March 23, 1965 R. G. BEAN 3,174,746

MASTER FIXTURE

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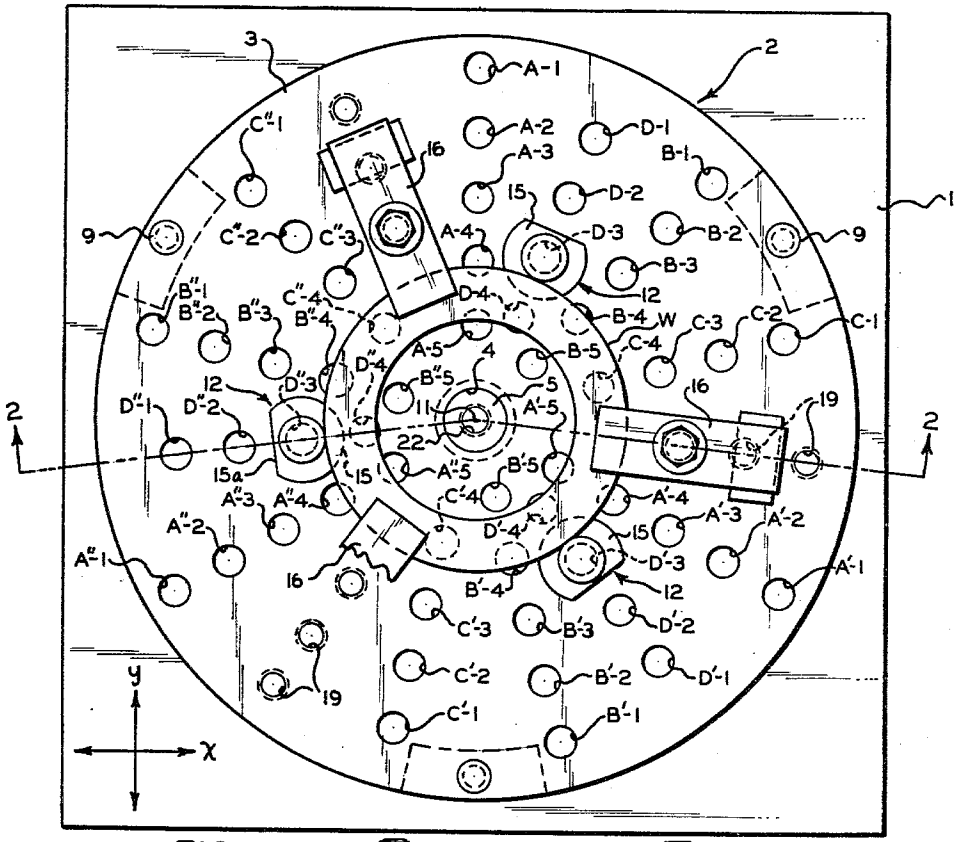


