June 7, 1938. W. S. PRAEG 2,120,041

BROACH

Filed May 24, 1937

FIG. 1.

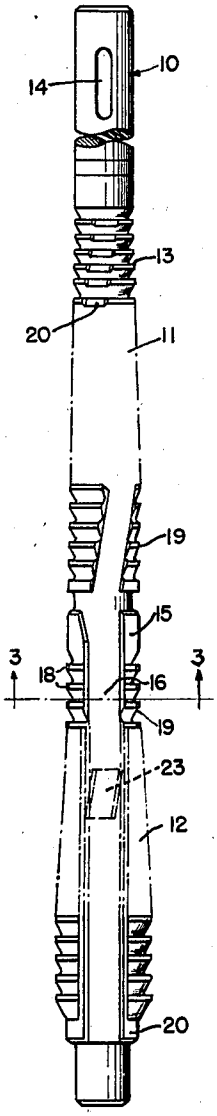


FIG. 4.

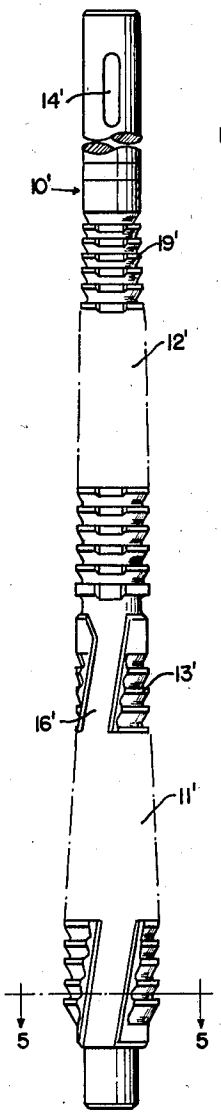


FIG. 3.

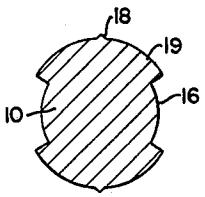


FIG. 2.

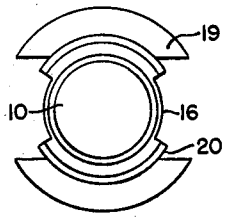


FIG. 5.

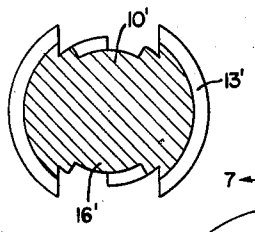


FIG. 6.

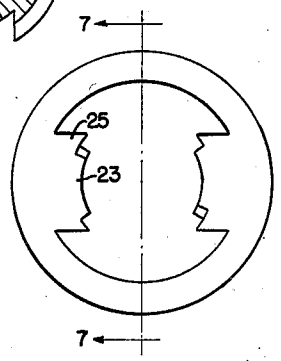
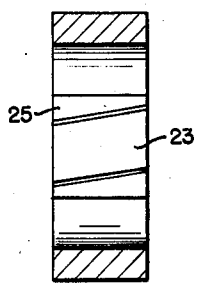


FIG. 7.



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BROACH

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Application May 24, 1937, Serial No. 144,515

11 Claims. (Cl. 29—95.1)

This invention relates to broaching and has for a particular object the construction of a broach adapted to form both a spiral and a straight spline or groove in a single operation.

It is a further object of the invention to provide a broach which will, in the first part of its movement, form a spline or groove of a predetermined angularity. During the completion of the movement of the broach, the broach will be guided by the spline or groove first formed engaging the broach to form a second spline or groove of an angularity different from the first.

It is a further object of the invention to provide a broach with teeth arranged in a spiral row from end to end which is adapted to establish and maintain accurate spiral guiding action solely by the engagement of the broach with the work piece.

