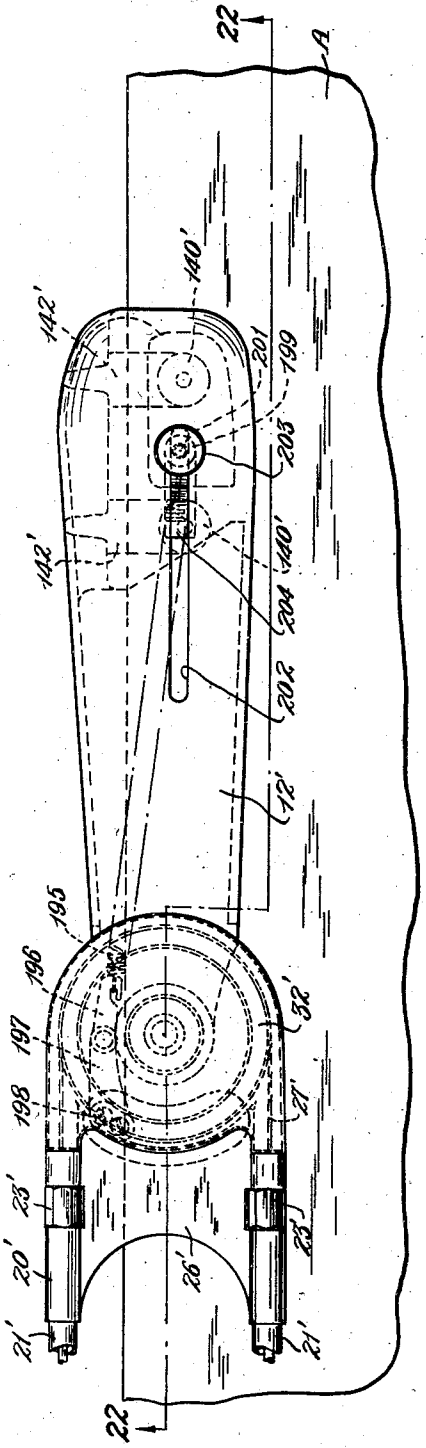


FIG. 21

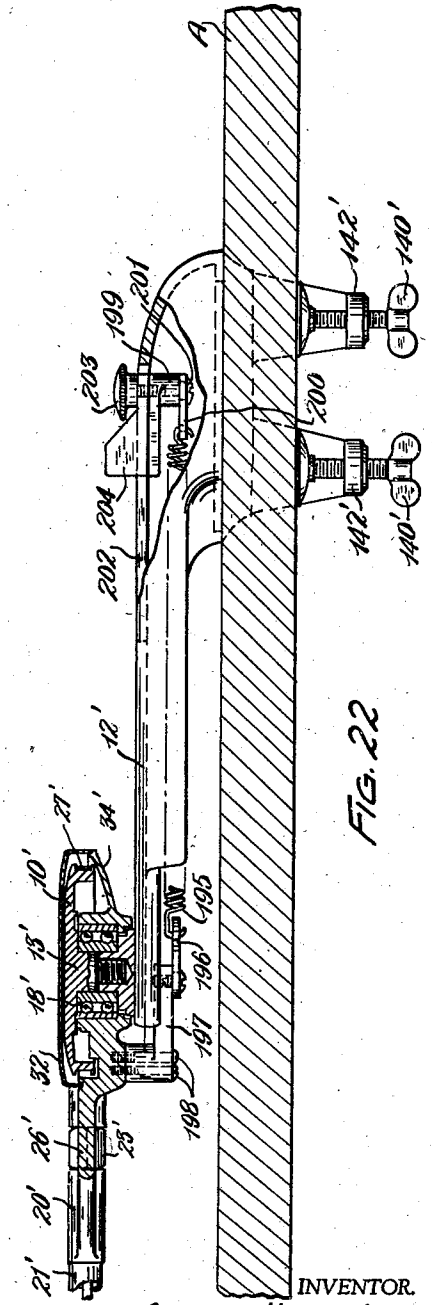


FIG. 22

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Patented Jan. 7, 1941 2,228,140

UNITED STATES PATENT OFFICE

2,228,140

DRAFTING MACHINE

Charles Henry Little and Charles Hubbard Little,
Cleveland Heights, Ohio

Application December 27, 1937, Serial No. 181,790

21 Claims. (Cl. 33—79)

The present invention relates to drafting machines and more particularly to drafting machines of the wheel and band type wherein the parallel motion mechanism or arm comprises a plurality of parallelograms comprising wheels held in spaced relation by struts and operatively connected together by flexible bands.

An object of the present invention is to provide a novel and improved drafting machine of the type referred to which will be light in weight and embody the desired characteristics of stiffness and flexibility, and in which the wheels of the parallelograms are held in spaced relation by struts or strut frames which wholly enclose the wheels and the bands encircling the same.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to in which the struts or strut frames entirely enclose the wheels and bands, and include parallel tubes through which the bands extend but which will permit the bands to be readily assembled or removed, and "tuned."

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to wherein the struts or strut frames comprise parallel tubes through which the bands extend and removable covers for the wheels and that part of the band adjacent the latter.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to having a parallel motion mechanism comprising two pivoted unitary sections connected together at the center of the wheels.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to wherein the protractor is concentric with the wheel at the protractor end of the parallel motion mechanism or arm, and comprising an offset anchor so as to extend the range of unobstructed operation of the machine at the left part of the board.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to including struts or strut frames comprising parallel tubes through which the bands extend wherein the parallel tubes are rotatably connected to the end members or yokes of the struts so as to impart desired flexible characteristics to the drafting machine.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to comprising struts or strut frames including parallel tubes through which the bands extend and wherein the tension of the bands can be adjusted by means of nuts threaded onto the tubes and engaging against the end members or yokes.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to comprising struts or strut frames for maintaining the wheels in spaced relation including parallel tubes through which the bands extend and end members so constructed and reenforced as to obtain maximum strength with minimum weight.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to comprising a counterpoise for each arm including means for adjusting the tension of the counterpoise springs.

