J. NEUMAIER.

PROTRACTOR.

APPLICATION FILED FEB. 28, 1919.

1,329,005.

Patented Jan. 27, 1920.

3 SHEETS—SHEET 1.

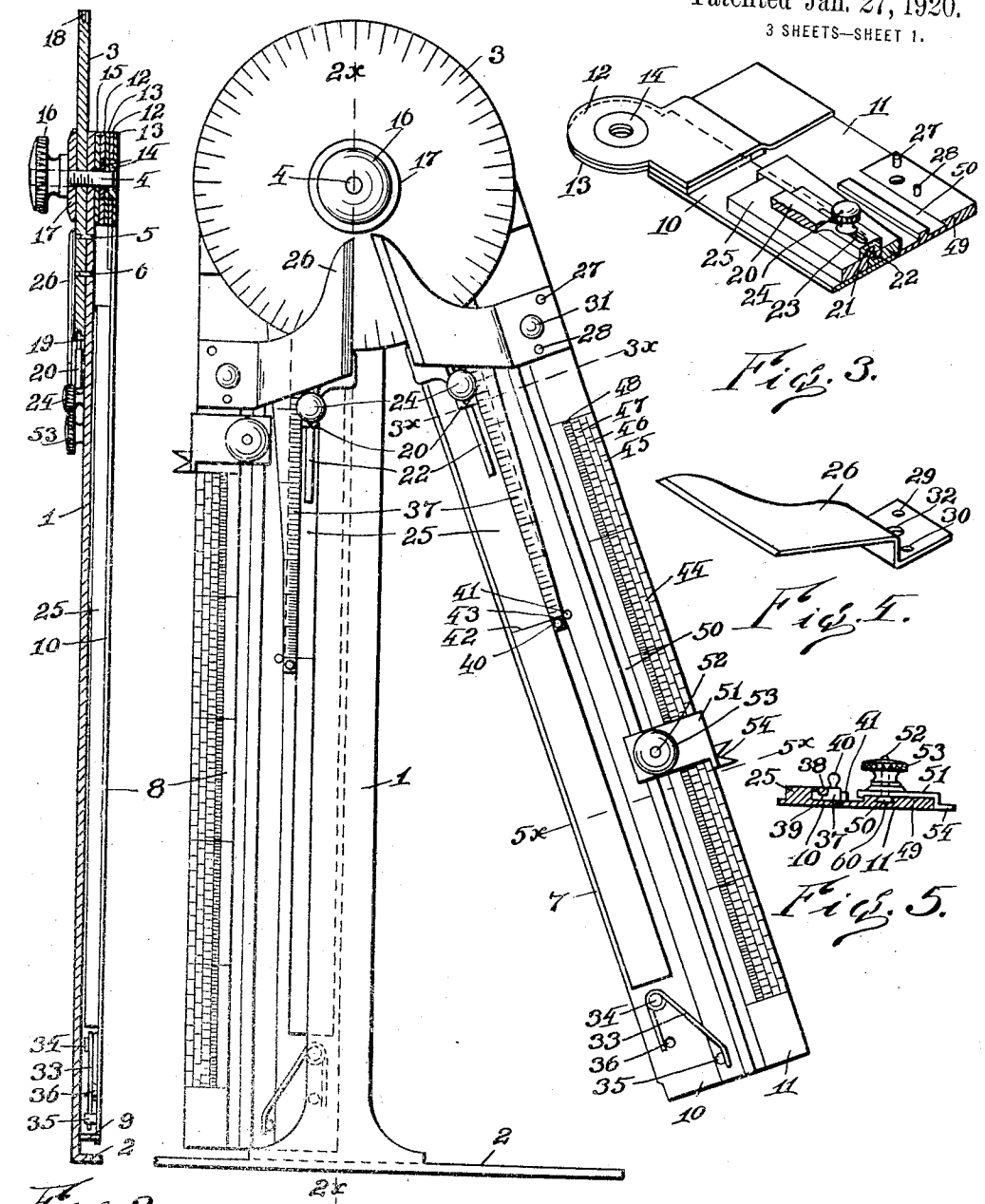

Fig. 2.

Fig. 1.

Fig. 3.

Fig. 4.

Fig. 5.

Witness

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3 SHEETS—SHEET 2.

