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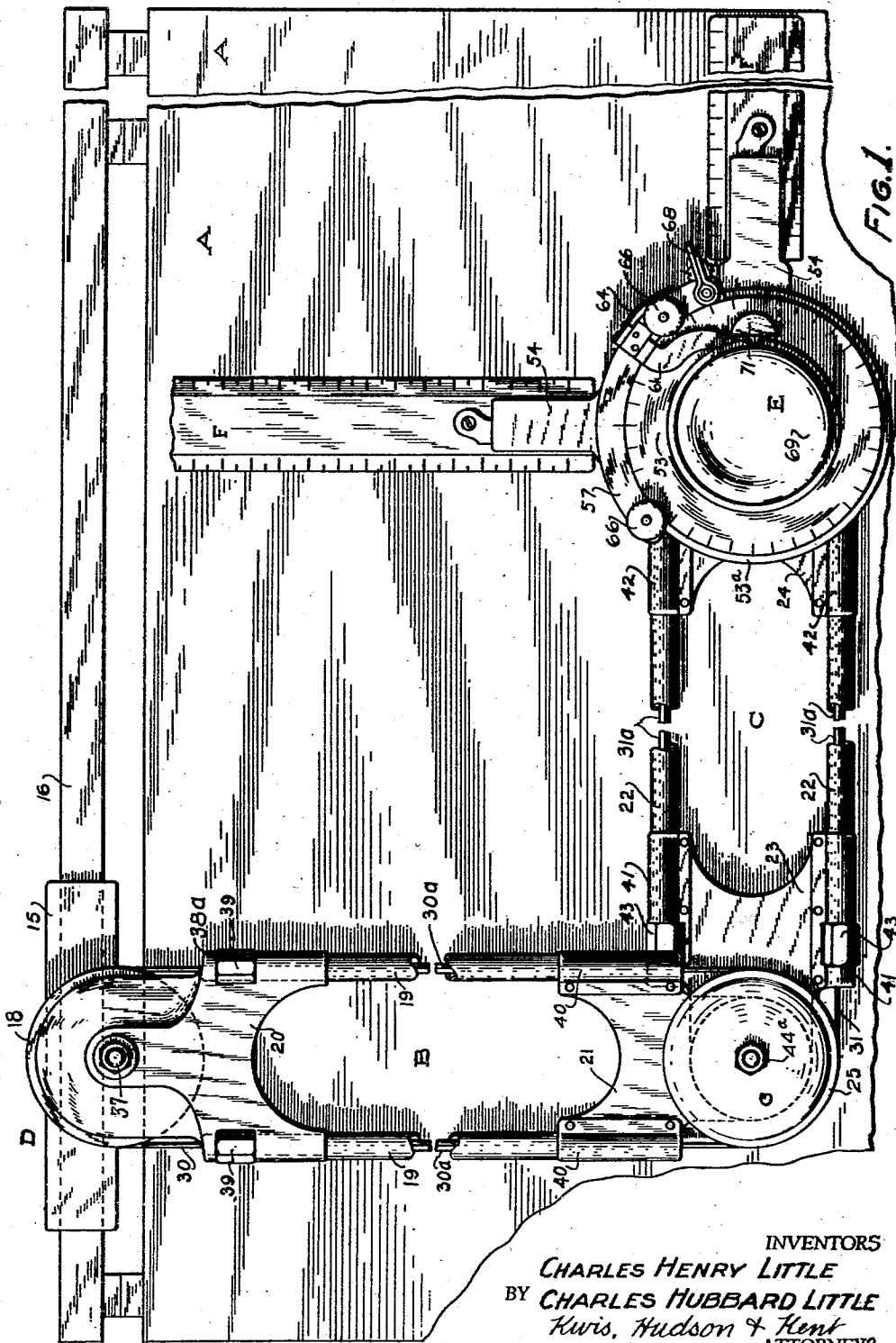
C. H. LITTLE ET AL

2,168,940

DRAFTING MACHINE

Filed Sept. 21, 1936

6 Sheets-Sheet 1



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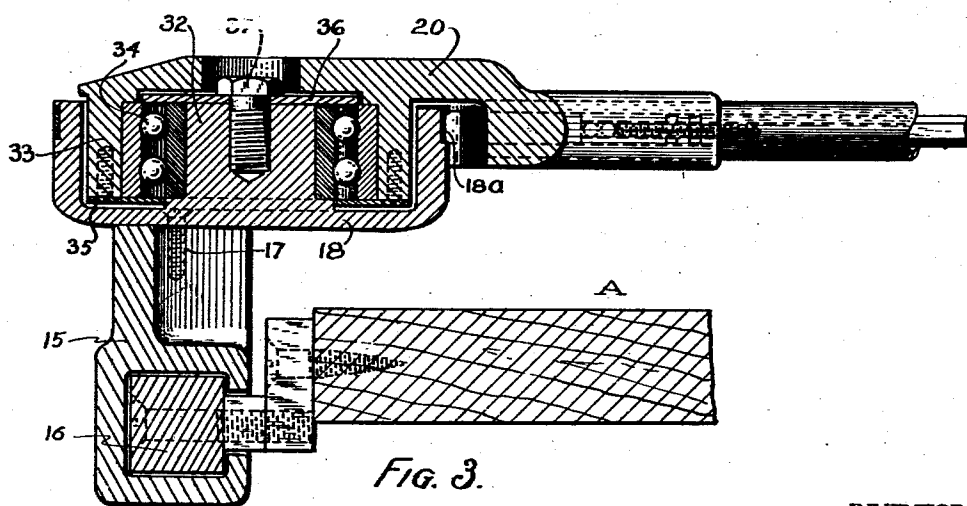
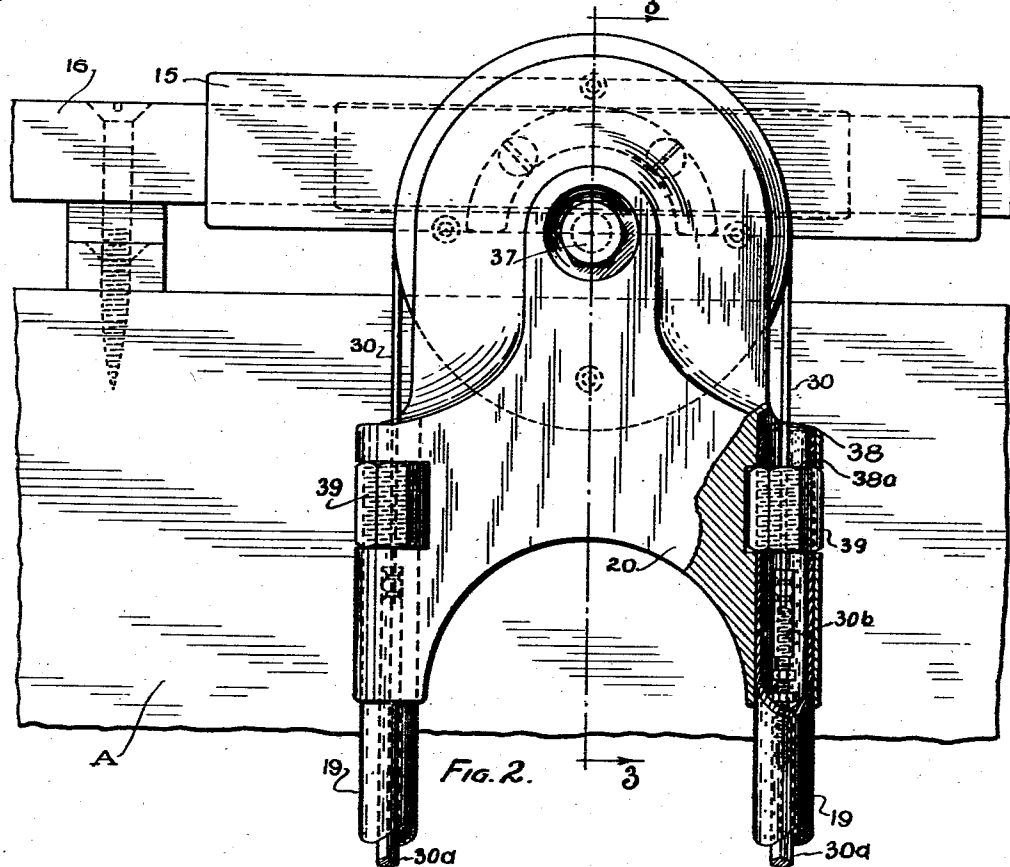
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DRAFTING MACHINE