FIG. 1

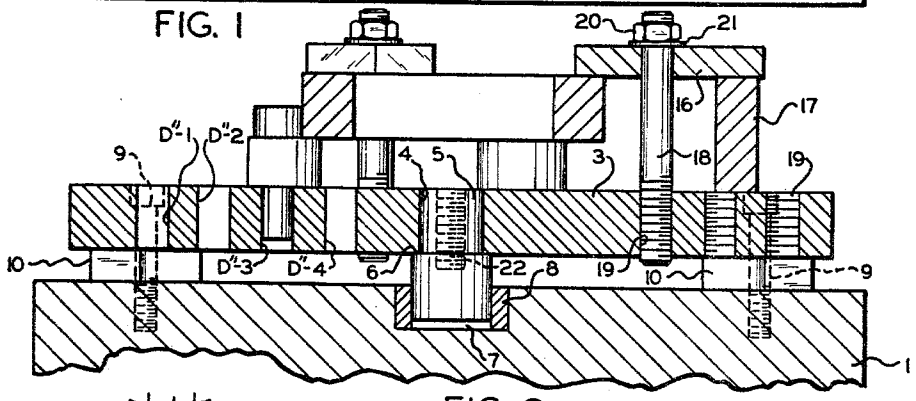


FIG. 2

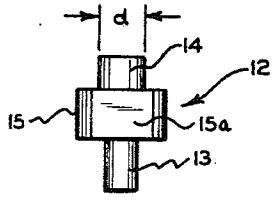


FIG. 3

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MASTER FIXTURE

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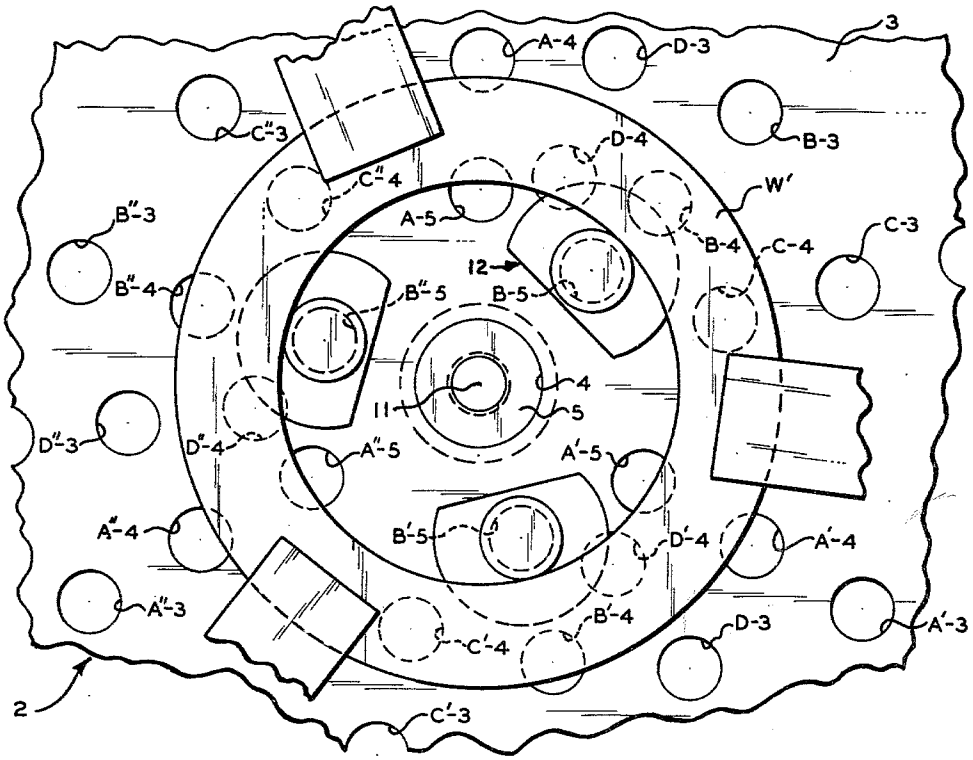


FIG. 4

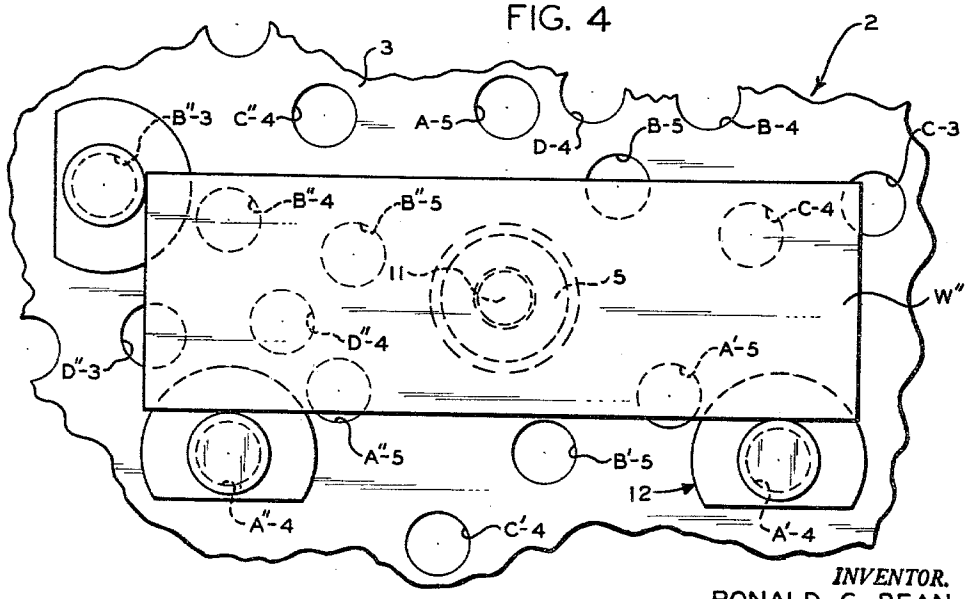


FIG. 5

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O.D.	LOC.	PIN DIA.
10	B-1	1/2
10 1/16	A-1	15/16
10 1/8	A-1	7/8
10 3/16	A-1	13/16
10 1/4	A-1	3/4
10 5/16	A-1	11/16
10 3/8	A-1	5/8
10 7/16	A-1	9/16
10 1/2	A-1	1/2

O.D.	LOC.	PIN DIA.
9	D-1	1/2
9 1/16	C-1	15/16
9 1/8	C-1	7/8
9 3/16	C-1	13/16
9 1/4	C-1	3/4
9 5/16	C-1	11/16
9 3/8	C-1	5/8
9 7/16	C-1	9/16
9 1/2	C-1	1/2
9 9/16	B-1	15/16
9 5/8	B-1	7/8
9 11/16	B-1	13/16
9 3/4	B-1	3/4
9 13/16	B-1	11/16
9 7/8	B-1	5/8
9 15/16	B-1	9/16