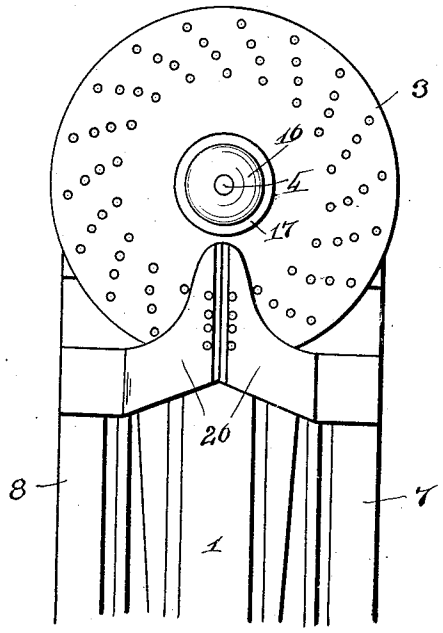

Fig. 6.

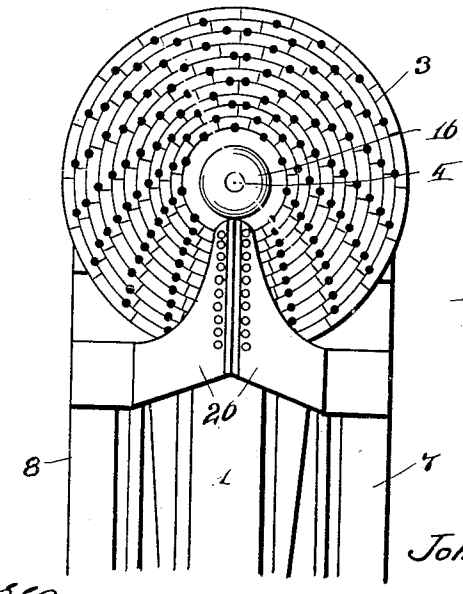

Fig. 7.

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3 SHEETS—SHEET 3.

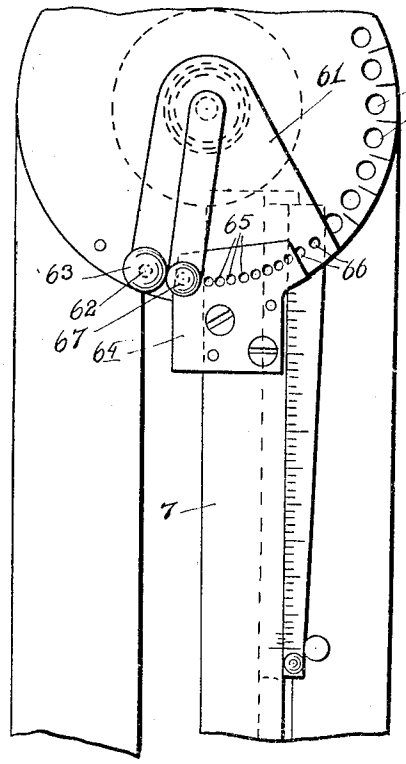

Fig. 8.

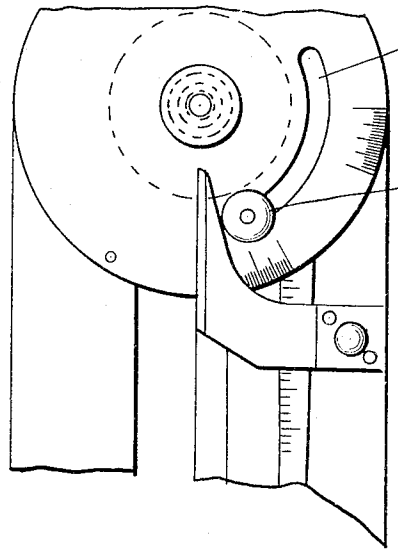

Fig. 9.

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UNITED STATES PATENT OFFICE.

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PROTRACTOR.

1,329,005. Specification of Letters Patent. **Patented Jan. 27, 1920.**

Application filed February 28, 1919. Serial No. 279,825.

To all whom it may concern:

Be it known that I, JOHN NEUMAIER, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Protractors, of which the following is a specification.

The object of this invention is to provide a new and improved form of protractor for use in a drafting room or machine shop.