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6 Sheets-Sheet 2



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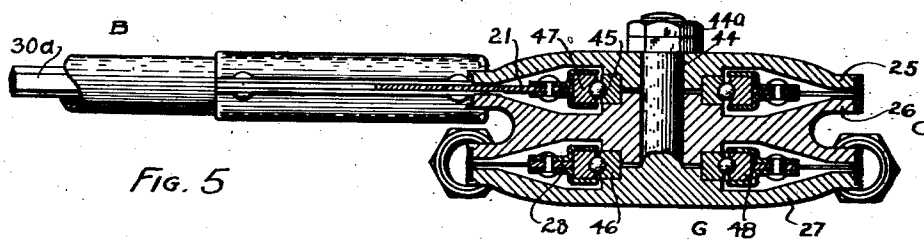
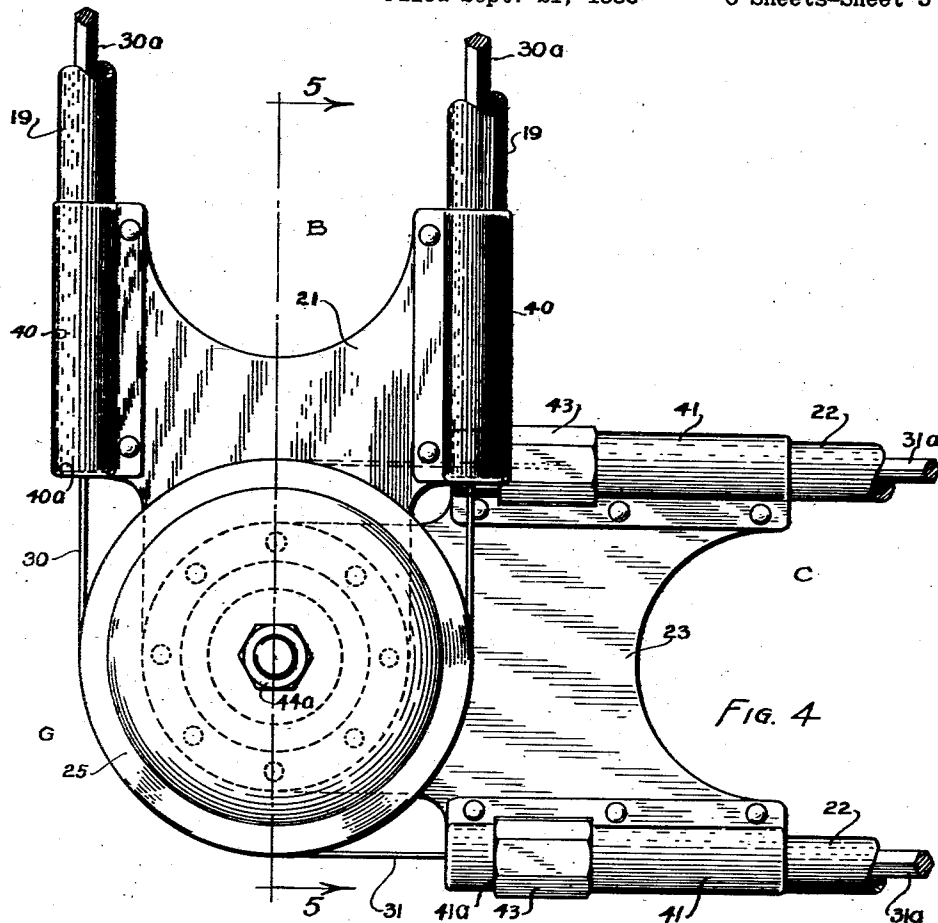
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6 Sheets-Sheet 3