O.D.	LOC.	PIN DIA.
8	B-2	1/2
8 1/16	A-2	15/16
8 1/8	A-2	7/8
8 3/16	A-2	13/16
8 1/4	A-2	3/4
8 5/16	A-2	11/16
8 3/8	A-2	5/8
8 7/16	A-2	9/16
8 1/2	A-2	1/2
8 9/16	D-1	15/16
8 5/8	D-1	7/8
8 11/16	D-1	13/16
8 3/4	D-1	3/4
8 13/16	D-1	11/16
8 7/8	D-1	5/8
8 15/16	D-1	9/16

O.D.	LOC.	PIN DIA.
7	D-2	1/2
7 1/16	C-2	15/16
7 1/8	C-2	7/8
7 3/16	C-2	13/16
7 1/4	C-2	3/4
7 5/16	C-2	11/16
7 3/8	C-2	5/8
7 7/16	C-2	9/16
7 1/2	C-2	1/2
7 9/16	B-2	15/16
7 5/8	B-2	7/8
7 11/16	B-2	13/16
7 3/4	B-2	3/4
7 13/16	B-2	11/16
7 7/8	B-2	5/8
7 15/16	B-2	9/16

O.D.	LOC.	PIN DIA.
6	B-3	1/2
6 1/16	A-3	15/16
6 1/8	A-3	7/8
6 3/16	A-3	13/16
6 1/4	A-3	3/4
6 5/16	A-3	11/16
6 3/8	A-3	5/8
6 7/16	A-3	9/16
6 1/2	A-3	1/2
6 9/16	D-2	15/16
6 5/8	D-2	7/8
6 11/16	D-2	13/16
6 3/4	D-2	3/4
6 13/16	D-2	11/16
6 7/8	D-2	5/8
6 15/16	D-2	9/16

O.D.	LOC.	PIN DIA.
5	D-3	1/2
5 1/16	C-3	15/16
5 1/8	C-3	7/8
5 3/16	C-3	13/16
5 1/4	C-3	3/4
5 5/16	C-3	11/16
5 3/8	C-3	5/8
5 7/16	C-3	9/16
5 1/2	C-3	1/2
5 9/16	B-3	15/16
5 5/8	B-3	7/8
5 11/16	B-3	13/16
5 3/4	B-3	3/4
5 13/16	B-3	11/16
5 7/8	B-3	5/8
5 15/16	B-3	9/16

O.D.	LOC.	PIN DIA.
4	B-4	1/2
4 1/16	A-4	15/16
4 1/8	A-4	7/8
4 3/16	A-4	13/16
4 1/4	A-4	3/4
4 5/16	A-4	11/16
4 3/8	A-4	5/8
4 7/16	A-4	9/16
4 1/2	A-4	1/2
4 9/16	D-3	15/16
4 5/8	D-3	7/8
4 11/16	D-3	13/16
4 3/4	D-3	3/4
4 13/16	D-3	11/16
4 7/8	D-3	5/8
4 15/16	D-3	9/16

O.D.	LOC.	PIN DIA.
3	D-4	1/2
3 1/16	C-4	15/16
3 1/8	C-4	7/8
3 3/16	C-4	13/16
3 1/4	C-4	3/4
3 5/16	C-4	11/16
3 3/8	C-4	5/8
3 7/16	C-4	9/16
3 1/2	C-4	1/2
3 9/16	B-4	15/16
3 5/8	B-4	7/8
3 11/16	B-4	13/16
3 3/4	B-4	3/4
3 13/16	B-4	11/16
3 7/8	B-4	5/8
3 15/16	B-4	9/16

O.D.	LOC.	PIN DIA.
2	B-5	1/2
2 1/16	A-5	15/16
2 1/8	A-5	7/8
2 3/16	A-5	13/16
2 1/4	A-5	3/4
2 5/16	A-5	11/16
2 3/8	A-5	5/8
2 7/16	A-5	9/16
2 1/2	A-5	1/2
2 9/16	D-4	15/16
2 5/8	D-4	7/8
2 11/16	D-4	13/16
2 3/4	D-4	3/4
2 13/16	D-4	11/16
2 7/8	D-4	5/8
2 15/16	D-4	9/16

O.D.	LOC.	PIN DIA.
1 9/16	B-5	15/16
1 5/8	B-5	7/8
1 11/16	B-5	13/16
1 3/4	B-5	3/4
1 13/16	B-5	11/16
1 7/8	B-5	5/8
1 15/16	B-5	9/16