Another object of the present invention is to provide a novel and improved drafting machine of the character referred to comprising a spring counterpoise and an offset anchor forming a cover or housing for the counterpoise spring.

Another object of the present invention is to provide a novel and improved drafting machine of the type referred to comprising a flexible band encircling the wheels thereof the cross-sectional area of which band is increased in the portion thereof intermediate the wheels.

Another object of the present invention is to provide a novel and improved protractor assembly for a drafting machine including a spring-pressed pawl or detent cooperating with an internally notched plate.

The present invention resides in certain novel details of construction, and combinations and arrangements of parts, and further objects and advantages will be apparent to those skilled in the art to which the invention relates from the following description of the preferred embodiments thereof described with reference to the accompanying drawings forming a part of this specification in which similar reference characters designate corresponding parts, and in which:

Fig. 1 is a plan view of a drafting machine embodying the present invention;

Fig. 2 is an enlarged plan view of a portion of the anchor end of the drafting machine shown in Fig. 1;

Fig. 3 is a section with portions in elevation on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged plan view of the elbow portion of the parallel motion mechanism or arm of the drafting machine shown in Fig. 1;

Fig. 5 is a section with portions in elevation taken on the line 5—5 of Fig. 4;

Fig. 6 is an enlarged plan view of the protractor end of the drafting machine shown in Fig. 1;

Fig. 7 is a section on the line 7—7 of Fig. 6;

Fig. 8 is an enlarged view of a portion of Fig. 6 with parts broken away;

Fig. 9 is a perspective view of the protractor assembly shown in Fig. 6;

Fig. 10 is a section on the line 10—10 of Figs. 6 and 8;

Fig. 11 is a section on the line 11—11 of Figs. 6 and 8;

Fig. 12 is a section on the line 12—12 of Fig. 6;

Fig. 13 is an enlarged perspective view of the upper end member or yoke of the strut for the anchor parallelogram;

Fig. 14 is a section approximately on the line 14—14 of Fig. 13;

Fig. 15 is a perspective view of the cover member for the yoke shown in Fig. 13;

Fig. 16 is a perspective view of the cover for that part of the band which extends around the wheel of the protractor assembly;

Fig. 17 is a section on the line 17—17 of Fig. 16;

Fig. 18 is a section on the line 18—18 of Fig. 16;

Fig. 19 is a plan view of the anchor shown in Fig. 1 with portions thereof broken away;

Fig. 20 is a section on the line 20—20 of Fig. 19 with portions in elevation;

Fig. 21 is a plan view of the anchor end of a drafting machine of modified construction embodying the present invention; and

Fig. 22 is a section on the line 22—22 of Fig. 21 with portions in elevation.

Referring to the drawings, the drafting machine shown therein comprises a parallel motion mechanism or arm of the wheel and band type, including two angularly movable sections or parallelograms, the upper end of which arm is connected to the drafting board A through the medium of an anchor assembly designated in general by the reference character B, while the lower end thereof is provided with a protractor assembly, designated generally by the reference character C, which protractor assembly includes a ruler assembly D. Generally speaking, each of the sections or parallelograms of the parallel motion mechanism or arm comprises a pair of wheels of equal diameter encircled by a flexible band and held in spaced relation by struts or strut frames. In the present instance, the struts or strut frames are so constructed and arranged that they completely encircle the bands and wheels, thereby producing a neat appearance and protecting the operator from any possible injury in the event that a band should break during operation, or the like. The construction is also such that dirt, etc., is excluded from the bearings.

The anchor section or parallelogram comprises the wheels 10 and 11, the strut E operatively connected to the wheels in a manner hereinafter referred to, and a band designated generally by the reference character F encircling the wheels. The upper wheel 10, which in some respects forms a part of the anchor mechanism, is connected to a bracket member or casting 12 which forms the anchor proper and constitutes a housing for a counterpoise mechanism hereinafter referred to, through the medium of a hub 13 formed integral with the wheel 10. The lower end 14 of the hub 13 is reduced and threaded into a tapped aperture in the top of a boss 15 formed integral with the member 12. The upper side of the wheel 10 is provided with a plurality of apertures 16 for the reception of a spanner wrench used in securing the wheel to the member 12. The hub 13 of the wheel 10 and the boss 15 of the member 12 are concentric with and form a support for the inside race 17 of an anti-friction bearing 18, the outside race 19 of which is fixed in the upper end member or yoke 20 of the strut E. The inside race 17 of the anti-friction bearing 18 is securely clamped between the wheel 10 and a shoulder formed on the member 12 by the boss 15, and the wheel 10 is held fixed to the member 12 of the anchor through the medium of friction alone.

The lower wheel 11 of the anchor parallelogram or section of the arm is held in spaced relation with respect to wheel 10 through the medium of the strut or strut frame E consisting in general of parallel tubes 21 through which the straight portions of the band F extend, and upper and lower end members or yokes 20 and 22. The upper ends of the tubes 21 extend into suitable cylindrical sleeves formed in the yoke 20 and are held therein and adapted to be adjusted longitudinally of the yoke member through the medium of nuts 23 threaded on the ends of the tubes and engaged within suitable slots 24 in the yoke 20. The lower ends of the tubes 21 extend into suitable cylindrical apertures in the lower end member or yoke 22. As previously stated, the upper end member or yoke 20 is rotatably supported coaxially with the upper wheel 10 through the medium of the anti-friction bearing 18 and the lower wheel 11 is rotatably supported in the yoke 22 through the medium of an anti-friction bearing 25.

