P. P-G. HALL

MILLING CUTTER.

APPLICATION FILED MAR. 24, 1920.

1,415,339.

Patented May 9, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

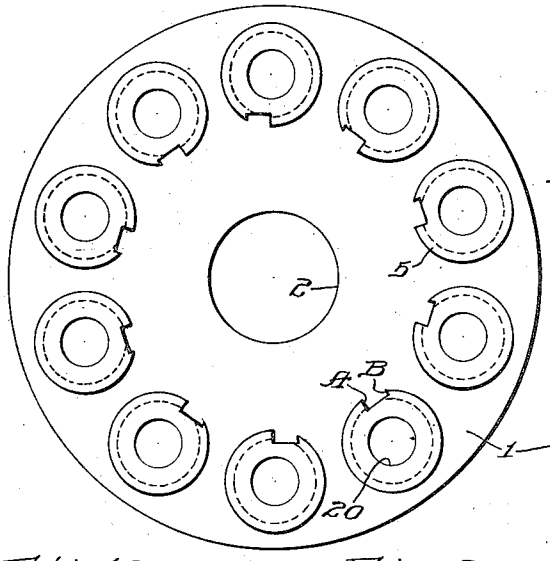


Fig. 2.

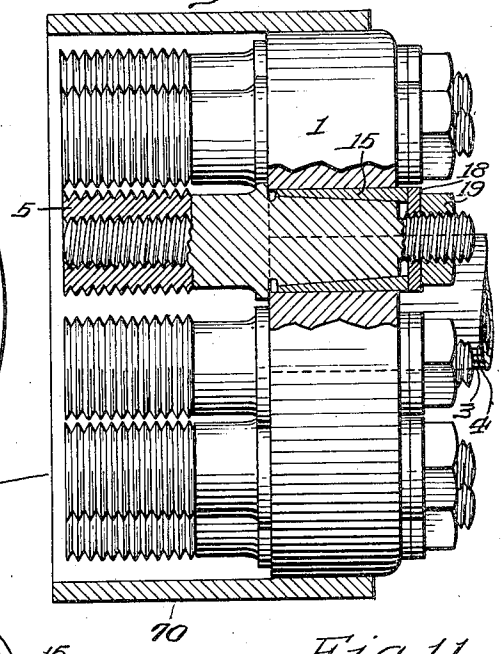


Fig. 10.

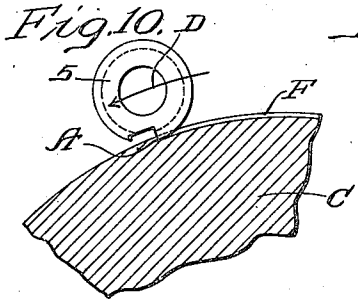


Fig. 3.

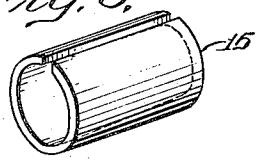


Fig. 11.

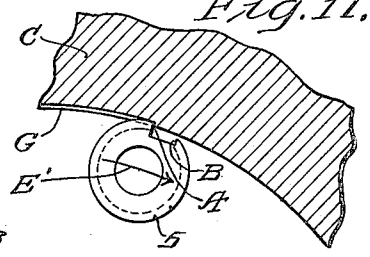


Fig. 4.

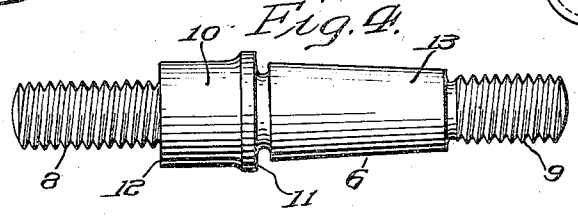


Fig. 15.

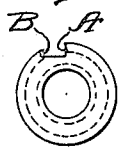


Fig. 16.

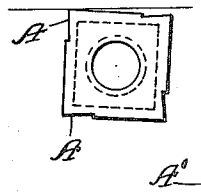


Fig. 17.