FIG. 6

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MASTER FIXTURE

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I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.	I.D.	LOC.	PIN DIA.
3	B-5	1/2	4	D-4	1/2	5	B-4	1/2	6	D-3	1/2	7	B-3	1/2	8	D-2	1/2	9	B-2	1/2	10	D-1	1/2	11	B-1	1/2
3 1/16	B-5	9/16	4 1/16	D-4	9/16	5 1/16	B-4	9/16	6 1/16	D-3	9/16	7 1/16	B-3	9/16	8 1/16	D-2	9/16	9 1/16	B-2	9/16	10 1/16	D-1	9/16	11 1/16	B-1	9/16
3 1/8	B-5	5/8	4 1/8	D-4	5/8	5 1/8	B-4	5/8	6 1/8	D-3	5/8	7 1/8	B-3	5/8	8 1/8	D-2	5/8	9 1/8	B-2	5/8	10 1/8	D-1	5/8	11 1/8	B-1	5/8
3 3/16	B-5	11/16	4 3/16	D-4	11/16	5 3/16	B-4	11/16	6 3/16	D-3	11/16	7 3/16	B-3	11/16	8 3/16	D-2	11/16	9 3/16	B-2	11/16	10 3/16	D-1	11/16	11 3/16	B-1	11/16
3 1/4	B-5	3/4	4 1/4	D-4	3/4	5 1/4	B-4	3/4	6 1/4	D-3	3/4	7 1/4	B-3	3/4	8 1/4	D-2	3/4	9 1/4	B-2	3/4	10 1/4	D-1	3/4	11 1/4	B-1	3/4
3 5/16	B-5	13/16	4 5/16	D-4	13/16	5 5/16	B-4	13/16	6 5/16	D-3	13/16	7 5/16	B-3	13/16	8 5/16	D-2	13/16	9 5/16	B-2	13/16	10 5/16	D-1	13/16	11 5/16	B-1	13/16
3 3/8	B-5	7/8	4 3/8	D-4	7/8	5 3/8	B-4	7/8	6 3/8	D-3	7/8	7 3/8	B-3	7/8	8 3/8	D-2	7/8	9 3/8	B-2	7/8	10 3/8	D-1	7/8	11 3/8	B-1	7/8
3 7/16	B-5	15/16	4 7/16	D-4	15/16	5 7/16	B-4	15/16	6 7/16	D-3	15/16	7 7/16	B-3	15/16	8 7/16	D-2	15/16	9 7/16	B-2	15/16	10 7/16	D-1	15/16	11 7/16	B-1	15/16
3 1/2	A-5	1/2	4 1/2	C-4	1/2	5 1/2	A-4	1/2	6 1/2	C-3	1/2	7 1/2	A-3	1/2	8 1/2	C-2	1/2	9 1/2	A-2	1/2	10 1/2	C-1	1/2	11 1/2	A-1	1/2
3 9/16	A-5	9/16	4 9/16	C-4	9/16	5 9/16	A-4	9/16	6 9/16	C-3	9/16	7 9/16	A-3	9/16	8 9/16	C-2	9/16	9 9/16	A-2	9/16	10 9/16	C-1	9/16	11 9/16	A-1	9/16
3 5/8	A-5	5/8	4 5/8	C-4	5/8	5 5/8	A-4	5/8	6 5/8	C-3	5/8	7 5/8	A-3	5/8	8 5/8	C-2	5/8	9 5/8	A-2	5/8	10 5/8	C-1	5/8	11 5/8	A-1	5/8
3 11/16	A-5	11/16	4 11/16	C-4	11/16	5 11/16	A-4	11/16	6 11/16	C-3	11/16	7 11/16	A-3	11/16	8 11/16	C-2	11/16	9 11/16	A-2	11/16	10 11/16	C-1	11/16	11 11/16	A-1	11/16
3 3/4	A-5	3/4	4 3/4	C-4	3/4	5 3/4	A-4	3/4	6 3/4	C-3	3/4	7 3/4	A-3	3/4	8 3/4	C-2	3/4	9 3/4	A-2	3/4	10 3/4	C-1	3/4	11 3/4	A-1	3/4
3 13/16	A-5	13/16	4 13/16	C-4	13/16	5 13/16	A-4	13/16	6 13/16	C-3	13/16	7 13/16	A-3	13/16	8 13/16	C-2	13/16	9 13/16	A-2	13/16	10 13/16	C-1	13/16	11 13/16	A-1	13/16
3 7/8	A-5	7/8	4 7/8	C-4	7/8	5 7/8	A-4	7/8	6 7/8	C-3	7/8	7 7/8	A-3	7/8	8 7/8	C-2	7/8	9 7/8	A-2	7/8	10 7/8	C-1	7/8	11 7/8	A-1	7/8
3 15/16	A-5	15/16	4 15/16	C-4	15/16	5 15/16	A-4	15/16	6 15/16	C-3	15/16	7 15/16	A-3	15/16	8 15/16	C-2	15/16	9 15/16	A-2	15/16	10 15/16	C-1	15/16	11 15/16	A-1	15/16

FIG. 7

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United States Patent Office

3,174,746

Patented Mar. 23, 1965

3,174,746

MASTER FIXTURE

Ronald G. Bean, Saginaw, Mich., assignor to Baker Perkins Inc., Saginaw, Mich., a corporation of New York

Filed Oct. 9, 1961, Ser. No. 143,934
10 Claims. (Cl. 269—297)

This invention relates to fixtures and more particularly to a master or universal fixture construction that is capable of supporting any one of a number of different size workpieces on the work holding apparatus of automatically operated machinery such as drilling, milling and boring machines.