The wheels are operatively connected together by the band F which, as previously stated, extends through the tubes 21. In the embodiment of the invention shown, the band F consists of two flexible flat steel sections 27 and 28 encircling the wheels 10 and 11, respectively, and operatively connected by sections or rods 29 of increased cross-section. The rods 29 form those parts of the band which are not required to bend about the wheels, and the flexible flat steel bands are connected thereto by connectors 30, see Fig. 4, located at opposite ends of the rod sections 29 and having threaded engagement therewith. The threads at opposite ends of the rod sections 29 are right-hand and left-hand, on the order of a turnbuckle, and function in a similar manner. Holes 31 at opposite ends of the rods 29 facilitate the manipulation of the rods. The flat steel sections of the bands are long enough to permit the wheels to rotate through at least about 270°. In other words, they should not be less than about one and one-quarter times the circumference of the wheels. In the embodiment of the invention shown, the wheels are three and one-half inches in diameter, the flat sections of band are one-quarter of an inch wide and twenty-thousandths of an inch thick, and the cross-sectional area of the rods is about three times as great as that of the flat sections of the band.

According to the provisions of the present invention, the struts or strut frames and covers entirely enclose the wheels and bands. As previously stated, the straight sections of the band F extend through the parallel tubes 21, and in order to enclose the wheels 10 and 11 and the flat parts 27 and 28 of the band which encircles the wheels, the yoke members 20 and 22 are provided with removable covers 32 and 33, respectively. Enlarged detail views of the yoke member 20 and

the cover 32 therefor are shown in Figs. 13, 14, and 15. As shown in Figs. 13 and 14, the upper yoke member 20 comprises two offset sections 26 and 34, the former of which is comparatively heavy and offset vertically about the lower thinner section 34. The latter section 34 has the hub 35 formed integral therewith, projecting above and below the plane thereof within which hub the outside race 19 of the anti-friction bearing 18 is fixed. The upper heavy section 26 of the yoke member extends toward the left as viewed in Figs. 3 and 13 to closely adjacent the wheel 10, and conforms with the circumference thereof. That part of the lower thinner section 34 immediately inside of the wheel 10 and between the wheel 10 and the hub 35 in line with the longitudinal axis of the strut frame is reenforced with an enlargement or projection 36 formed integral with the yoke member.

What would otherwise be a relatively thin section between the part 26 of the yoke member and the reenforcing projection 36 is strengthened and reenforced by a projection or pad 37 cast integral with the yoke member on the under side thereof as viewed in the drawings. The side of the member 37 adjacent the hub 35 is curved about the hub in a manner similar to that in which the end of the member 36 remote from the hub is shaped, but the two reenforcing members overlap, see Fig. 3. The cup-shaped wheel 10 is as shown in Fig. 3 and the projection 36 extends closely adjacent the inside edge of the wheel and conforms thereto. The construction is such as to produce a uniformly strong section, to the right of the hub 35, as viewed in Fig. 13, even though the upper part of the yoke member has what resembles a cut-out portion 38 to accommodate the rim of the wheel 10. A section similar to that shown in Fig. 14 will embrace the ends of the section 26 and of the reenforcing member 37 while still including the reenforcing member 36. The particular yoke shown is made of cast aluminum and the shape of the reenforcing members or sections formed integral therewith is clearly shown in the drawings.

The removable cover 32 which cooperates with the yoke 20 to form an enclosure for the wheel 10 has peripheral flanges 40 and 41 thereon, the former of which is adapted to engage a shoulder 42 about the periphery of the section 34 of the yoke 20 while the latter engages within a groove 43 formed in the section 26 of the yoke. The construction is such that the yoke 20 together with the cover 32 form a complete cover for the wheel 10 and that part of the band encircled thereby. The under part 44 of the hub of the yoke member and the adjacent part 45 of the member 12 are so constructed and arranged that the opening or clearance therebetween forms an irregular path or labyrinth, as shown in Fig. 3, which prevents the entrance of dirt, etc., into the bearings.

The lower end member or yoke 22 of the anchor parallelogram is similar in construction to the upper yoke member 20 just described, with the exception that the lower ends of the parallel rods 21 merely abut against shoulders in the ends of the apertures or sleeves in the yoke member within which they are positioned instead of incorporating adjusting means, and the section 46 which corresponds to the section 26 of the yoke member 20 is not quite as thick as the section 26 because this yoke member is not required to carry the same weight nor is it subjected to as great a strain as the yoke member at the anchor end of the arm. The wheel 11 and the section of flexible band 28 extending about the periphery thereof is enclosed by a cover 33 similar to the cover 32 previously referred to and detachably connected to the yoke member 22 in a like manner.

The left-hand wheel 48 of the protractor section or parallelogram and the wheel 11 of the anchor parallelogram are similar in construction and non-rotatably secured together, through the medium of threaded reduced sections 49 and 50 formed integral with the hubs 51 and 52 of the wheels 11 and 48, respectively. The threaded portions 49 and 50 are threaded into opposite ends of a suitably tapped aperture in a spacer member 53 interposed between the wheels. Both wheels 11 and 48 are provided with apertures similar to the apertures 16 in the wheel 10, adapted to receive spanner wrenches through the medium of which the wheels may be relatively rotated to assemble and disassemble the same with the space member 53. The construction is such that the wheels are held in fixed relation, with reference to the spacer member 53 and each other, by friction only.