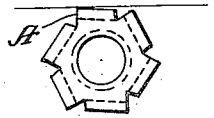


Fig. 18.

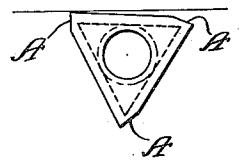


Fig. 19.



Inventor.
Peter P.G Hall,
By Blount, Moulton & Hebert
Attorneys

P. P-G. HALL.

MILLING CUTTER.

APPLICATION FILED MAR. 24, 1920.

1,415,339.

Patented May 9, 1922.

2 SHEETS—SHEET 2.

Fig. 5.

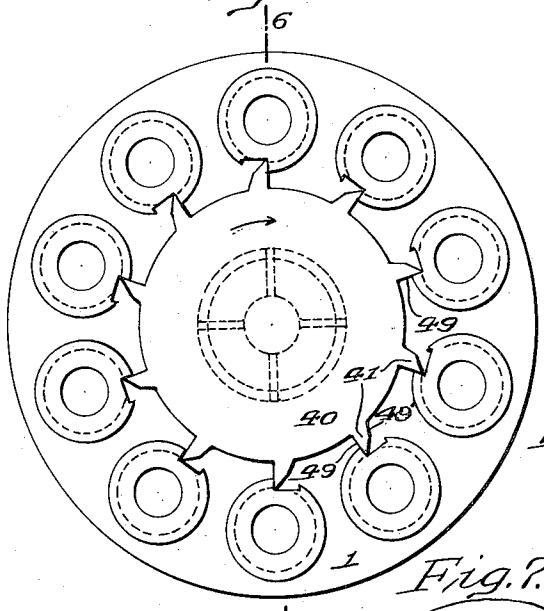


Fig. 6.

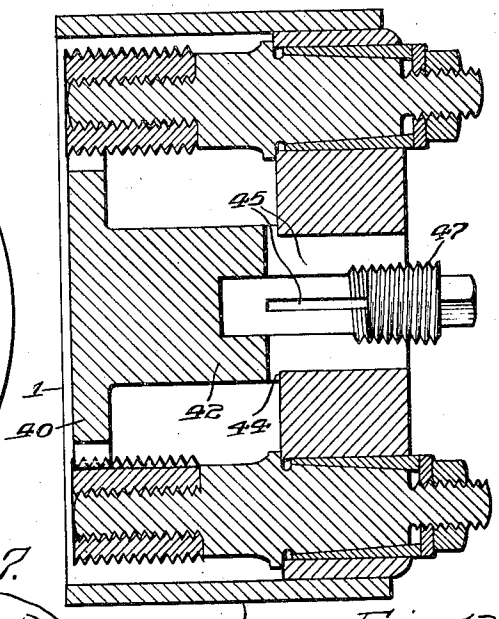


Fig. 7.

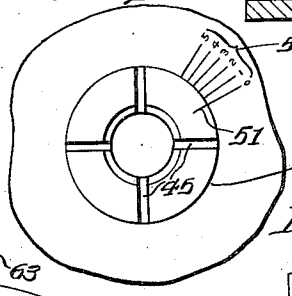


Fig. 12.

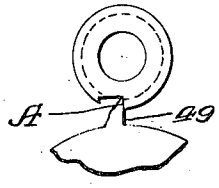


Fig. 13.