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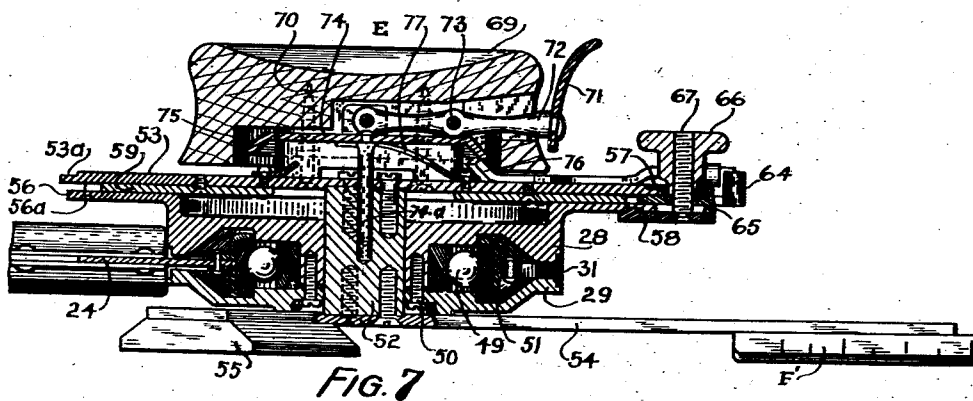
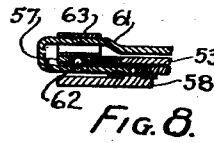
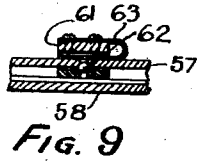
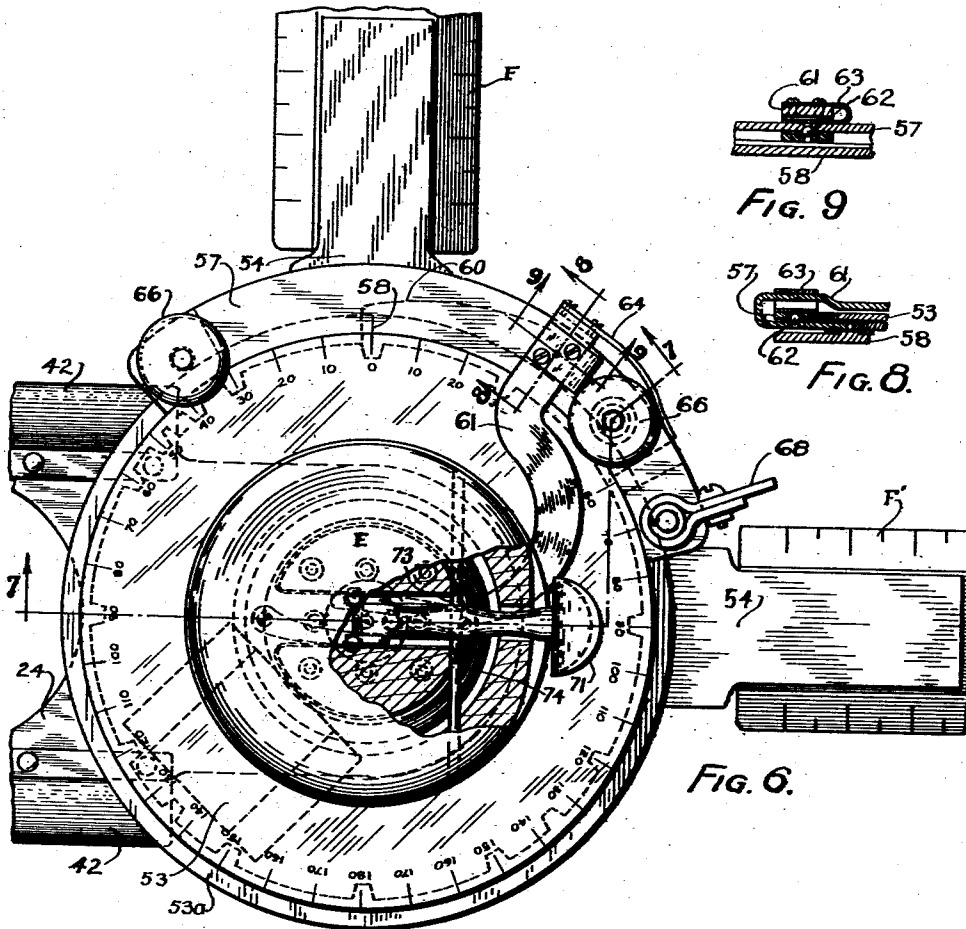
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6 Sheets-Sheet 4



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DRAFTING MACHINE

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6 Sheets-Sheet 5

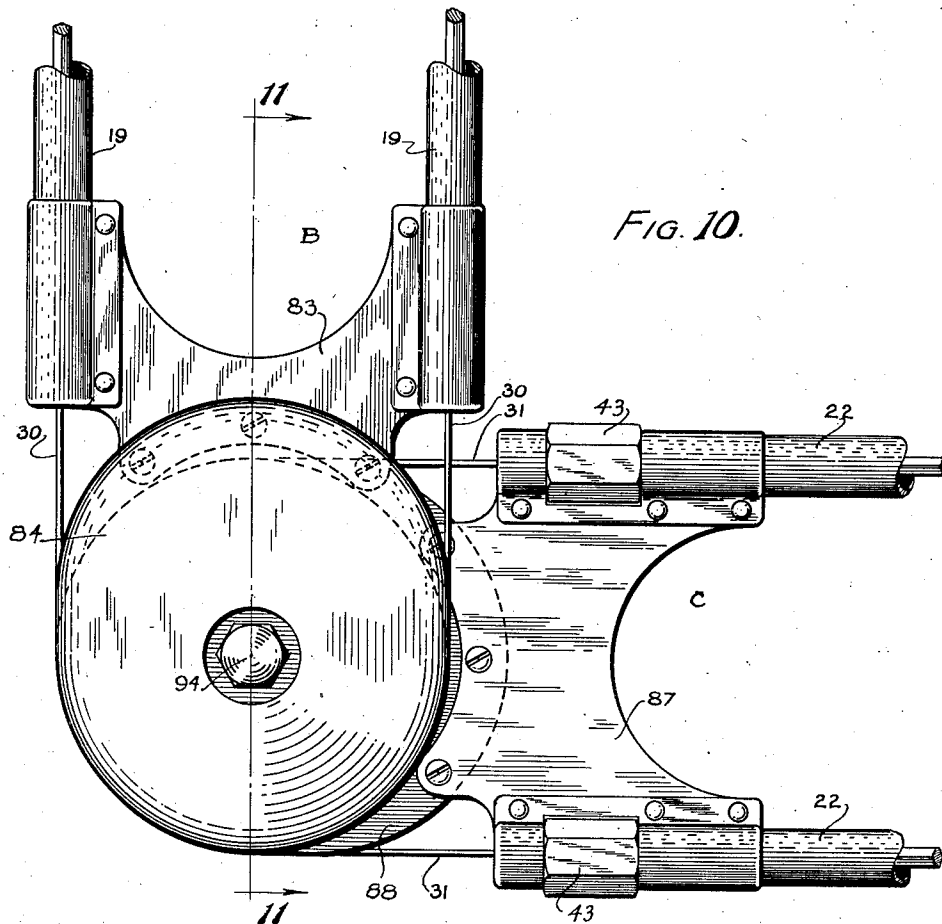


Fig. 10.

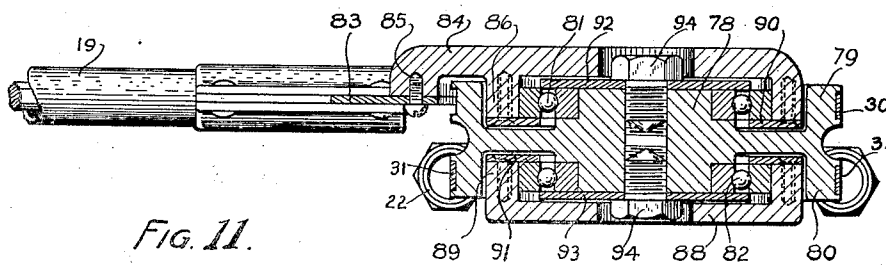


Fig. 11.