The wheel 11 of the anchor section or parallelogram is rotatably supported in the strut E through the medium of the anti-friction bearing 25, previously referred to, the inside race 54 of which is fixed on the hub 51 of the wheel 11 while the outside race 55 thereof is fixed within the hub 56 of the yoke member 22. The left-hand end of yoke member 57 of the protractor strut or strut frame G, and in turn the strut frame, is rotatably supported coaxial with the wheel 48 of the protractor section or parallelogram through the medium of an anti-friction bearing 58, the inside race 59 of which is fixed to the hub 52 of the wheel 48, while the outside race 60 thereof is fixed within the hub 61 of the yoke 57. Adjacent parts of the spacer member 53, the yokes 22 and 57 are so constructed that the clearance therebetween is in the form of an irregular path or labyrinth, as clearly shown in Fig. 5, so as to prevent the entrance of dirt into the bearings. Washers 62 and 63 interposed between the spacer member 53 and the bearings 25 and 58, respectively, assist in preventing the entrance of dirt, etc. into the bearings.

The band operatively connecting the wheel 48 of the protractor parallelogram at the elbow of the arm and the wheel 64 at the protractor end of the arm is similar in construction to the band F already described, and will not be referred to in detail. Suffice it to say that the corresponding parts thereof are designated by similar reference characters.

The strut frame G of the protractor parallelogram is similar in construction to that of the anchor parallelogram and comprises parallel rods 65 similar to the rods 21 through which the straight sections of the band extend. The left-hand ends of the rods 65 are connected to the yoke member 57 in a manner similar to that in which the upper ends of the rods 21 are connected to the yoke member 20. In other words, the same provision is made for adjusting the rods relative to the yoke members in the protractor parallelogram as has been heretofore described with reference to the anchor parallelogram. The right-hand ends of the rods 65 project into suitable apertures formed in the yoke member 66 in a manner similar to that in which the lower ends of the rods 21 project into similar apertures in the yoke member 22. In order to

enclose the wheel 48 and the thin flexible part of the band encircling the same, while permitting access thereto for the purpose of assembly, replacement, tuning, etc., the yoke member 57 is provided with a detachable cover 67 similar to the covers 32 and 33 heretofore referred to.

The wheel 64 of the protractor parallelogram which forms a part of the protractor assembly is rotatably supported in the yoke 66 at the free end of the strut G through the medium of antifriction bearings 68, the inside race 69 of which is secured on the hub 70 of the wheel 64 by a flanged nut 71 threaded onto the lower end of the hub. The outside race 72 is fixed in the right-hand yoke member 66 of the protractor strut G, which yoke member 66 is similar in construction to the other yoke members previously described but, in view of the fact that it is at the free end of the arm where it is not subjected to as much strain, it is not necessary to make the same quite as heavy or as strong as the other yoke members. The cover for the yoke member 66 is necessarily different from the other covers referred to, since the wheel 64 forms a part of the protractor assembly, as will be hereinafter apparent. Both the nut 71 and the wheel 64 are provided with suitable apertures for the reception of spanner wrenches to facilitate tightening the nut 71, and the construction is such that the wheel 64 is fixed to the inside race 69 by friction alone. The adjacent parts of the nut 71 and the yoke 66 are so constructed and arranged that the clearance therebetween is in the form of an irregular path or labyrinth, see Fig. 7, which prevents the entrance of dirt, etc., into the bearing.

The protractor in the present instance comprises a disk 73 rotatably supported on an intermediate member or ring 74, which ring 74 is in turn rotatably supported on the upper side of an annular flange 75 formed integral with the wheel 64, which flange is hereinafter referred to as the holding plate 75. The ring 74 has a projection 76 formed integral therewith, to the upper side of which is secured a member 77 upon which the dead line 78 is formed, and a pair of lugs 79 projecting from opposite sides thereof spaced 90° from the dead line 78. The ring member 74 is adapted to be adjusted angularly about the axis of the wheel 64, and clamped in any desired position by a pair of clamp members 80 carried by screws 81, the shanks of which project upward through the lugs or projections 79 where they are provided with knurled thumb nuts 82. The radial inner edges of the clamp members 80 are adapted to engage over an annular flange formed on the periphery of the holding plate 75 and the radial outer ends of the clamp members have slight projections or ridges 83 adapted to engage the under surface of the projections 79 and about which the clamp members fulcrum. An annular tongue and groove connection 84 between the holding plate 75 and the ring member 74 assists in holding these members in their proper position while permitting rotatable adjustment of the member 74 relative to the holding plate 75.

The protractor plate 73 of the ruler assembly D is rotatably supported coaxial with the wheel 64 through the medium of a bolt 85 having an enlarged head 86 and a knurled cylindrical section 87 below the head 86. The bolt 85 is rotatably supported in the wheel 64 through the medium of an anti-friction bearing 88, the inside race of which surrounds the shank of the bolt 85 directly above the head 86 while the outside race thereof is fixed in the hub 70 of the wheel 64. A washer 89 located directly above the bearing 88 prevents the entrance of dirt into the bearing. The hub of the protractor plate 73 is clamped between the washer 89 and a member 90 located directly above the protractor plate by a nut 91 threaded onto the upper end of the bolt 85. The ruler plate 92, which carries the horizontal and vertical rulers 93 and 94, consists of a flat plate secured to the knurled part 87 of the bolt 85, and comprises horizontal and vertical arms 95 and 96. The under sides of the rulers 93 and 94 are provided with tapered dovetailed grooves 97 into which similarly shaped ends of the arms 95 and 96 project, see Fig. 12. The construction is such that the rulers can be readily chucked to or removed from the ruler arms.