Other objects will be apparent from the following specification when taken in connection with the drawing in which

Figure 1 is an elevation of one form of broach constructed in accordance with my invention;

Figure 2 is an end view taken from the bottom of Figure 1;

Figure 3 is a section taken on the lines 3—3 of Figure 1;

Figure 4 is an elevation of the modified form of broach;

Figure 5 is a section taken on the lines 5—5 of Figure 4;

Figure 6 is an end elevation of a piece broached by the broach illustrated in Figure 1;

Figure 7 is a section taken on the lines 7—7 of Figure 6.

I have illustrated in Figure 1 one embodiment of my invention. In this figure I have indicated at 10 a broach which comprises two sections 11 and 12. Section 11 is adapted to establish and maintain a spiral guiding action while forming a spiral spline in the work piece. Section 12 is adapted to receive the spiral spline formed by the first section in a straight groove 16 and to guide the broach while teeth on the second section or straight splines or grooves. The broach at the entering end has an aperture 14 adapted to be connected to suitable mechanism for drawing the broach through the work. Teeth 13 in the first section of the broach are of gradually increasing height from end to end, have a spiral groove 20 therein, and will form a spiral spline. These teeth may be formed according to the teachings of my copending application, Serial No. 139,082, filed April 26, 1937. For example, the first few of the teeth may be of lesser width than the groove to be formed and will establish and maintain accurate spiral guiding action. These teeth are of lesser pitch than is standard for a broach of the diameter used. This reduction in pitch will permit a plurality of teeth to come into guiding engagement with the work upon a correspondingly reduced length of travel of the broach relative to the work. The succeeding teeth are wider and will finish the groove or spline to final desired width and depth. The last few teeth 19 of this section of the broach are of uniform diameter and are adapted to impart a final finish to the spline or groove finished by this section of the broach. Making these teeth the same diameter also provides for a series of teeth which will finish the work to desired dimensions after the first or second tooth of these series has become worn.

Intermediate the sections 11 and 12 is a cylindrical dwell 15. Beginning at this dwell is the groove 16 which continues throughout the second section at a uniform width and diameter. The width of this groove 16 is sufficiently greater than the normal width of the spline 23 formed by the section 11, so that the spline will be received in the groove at an angle thereto. The groove will guide the spline and therefore the broach, while the section 12 performs its cutting operation. The section 12 has segmental cylindrical portions 20 with the aforesaid groove 16 formed therein. Suitably arranged on this cylinder are a plurality of teeth 19 which may be of any desired configuration. As shown in Figure 1, these teeth are arranged to cut straight grooves of considerable circumference. It will be obvious, however, that they may be relatively narrow and may cut straight splines or grooves of any desired configuration or dimension. As in the first section, the last few teeth are of uniform diameter, for the same purpose as specified for the teeth in section 11. The first few entering teeth of section 12 have chisel points 18 which are adapted to assist in initiating the straight guiding action desired for the second section of the broach.

The operation of the broach is apparent from the foregoing description. As the broach enters the work, which may rotate relative to the broach due to rotatable mounting of either the broach or the work, the first few of the teeth 13 will establish a spiral guiding action. Three or four teeth are sufficient to accomplish this. These entering teeth are somewhat narrower than the final teeth, so that when the work has reached the dwell 15, the work has a smooth cylindrical

hole broached therein with an accurately finished spline **23**. This spline **23** is at a predetermined spiral angle.

This spline will enter the straight groove **16** while the work is over the dwell. Since groove **16** continues through the part **12** at uniform width and diameter, the spline **23**, which is received therein at an angle thereto, will prevent rotation of the work relative to the spline.

While the straight cut is being initiated by the first few of teeth **19**, the straight guiding action is assisted by chisel teeth **18**. These teeth form a shallow groove, which is removed by teeth further toward the rear of the broach.

In this manner, having once formed a spline or groove in a work piece by the first part of a broach, it is possible to use this spline or groove with a cooperating part on the second section to obtain accurate guiding action for the second cut.