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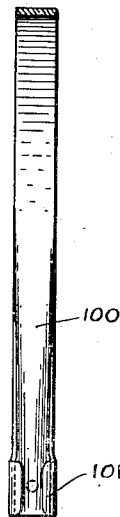
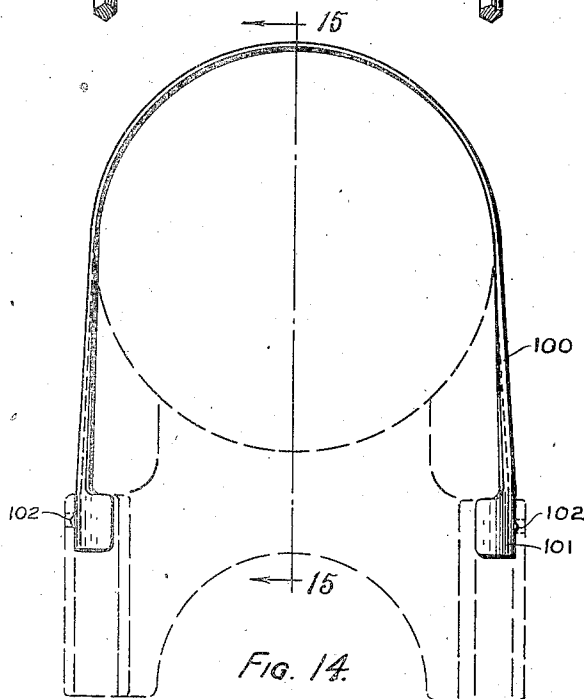
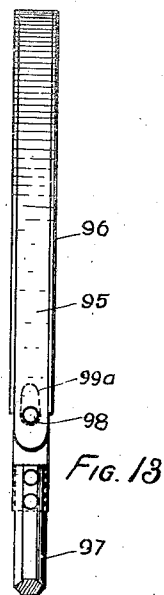
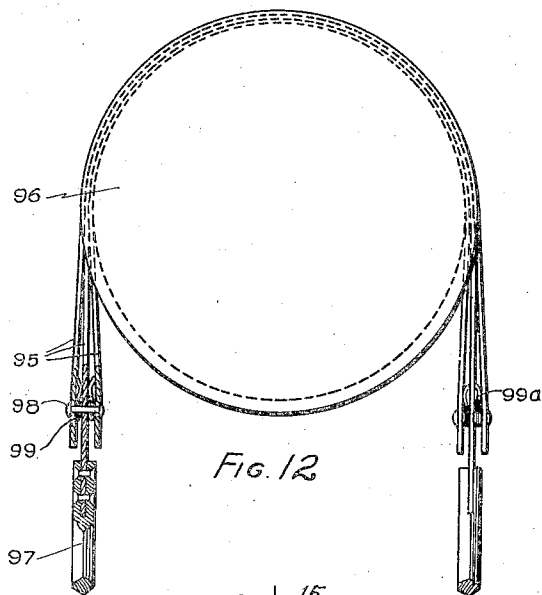
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DRAFTING MACHINE

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6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,168,940

DRAFTING MACHINE

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

Application September 21, 1936, Serial No. 101,738

23 Claims. (Cl. 33—79)

This invention relates to drafting machines wherein the parallel motion mechanism is in the form of an arm composed of two pivoted or hinged parallelograms of the wheel and band type.

In machines of this type, each section of the jointed arm includes two wheels of equal diameter about which is a severely tensed band, the wheels being supported in spaced relation by a strut or strut frame.

An object of the present invention is to provide a drafting machine of the general type referred to above wherein the wheels of the two parallelograms are connected by struts or strut frames which cover the bands and which at the same time embody the desirable features of lightness in weight, lateral stiffness, and compensating flexibility.

A further object is to provide a convenient means for adjusting the center to center relationship of the wheels of the parallelograms and therefore the tautness of the bands.

A further object is to provide a novel construction of the wheels, or at least part of the wheels about which the bands pass and a novel and improved manner of connecting the struts to the bearings, the particular object in this respect being to provide two-part wheels and to connect the struts centrally of the wheels so as to centralize the stresses which are transmitted to the bearings, thereby providing for easy movement of the parallel motion members relative to each other and relative to the anchor.

A further object is to provide a construction wherein the struts include parallel tubes through which the bands extend and which at the same time admit of the ready application of the bands to the struts and wheels.

A still further object is to provide certain improvements in the construction of the protractor and of the machine which facilitate the angular adjustment of the rulers.

The invention may be briefly summarized as consisting in certain novel combinations and arrangements of parts and details of construction which will be described in the specification and set forth in the appended claims.

In the accompanying sheets of drawings wherein we have shown the preferred embodiment of the invention and certain modifications;

Fig. 1 is a top plan view of the machine applied to a drafting board a portion of which is shown;

Fig. 2 is an enlarged plan view of the anchor end of the machine with portions broken away;

Fig. 3 is a sectional view substantially along the line 3—3 of Fig. 2;

Fig. 4 is an enlarged plan view of the elbow portion of the machine or of that portion adjacent the pivotal connection between the two parallelograms or sections of the jointed arm;

Fig. 5 is a sectional view substantially along the line 5—5 of Fig. 4;

Fig. 6 is an enlarged plan view of the protractor end of the machine;

Fig. 7 is a sectional view substantially along the irregular line 7—7 of Fig. 6;

Figs. 8 and 9 are detail sectional views substantially along the lines 8—8 and 9—9 of Fig. 6;

Figs. 10 and 11 are, respectively, a plan view and a sectional view similar to Figs. 4 and 5 showing the modification in the construction of the end plates of the struts and the manner of connecting them by anti-friction bearings to the band wheels;

Figs. 12 and 13 are, respectively, a plan view and a side view of a modification in the band which may be utilized in either or both sections of the jointed arm; and

Figs. 14, 15, and 16 are, respectively, a plan view, a side view, and a partial end view of a guard which may be attached to an end of either section of the jointed arm to protect the user against injury should the band break at a point where it is exposed or not enclosed in the arrangement shown in the preceding figures.

Referring now to the drawings, the drafting machine is shown in Fig. 1 applied to a drafting board A. The parallel motion mechanism or jointed arm is composed of two parallelograms or sections B and C, the former being anchored to the board at D and the latter carrying at its free end protractor mechanism E provided with two rulers F and F' which, as usual, are at right angles to each other and which are given a parallel motion over the drafting board when the machine is in use. The two sections are hinged together at the elbow of the jointed arm, the same being designated G. With this brief description of the general make-up of the machine which in principle is common to all machines of this type, we will next describe the detailed construction of the various parts.

The particular type of anchor is not material to the present invention, but in this instance the anchor end B of the machine includes an anchor member 15 which is slidable along a rail 16 which is secured to and extends along the upper edge of the board A. At the top of the anchor member 15 and in this instance secured

thereto by screws 17 is a fixed upwardly facing cup 18 having an annular upstanding wall constituting a bearing receptacle and on its outer periphery being grooved at 18a to form the fixed band wheel at the anchor end of the machine.

The strut for the section B of the parallel motion mechanism includes two similar tubes 19, 19 through which the endless band for this section extends, and two end plates 20 and 21 which are differently formed and shaped, as will be pointed out presently.

The section C of the parallel motion mechanism includes two similar tubes 22 through which the band of this section extends and two end plates 23 and 24 which are generally the same in construction and substantially the same as the end plate 21 of the section B.