The ruler assembly D includes the usual hand grasp 98 which, in the present instance, is connected to the stud 85 through the medium of the member 90 secured under the nut 91 and having upturned ends 99 to which the hand grasp is connected by screws 100. To facilitate the setting of the ruler assembly to the angles of the protractor most commonly used, that is, 0°, 30°, 45°, 60°, and 90°, the ruler assembly D in the present instance includes a spring-pressed pawl designated generally by the reference character H which cooperates with suitable notches 106 formed in the ring member 74. In the present instance the ruler assembly is adapted to be rotated through 360°, and the notches 106 are formed in each of the four quadrants of the protractor. The pawl H comprises two plates 107 and 108 suitably secured together as by rivets 109. The lower plate 108 is slidably supported on the upper surface of the protractor plate 73 and has a tongue or projection 111 formed integral therewith which extends down through a suitable aperture 112 in the protractor plate where it is provided with a reduced end 113 adapted to engage within the notches 106. The lower end of the plate 108, as viewed in Fig. 8, is provided with a thumb grasp 114 secured thereto by a screw 115. The upper plate 107 is pivotally connected to a member 116 through the medium of a ball pivot 117. The plates 107 and 116 are preferably made of hardened steel so as to reduce the wear in the pivot to a minimum. The plate 116 is shaped as shown in Fig. 8 and has secured to the upper side thereof a similarly shaped plate 118, the lower right-hand end 119 of which is offset and projects above the plate 107, thus securely holding the pivot assembled. The pawl H is continuously urged in a counterclockwise direction about the pivot 117, as viewed in Fig. 8, by a tension spring 120, one end of which is connected to a projection 121 formed integral with the plate 108 while the other end is connected to a projection 122 formed integral with the member 90.

At times it is desirable to secure the pawl H in an inoperative position, thus leaving the ruler assembly free to be rotated without the necessity of manually holding the pawl in a position to clear the notches 106, and, for this purpose, the present protractor assembly is provided with a latch member 125 pivotally supported on the upper side of the protractor plate 73. The left-hand end of the latch member 125, as viewed in Fig. 8, is adapted to be engaged behind a projection 127 on the plate 108. The right-hand end

of the latch is provided with a raised part 128 adapted to be engaged by the thumb of the operator when it is desired to rotate the latch so as to engage the opposite end thereof behind the projection 127. When the operator desires to lock the pawl H in an inoperative position, he presses the thumb grasp 114 and then draws his thumb downwardly as viewed in Figs. 8 and 9, wiping the projection 128 with the lower part of his thumb, thus rotating the latch 125 into engaging position while maintaining the pawl H in its inoperative or retracted position at the same time.

Provision is made for securely locking the ruler assembly D relative to the protractor plate 73 in the form of a stud 130, the head 131 of which is provided with a groove 132 adapted to engage over the radially inward edge of the ring member 74. The shank of the stud 130 which projects upwardly through suitable apertures formed in the plates 116 and 118 is provided with a wing nut 133 which, upon being tightened, securely clamps the protractor plate 73 to the ring member 74. The protractor plate 73 is cut out as indicated at 134 to permit free vertical movement of the head 131 of the stud 130. The head 131 of the stud 130 is elongated as shown in Fig. 8, and the groove 132 therein is formed on a radius, as clearly shown in the aforesaid figure, which radius is less than the radius of the inside diameter of the ring member 74 and permits the head 131 to pass over the notches 106 without engaging therein, thus permitting free rotation of the ruler assembly D. From the foregoing construction it will be apparent that by loosening the knurled nuts 82 the dead line 78 may be moved or set to any desired angle, after which the knurled nuts 82 are tightened, whereupon the protractor readings are reckoned from a new base line of any desired angularity. Also the notches will read from the new base line.

The wheel 64 at the protractor end of the arm and the band adjacent to and engaging the wheel are enclosed within the yoke 66 and a cover 135. The cover 135 is in the form of a band located radially of the wheel proper and adapted to be clipped or otherwise detachably connected to flanges 136 on the yoke 66 adjacent the cylindrical portions thereof which receive the rods 65 through the medium of reversely bent flanges 137 adapted to engage over the flanges 136. The yoke 66 has a small ridge or tongue 138 formed about the periphery thereof which fits into a groove formed on the cover 135. A small clearance is provided between the upper edge of the cover 135 and the under side of the holding plate 75. The particular construction of the cover 135 referred to is clearly shown in Figs. 16, 17, and 18.

The preferred embodiment of the invention shown includes counterpoise mechanism for both the anchor and the protractor sections or parallelograms of the arm. For the most part, this mechanism is enclosed within the member 12 of the anchor and only a small part thereof is ordinarily visible. The member 12 which forms the anchor proper is clamped to the upper edge of the drawing board A in any desired position by clamp screws 140 threaded through suitable bosses formed on the lower ends of depending projections 142 formed integral with the housing 12. The counterpoise mechanism for the anchor parallelogram of the arm comprises two tension springs 145 the left-hand ends of which, as shown in Figs. 19 and 20, are connected through the medium of a connector 146 and a member 147 to the upper yoke member 20 of the strut E. The connector 146 is pivotally secured to the lower end of the member 147 by a shouldered screw 148 and the upper end of the member 147 is secured to the under side of a ring-like member 149 by a screw 150. The upper side of the ring-like member 149 conforms to the shape of the under side of the yoke, surrounds the under part 44 of the hub, and is fixed to the yoke 20 by screws 151. The under side of the member 149 is flat and, in addition to forming a support for the member 147, forms a support for a plurality of rollers 152 hereinafter referred to. The member 147 to which the springs 145 are attached is located to the left and slightly below the axis about which the upper end of the strut or strut frame E is rotatably supported when the anchor strut is in a vertical position. As the strut frame is rotated during operation, the tension of the spring is increased or decreased as the case might be, the required amount to counterbalance the weight of the arm.