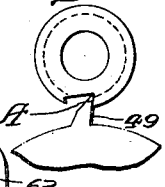
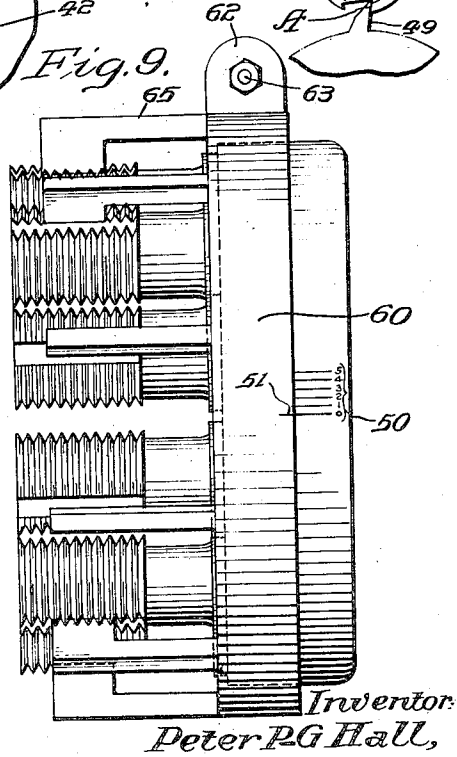


Fig. 8.

Fig. 9.



Inventor:
Peter P.G Hall,
By Blount, Moulton & Hibbert
Attorneys

UNITED STATES PATENT OFFICE.

PETER P-G. HALL, OF PHILADELPHIA, PENNSYLVANIA.

MILLING CUTTER.

1,415,339. Specification of Letters Patent. Patented May 9, 1922.

Application filed March 24, 1920. Serial No. 368,239.

To all whom it may concern:

Be it known that I, PETER P-G. HALL, a citizen of the United States, and a resident of the city of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Milling Cutters, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to milling cutters and is particularly adapted for cutting threads with machines of the general character of that shown in U. S. Letters Patent No. 1,316,718, granted to me September 23, 1919 for planetary metal-working machine, although my invention, if desired, may be conveniently employed for other purposes besides thread cutting, either with machines of the general type shown in my said patent or of other forms and types.

In milling threads, either external or internal, it has been customary to employ a single cutter provided with any desired number of threads per inch but without pitch, the cutter being ground so as to form therein a plurality of longitudinally extending grooves, thus affording a plurality of cutting surfaces. A cutter through the medium of the said patented machine, or otherwise, is revolved eccentrically about the work on which the thread is to be cut and simultaneously rotated on its own axis until the cutting edges or teeth of the cutter are advanced into the work for a sufficient distance to produce the full depth of thread, after which the cutter, continuously rotating on its own axis, is carried around the work and simultaneously advanced for a sufficient distance to produce the desired helical thread thereon.

Although cutters of the general character of that referred to above are ordinarily formed from the highest grades of alloy steel, materials which are of relatively great cost, they frequently become dull, necessitating regrinding of the cutting faces formed by the longitudinal grooves as aforesaid; an operation which of course tends to widen the grooves and diminish the amount of metal in the rear of the cutting faces. Since each cutter is provided with a plurality of these grooves, the amount of metal in the rear of each cutting face, even of a new cutter, is rather limited, and as each sharpening operation diminishes the same by an amount equal to the amount of metal ground off, the life of the cutter is relatively short. In addition to the above, the metal in the rear of the cutting faces "drops off" radially whereby each successive grinding presents new cutting faces of less radial magnitude than the preceding cutting faces. Accordingly, after each grinding it is necessary, for obtaining accurate results, to adjust the relation of the cutter and the work to compensate for the reduced cutting radius of the cutter elements. By my invention, however, the material in the rear of the cutting surface on each cutting element does not "drop off" radially but is uniform in radial extent so that successive grinding of the cutting surface does not reduce the magnitude of the newly presented cutting face as in the old form of cutter.

Moreover, as is well known, in order to secure most efficient results in milling different sorts of metal, the angle between the metal in the rear of the cutting face and the surface of the work must be varied, or to use the term generally employed by tool makers, the cutter should be "backed off" in different amounts for operation on different sorts of metal. As this backing off is effected by suitably grinding the cutter when it is being made and ordinarily before it is hardened, it is obvious that a plurality of cutters must be kept on hand each adapted for use with a particular kind of metal, and that the proper cutter must be selected and employed for each different job, depending on the character of the metal upon which the cutting operation is to be performed.