As previously mentioned, the grooved cup-shaped member 18 attached to the anchor member 15 constitutes the upper wheel for the section B of the jointed arm. The other three wheels are in the preferred form of the invention each two-part wheels. At the elbow G, two wheels are aligned or are concentric, the upper wheel at the elbow end of section B being formed by the two parts 25 and 26, and the lower wheel, which is at the elbow end of section B, being composed of the parts 26 and 27, the part 26 being common to the two wheels. At the protractor end of the machine the wheel for the outer end of section C is composed of the two parts 28 and 29. The purpose of having two-part wheels at the elbow and at the protractor end of the machine will be referred to presently.

The endless band for the section B and which extends about the fixed wheel 18 and the wheel 25, 26 is designated 30, and the endless band for the section C which extends about the two-part wheel 26, 27 at the elbow and the two-part wheel 28, 29 at the protractor end is designated 31.

Although the construction of the struts or strut frames of both sections B and C have the requisite stiffness against bending laterally or parallel with the surface of the board it is desirable that they have certain flexibility substantially at right angles to the board, as when the protractor end of the machine is elevated or possibly somewhat twisted, and in order to provide this flexibility which is desirable to the extent stated, the end plates 21, 23, and 24 are made relatively thin, i. e., are preferably either stampings or may be formed in some instances by the extrusion process. On the other hand, since the major portion of the weight of the machine is supported from the anchor end thereof, the end plate 20 is relatively stiff and heavy and is preferably in the form of a casting, the form and construction of this end plate being best illustrated in Figs. 2 and 3. By reference to these figures it will be seen that the end plate 20 is journaled to rotate about the axis of the cup-shaped wheel member 18 which is provided at the center with an upstanding annular boss 32. The end plate 20 has a downwardly extending cylindrical flange 33 which surrounds the central boss 32 and is journaled thereon through the medium of a double ball bearing 34. The assembly is completed by a lower plate 35 which is secured to the bottom of the flange 33 and an upper plate 36 which is secured to the top of the upstanding boss 32, these plates locking the parts together and serving to exclude dirt from the bearing. The parts can be disassembled by the removal of a cap screw 37 which holds the upper plate 36 in place, the head of this screw being accessible through an opening in the top

of the plate 20. The double ball bearing is provided at this joint so as to avoid play and to prevent sag due to the overhanging load which is transmitted to the wheel member 18 and anchor.

The end plate 20 projects from its pivotal connection with the wheel member 18 for a distance over the board and is somewhat fork-shaped, as will be seen by reference to Fig. 2, the sides of the fork being provided with elongated cylindrical openings 38 which receive the two tubes 19 in parallel relation. Near their inner ends the cylindrical openings 38 are notched out and in these notches are located adjusting nuts 39 which receive the inner threaded ends of the tubes 19 so that by adjusting the nuts with a suitable wrench the center to center relation of the two wheels of this parallelogram or section of the jointed arm may be varied.

At the elbow end of this parallelogram, the tubes 19 are fitted into sleeves 40 at the sides of the end plate 21. This end plate, as well as the end plates 23 and 24, is thinner than the end member 20 at the anchor end of the machine and provides flexibility as already pointed out. These end plates may be formed in different ways, as by stamping or by the extrusion process. In either case, the sleeves 40 and the corresponding sleeves of the end plates 23 and 24 may be formed integral with the plates or they may be separately formed from sheet metal and secured thereto by riveting or otherwise. It might be here stated that the plates and the tubes of the struts and other parts of the machine wherever permissible are made of light durable material such as duralumin.

When the nuts 39 are turned to tighten the band, which in effect lengthens the tubes 19 and increases the center to center distance between the two wheels of this parallelogram, the nuts 39 then bear against the shoulders 38a at the far side of the notches, i. e., toward the anchor, and the ends of the rods at the elbow end of the section then bear against suitable shoulders of the tubes 40 which shoulders may be formed by turning inwardly the ends of the sleeves 40, as shown at 40a in Fig. 4. During this adjustment of the nuts 39, the tubes 19 do not turn, and, if necessary to prevent their turning, their ends at the elbow part of the parallelogram may be secured in the tubes 40 of the end plate 21, as by riveting or otherwise.

In similar fashion the center to center distances between the wheels of the section C of the jointed arm may be adjusted. The end plate 23 has sleeves 41 on opposite sides thereof and the end plate 24 has sleeves 42 on opposite sides thereof which sleeves receive the end portions of the tubes 22. The sleeves 41 are notched out to receive adjusting nuts 43 which are in threaded relation with the ends of the tubes 22 toward the elbow of the machine. By adjusting these nuts 43, the center to center distance of the wheels of section C can be increased to tighten the band 31 or decreased to loosen it. The protractor ends of the tubes 22 are then in abutting relation with the sleeves 42 and the nuts during the tightening operation bear against shoulders 41a at the elbow ends of the sleeves 41, and the tubes 22 may be held from turning while the nuts 43 are being adjusted in precisely the same manner as with section B of the machine.

It will be understood, of course, that when the nuts 39 are being adjusted the tubes 19 will slide in the tubular openings 38 of the end plate 20, the

and when the nuts 43 are adjusted, the tubes 22 will slide in the sleeves 41.

Considering next the manner in which the end plates 21, 23, and 24 of the struts of the sections B and C are rotatably connected to their respective band wheels, it will be noted that at the elbow G, see particularly Figs. 4 and 5, the three wheel members 25, 26, and 27 are held in concentric relationship by a bolt and nut construction consisting in this instance of an integral central stud 44 projecting upwardly from the lower wheel member 27 centrally through the wheel members 25 and 26 and nuts 44a at the upper end of the stud. When the nuts are tightened there is clamped between the wheel members 25 and 26 the inner race of a ball bearing unit 45, and at the same time there is clamped between the wheel members 26 and 27 the inner race of a ball bearing unit 46, the inner races of these bearings spacing apart the wheel members 25 and 26 and the wheel members 26 and 27. The end plate 21 has a portion at the elbow which extends around the ball bearing unit 45 and is concentric therewith, and this portion has a race housing 47 which receives the outer race of the ball bearing unit 45. Similarly, the end plate 23 of section C of the machine has at the elbow a portion which surrounds and is concentric with the bearing unit 46, and it is provided with a race housing 48 which receives the outer race of the ball bearing unit 46. In a similar fashion, the end plate 24 at the protractor end of the machine is connected to the wheel members 28 and 29, these two wheel members being provided between them with a ball bearing 49 (see Fig. 7) the inner race of which is clamped between the wheel members by screws 50 which secure them in fixed concentric relation, and the end plate 24 is provided with an annular portion which surrounds this ball bearing unit and has a race housing 51 which receives the outer race of the ball bearing unit 49. The remainder of the construction of the protractor end of the machine will be described presently.