Another object of this invention is to provide this protractor with a number of index plates which are interchangeable on the protractor, by means of which the protractor is adapted to be used for any kind of work requiring accurately laid out angles or subdivision of angles.

Another object of this invention is to provide a protractor with a sliding scale by means of which the degrees, minutes and seconds can be measured and directly read off from the instrument without the use of a vernier.

These and other objects of this invention will be fully illustrated in the drawings, described in the specification and pointed out in the claims at the end thereof.

In the accompanying drawings,

Figure 1 is a plan view of the protractor embodying the invention.

Fig. 2 is a vertical section through the protractor, the section being taken on the line $2^{\times}$—$2^{\times}$ of Fig. 1.

Fig. 3 is a sectional perspective view of the end of one of the arms, the section being taken on the line $3^{\times}$—$3^{\times}$ of Fig. 1.

Fig. 4 is a detail perspective view of one of the indicators.

Fig. 5 is a sectional view of one of the arms, the section being taken on the line $5^{\times}$—$5^{\times}$ of Fig. 1.

Fig. 6 is a plan view of a portion of the protractor with a different form of index plate in place thereon.

Fig. 7 is a plan view of a portion of the protractor with another form of index plate in place thereon.

Fig. 8 is a plan view of a modified form of index plate and adjustment thereon.

Fig. 9 is a plan view of another modified form of index plate and adjustment thereon.

In the several figures of the drawings like reference numerals indicate like parts.

The protractor comprises in its construction the central and stationary arm 1 which is provided with a flange forming the T-shaped base 2 which projects at right angles to the arm 1 on either side at the end thereof. This base is used to level the instrument on a T square when used on a drafting board and it also forms a support for the instrument when it is used in an upright position on a leveling plate in the machine shop.

Carried on the opposite end of the arm 1 is the protractor or index plate 3 which is accurately centered on the pivot stud 4 and held from rotating thereon by the pins 5 and 6. The index plate 3 can be easily removed and other plates having corresponding openings may be substituted therefor and held in the same position. These pins are provided permanently in the arm 1 and project out therefrom to engage corresponding openings provided in the index plate 3 in order to hold this plate in line with the arm 1 and keep it from turning thereon.

Mounted to swing on the stud 4 below the index plate 3 are the scales or arms 7 and 8 one on each side of the stationary arm 1. A pin or stop 9 provided on the under-side of the arm 1 near the base 2 thereof operates to hold each of the swinging arms 7 and 8 in line with the stationary arm 1 and prevents them from swinging past the center of zero line.

Each of the arms 7 and 8 is made up of two sections 10 and 11 each having separate bearing plates 12 and 13 through which passes the stud 4. The bearing plates 13 of the arms 10 are provided with a circular opening just large enough for the stud 4 to pass therethrough but the openings in the bearing plates 12 of the arms 11 are larger and receive a circular washer 14 through the center of which passes the stud 4. This is for a purpose that will presently appear.

Between the under side of the end of the

arm 1 and the bearing plates 12 and 13 is inserted the washer 15 and between the index plate 3 and the thumb screw 16 is inserted the washer 17. As shown in Fig. 3 the bearing plate 12 of the section 11 projects up and overlaps the section 10 and its bearing plate 13 so as to bring both of the bearing plates 12 and 13 of the arms 10 and 11 frictionally in contact with one another.

The stud 4 is riveted or otherwise fastened into the center of the bearing plate 13 of the arm 8 and projects upwardly and successively through the washer 14 provided in the center of the bearing plate 12 of the arm 8, the bearing plate 13 and washer 14 in the center of bearing plate 12 of the arm 7, the washer 15, the end of the stationary arm 1, the index plate 3, the washer 17 and into the thumb screw 16 which is threaded thereon. This enables the operator of the instrument to lock the arms 7 and 8 in any desired position by clamping all of the bearing plates against the under side of the end of stationary arm 1 by means of the thumb screw 16.

If desired the washer 14 in the bearing plate 12 of the arm 8 may be made integral with the bearing plate 12 so as to provide sufficient thickness of metal in the bearing plate 13 for the stud 4 to be anchored thereon. This construction is shown in section in Fig. 2.