The counterpoise mechanism for the protractor parallelogram comprises the tension springs 153, the left-hand ends of which are connected to a wheel 154 through a connector 155 pivotally connected to the end of a crank member or lever 156 which in turn is pivotally connected to a boss 157 formed on the under side of the wheel 154 by a shouldered screw 158. The boss 157 is located at one side of the axis about which the wheel 154 rotates so as to effect a crank action. The wheel 154 is rotatably connected to the under side of the member 12 by a stud 159 threaded into a suitable aperture in the member 12 and provided with a jam nut 160 threaded thereon below the wheel 154. A spacer collar 161 about which the wheel 154 rotates permits free movement of the wheel. The wheel 154 is operatively connected to the strut or strut frame G of the protractor parallelogram by a cable 162 one end of which is secured to the under side of the wheel 154 in any convenient manner. From the wheel 154 the cable 162 extends toward the left, see Figs. 1 and 19, passes around a wheel 163 and extends down toward the elbow of the arm underneath the right-hand tube 21. The wheel 163 is equal in diameter to the wheel 10 and is carried by three spaced rollers 152 secured to the under side of the member 149 by shouldered screws 164. The rollers 152 engage within a groove 165 formed in the wheel 163 which construction holds the parts assembled while permitting free rotation of the wheel 163. The lower end of the cable 162 is wrapped about and then secured to a wheel 166 located at the elbow of the arm and fixed to the upper side of the yoke 57 of the protractor parallelogram by screws 167. The wheels 163 and 166 are of equal diameter.

The member 156 is cut out, as shown in Fig. 19, and engages a projection 168 formed integral with the stud 159 upon being rotated in a clockwise direction as viewed in Fig. 19. The construction is such that the tension of the springs 153 will not decrease as the pivot for the member 156 passes over dead center upon rotation of the wheel 154 by movement of the parallel motion arm. Unless this were done, the tension of the springs 153 would be released when pivot 158 passes dead center. In order to permit the device to be adjusted, the under side of the wheel 154 is provided with a plurality of bosses similar to the boss 157.

The right-hand ends of the springs 145 and

153 are connected to opposite ends of a lever 170 pivotally connected to a flat rectangular end 171 of a threaded rod 172. The lever 170 comprises upper and lower plates 173 and 174 one above and the other below the flattened end 171 of the member 172. The members 173 and 174 are pivotally connected to the end 171 of the member 172 by means of a shouldered screw 175 which permits free rotation of the levers relative to the member 172. The springs 145 are connected to the under side of the lever 170 by connector 176 and the springs 153 are connected to the upper side of the opposite end of the lever 170 by connectors 177. The fulcrum or pivot for the lever 170 is not midway between the ends thereof but is closer to the end connected to the springs 145, as shown in Fig. 19, so as to balance the springs in the desired manner.

The right-hand threaded end of the member 172 projects through suitable apertures 178 and 179, the former of which is formed in a member 180 carried by a lever 181 fixed to the member 12. The member 172 is adapted to be moved parallel with the top edge of the board A to adjust the tension of the springs 145 and 153 through the medium of a gear 182 rotatably supported thereby and interposed between the member 180 and the right-hand end of the member 12. Wear plates 183 and 184 are interposed between the gear 182 and the members 180 and 12 respectively.

The right-hand threaded end of the member 172 is enclosed within a tubular projection 185 formed integral with the anchor member 12. The gear 182 is adapted to be rotated in either direction to adjust the tension of the springs depending upon the angle of the drawing board, etc., by a second gear 186 continuously in mesh with the gear 182 and fixed to the lower end of a shaft 187 rotatably supported in a suitable aperture formed in member 12. A crank 188 fixed to the upper end of the shaft 187 above the member 12 and rotatable in a plane parallel to the working surface of the drawing board provides means for rotating the gears 182 and 186. Rotation of the member 172 relative to the member 12 is prevented by cross arm 190 secured to the left-hand end of the member 172, which cross arm is adapted to engage spaced members 191 fixed to the under side of the member 12. The construction is such that the cross member 190 is free to slide underneath the members 191 while preventing rotation of the member 172 relative to the member 12.

In some instances, particularly where the instrument is to be used on a drafting board or table having comparatively little inclination, the counterpoise may be omitted altogether, or may be applied to only one of the sections or parallelograms of the arm. Figs. 21 and 22 show a modification of the embodiment of the invention just described wherein the counterpoise is applied only to the anchor section or parallelogram of the arm. The drafting machine shown in these figures is for the most part similar to that previously described and the corresponding parts are designated by the same reference characters with a prime mark affixed thereto. As shown in these figures, the counterpoise comprises a single spring 195 the left-hand end of which is connected through the medium of a connector 196 to the free end of the lever 197 fixedly secured to the under side of the yoke member 20' by screws 198. The right-hand end of the spring 195 is pivotally secured to the lower end of a member 199 through the medium of the connector 200 by a shouldered screw 201. The member 199 is slidably supported in a slot 202 formed in the upper side of the anchor bracket 12' and adapted to be clamped in any adjusted position by means of a knurled nut 203.

In order to facilitate adjustment of the member 199 along the slot 202, the member has formed integral therewith a projection 204 extending upwardly through the slot 202 which projection is adapted to be engaged by the operator in adjusting the tension of the spring 195. The lever 197 is so constructed that when the anchor section of the arm is in a horizontal position, that is, in a position parallel with the upper edge of the board, the pivot for the connector 196 will be above the axis of rotation of the strut, see Fig. 21. But when the anchor section or parallelogram of the arm is in a vertical position, that is, in a position normal to the upper edge of the board, the pivot for the connector 196 will be in alignment with the axis of rotation of the strut and no force will be exerted tending to rotate the arm about its connection with the anchor. As movement of the arm in a counter-clockwise direction, as viewed in Fig. 21, is continued, the pivot for the connector 196 will move below the axis of rotation of the strut and a counterpoise action will be again effected.