The purpose of the two-part wheels at the elbow B and at the protractor will now be briefly referred to. The two pairs of wheels about which the bands pass are of course of the same diameter and the two parts composing each of the two wheels at the elbow and the two parts composing the wheel at the protractor are concentric and each pair of the three sets of wheel parts has band grooves which are of the same diameter and are concentric, one-half of each band groove being formed in one wheel part and the other half in the other wheel part. The grooved peripheral portions of these wheel halves are spaced apart a distance slightly greater than the thickness of the end plates 21, 23, and 24 which plates extend into the spaces between these wheel members and are attached to the race housings 47, 48, and 51 respectively at the center planes of the three ball bearing units 45, 46, and 49. Thus the stresses incident to the heavy tension imposed in the bands are transmitted to the bearings in a manner such that they are centralized with respect to the bearings, thus providing for ease of movement between the relatively movable parts of the machine while at the same time admitting of a certain amount of free flexibility due to the flexible end plates 21, 23, and 24 if the protractor end of the machine is lifted from the board and possibly twisted as it is from time to time when being used. Although the centralization of the stresses with respect to the bearings

is highly desirable, we do not regard it essential to the invention, and later on we will describe a modified construction wherein the use of split pulleys and the connection of the struts to the bearings in line therewith are avoided without sacrificing materially at least the feature of flexibility.

Considering next the endless bands heretofore referred to and designated 30 and 31 for the sections B and C respectively, each band may be a continuous endless steel ribbon flexible throughout, but in view of the fact that the tension to which the band is subjected is quite great, there is a tendency for the band to stretch, and, accordingly, we prefer that only those portions of the band which engage the band wheels be in the form of a flexible steel ribbon and the remaining portions, particularly the portions which extend through the major portion of the length of the tubes 19 and 22 be substantially inflexible and of much heavier cross-section so as to undergo practically no stretching under the tensile load. Thus in Figs. 1, 2, and 3 the band 30 has its loop portions in the vicinity of the wheels formed of steel ribbon and the intermediate portions in the tubes formed of rods 30a which, in this instance, are hexagonal in cross-section, although, of course, that is not important. In like manner the band for the section C, designated 31, has portions which extend through the tubes and which are composed of rods 31a, the same being shown in Figs. 1 and 4. In each instance the ends of the ribbon may be attached to the rods by riveting them thereto, as shown by dotted lines in Fig. 2.

With the construction illustrated it is necessary that there be a joint in each band to enable it to be threaded through the tubes and applied around the wheels, and this can be conveniently done by forming a coupling in one of the rods near its end, as shown at 30b at the righthand side of Fig. 2, whereby the free ends can be joined together by a connection in the form of a turnbuckle composed of an adjustable or rotatable member turnable by means of a wrench and provided with right and lefthand threaded portions engaging in right and lefthand threaded sockets in the corresponding portions of the rod to be joined. This not only enables the ends to be readily attached but provides also a certain amount of adjustment or take-up in the length of the band. Generally, however, the coupling 30b is not utilized to adjust the tension of the band as the adjusting of either band can be taken care of by means of the adjusting nuts 39 or 43.

With this arrangement it is a simple matter to apply a band to the machine since the coupling can be exposed at a point between the tube and the adjacent wheel, as will be obvious by an inspection of Fig. 2. However, we do not regard it essential that a construction be employed which requires the use of a detachable coupling. To explain, the bands or the major portions thereof are enclosed in the tubes for several different reasons, chief of which is the fact that the enclosures protect the user from being cut or otherwise endangered should a band break. However, this advantage can be obtained without having the bands wholly enclosed. The bands may be enclosed in tubes or equivalent enclosing members open on the lower side. We regard it within the scope of the present invention to utilize longitudinally slit tubes for enclosing the parallel portions of the bands, longitudinally slit sleeves which receive the ends of the tubes

on the four end plates of the struts, and longitudinally slit adjusting nuts, the slits in all of which being made wide enough to accommodate the band including the rods 30a and 31a if they are employed, and, when aligned, will admit of the quick application of an endless band with its ends permanently joined and thus do away with the detachable coupling.

Referring now to the protractor end of the machine, the two wheel members 28 and 29 for the endless band 31 of section C of the jointed arm are mounted upon a central hub member 52 to the top of which is secured a protractor plate 53 and to the lower end of which is secured a ruler supporting arm 54 to which are detachably secured the rulers heretofore referred to and designated F and F'. The ruler supporting arm has an extension to which is secured a pad or bottom rest 55 which, together with the rulers, supports the protractor end of the machine on the drafting board.

The protractor mechanism is in many respects similar to that disclosed in the Charles H. Little application Serial No. 64,139 filed February 15, 1936, but embodies certain improvements there-over to be referred to presently.

The wheel member 28 has an annular flange 56 at the top constituting the holding plate for the protractor, this plate having on its under side an annular groove 56a while the protractor plate 53 has around its periphery a groove 53a, the groove 56a and the groove 53a accommodating two segments one above the other, the upper segment being designated 57 and the lower segment being designated 58. As in the prior application, the protractor plate is graduated throughout its periphery and the zero line which is designated 58 is carried by the upper segment 57, the two segments being similar in purpose and arrangement with respect to the protractor 53 and the holding plate 56 as in the prior Little application.

Secured to the lower side of the protractor plate 53 is a plate 59 notched at its periphery to receive the end of a pawl 60, the notches being arranged at the most used angles, to wit, 0°, 30°, 45°, 60° and 90°. The pawl 60, which is adapted to have a pivotal swinging movement between the lower holding plate 56 and the protractor plate 53, is attached to or in this instance formed integral with a releasing lever 61 which is pivoted by means of a ball pivot 62 to the upper segment plate 57, as shown in Fig. 8, a spring 63 attached to the lever and bearing against the upper segment plate as shown in Fig. 9 serving to hold the parts in their proper relation. The pawl is held in its normal position with its operative end in one of the notches by a spring 64 which is secured to the lever and engages the segments, as shown in Fig. 6, and the end of the pawl is withdrawn from one of the notches by manipulation of the lever 61 in the manner to be explained presently.

The segments are clamped in position to the holding plate 56 by a pair of clamps 65 one of which is shown in Fig. 7 and each adapted to be tightened and released by a knurled nut 66 on a threaded stud 67 projecting upwardly from the lower segment 58. When the nuts are loosened, the segments may be moved circumferentially in either direction to vary the position of the zero line 58 with reference to the protractor. By means of a clamp indicated at 68, the protractor may be clamped in any position intermediate those to which it may be positioned by

the pawl 60, but as the details of this clamp form no part of the present invention, it requires no further consideration.

The protractor and the rulers are adapted to be turned to any desired position when the pawl 60 is withdrawn from the notched plate 59 by the operator turning the handle 69 which is attached by screws 70 shown by dotted lines in Figs. 6 and 7 to the protractor plate. In the Little application referred to above, the lever 61 extends over the protractor plate adjacent the handle, but, with the arrangement therein illustrated, it is difficult for the operator with one hand to release the pawl and also turn the handle since the handle and the lever are mounted on different parts. In the present application, the part which releases the pawl is carried by the handle. This part consists of a thumb or finger piece 71 carried on a lever 72 which is pivoted at 73 in a recess of the handle, the pivot being intermediate the ends of the lever, as shown in Fig. 7. At its inner end this lever has a pin and slot connection with the center of a disk 74 guided by a pin 74a to move vertically in an annular cavity of the handle, and provided at its periphery with an inclined camming portion 75. The under inclined surface of this camming portion 75 is adapted to be engaged by a similarly inclined inner end 76 of the pawl operating lever 61 which lever extends inwardly over the protractor and into the cavity which receives the disk 74 through an annular slot or space between the protractor plate 53 and the outer portion of the handle. The arrangement is such that the operator who wishes to adjust the positions of the rulers and the protractor will grasp the handle and pull in the thumb piece 71, and this will depress the disk 74 and, by the camming action of the latter, the lever 61 is rocked so as to disengage the pawl from the notched plate 59. He can then with the same hand turn the handle through any desired arc up to complete revolution. When the handle has been turned so as to position the protractor and the rulers as desired, the operator releases the thumb piece, whereupon the pivoted lever 72 which carries the thumb piece is returned to its original position by one or more suitable springs, in this instance a pair of leaf springs 77, which are carried by the protractor plate within the cavity of the handle so as to engage the under side of the disk 74. Of course, on the release of the thumb piece 71 the spring 64 will urge the end of the pawl toward the periphery of the notched plate 59.