Among the principal objects of my invention are to provide a milling cutter adapted for milling threads or for performing other milling operations which will afford a plurality of cutting surfaces or faces, each formed in a separate cutting element composed of suitable cutting material, these cutting elements being so designed that a maximum amount of metal is provided in the rear of each cutting face or surface, so that the cutters may be resharpened a great number of times with successively presented cutting surfaces of uniform size and shape before all of the metal in the rear of the cutting surfaces or faces is exhausted, thus greatly prolonging the life of the cutter and materially decreasing the cost of operation thereof, as well as avoiding the necessity of relative adjustment of the cutting elements

and the work after each grinding of the cutting faces of the cutter.

Further objects of my invention are to provide a milling cutter comprising a plurality of independent yet corelated cutting elements affording a plurality of cutting faces or surfaces and in which the several cutting elements may be accurately and quickly adjusted or backed off the requisite amount for maximum efficiency of operation with the particular metal on which the cutting operation is to be performed. These elements may be employed in any number desired.

Further objects of my invention are to provide a milling cutter embodying the foregoing characteristics and advantages which may be employed for the purpose of milling threads or performing other milling operations either on the exterior or the interior of any given piece of work as may be desired in connection with any suitable form or type of actuating machine; which may be quickly and accurately adjusted for these operations by an ordinary mechanic, and which is adapted to accurately, efficiently and economically perform the various operations for which it is intended.

My invention further includes all of the other various objects and novel features of construction and arrangement hereinafter more definitely specified and described.

In carrying out my invention I may employ any suitable combination and arrangement of instrumentalities adapted to bring about the results intended, but for the purpose of enabling those skilled in the art to comprehend the invention I have illustrated in the accompanying drawings and will now describe a preferred embodiment thereof which is adapted for milling either external or internal threads when actuated by a suitable machine, for example, such as is shown in my Patent No. 1,316,718, hereinbefore referred to.

In the drawings, Fig. 1 is a front elevation of the cutter removed from its supporting arbor, the cutting elements being in position for cutting external threads; Fig. 2 is a side elevation, partially in section, of the cutter shown in Fig. 1 and supported on a suitable arbor; Fig. 3 is a perspective view of a detail of the device and Fig. 4 an enlarged side elevation of one of the cutting element supporting studs. In Figs. 5 and 6, which are respectively a front elevation and a transverse section of the cutter shown in Figs. 1 and 2, I have illustrated a method of setting the cutting elements to the proper position for operating upon any given piece of work, while Fig. 7 is a fragmentary rear elevation of the cutter shown in Fig. 5 showing the rear end of the setting gauge employed in setting the cutting elements. In Figs. 8 and 9 I have illustrated the operation of setting the cutters for cutting internal threads, Fig. 8 being a front elevation of the cutter with the setting gauge in position, and Fig. 9 a side elevation thereof. Figs. 10 and 11 are enlarged fragmentary views in section of relative positions of a cutting element and the piece of work operated upon for cutting external and internal threads respectively. Figs. 12 and 13 each are respectively detail views showing a single cutting element and a portion of the setting gauge shown in Figs. 5 and 6 with the latter in different positions for effecting different adjustments of the cutting elements, and Fig. 14 is a detail view in end elevation of a preferred form of cutting element showing the appearance of the same after it has been sharpened a large number of times, the broken lines indicating the metal which has been removed in the sharpening operation. In Figs. 15, 16, 17 and 18, I have shown in end elevation a number of different forms of cutting elements which may be employed in the cutter, although it will be understood that forms other than those shown may be utilized if desired, the said figures being merely illustrative of cutting elements of different types.