Machinery of the kind with which the invention is particularly adapted for use includes so-called numerically controlled drilling, milling and boring machines of the kind having a work supporting table and a tool support, one of which is capable of programmed movements through a cycle of operations to and from a starting point. In conditioning such a machine for operation on a workpiece, considerable care must be exercised in locating the workpiece, inasmuch as improper or careless locating of a workpiece will result in its being improperly machined and may render it worthless. Because of the accuracy required in conditioning such a machine for operation, it is not uncommon for a substantial portion of the shop time charged to a workpiece to represent "set-up" time. Where the part to be machined is a high production part, the ratio of "set-up" time to "running" time may be relatively low, but in the event of a low production part the "set-up" time may be inordinately and excessively high as compared to the "running" time.

A particular object of this invention is to provide a fixture that is adapted to support any one of a large number of different size and shape workpieces, and yet is so constructed as to enable extremely rapid and accurate changeovers from the machining of one part to another.

Another object of the invention is to provide a master fixture of the character to which I refer which accommodates workpieces of various shapes with equal facility.

A further object of this invention is to provide a master fixture which has the foregoing advantages and yet is of such simplified construction as to be easily understood and operated by relatively unskilled personnel.

Another object of the invention is to provide a simplified fixture for supporting workpieces of various shapes and sizes which is of relatively low cost as compared to other kinds of known fixtures.

A further object of the invention is to provide a fixture of this type which is extremely flexible in its capacity for handling odd sized workpieces.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawings, in which:

FIGURE 1 is a plan view illustrating a fixture constructed in accordance with the invention and mounted on a machine table, the fixture supporting an annular workpiece;

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1;

FIGURE 3 is an elevational view of one of the workpiece locating members forming part of the device;

FIGURE 4 is an enlarged, fragmentary view similar to FIGURE 1 but illustrating a different workpiece supported thereby;

FIGURE 5 is a view similar to FIGURE 4 but illustrating still another workpiece supported by the apparatus;

FIGURE 6 is a chart listing the sizes and locations of

locating pins for outside diameter clamping of workpieces; and

FIGURE 7 is a similar chart, but listing diameters and locations of pins for inside diameter clamping of workpieces.

Apparatus constructed in accordance with the invention is adapted for use in conjunction with a numerically controlled machine of known kind having a table 1 that is movable under the influence of a programming tape controlled mechanism (not shown) in either or both of two directions in the same plane. The directions of movement of the table are traditionally referred to as the X and Y directions, and all movements of the table 1 are related to a "zero" or starting point that is determined by the machine manufacturer.

A fixture constructed in accordance with the illustrative embodiment of the invention is represented generally by the reference character 2 and comprises a disk 3 that is provided with an opening 4 at its center for reception of a mounting post 5. The post 5 preferably is shouldered as at 6 and is received in an opening 7 drilled in the table 1, the opening 7 being surrounded by an annular wear bushing 8. Adjacent its periphery, the disk 3 may be provided with three equally spaced openings through which extend hold-down bolts 9 having threaded ends received in correspondingly threaded openings tapped in the table 1. Preferably, spacer blocks 10 are provided at each of the three mounting points of the disk 3 so as to space the latter above the upper surface of the table 1 to provide clearance for chips.

The opening 7 in the table 1 is very precisely located with respect to the machine's zero or starting point referred to above. The opening 7 is so located that its exact center is at a known position with respect to the zero position of the machine. The disc 3 is carefully mounted on the table so that the center of the opening 4 coincides with the center of the opening 7. Since the center of the opening 4 lies at the center of the disc 3 and coincides with the center of the opening 7, the disk 3 will be oriented to the movements of the table relative to its starting point. The fixture may be mounted at any part of the table 1, or more than one fixture may be mounted on the same table, so long as the center of each fixture is oriented with the movement of the table. The center of the disk, however, is particularly important with relation to the structure yet to be described, and the center of the disk hereinafter will be referred to as the reference zone or point 11.