The washers 14 permit the sections 11 of the arms 7 and 8 to move independently of the sections 10 because the pressure exerted on the top and bottom of each of the bearing plates 12 by the thumb screw 16 is partially taken up by the washers 14 and allows the bearing plates 12 of the sections 11 to rotate around the washers 14 and move independently while the bearing plates 13 remain rigidly clamped to the stationary arm by the thumb screw 16 as heretofore described. When the thumb screw 16 is released both of the arms 7 and 8 can freely swing around the pivot stud 4 and be adjusted on the index plate according to the desired angle which is to be measured or laid out by the instrument.

The periphery of the index plate is provided with a series of radial holes 18 which are spaced apart according to the degrees laid out on the edge of the index plate. These openings 18 are adapted to be engaged by the pins 19 which are provided on the end of the slides 20 mounted to slide on each of the sections 10 of the arms 7 and 8. The slides 20 consist of a sliding plate which is provided with a channeled groove 21 on the under side thereof into which engages the rail 22 provided on the section 10 of the arms 7 and 8 and on which the sliding plate is mounted to slide. A slot 23 is cut into the top of the sliding plate through which passes the thumb screw 24 which is threaded into the rail 21 and by means of which the slide may be adjustably clamped to the sections 10 of the arms 7 and 8.

The pins 19 are moved to engage one of the openings 18 in the periphery of the index plate which correspond with the angle indicated on the index plate at which the arms are to be set and lock the sections 10 thereof rigidly in place in this predetermined position.

The rail 21 is elevated on a rib 25 provided on the section 10 of each of the arms 7 and 8. This is for the purpose of making the pointer or pin 19 of the slide 2 overlap the stationary arm 1 when one or both of the arms 7 and 8 are in the position shown at the left in Fig. 1 and permit the pins to engage the first few holes 18 in the index plate 3 which are located above the stationary arm.

A pointer or hand 26 is rigidly clamped on top of each of the sections 11 of the arms 7 and 8, which pointers overlap the sections 10 and the slides 20 mounted thereon and project over the top surface of the index plate 3 in such a manner that the inner edge thereof extends radially to the center of the index plate and is also in line with the pins 19 of the slides 20 and their corresponding holes 18 in the periphery of the index plate. Each of the pointers 26 is properly anchored and lined up by means of the pins 27 and 28 which project from the sections 11 and engage corresponding openings 29 and 30 in the pointer or hand 26. A clamping screw 31 is used to clamp the pointer on to the section plate 10, which screw passes through a hole 32 in the pointer plate and is threaded into the section 11 of each of the arms 7 and 8.

To hold the outer ends of the sections 10 and 11 together a spring 33 is mounted on the stud 34 provided near the outer end of each of the sections 10. This spring is coiled around this stud and has one end thereof projecting over the outer edge of the section 11 and engages the stud 35 provided near the outer end of the section 11. The other end of the spring 33 engages a second stud on the section 10 thus holding the center of the spring 33 against rotation in one direction while the end of the spring engaging the stud 35, holds the section 11 yieldingly against the side of the section 10.

The ends of the sections 10 and 11 are moved away from each other by giving the section 11 a limited but independent rotary motion around the stud 4 and away from the section 10. This is done as follows:

A wedge shaped slide 37 is adapted to slide with its straight side along the edge of the rib 25 and for this purpose the rib

is provided with an overhanging and downwardly projecting edge 38. This edge engages with a corresponding channel 39 provided on one side of the wedge shaped slide 37 and holds this slide in a straight line movement along the edge of the rib 25. A handle 40 is provided on the end of the wedge shaped slide 37 by means of which the slide is moved along the edge of the rib 25.

The inclined side of the wedge shaped slide faces the section 11 and partially overlaps the top thereof. A stud or pin 41 normally engages the end of the inclined side of the slide 25, which pin is mounted in the section 11 near the edge thereof and projects upwardly therefrom.