The form of cutter shown may conveniently comprise a circular base plate 1 provided with a centrally disposed aperture 2 suitable for the reception of an arbor 3, by means of which the cutter is supported in the machine, the arbor being preferably provided with a central aperture 4 through which oil or other lubricant may be pumped during the cutting operation. The base plate serves as a support for the cutting elements 5, which are disposed in operative relation around the plate at equal distances from its center, each of the elements being conveniently supported in fixed operation relation with the plate in any convenient manner. In the form of the invention shown, each cutting element, which it will be understood is formed of suitable alloy steel or other cutting material, preferably in one of the forms and in the manner hereinafter described, is mounted on a stud 6 of the form best shown in Fig. 4 and which may preferably comprise threaded end portions 8 and 9, a boss 10 terminating in shoulders 11 and 12 and a conical portion 13, which is adapted for engagement in a split collet 15, Fig. 3, longidudinally tapered in conformity with the tapered portion of the stud and the exterior of which is preferably cylindrical and of a diameter to normally conveniently enter one of the cylindrical apertures with which the base plate is provided.

Each stud is adapted for reception on its threaded end 9 of a washer 18 and a nut 19, and it will be evident that by entering the studs in the apertures in the plate 1, with the shoulders 11 thereof in intimate contact with the face of the base plate, slipping the tapered collets over the tapered

portions of the studs, and setting up on the nuts 19 against washers 18 interposed between the ends of the collets and the nuts, the tapered collets will be wedged or jammed firmly between the tapered or conical portion 13 and the surface of the cylindrical bores or apertures provided in the base plate 1, whereby the shoulders 11 of the studs may be drawn forcibly against the face of the base plate and the studs held in rigid operative relation with respect thereto in any desired position to which they may have been rotated about their longitudinal axes before the nuts 19 were finally tightened in the manner aforesaid.

The cutting elements 5 are formed from suitable alloy steel or other material and are arranged to be supported on the studs in any suitable manner to maintain an operatively rigid relation therewith, and for this purpose each element may preferably comprise a central internally threaded aperture 20 adapted for reception of the threaded portion 8 of its respective stud, so that the elements may be readily assembled on the stud against the shoulders 12 or removed therefrom.

It will be understood, however, that other means of assembling and maintaining the elements on the studs may be employed if desired in constructions in which the elements are made separate from the studs. For example, the elements might be keyed on the studs or brazed or otherwise secured thereto, and under certain conditions the cutting elements and studs might be made integral as from a single piece of material, although such construction would enhance the cost of the cutter through the increased amount of alloy steel or other cutting material necessitated thereby. Moreover, it will be understood that means other than those illustrated may be employed for supporting the studs on the plate and providing for their axial adjustment in the operation of setting the cutting elements hereinafter described.

As stated, the cutting elements themselves may be of any suitable or preferred form, for example as shown in Figs. 15 to 18, inclusive, but I have found that extremely satisfactory results can be obtained and a maximum economy of cutting steel effected when the elements are made in the form of cylinders internally threaded as hitherto described for attachment to the supporting studs and provided on their exteriors with a suitable number of threads per inch of the desired depth and inclination but without pitch, so that in effect the threads form a plurality of longitudinally disposed peripheral unconnected ridges on the cutting element. In order to provide the cutter with a cutting face or surface, a slot is milled or otherwise formed longitudinally thereof in depth at least equal to or preferably greater than the depth of the threads thereof, and while this slot may be of any suitable form, I prefer to make it substantially in the form of a keyway having its bottom at right angles to its walls or sides, one of which is preferably directed radially of the cutting element, as best shown in Fig. 15, so that when the operation is finished one of the parallel sides of the slot will lie in a plane passing through the center of the element while the other will lie in a plane substantially parallel to but not including the center or axis of the cutting element. The first of these sides, namely that lying in the radial plane, forms the cutting surface or face of the element, and it will be apparent that this face may be ground back in the operation of resharpening the cutter for a distance nearly equal to the circumference of the element extending from the initial cutting surface or face to the face on the opposite side of the initially formed slot, as clearly shown by Fig. 14, before reaching a point beyond which there is insufficient metal between the last ground cutting face and the face on the opposite side of the initially formed slot to properly support the former during the cutting operation. For convenience, in the various figures of the drawing, I have designated the cutting faces of the various elements as A, and in the preferred form of cutting element, (see Fig. 15), to produce the best results in operation these faces will ordinarily be disposed in a plane intersecting or coincident with the central longitudinal axis of the cutting element, the opposite face B ordinarily not including said axis and being preferably substantially parallel to the original or initial cutting surface A. In resharpening the elements the cutting face A will preferably always be maintained in a radial plane, as best shown in Fig. 14, in which the metal has been successively ground away from the point A to the point A′ following the direction of the arrow. While under some conditions it may be desirable to grind off the face B to afford greater clearance or for other reasons, I prefer to maintain this face substantially normal to a plane tangent to the periphery of the element at the outer edge of the initial cutting face A, so that a suitable spanner wrench can be engaged with the face B to conveniently unscrew the element from its supporting stud.