It was heretofore stated that it is not essential that there be employed at the elbow and at the protractor end of the machine two-part pulleys and that the struts be extended inwardly between the pulley parts and connected by anti-friction bearings to the wheels centrally of the bearings. A construction modified in the respects just stated is shown in Figs. 10 and 11. With the construction here illustrated, there is one wheel member 78 at the elbow, this wheel member being provided at its periphery with two band wheel portions 79 and 80 which are of course concentric and of the same diameter and are provided with grooves to receive the bands 30 and 31 of the sections B and C respectively. The hub of the wheel member 78 is grooved to receive the inner races of two ball bearing units 81 and 82 one above the other and in line respectively with the strut of section B and the strut of section C. The elbow end of the strut of section B is composed of a relatively thin and relatively flexible

plate 83 formed as before and to which the tubes of the strut are connected, as previously described. The elbow end of the strut of section B is completed by a relatively heavy cast or forged piece 84 which is attached to the relatively thin and relatively flexible piece 83 by screws 85 and extends from the piece 83 laterally over the wheel member 78. It is provided with a downturned annular flange 86 which receives the outer race of the upper ball bearing unit 81. Similarly, the elbow end of the strut of section C is composed of a relatively thin and relatively flexible plate 87 to which is attached a relatively heavy cast or forged piece 88 which extends downwardly from the piece 87 and under the wheel member 78 and is provided with an upturned annular flange 89 which receives the outer race of the lower ball bearing unit 82. The assembly is completed by annular disks 90 and 91 which are secured to the inner ends of the flanges 86 and 89 and overlap the outer races of the two ball bearing units and by disks 92 and 93 which are secured by centrally disposed screws 94 to the opposite ends of the wheel member 78 and overlap the bearing units so as to hold the parts in assembled relation and exclude dirt from the bearings. Access can be had to the heads of the screws 94 to tighten or loosen them, as may be desired, through openings in the cast or forged members 84 and 88. Thus both struts are connected by the anti-friction bearings to the wheel member having one-part band wheels for the two struts, the struts being carried over the ends of the elbow in offset relation to the relatively flexible parts connected with the tubes of the struts so that the desired flexibility is nevertheless obtained.

If the stretching of the ribbon portions of the bands is of a serious nature, it can be reduced to a minimum and made almost negligible by using a laminated ribbon composed of several superposed sections. Although any number of sections may be superposed, we have shown in Fig. 12, by way of example, a flexible ribbon composed of three superposed sections designated 95. These sections contact with each other where they engage the band wheel 96 but as they leave the wheel they are preferably separated, as illustrated in Fig. 12. The middle band only is connected by rivets or otherwise to the relatively inflexible rods 97 which are designed to extend through the strut tubes as before and adjacent the ends of the rods the bands are connected together in this instance by a rivet 98 where the bands are spaced apart by washers 99. With this manner of connecting the ends of the bands, the rivets will act as compensators to permit the slight sliding movement that may occur between the sections or laminae as the band wraps onto or unwraps from the band wheel due to the slight difference in the radii of the substantially semi-circular portions of the bands which are in contacting relation and extend substantially around one-half the circumference of the band wheel. It will be understood, of course, that this same construction may be employed at the four band wheels at the two ends of both sections of the jointed arm. We might add that the load on the strands 95 will normally be uniform from one rivet 98 around the wheel to the other rivet. However, if the tension imposed on the strands should be unequal for any reason, as, for example, because of a slight inaccuracy in the location of the holes which are punched in the end portions of the strands to receive the rivets, this can be compensated for by suitable equalizers,

such as springs 99a which in this instance have eyes fitted onto the rivets and have bowed portions which lie between and bear against adjacent strands so as to tend to spread them and remove any slack that may exist.

With the construction illustrated and so far described, the liability of injury from breakage of a band is greatly reduced by enclosing the major portions of the bands between the band wheels, as illustrated, only the portions which embrace the band wheels and the short straight portions extending therefrom being exposed. If the danger of injury by reason of breakage of the exposed portions be of any consequence, the same may be eliminated by placing guards around the exposed portions. In Figs. 14 and 15 we have shown a guard at 100, the guard here shown being substantially U-shaped with a semi-circular portion adapted to extend about the corresponding portion of the band wheel and substantially straight portions extending to the tubular portions of the struts into which the straight portions of the band extend. In this instance the guard is provided with enlarged ends 101 which are adapted to be fitted into the tubular portions of the strut which is shown in dotted lines in Fig. 14. They can be readily slipped into place and as readily removed, and in this case the enlarged ends are provided with projections 102 which are adapted to snap into openings provided in the strut tubes to hold the guard in place. It will be understood that the guard will partially envelop and lie close to the portion of the band which extends from the end of one tube of a strut around the band wheel to the end of the opposite tube. These guards are not deemed necessary but may be provided if desired and are readily applied or removed.

Thus we have provided a drafting machine which can be produced inexpensively and which is accurate, easily moved about the board with great freedom of movement, has the desired flexibility, and can be operated with utmost safety to the draftsman. While we have shown the preferred embodiment and certain modifications, we do not desire to be confined to the precise details shown but aim in our claims to cover all modifications which do not involve a departure from the spirit and scope of the invention.

Having thus described our invention, we claim:

1. A drafting machine having a parallel motion mechanism in the form of two pivoted sections of the band and wheel type, each section comprising a strut with wheels at opposite ends thereof, and a band extending about the wheels, the end of one strut of the machine being relatively stiff and the other end of the strut being relatively flexible to provide flexibility at right angles to the board on which the machine is used.

2. A drafting machine of the band and wheel type having parallel motion mechanism in two sections with an anchor end, a protractor end, and an elbow at which the two sections are pivoted, each section comprising a pair of wheels, a band extending about the same, and a strut between the wheels, the strut at the anchor end being relatively rigid and the strut ends at the elbow and at the protractor being made relatively flexible to provide stiffness in the plane of the struts and relative flexibility at right angles thereto.

3. A drafting machine having a parallel motion mechanism composed of two pivoted sections each 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 comprising an end member having hollow portions and band encasing side members extending into said hollow portions, said hollow portions and said side members being relatively rotatable and having cooperating thrust-resisting abutments.