In the embodiment of the invention shown in the drawings, the disk 3 includes a number of sets of rows of openings formed therein so as to radiate from the reference point 11. The first row of one set of openings is identified by the reference letter A, the second row of the one set of openings is indicated by the reference letter A′, and the third row of the one set of openings is indicated by the reference letter A″. Each of the three rows of openings is preferably angularly spaced 120° from the others. Each of the rows A, A′ and A″ includes a plurality of openings, all of which are of uniform size and all of which are uniformly spaced from one another. Each opening in a row is numbered, beginning with the radially outermost opening. Thus, the radially outermost opening in the three rows is numbered A–1, A′–1, A″–1, respectively, the next opening in the rows is numbered A–2, A′–2 A″–2, and so on, to the innermost opening in the rows which, in the illustrative embodiment, has the number A–5, A′–5 and A″–5, respectively. The number of openings in a particular row will depend on the diameter of the disk 3, and it should be understood that there may be more or fewer than five openings in the rows.

The disk 3 includes a number of other sets of rows of

openings. In the disclosed embodiment there are three such other sets of rows, the individual rows of which are identified by the letters B, B′ and B″; C, C′ and C″; and D, D′ and D″. Hereinafter, whenever reference is made to rows A, B, C, or D, it is intended that the other rows of a particular set be included.

In each instance the rows of each set of rows B, C and D are spaced from one another by 120°. The individual openings in each of these rows of openings are numbered in a manner similar to the numbering of the rows A, but are identified by the letters B, C or D, respectively.

The spacing between the openings in each of the rows B, C and D preferably corresponds exactly to the spacing between each of the openings in the rows A, but the radial distance from the reference point **11** of each of the openings in the rows A, B, C and D is different. For example, the distance from the center of the opening A–1 to the reference point **11** may be five and one-half inches and the spacing between each of the openings in the rows A may be one inch. The distance from the reference point **11** to the center of the opening B–1 may be five and one-fourth inches, although the spacing between each of the openings in the rows B again is one inch. The distance from the center of the opening C–1 to the reference point **11** may be five inches, with the openings in the row one inch apart, and the distance from the center of the opening D–1 to the reference point **11** may be four and three-fourths inches, the openings also being spaced one inch apart. It will be observed from FIGURE 1 that each of the rows A and B includes five openings, whereas each of the rows C and D includes only four openings. The reason for the difference in number of openings is to avoid an undue concentration of openings adjacent the reference point **11**.

Apparatus constructed in accordance with the invention includes a plurality of workpiece locating members or pins designated generally by the reference character **12**. Each of the pins includes a mounting stem **13** of uniform diameter and of such size as snugly to be received in any opening of the rows of openings formed in the disk **3**. At the opposite end of the member **12** is a cylindrical workpiece engaging part **14**, the diameter *d* of which will vary in a manner yet to be described. Interposed between the elements **13** and **14** is a workpiece supporting portion **15**, one face of which is ground flat as at **15***a* for a purpose to be explained. In all of the members **12**, the height of the portion **15** will be the same, but the diameter of such portions also will vary according to the variations in diameter of the portions **14** so as to provide ample support for a workpiece.

FIGURES 1 and 2 illustrate the apparatus as supporting an annular workpiece W by means of three workpiece locating pins **12**, the latter being mounted in the openings D–3, D′–3, and D″–3 of the rows D, D′– D″, respectively. The workpiece W rests upon the supporting portion **15** of each member **12** to provide a three-point support for the workpiece and the arrangement and diameters of the parts **14** of the members **12** are such that the center of the workpiece W coincides with the reference point **11** so that the disk **3** and the workpiece W are mounted concentrically.

Means may be provided to clamp the workpiece in position for machining and such means is disclosed in FIGURES 1 and 2 as comprising a plurality of straps **16** having corresponding ends bearing upon the workpiece W and their opposite ends bearing upon blocks **17** which may be removably supported on the disk **3**. The straps **16** are apertured for reception of an anchor bolt **18** having a threaded end that may be received in any one of a number of threaded openings **19** formed in the disk **3** and spaced 120° from one another as is indicated in FIGURE 1. The straps **16** may be caused to bear forcibly against the workpiece W by threading a nut **20** tightly against a washer **21** interposed between the nut and the strap **16**.

In those instances where an annular workpiece is supported on the disk **3**, a strap **16** of such size as to span the opening in the workpiece may be placed atop the latter and one of the studs **18** may be threaded into a threaded opening **22** formed in the post **5**, thereby requiring but a single anchor strap and post to clamp the workpiece on the fixture. It is to avoid interference between the supporting portions **15** of the pins **12** and the center stud **18** that one side of each part **15** is ground flat.

For the sake of clarity, the straps **16** are shown in the drawings as extending toward the center or reference point **11** of the fixture. In actual practice it is preferable that the straps **16** bear against the workpiece as close as possible to the points where the latter is supported by the members **12**, so as to avoid deflecting the workpiece between its supports.