In both embodiments of the invention shown, the connection between the parallel motion arm and the anchor is offset to the left a considerable distance from the point at which the anchor bracket is connected to the board, leaving a clearance for the vertical scale underneath the anchor, as clearly shown in Figs. 20 and 22. This, together with the fact that the protractor is coaxial with the wheel 64 at the free end of the arm, greatly extends the most convenient range of operation of the drafting machine, that is, at the left end of the board.

The springs are employed in pairs in the preferred embodiment of the invention so that, in the event one should break while the instrument is being used on a substantially vertical board, the arm will not fall free but will be partially held by the second spring. It will be apparent that two springs may be employed in the embodiment shown in Figs. 21 and 22 if desired.

From the foregoing description of the preferred embodiments of the invention it will be apparent that the objects heretofore enumerated and others have been accomplished and that a new and improved drafting machine has been provided. The fact that each section is a unit facilitates assembly, and enclosing the wheels, bands, bearings, etc. produces a neat appearance and excludes dirt, etc. from the operating parts. The use of anti-friction bearings permits the use of bands of greater cross-sectional area, thus greatly increasing the stability of the rulers. The fact that the side rods of the struts are rotatably connected to the end members or yokes produces flexibility normal to the working surface of the board, with the result that the rulers always lie flat and the protractor can be lifted without injury to the arm. The central connection at the elbow of the arm permits the arm to be swung through 360°, if desired. The counterpoise springs for both sections of the arm can be simultaneously adjusted and very little, if any, of the counterpoise mechanism is ordinarily visible.

While the preferred embodiments of the invention herein shown have been described in considerable detail, it is to be understood that the in-

vention is not limited to the particular constructions shown which may be varied within the scope of this invention. It is our intention to cover hereby all adaptations, modifications, and variations of the aforesaid constructions which come within the practice of those skilled in the art to which the invention relates, and we particularly point out and claim as our invention the following:

1. A drafting machine having a parallel motion mechanism including a pair of wheels at least one of which has an axially extending annular flange, an endless band extending about the same, and a pivoted strut between the wheels for holding them in spaced relation with the band under tension, said strut comprising a reenforced end member or yoke adjacent one of said wheels and having an arcuate groove therein adapted to receive the annular flange of the wheel and a reenforcing portion opposite said groove.

2. A drafting machine having a parallel motion mechanism including a pair of wheels, a band extending about the same, and a strut between the wheels for holding them in spaced relation with the band under tension, the strut of one section being composed of end members and band encasing side members, said end members having arcuately shaped channels on one side for the reception of the wheels, and reenforcing means directly opposite said channels.

3. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, an internally notched member connected to the wheel at the protractor end of the parallel motion mechanism and located above the same, a ruler assembly including an angle indicating member located above the internally notched member and rotatably supported coaxially with the last mentioned wheel, and a spring pressed pawl pivotally connected to the upper side of the last mentioned member and adapted to engage in the notches in the internally notched member.

4. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, a band extending about the wheels, and a strut between the wheels for holding them in spaced relation with the band under tension; a plate rotatably supported by the wheel at the protractor end of the parallel motion mechanism and adjustable within a limit of 180 degrees or more, a pair of clamps for clamping said plate to said wheel, said clamps being diametrically opposite each other, a second plate rotatably supported coaxially with said wheel, and means for clamping the plate to said first named plate, one of said plates having a dead line and the other plate having a co-operating protractor scale.

5. A drafting machine having a parallel motion mechanism composed of two pivoted sections, a protractor assembly including an internally notched plate supported by the parallel motion mechanism, a second plate rotatably supported coaxially with the internally notched plate, and a clamp carried by the second plate for clamping the same to the internally notched plate, said clamp having a slot therein adapted to receive the inside edge of the internally notched plate, the radius of said slot being less than the internal radius of the notched plate.

6. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, and struts between the wheels for holding them in spaced relation with the bands under tension, an internally notched plate rotatably supported by the wheel at the protractor end of the parallel motion mechanism, a pair of clamps for clamping said plate to said wheel, a protractor plate rotatably supported coaxially with the wheel at the protractor end of the parallel motion mechanism, and a clamp carried by said protractor plate for clamping the same to the internally notched plate, said clamp having a slot therein adapted to receive the inside edge of the internally notched plate, the radius of said slot being less than the internal radius of the notched plate.

7. A counterpoise for a parallel motion mechanism of a drafting machine, said counterpoise comprising a spring one end of which is adapted to be operatively connected to the parallel motion mechanism, a member attached to the other end of the spring, and means for moving said member relative to the board to which the machine is attached, said last mentioned means comprising a crank rotatable in a plane substantially parallel with the working surface of the drawing board.

8. A counterpoise for a parallel motion mechanism of a drafting machine, said counterpoise comprising a spring one end of which is adapted to be operatively connected to the parallel motion mechanism, a member attached to the other end of the spring, and means for moving said member relative to the board to which the drafting machine is attached, the last mentioned means comprising a gear having threaded engagement with said member and a crank rotatable in a plane substantially parallel with the working surface of the board for rotating the gear.

9. A counterpoise for a parallel motion arm of a drafting machine composed of two pivoted sections, said counterpoise comprising two springs, means for connecting one end of one of the springs to one of the sections, means for connecting the other of said springs to the other of the sections, a lever, means for connecting the other ends of the springs to opposite ends of said lever, and means for moving said lever to adjust the tension of the springs.