When the slide is moved along the edge of the rib 2 toward the end of the arm the pin 41 is gradually forced outwardly which moves the section 11 away from the section 10. This is possible even after the arms 7 and 8 have been locked in place by the thumb screw 16 as heretofore pointed out. The independent movement of the section 11 away from the section 10 is determined by the inclined side given to the wedge shaped slide 37. The straight edge of the slide is calibrated into sixty divisions corresponding to the sixty minutes of a degree so that when the slide 37 is moved a distance equal to one division the section 11 will be wedged away and given an independent turn around the stud 4 and away from the section 10 which equals 1/60 of one degree and represents an angle of one minute on the index plate 3. A zero line 42, provided on the rib 25, is used to determine the distance the slide is moved one way or the other, which zero line normally is in line with the zero line 43 on the end of the wedge shaped slide 37.

The spring 33 keeps the pin 41 yieldingly in contact with the inclined side of the slide 37 wherever the slide is moved and the section 11 cannot move away from the section 10 except as is indicated by the angle shown on the slide 37.

Instead of calibrating the slide 37 with sixty divisions as is shown in connection with arm 7, the slide can be divided into any other number of divisions, as for instance, into eighty-nine divisions, the first thirty divisions of which represent each two seconds or sixty seconds or one minute in all. The remaining fifty-nine divisions represent fifty-nine minutes which, with the first thirty divisions of two seconds each, represent an angle of one degree. The side of the wedge shaped slide, of course, must be correspondingly inclined as is shown in connection with the slide mounted on the arm 8 on which the distance representing the first thirty divisions is inclined but very slightly while the remaining portion of the slide representing the fifty-nine divisions is inclined accordingly so that the angle at which the section 11 is turned on the stud 4 independently of the section 10 equals exactly the fraction of the degree indicated on the index plate 3.

In this manner each of the arms may be set to any angle indicated on the index plate 3 which is divided into 360 degrees, for each of which degrees a hole 18 is drilled into the periphery of the index plate. The pins 19 provided on each of the arms can, therefore, lock its corresponding arm at any degree angle up to 180 degrees. Any fraction of one degree in which the arm is to be turned to increase the angle in addition to that indicated on the index plate is taken care of by the additional turn given to the outer section of the arm which is governed by the movement of the slide 37 and the amount of angular movement given to the outer section of the arm can be directly read on the scale provided thereon.

This method of reading angles does away with the well known vernier and has the advantage that the angle and fraction thereof can be directly read off from the instrument without calculating part of it with a vernier.

A scale 44 is provided on each of the sections 10 of the arms 7 and 8. This scale is made up of four sections 45, 46, 47 and 48 which run parallel to each other and are calibrated with one-eighth, one-sixteenth, one thirty-second, and one-sixty-fourth of an inch. The section 45 is calibrated with divisions each representing one-eighth of an inch starting with a zero line on each end thereof.

The section 46 begins on the same zero line and begins with a division on each end representing one-sixteenth of an inch. Each succeeding division, however, is one-eighth of an inch in length and therefore indicates only every other 1/16th of an inch as 3/16ths, 5/16ths, 7/16ths, etc. The even number of sixteenths are read off on the section 45, the division lines of which represent 1/8th or 2/16ths of an inch.

The section 47 also begins on the same zero line at each end of the scale and the first division thereof represents 1/32nd of an inch and each succeeding division line represents 1/16th or 2/32nds of an inch which, therefore, indicates only every other 1/32nd of an inch as 3/32nds, 5/32nds, 7/32nds, etc. The even number of thirty-seconds are read off on the sections 45 and 46 because 2/32 equals 1/16th which is indicated on scale 46 and therefore can be read off on that section, 4/32 equals 1/8th which is indicated on scale 45 and therefore can be read off on that scale, etc.

The section 48 begins on the zero lines of

the other scales but begins with a division representing 1/64th of an inch but each succeeding division line represents 1/32 or 2/64ths of an inch and therefore only every other 1/64 of an inch such as 3/64, 5/64, 7/64, etc., is indicated on this scale. The even numbers of sixty-fourths are read off on the sections 47, 46 and 45 because 2/64ths equals 1/32 which is indicated on scale 47 and can be read off on that scale, 4/64ths equals 1/16 which is indicated on scale 46 and can be read off on that scale, 6/64 equals 3/32 which is indicated on scale 47 and can be read off on that scale, 8/64 equals 1/8 which is indicated on scale 45 and can be read off on that scale.