It will be understood that as the operation of milling threads is one requiring extreme accuracy of adjustment of the machine and cutting devices employed therewith, and as in the particular form of milling cutter herein described the corresponding portions of the several threads on each of the cutting elements must ordinarily lie in a plane normal to the central axis of the base plate 1,

it is requisite that the several cutting elements shall be similar and shall be maintained at exactly the same distance from the face of the base plate, to accomplish which result means must be provided either for rigidly and relatively permanently securing the cutting elements to the studs, as by brazing them thereto, or else when the elements are arranged for removal from the studs as in the preferred form of the invention, the direction of the screw threads 8 must be such as to prevent the elements from backing off the studs during the milling operation, and for a similar reason the threads 9 on the other ends of the studs must be so arranged as to prevent the stud from unscrewing and backing out of the base plate under similar conditions. To accomplish these results, both sets of threads on each stud are therefore preferably made left handed when the cutter is to be used in the operation of cutting either a right hand or left hand external thread, and are preferably made right handed on the stud when the cutter is to be used for cutting either a right hand or left hand internal thread, under which conditions the resistance afforded by the work to the passage of the cutting elements therethrough will tend to force the elements against the shoulders 12 of the studs, and similarly tend to tighten rather than loosen the studs in the base plate. However, in case the elements are secured to the studs in a manner different from that shown in the drawing or are made integral therewith, or means other than those embodied in the preferred form of the invention employed to hold the studs in adjusted relation in the base plate, other suitable precautions may be employed or other means adopted for maintaining the cutting elements and studs in proper relation with the base plate.

It will be observed that the cutting elements in performing their cutting operation upon a piece of work C (Figs. 10 and 11), whether cutting an external or internal thread, rotate about the axis of the tool or tool assembly, not about their individual axes, the direction of movement of each cutting element being that indicated, for the purpose of illustration, by the arrow D in Fig. 10 for cutting an external thread and the arrow E in Fig. 11 for cutting an internal thread. The slot between the faces A and B is so cut, and each cutting element is so arranged relative to the piece of work operated upon, that the point of intersection of the face B and peripheral edge of the cutting element clears the uncut portion of the piece of work C, as clearly shown in Figs. 10 and 11, but the face A, being located in a radial plane of the cutting element, as well as of the piece of work when rotating about the axis of the tool assembly or the piece of work as indicated by the arrows D and E of Figs. 10 and 11, will enter the work the requisite depth for cutting the thread, indicated at F and G in Figs. 10 and 11 respectively.

Since, as previously stated, it is frequently necessary to resharpen the cutting elements, an operation ordinarily requiring their removal, as well as the removal of the studs from the base plate, means are preferably provided for resetting the cutting elements after they have been sharpened in suitable adjustable relation for the performance of their function, and for this purpose I preferably provide suitable setting gauges, by means of which the cutting elements may be conveniently, rapidly and properly set in a position to perform their intended function. While these gauges may be of any suitable or preferred form, convenient types thereof are shown in Figs. 5 to 9 inclusive, the gauge in the first three figures being suitable for adjusting the cutting elements in position for cutting threads where the work is positioned inside of the circle formed by the cutting elements on the base plate, and the gauge shown in Figs. 8 and 9 being suitable for setting the cutting elements where the thread cutting operation is to be performed on a piece of work held on the outside of the cutter and about which the cutter is caused to revolve.