In the illustrative embodiment of the invention, the distance between openings in any row of openings in the fixture has been stated to be one inch and the radial difference in spacing between the openings of successive sets of rows has been stated to be one-fourth inch. In such an arrangement, the provision of twenty-four pins **12** in three sets of eight pins each wherein the diameter *d* of the portion **14** of each pin in a set increases successively one-sixteenth inch, enables workpieces varying one-sixteenth inch in diameter to be accommodated on the fixture. If it should be desired to accommodate workpieces varying in diameter by one thirty-second inch, it would be necessary to provide three sets of sixteen pins each, having their diameters *d* varying by one thirty-second inch. Conversely, the provision of three sets of four pins each having their diameters *d* varying by one-eighth inch would enable the fixture to accommodate workpieces varying in diameter by one-eighth inch. In each instance the total difference in diameters of a set of pins equals one-half the spacing between openings in any row and twice the radial spacing between successive sets of rows.

The number of pins **12** and the amount of variation of the diameter *d* from one pin to another will depend, in large part, upon the sizes of the workpieces generally encountered in the machining operations, but in each case the total difference between the diameters *d* of a set of pins **12** equals half the difference of the spacing between openings in a row of openings and twice the radial distance between successive sets of rows of openings.

Apparatus constructed in accordance with the embodiment of the invention shown in FIGURES 1 and 2 can accommodate cylindrical or annular workpieces having outside diameters ranging from one and nine-sixteenths inches to ten and one-half inches. It will be understood, however, that larger diameter parts could be accommodated by making the fixture large enough to provide additional openings radially outwardly of the openings shown in the drawing.

To simplify the machine operator's task in orienting a particular workpiece on the fixture he will be provided with a chart of the kind illustrated in FIGURE 6, which includes the smallest and largest outside diameter part that can be accommodated on the fixture, and all other parts having diameters between the two extremes. It will be noted that the chart lists the workpieces in outside diameter variations of one-sixteenth inch. Adjacent each diameter listed on the chart is listed the opening of a row in which a particular work engaging member or pin should be inserted, and adjacent each pin location in the chart is the particular pin size that should be placed in the opening given. For example, assume that the workpiece illustrated in FIGURES 1 and 2 has an outside diameter of four and thirteen-sixteenths inches. The chart informs the workman that a pin having a diameter *d* of eleven-sixteenths inches should be placed in each of the openings D–3, D′–3, and D″–3. When such pins are placed in the appropriate holes, the workpiece W will be gripped by each of the pin portions **14** so as to fix the workpiece concentrically with the fixture, whereupon the machine may

be started to run through its programmed cycle of operations.

If a workpiece having a diameter of four and seven-eights inches, only one-sixteenth inch greater than the diameter of the workpiece just referred to, the openings D–3, D'–3 and D''–3 still will be used, but in this event a different set of workpiece supporting pins **12** will be used. The different set of pins will have their work engaging portions **14** formed to a diameter of five-eights inches, or one-sixteenth inch smaller than the pin diameter previously referred to.

Should a workpiece having a diameter more than one-fourth inch greater than the diameter of the workpiece W be substituted for the latter, then it would be necessary to place the work engaging pins in another series of holes. For example, if a workpiece has an outside diameter of five and one-eighth inches, pins having a diameter *d* of seven-eighths inch will be placed in each of the openings C–3, C'–3, and C''–3.

The apparatus shown in FIGURE 4 is the same as the apparatus previously described, except that the locating pins **12** are arranged to engage the inner surface of an annular workpiece W'. When the apparatus is used to clamp a workpiece with reference to its inside diameter, the chart shown in FIGURE 7 should be used. The fixture shown in FIGURE 4 can accommodate workpieces having inside diameters ranging from three inches to eleven and fifteen-sixteenths inches. The chart lists the pin locations and pin sizes for each one-sixteenth inch variation of the inside diameter. In order to find the proper locations for the pins **12** it is necessary only to measure the inside diameter of the workpiece W' and, using the chart, place the proper size pin in the appropriate opening. If it is found, for example, that the inside diameter of the workpiece W' is three and one-fourth inches, then pins having their work engaging portions **14** formed to a diameter of three-fourths inch should be placed in each of the openings B–5, B'–5 and B''–5, as is illustrated in FIGURE 4. Apart from the fact that the locating members **12** of the construction shown in FIGURE 4 are placed against the inside diameter surface of the workpiece, the apparatus and operation of the construction shown in FIGURE 4 is the same as that illustrated in FIGURES 1 and 2.

The fixture also is capable of accommodating square or rectangular workpieces of the kind shown at W'' in FIGURE 5. When using the fixture for such a workpiece, two identical pins **12** may be inserted in correspondings in two of three rows of a set, and other pins may be inserted in other openings to provide the necessary rigidity of support for the workpiece. The other pins may have different diameters *d* than the two pins first mentioned and they probably will have to be placed in rows other than the third row of the set in which the first two pins are located. Because of the adaptability of the fixture to accommodate workpieces differing in size by very small amounts, however, it is possible to support practically any size and shape workpiece so long as the length, width and/or diametral dimensions are less than the maximum diameters of the sets of rows.