In this manner any fraction of an inch including 1/64, 1/32, 1/16 and 1/8 can be read off on the scales by combining the scales of the four sections 45, 46, 47 and 48. This arrangement does away with the very fine divisions indicating sixty-fourths which are used on a scale in which all of the fractions 1/64, 1/32, 1/16 and 1/8 are calibrated on a single section of a scale.

The scales 44 are marked on an elevated level on the rib 49 provided on the sections 11 of each of the arms 7 and 8. This rib also has a dovetailed groove 50 cut therein at the rear of the scale 49 and parallel thereto. An indicator slide 51 is mounted on top of the rib 49 and projecting downwardly on either side thereof. In order to lock this indicator slide at any predetermined position on the scale 44, a stud 52 having a base 60 which is adapted to slide in the dovetailed groove 50, projects through the top of the slide 51 so that the thumb screw 53 on the end can be used to clamp the slide on the section 11 at any point on the scale 44. The downwardly projecting flange on the slide 51 on the outer side thereof is provided with the pointer 54 which has a V shaped slot cut therein, the apex of which is in line with the lower edge of slide 51. This edge is used as the indicating or recording line of the slide and any point marked by the pencil in the apex of the V slot of the pointer 54 will be in line with the line on the scale 44 which is indicated by the lower edge of the slide 51.

In Fig. 6 is shown a modified form of an index plate in which the angle of graduations are indicated by a series of holes which are drilled into the plate and distributed successively over a number of concentric circles thereon. This arrangement does away with the openings 18 in the periphery of the index plate and simplifies the locking of the arms thereon. The locking means in this case comprises a pin which is adapted to pass through any one of the holes provided in the pointer 26 and which register with the opening in the index plate that indicates the desired angle at which the arm or a scale is to be set.

In Fig. 7 the index plate is divided into a series of concentric circles, each of which is again divided into equal radial divisions of different denominations. By means of this plate any circle or part thereof can be divided into any of the divisions indicated on the index plate or any one or more divisions may be laid out by means of the arms of the instrument. The arms are locked in place at any of the division lines by a pin similar to the one referred to in connection with the pin used on the index plate shown in Fig. 6. For this purpose a small hole is drilled at a suitable distance behind each of the division lines on the index plate. Corresponding holes in the pointer are adapted to register with the holes in this index plate and the pin can lock the pointer to any of the divisions marked on the plate by passing it through the hole in the pointer and into the desired hole in the index plate.

The index plate shown in Fig. 8 has a series of holes 60 provided near the periphery of the plate, which holes are spaced apart 10 deg. Mounted above the index plate and normally rotating with the arm 7 is a locking plate 61 which is provided with the hole 62 through which the pin 63 is inserted to pass into one of the holes 60 and lock the arm 7 at intervals of 10 deg. to the index plate. The adjustment by which the arm 7 is moved in single degrees is secured by the plate 64. This plate is fastened to the arm 7 and overlaps the periphery of the locking plate 61. The portion of the plate 64 which overlaps the locking plate 61 is provided with a series of ten holes 65. These holes are adapted to individually register with a series of ten holes 66 provided in the locking plate 61 from which holes 66 the holes 65 are offset. The difference in spacing in the holes in the locking plate 61 from that in the series of the plate 64 is such that by advancing the arm 7 and locking plate 64 so that the pin 67 thereon can be advanced from the first hole in the series 65 into the second hole thereof and pass into the second hole of the series 66, the arm 7 will thereby be advanced one degree.

With the above adjustment the arm 7 may be advanced 10 deg. or any multiple thereof by moving its locking plate 61 so that the pin 63 is advanced a corresponding number of holes 60. The additional adjustment which moves the arm 7 from 1 deg. to 9 deg. either singly or collectively is secured by advancing the arm 7 with the plate 64 until the hole in the series 65, corresponding to the number of degrees in which the arm is to be moved, registers with the hole in the series 66 corresponding to the number

of degrees at which the arm is to be advanced.

The index plate shown in Fig. 9 is provided with the concentric slot 70 through which the thumb screw 71 is adapted to pass into the arm 7. This screw is adapted to clamp the arm 7 to the index plate at any desired point designated on the indexing on the periphery of the index plate.

I claim.

1. A protractor comprising a stationary arm, an index plate mounted on the end of said arm, a pair of swinging arms pivotally mounted on the end of said stationary arm and centrally of said index plate, locking means on each of said arms to lock said arms in any predetermined position indicated on said index plate.