Referring more particularly to Figs. 5, 6 and 7, the form of gauge shown therein may preferably comprise a substantially circular plate 40 provided with a plurality of radially projecting offsets or gauging elements 41 in number preferably similar to the number of cutting elements on the cutter with which the gauge is intended to be used. Projecting rearwardly from the plate and coaxial therewith is a preferably integral shank 42 of sufficient length to extend through the central aperture of the base plate when the outer face of the plate 40 is substantially flush with the outer extremities of the cutting elements, the shank being provided with a shoulder 44 adapted to engage the base plate and the rear end of the shank being of a diameter to snugly engage in aperture 2. Means are provided for holding the shank in adjustably fixed relation with the base plate which may conveniently comprise a plurality of slots 45 in the end of the shank and means for expanding the shank in the aperture, such as a tapered pipe plug 47 which may be screwed into an internally threaded central aperture in the end of the slotted shank to expand the latter sufficiently to hold it in any desired position with respect to the base plate.

Each of the gauging offsets 41 preferably comprises a face 49 disposed in a plane radial with respect to the base plate, the opposite side or face 49′ of the offset being shaped in any appropriate manner to enable

the point of the offset to conveniently enter the slot in the cutting element.

When it is desired to set the several cutting elements in proper position on the base plate the elements and their supporting studs are first assembled loosely on the plate, the shank of the setting gauge positioned in the aperture 2 and the pipe plug or other gauge positioning means placed in position but not screwed up so tightly as to prevent movement of the gauge. The latter is now turned to a predetermined position depending upon the nature of the material upon which the cutter is to operate, and then the pipe plug, or other position setting means, may be screwed into place so as to fix the gauge with respect to the base plate. The various cutting elements are now turned with their supporting studs so as to bring their cutting faces A into contact with the gauge faces 49 of the offsets and fixed in position with respect to the base plate by means of the nuts 19 or other means employed for that purpose. After all the cutting elements have been adjusted, the setting gauge is removed from the base plate and the cutter restored to its position on the arbor 4 preparatory to the milling operation.

It will be evident that the angular disposition of the gauge on the base plate will determine the position of the cutting faces A of the cutting elements and that as the gauge is advanced in the direction of the arrow in Fig. 5 the angle between the tangent to the cutting element at the cutting point and a line normal to the gauge face 49 of the adjacently positioned offset will be increased, or in other words, that the cutter will be backed off for any desired amount, thus enabling the various cutting elements to be properly set for most efficient operation with the particular metal in which the milling operation is to be performed. In order to assure the proper angular position of the setting gauge, I prefer to provide indicating means by the use of which the gauge may be brought with certainty to any desired position, a convenient embodiment of such means being shown in Fig. 7 and comprising a plurality of radial marks 50 on the back of the base plate and an index 51 on the adjacent end of the shank 42. Such an arrangement enables the operator to properly position the gauge for setting the cutters for operation in any given manner, since the marks 50 may be arranged either to indicate degrees or arranged in accordance with a table in which a number is assigned to each of the different kinds of metal with which the cutter may be employed, so that in setting the gauge the operator may either bring the index to the gauge mark showing the number of degrees of backing off which is proper for efficient operation on the kind of metal to be operated upon or else to the gauge mark opposite the number arbitrarily assigned to that metal in the table, thus insuring an accurate and proper setting of the cutter for the work to be formed.

After the position of the cutting face A is determined so as to give the proper amount of backing off, as aforesaid, the face A may be, and preferably is, ground back so as to be located in a plane substantially normal to the plane tangent to the piece of work at the cutting point. The face A will therefore generally not lie normal to a tangent to the cutting ridge of the cutting element at the apex of the cutting face A but at an angle thereto less than a right angle measured in the rear of the face A.