10. A counterpoise for a parallel motion arm for a drafting machine composed of two pivoted sections, said counterpoise comprising two springs, means for connecting one end of one of the springs to one of said sections, means for connecting one end of the other of the springs to the other section, a member adapted to be detachably connected to a drafting board or the like, a threaded rod carried by said member, a lever pivotally connected to said rod, means for connecting the opposite ends of the springs to opposite ends of said lever, a gear having threaded engagement with said rod, a second gear in mesh with said gear, and a crank rotatable in a plane substantially parallel with the working surface of the board for rotating said second gear.

11. A drafting machine having a parallel motion mechanism composed of two pivoted sections, an anchor to which the parallel motion mechanism is attached, and a counterpoise for said parallel motion mechanism, said counterpoise comprising a spring located underneath the anchor and operatively connected with the lower side of one of said sections for counterbalancing the same.

12. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the same, and struts between the wheels for holding them in spaced relation with the bands under tension, an offset anchor to which the parallel motion mechanism is attached, and a counterpoise for the parallel motion mechanism, the counterpoise including a spring and the anchor forming a cover for the counterpoise spring.

13. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, a pulley rotatably supported adjacent the anchor end of the parallel motion mechanism, and a counterpoise for both of the sections, said counterpoise comprising a spring connected to the lower section by a flexible cable encircling said pulley at the anchor end of the parallel motion mechanism.

14. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, a pulley rotatably supported adjacent the anchor end of the parallel motion mechanism, a second pulley fixed to the upper side of the strut of the lower section, and a counterpoise for both of the sections, said counterpoise comprising a spring connected to the pulley fixed to the lower section by a flexible cable encircling the pulley at the anchor end of the parallel motion mechanism.

15. A drafting machine for a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, a counterpoise for both of the sections, an anchor to which the parallel motion mechanism is connected, said counterpoise comprising a pulley or wheel rotatably supported by the anchor, a spring connected to the pulley or wheel rotatably supported by the anchor to one side of the axis of rotation thereof, a second wheel fixed to the upper side of the strut of the lower section, a third pulley or wheel rotatably supported adjacent the anchor end of the parallel motion mechanism, and a cable connected to the first two mentioned pulleys or wheels and extending about the third mentioned pulley or wheel at the upper end of the parallel motion mechanism.

16. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, an offset anchor to which the parallel motion mechanism is connected, a pulley or wheel rotatably connected to the under side of the anchor, a counterpoise for both of the sections, the counterpoise including a spring connected to the strut of the upper section at a point located to one side of the pivot therefor, a second spring connected to the pulley or wheel carried by the anchor, a pulley or wheel of uniform diameter rotatably supported by a plurality of rollers adjacent the upper end of the parallel motion mechanism, and a flexible cable encircling the last mentioned wheel, one end of the cable being connected to the pulley or wheel carried by the anchor, the other end of the cable being connected to the lower section of the parallel motion mechanism.

17. A drafting machine having a parallel motion mechanism composed of two pivoted sections each including a pair of wheels, bands extending about the wheels, struts between the wheels for holding them in spaced relation with the bands under tension, an offset anchor to which the parallel motion mechanism is connected, a pulley or wheel rotatably supported underneath the anchor, a pin projecting to one side of said pulley or wheel coaxial therewith, a counterpoise for both of the sections, the counterpoise including a spring connected to the strut of the upper section at a point located to one side of the pivot therefor, a second spring connected to the pulley or wheel underneath the anchor, a wheel of uniform diameter rotatably supported by a plurality of rollers adjacent the upper end of the parallel motion mechanism, a flexible cable encircling the last mentioned wheel, one end of the cable being connected to the wheel underneath the anchor, the other end of the cable being connected to the lower section of the parallel motion mechanism, the connection between the second spring and the pulley or wheel underneath the anchor comprising a lever having a cutout portion adapted to engage said pin so as to prevent the lever from being carried past dead center, and means for adjusting the connection of the lever with the pulley or wheel.

18. In a protractor assembly for a drafting machine the combination of a ruler having a tapered slot in the under side thereof opening into one end, and a ruler supporting arm or member having a tapered end projecting into and engaging the sides of the slot in the ruler and lying wholly within the confines of the ruler.

19. In a drafting machine of the wheel and band type the combination of: a pair of wheels; a flexible band encircling said wheels and engaging the same for maintaining them in definite angular relationship with respect to each other; and a strut for maintaining said wheels in spaced relation, said strut comprising end members or yokes encasing the wheels and tubular side members encasing the band and extending between said end members for maintaining the same in spaced relation, one of said end members having means affording access to the band therein, said end members and the ends of said tubular side members being in telescopic relationship and having abutting portions.

20. In a drafting machine of the wheel and band type the combination of: a pair of wheels, a flexible band encircling said wheels and engaging the same for maintaining them in definite angular relationship with respect to each other; and a strut for maintaining said wheels in spaced relation, said strut comprising end members or yokes encasing the wheels and having portions extending around the band engaging portions of the wheels and spaced closely thereto, and tubular side members encasing the portions of the band between the wheels and extending between the end members so as to maintain them in spaced relation, one of the end members having means affording access to the band permitting its application or removal, said end members and the ends of the tubular side members being in telescopic relationship and having abutting portions.

21. In a drafting machine of the wheel and band type the combination of: a pair of wheels;

a flexible band encircling said wheels and engaging the same for maintaining them in definite angular relationship with respect to each other; and a strut for maintaining said wheels in spaced relation, said strut comprising end members or yokes encasing the wheels and tubular side members encasing the band and extending between said end members for maintaining the same in spaced relation, one of said end members having means including a movable cover affording access to the band therein, said end members and the ends of said tubular side members being in telescopic relationship and having abutting portions.

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