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 same, and a strut between the wheels for holding them in spaced relation with the band under tension, the strut of one section comprising end members with hollow portions and band encasing side members extending into said hollow portions, the hollow portions of one end member having means for adjusting the center to center distance of the wheels.

5. A drafting machine having a parallel motion mechanism composed of two pivoted sections each 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 comprising end members with hollow portions and band encasing side members extending into said hollow portions, the hollow portions of one end member having adjustable nuts in threaded relation with the side members.

6. In a drafting machine, a parallel motion mechanism composed of pivoted sections each including a pair of wheels, a band extending about the same, and a strut extending between the wheels, the strut of one section comprising end members and band enclosing side members extending therebetween, one of the end members having hollow portions notched between their ends, and nuts received in the notches in threaded relation to the side members.

7. In a drafting machine, a parallel motion mechanism composed of pivoted sections each including a pair of wheels, a band extending about the same, a strut extending between the wheels, the strut comprising end members with band enclosing side members extending therebetween, one of the end members having hollow portions notched between their ends, and nuts received in the notches in threaded relation with the side members, the other end member having hollow portions in which the side members extend and are fixed.

8. A drafting machine having a parallel motion mechanism in the form of a jointed arm composed of two pivoted sections each having two wheels, a band extending about the same, and a strut for holding the wheels apart, the strut comprising a pair of end members with non-rotatable sleeve-like portions at opposite sides thereof, and band encasing tubes in parallel relation having their ends extending into said sleeve-like portions, said portions and said tubes being relatively rotatable and having cooperating thrust-resisting abutments.

9. A drafting machine having a parallel motion mechanism in the form of a jointed arm including two pivoted sections each having two wheels, a band extending about the same, and a strut for holding the wheels apart with the band under tension, the strut comprising a pair of end members with sleeve portions at opposite sides thereof, band enclosing tubes in parallel relation having their ends extending into the sleeve portions of the end members, two of the sleeve portions on opposite sides of the strut being notched, nuts located in the notches and

engaging threaded ends of the tubes whereby the effective length of the tubes may be varied by adjusting the nuts, the nuts bearing against shoulders formed by the notches when the nuts are turned to lengthen the tubes and thereby increase the tension of the band.

10. A drafting machine having a parallel motion mechanism in the form of a jointed arm composed of pivoted sections each including a pair of wheels, an endless band extending about the same, and thrust resisting means between the wheels, at least one of said wheels being composed of two annular portions with the said thrust resisting means extending between said portions.

11. A drafting machine having a parallel motion mechanism in the form of a jointed arm comprising pivoted sections of the wheel and band type, one of the sections having a pair of wheels, a band extending about the same, a strut for holding the wheels apart with the band under tension, an anti-friction bearing between one of the wheels and the strut, said wheel comprising two axially spaced parts and the strut extending between said parts to the anti-friction bearing.

12. In a drafting machine, a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, one of the sections comprising two wheels, a band extending about the same, a strut spacing the wheels apart with the band under tension, and anti-friction bearings between the strut and the wheels, the strut having end members one extending to one side of the wheel and connected with the anti-friction bearing and the other extending directly to the anti-friction bearing centrally of the wheel.

13. In a drafting machine, a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, one of the sections comprising two wheels, a band extending about the same, a strut spacing the wheels apart with the band under tension, and anti-friction bearings between the strut and the wheels, the strut having end members one extending to one side of the wheel and connected with the anti-friction bearing and the other extending directly to the anti-friction bearing centrally of the wheel, the latter wheel being in two axially spaced parts.

14. In a drafting machine, a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, one of the sections comprising two wheels, a band extending about the same, a strut for holding the wheels apart with the band under tension, and anti-friction bearings between the ends of the strut and the wheels, the strut extending directly inwardly in substantially a straight line to the anti-friction bearings at both ends whereby the stresses are transmitted centrally of the bearings.

15. In a drafting machine, a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, one of the sections comprising two wheels, a band extending about the same, a strut for holding the wheels apart with the band under tension, and anti-friction bearings between the ends of the strut and the wheels, the strut extending directly inwardly in substantially a straight line to the anti-friction bearings at both ends whereby the stresses are transmitted centrally of the bearings, the wheel at each end of the strut

being composed of two axially spaced parts between which the strut extends.

16. A drafting machine having a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, each section of the arm comprising a pair of band wheels, an endless band extending about the same, a strut between the wheels having portions enclosing parallel portions of the band, and a guard detachably carried by one of the struts and extending circumferentially about the outside of a curved portion of one of the bands.

17. In a drafting machine having a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, an endless band comprising a pair of relatively inflexible intermediate portions and multi-strand flexible portions operatively connected to the ends of said members and adapted to extend about band wheels.

18. In a drafting machine having a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, an endless band comprising a pair of relatively inflexible intermediate portions and end portions each adapted to extend about a band wheel and composed of a plurality of superposed flexible ribbons fastened together and having operative connections with the adjacent ends of said first named portions.

19. In a drafting machine having a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, an endless band comprising a pair of relatively inflexible intermediate portions and end portions each adapted to extend about a band wheel and composed of a plurality of superposed flexible ribbons fastened together and at least one being attached to the adjacent ends of said first named portions.

20. In a drafting machine having a parallel motion mechanism in the form of a jointed arm comprising sections of the wheel and band type, an endless band comprising a pair of relatively inflexible intermediate portions and end portions each adapted to extend about a band wheel and composed of a plurality of superposed flexible ribbons including one having its ends attached to the first named portion and one or more other ribbons attached to the first named ribbon with flexible joints allowing slight relative movement between the ribbons.

21. A protractor head for a drafting machine comprising a holding plate, a ruler assembly having a plurality of notches therein and including a protractor plate having graduations thereon, a member having a dead line thereon for said graduations, said holding plate and said ruler assembly and said member being relatively rotatable, a handle connected with said ruler assembly for rotating the same, a pawl supported on said member and engageable with said notches for holding said ruler assembly relative to said member, means for securing said member in adjusted position relative to said holding plate, a releasing member for said pawl carried by said handle, and an operative connection between said releasing member and said pawl.

22. A protractor head for a drafting machine comprising a holding plate, a ruler assembly having a plurality of notches therein and including a protractor plate having graduations thereon, a member having a dead line thereon for said graduations, said holding plate and said ruler assembly and said member being relatively rotatable, a handle connected with said ruler assembly for rotating the same, a pawl supported on said member and engageable with said notches for holding said ruler assembly relative to said member, means for securing said member in adjusted position relative to said holding plate, a releasing member for said pawl carried by said handle, and means for operatively connecting said releasing member and said pawl regardless of the relative angular position between said ruler assembly and said member.

23. A drafting machine having a parallel motion mechanism composed of two pivoted sections each 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 comprising an end member and a band encasing side member, means for adjusting the length of said strut, one of said members having a hollow portion and the other of said members extending into said hollow portion, said end member and said side member being relatively rotatable and having cooperating thrust-resisting abutments.

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