It will be obvious that the arrangement of parts may be different, in that the first section of the broach may be adapted to form a straight spline and the second section of the broach may be formed with a spiral groove adapted to receive this straight spline and guide the broach by the engagement of the spline and groove. Such an arrangement is illustrated in Figure 4. The arrangement of parts in Figure 4 constitutes merely a reversal of Figure 1 and will be described only briefly.

In this figure the first section **12'** of the broach **10'** has teeth **19'** forming a straight spline and the second section **11'** has a spiral groove **16'** therein of sufficient width to receive the straight spline at an angle thereto. This straight spline serves as guiding means in the spiral groove. In addition, the first few entering teeth of the teeth **13'** of the section **11'** may be narrower than the final desired groove width, and of reduced pitch, as mentioned in connection with the teeth **13** of Figure 1, and as more fully described in my above mentioned copending application Serial No. 139,082, filed April 26th, 1937.

Figures 6 and 7 illustrate a piece broached by a broach as illustrated in Figure 1. It will be noted in these figures that the spline **23** formed by the first section is angularly related to the work piece and the spline **25** formed by the second section of the broach is parallel to the axis of the work piece.

As a specific example, a broach may be formed according to the teachings of Figures 1 to 3 with the following dimensions. The first section **11** has substantially 43 teeth each adapted to take a cut of .005 inch. These teeth are arranged at a right hand spiral angle of 7° and the last few teeth will finish the inside diameter of the broach to 1.185 inches, leaving a spiral spline of a height of .234 inch. The two sections of the broach **11** and **12** may be spaced apart by a dwell **15** which may be substantially an inch in length, if the work piece is less than an inch in length. This dwell is to permit the teeth of the first part to be entirely free from the work piece before the teeth of the second part come into engagement therewith. In any case, the dwell **15** is to be longer than the work piece. The straight groove formed in the second part of the broach will have a width of .348 inch as measured with .125 inch diameter pins. The width of the spiral spline as measured with the same pins may be .2172 inch. This difference in width is to permit the spiral spline to be received in the straight groove at an angle thereto. The first few teeth on the spiral end of the groove may have a pitch of ¼ inch and the remaining teeth may have a pitch of $\frac{A}{16}$ inch. The teeth on the second section of the broach, which may be substantially 75 in number, may increase from an outside diameter of 1.190 inches to 1.581 inches, thus forming a straight groove with a depth of .391 inch.

While I have illustrated my invention as applied to internal broaches for cutting spiral and straight splines or grooves in a single operation, it will be evident that it is not limited to such use. For example, broaches may be constructed according to this teaching which will cut spiral splines or grooves of different spiral angles. Also, it will be apparent that the invention may be practiced with an external broach adapted to cut either a straight and a spiral spline or groove or two spiral splines or grooves of different spiral angles. Therefore while I have illustrated two preferred embodiments of my invention, I do not desire to be limited thereto, as it will be apparent to those skilled in the art that various additions, modifications, omissions and substitutions may be made as will be within the spirit and scope of my invention as defined in the appended claims.

What I claim as my invention is:

1. A broach for taking a spiral cut and a straight cut in a single operation comprising a first section, and a second section, said first section having teeth adapted to establish and maintain proper guiding action while taking one of said cuts, guiding means on said second section cooperating with said first cut to guide said broach relative to the work, and teeth on said second section, said teeth being guided by said guiding means and said first cut, while completing said second cut.

2. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section having a series of teeth of gradually increasing height, followed by a plurality of finishing teeth of equal size, said teeth being arranged to establish and maintain suitable guiding action while cutting one of said splines, a second section having a series of teeth of gradually increasing height followed by a plurality of finishing teeth of equal size, said second section having a groove adapted to receive said spline formed by the teeth of said first section and to guide said broach relative to said work so that the teeth of said second section will cut said other spline.

3. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with teeth of gradually increasing height and arranged in a spiral row from end to end, whereby said spiral teeth will establish and maintain a spiral guiding action while cutting said spiral spline, a second section adapted to cut a straight spline having teeth arranged in a straight row and of gradually increasing height, a straight groove in said second section of such width as to receive said spiral spline and therewith to guide said broach without relative rotation while said straight teeth cut a straight spline.

4. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with teeth of gradually increasing height and arranged in a spiral row from end to end, whereby said spiral teeth will establish and maintain a spiral guiding action while cutting said spiral spline, a second section adapted to cut a straight spline having teeth arranged in a straight row and of gradually increasing height, a straight groove in said sec-

ond section of such width as to receive said spiral spline and therewith to guide said broach without relative rotation while said straight teeth cut a straight spline, the first few teeth of said second section having chisel points in a straight row at their tops to assist in establishing the straight guiding action as said second sections of teeth begin to cut said work.

5. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with a series of teeth of gradually increasing height and arranged in a straight row from end to end, said teeth adapted to establish and maintain correct guiding action while cutting said spline to required depth, a second section comprising a series of teeth of gradually increasing height arranged in a spiral row from end to end, and guiding means on said second section comprising a spiral groove of the same lead as the desired spiral spline and of a width to accommodate said straight spline cut by said first section, and therewith to guide said broach while said second mentioned teeth cut said spiral spline.

6. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with teeth of gradually increasing height and arranged in a spiral row from end to end, whereby said spiral teeth will establish and maintain a spiral guiding action while cutting said spiral spline, a second section adapted to cut a straight spline having teeth arranged in a straight row and of gradually increasing height, a straight groove in said second section of such width as to receive said spiral spline and therewith to guide said broach without relative rotation while said straight teeth cut a straight spline, and a round pilot portion intermediate said first and second sections, provided with a groove interconnecting said groove in said section with the groove between the teeth of said first section.

7. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with a series of teeth of gradually increasing height and arranged in a straight row from end to end, said teeth adapted to establish and maintain correct guiding action while cutting said spline to required depth, a second section comprising a series of teeth of gradually increasing height arranged in a spiral row from end to end, and guiding means on said second section comprising a spiral groove of the same lead as the desired spiral spline and of a width to accommodate said straight spline cut by said first section, and therewith to guide said broach while said second mentioned teeth cut said spiral spline, and a round pilot portion intermediate said first and second sections, provided with a groove interconnecting said groove in said section with the groove between the teeth of said first section.

8. A broach for forming a spiral spline and a straight spline in a single operation, comprising a first section with teeth of gradually increasing height and arranged in a spiral row from end to end, the first few of said teeth being of lesser width than said spline to be cut, the balance of the teeth in this section being of full width, whereby said spiral teeth will establish and maintain a spiral guiding action while cutting said spiral spline, a second section adapted to cut a straight spline having teeth arranged in a straight row and of gradually increasing height, a straight groove in said second section of such width as to receive said spiral spline and therewith to guide said broach without relative rotation while said straight teeth cut a straight spline.

9. A broach comprising two sections, adapted respectively to form a spiral spline and a straight spline in a single operation, said first section shaped to form one of said splines, means on said second section to guide said broach by engagement with said first spline, said second section being shaped so as to form said second spline when guided by said means.

10. A broach comprising two sections adapted to form two separate splines of different spiral angles, said first section shaped to form one of said splines, means on said second section to guide said broach by engagement with said first spline, said second section being shaped so as to form said second spline when guided by said means.

11. A broach for forming two splines of different angularity in a single operation, comprising a first section with teeth of gradually increasing height arranged in a row from end to end, whereby said teeth will establish and maintain guiding action while cutting said spline, a second section adapted to cut a spline of a different angularity having teeth arranged in a row having a different angularity from said first row of teeth and of gradually increasing height, a groove in said second section of such width as to receive said first spline, said groove being of the same angularity as the teeth of second section, whereby to guide said broach relative to the work while the teeth of said second section cut a spline.

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