2. A protractor comprising a stationary arm, an index plate mounted on one end of said arm, a T shaped base provided on the other end of said arm, a pair of swinging arms pivotally mounted on the end of said stationary arm and centrally of said index plate, each of said swinging arms comprising an inner and an outer section, the outer of said sections being adapted to swing independently of said inner sections.

3. A protractor comprising a stationary index plate, a base therefor, a pair of arms mounted centrally of said index plate, means for progressively locking said arms on the periphery of said index plate, each of said arms comprising an inner and an outer section, said outer sections being yieldingly held against said inner sections, means on said inner sections to force said outer section away from said inner section, and swing said outer section on said index plate independently from said inner section.

4. A protractor comprising a stationary index plate, a base therefor, a pair of arms pivotally mounted centrally of said index plate, each of said arms comprising an inner and an outer section, means for locking said inner section to said index plate, and means for yieldingly holding said outer section against said inner section.

5. A protractor comprising a stationary index plate, a base therefor, a pair of arms pivotally mounted in the center of said index plate, each of said arms comprising an inner and an outer section, means provided on said inner section for locking said inner section to said index plate, a wedge shaped scale mounted to slide on said inner section, said wedge shaped slide engaging said outer section and forcing said outer section away from said inner section on the movement of said wedge shaped scale.

6. A protractor comprising a stationary index plate, a base therefor, a pair of arms pivotally mounted in the center of said index plate, each of said arms comprising an inner and an outer section, each of said outer sections being independently mounted to swing in the center of said index plate, a spring connecting said inner and said outer section of said arms, said spring being adapted to yieldingly hold said outer section against said inner sections, a wedge shaped slide mounted between said inner and said outer sections, said slide being adapted to swing the outer section away from said inner section on the movement thereof.

7. A protractor comprising a stationary index plate, a base therefor, a pair of arms pivotally mounted in the center of said index plate, each of said arms comprising an inner and an outer section, each of said outer sections being independently mounted to swing in the center of said index plate, a spring connecting said inner and said outer section of said arms, said spring being adapted to yieldingly hold said outer section against said inner sections, a wedge shaped slide mounted between said inner and said outer sections, said slide being adapted to swing the outer section away from said inner section on the movement thereof, said wedge shaped slide having a scale thereon, said scale indicating the additional angular movement of said outer section on said index plate away from said inner section.

8. A protractor comprising an index plate, an arm mounted to swing concentric to said index plate, a locking plate on said arm overlapping said index plate, means to adjust said locking plate on said index plate and means to adjust said arm on said locking plate said means overlapping said locking plate.

9. A protractor comprising an index plate, an arm mounted to swing concentric to said index plate, a locking plate on said arm overlapping said index plate, means to adjust said locking plate on said index plate, means to adjust said arm on said locking plate, said means overlapping said locking plate and means on said arm to adjust said arm independently of said locking plate and said adjusting means thereon.

10. In a measuring instrument, the combination of a pair of arms pivotally mounted on a center, and a wedge shaped plate movable between the arms to spread them apart said plate overlapping both arms and a pin on one arm with which said plate makes sliding contact.

11. In a measuring instrument, the combination of a pair of arms pivotally mounted on a center, a wedge shaped plate movable between the arms to spread them apart, said plate overlapping both arms and a pin on one arm with which said plate makes sliding contact, and a spring connecting

said arms and drawing them together against the plate.

12. In a measuring instrument, the combination of a pair of arms pivotally mounted on a center, one of said arms having a round pin thereon, and a wedge shaped plate movable between the arms to spread them apart, said plate having a long bearing against one of said arms and bearing against the pin on the other arm.

13. In a measuring instrument, the combination of two arms pivoted on a center, a dial mounted on the center above the arms, and an indicator mounted on each arm outside of the dial and projecting inwardly over the dial for the purpose of indicating between them the angular measurement between the arms.

14. In a measuring instrument, the combination of a plate mounted to rotate on a center, a second plate mounted to rotate on the same center, means for producing angular movement between the plates, said means having a longitudinal movement and producing unit angular movements for unit longitudinal movements.

In testimony whereof I affix my signature.

JOHN NEUMAIER.