The fixture has been disclosed as comprising four separate sets of radiating openings and wherein the difference between the radial dimension of successive sets of openings is equal to one-fourth the distance between openings of any set of openings. It is not essential that four sets of openings be provided, however. It would be possible to provide more or fewer sets of openings. Important considerations in constructing the fixture depicted are that the openings of each set be uniformly spaced from one another; that the total radial difference between the openings of successive sets be evenly divisible into the spacing between openings of a set of openings; and that the total difference between the diameters *d* of the locating pins **12** be equal to twice the difference of the radial distance between the openings of successive sets of openings.

The disclosed embodiment is representative of presently preferred forms of the invention, but is intended to be illustrative rather than definitive thereof. The invention is defined in the claims.

I claim:

1. A fixture for supporting workpieces of different sizes, said fixture comprising a body member having a plurality of sets of openings radiating from a reference zone, each of said sets having a plurality of rows of spaced apart openings; and a plurality of workpiece locating members, each of said locating members having a mounting portion adapted to fit in any opening of any of said sets of openings, and having a workpiece engaging portion a part of which is adapted to contact said workpiece and being of a size so related to the distance from said reference zone to the opening in which each of said locating members is mounted that the distance from the point of workpiece contact of said part of said engaging portion of each of said locating members to said reference zone corresponds to the distance between said reference zone and the contacted surface of a workpiece mounted on said body member.

2. The apparatus set forth in claim 1 wherein each of said workpiece locating members includes a workpiece supporting portion interposed between said mounting portion and said workpiece engaging portion.

3. A fixture for supporting workpieces of different sizes, said fixture comprising a body member having a reference zone from which extend at least three radiating rows of openings, the openings of each row being uniformly spaced apart from one another; and at least three sets of workpiece locating members, each of said locating members including a first portion for removable reception in any one of said openings and a workpiece engaging portion, the workpiece engaging portion of each of said locating members in each set thereof varying uniformly in size from the size of all other engaging portions of the set by an amount such that the total variation in sizes of all of the engaging portions of the locating members in a set is equal to at least one half the spacing between said openings.

4. The apparatus set forth in claim 3 wherein each of said locating members includes a workpiece supporting portion interposed between said engaging portion and said first portion.

5. A fixture for supporting different size workpieces, said fixture comprising a body member having a first set of rows of uniform openings radiating from a reference point, at least one other set of rows of uniform openings the same size as the first mentioned openings and radiating from said point along lines angularly spaced from the rows of said first set of rows, each of the openings of said first set of rows being uniformly spaced apart, each of the openings of said other set of rows being uniformly spaced apart, the radial dimension from said point to any opening of said first set of rows being different from the radial dimension from said point to any opening of said other set of rows; and a plurality of workpiece locating members each having a mounting portion adapted to be received in any of said openings, and each of said locating members having a workpiece engaging portion.

6. The apparatus set forth in claim 5 wherein the spacing between openings in each of said sets of rows is the same.

7. The apparatus set forth in claim 5 wherein said plurality of workpiece locating members comprises a number of such members for each row of openings and wherein the size of the engaging portion of each locating member of said number of members varies uniformly, the number of locating members for each row being such that the total variation in size of the engaging portions thereof equals at least one half the spacing between openings in such row.

8. The apparatus set forth in claim 7 including a workpiece supportnig portion on each of said locating members and interposed between said mounting portion and said engaging portion, the supporting portion of each of said number of locating members varying in size in accordance with the variation in size of said engaging portion.

9. A fixture for supporting different size workpieces, said fixture comprising a body member having a plurality of sets of uniform openings radiating from a reference point, each of said sets of openings comprising three rows of openings uniformly spaced circumferentially, the openings in each set of rows being uniform in size and uniformly spaced radially from one another, the radial distance from said reference point to any opening of one set of openings being different from the radial distance from said point to any opening of any of the other sets of openings, the total difference in said radial distances between openings in said sets being evenly divisible into the spacing between openings of any of said sets of openings; and a plurality of sets of locating members for each row of openings of a set of openings, each of said locating members having a mounting portion adapted to fit in any opening of any of said sets of openings and having a workpiece engaging portion adapted to engage a workpiece, the engaging portion of each locating member in a set varying in size by an amount such that the total variation in size of all of the engaging portions of a set of locating members is equal to twice the difference of the

radial distance between openings of successive sets of openings.

10. The apparatus set forth in claim 9 wherein there are four sets of openings and wherein the difference between radial distance between openings of successive sets is one-fourth the spacing between openings of any set of openings.

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