In Figs. 8 and 9 I have illustrated a form of gauge suitable for setting the cutting elements when the cutter is to be used for milling operations by revolving the same around the exterior of a piece of work to cut external threads thereon or around its interior when cutting internal threads, such gauge consisting of a transversely split band 60 provided with a pair of outwardly directed lugs 62 adapted for reception of a clamping or binding bolt 63 by means of which the band may be fixedly clamped around the periphery of the base plate 1. The band is provided with laterally directed offsets 65, the outer ends of which are turned inwardly and formed with faces 49 for engagement with the cutting faces of the cutting elements in a manner substantially similar to that already described and also with an index 51 cooperating with gauge marks 50 on the periphery of plate 1, by means of which the gauge may be positioned to secure the desired adjustment of the cutting elements in the manner similar to that above described.

For insuring adequate lubrication for the cutting surfaces during the milling operation I prefer to provide a suitable sleeve 70 which may be slipped over and frictionally positioned or otherwise suitably maintained on the base plate 1, the sleeve being of sufficient length to enclose the cutting elements and serving to retain temporarily the oil or other lubricating compound which is supplied through the aperture 4 in the arbor by any suitable pumping means in a manner which will be readily understood by those familiar with the art. It will, however, be understood that a sleeve of this character can only be employed when the milling operation is being perfomed on work positioned within the circle bounded by the cutting elements and that when the cutter is required to travel around a piece of work positioned outside of the said circle the sleeve is removed from the base plate and other means employed for maintaining the lubricant on the cutting surfaces.

While I have herein described and illus-

trated a preferred embodiment of my invention adapted for the production of either external or internal threads, I do not thereby desire or intend to limit myself in any way to the employment of the invention for that purpose alone, as the same may be readily adapted for use in other milling operations and arranged for actuation by and for use in connection with various types of machines as may be desired, and the details of construction and arrangement of the cutter may be suitably modified or varied to adapt the cutter for use under different conditions encountered in practice and for different purposes, without departing from the spirit and scope of the invention as defined by the appended claims.

Having thus described my invention, I claim and desire to protect by Letters Patent of the United States:

1. In a metal working mechanism, the combination of a cutter provided with a plurality of cutting elements, means for adjustably securing said cutting elements in operative cutting position, each cutting element being provided with a cutting surface and a plurality of unconnected peripheral parallel ridges each having the profile of a thread to be formed in the work.

2. In a metal working mechanism, the combination of a cutter adapted to simultaneously cut a plurality of threads in a piece of work, said cutter comprising a rotatable base plate, a plurality of cutting elements rotatably and adjustably mounted on said base plate with the axes thereof at equal radial distances from the axis of rotation of said base plate, and means comprising an exteriorly tapered stub and an interiorly tapered collet for firmly securing said cutting elements in adjusted cutting position on said plate, each cutting element being provided with a cutting face and a relatively large amount of resharpening material of constant radial magnitude.

3. In a metal working mechanism, the combination of a cutter adapted to simultaneously cut a plurality of threads in a piece of work, said cutter comprising a rotatable base plate, a plurality of cutting elements rotatably and adjustably mounted on said base plate with the axes thereof at equal radial distances from the axis of said base plate, means for firmly securing said cutting elements in adjusted cutting position on said plate, each cutting element being provided with cutting faces and a relatively large amount of resharpening material of constant radial magnitude at the rear of said faces, and adjustable means attachable to said cutter for gauge setting said cutting elements for different cutting operations.

4. In a rotating cutting tool, the combination of a cutting element provided with a cutting surface located in a substantially radial plane, and peripheral reserve cutting material of constant radial magnitude for providing frequent successive resharpened surfaces said material having the form of a plurality of parallel ridges each ridge being in transverse section a replica of the thread desired to be formed in the work.

5. In a rotating thread cutting tool, the combination of a cutting element provided with a cutting surface located in a substantially radial plane and having a slot substantially parallel to said face, and peripheral reserve cutting material of constant radial magnitude for providing frequent successive resharpened surfaces said material having the form of a plurality of parallel ridges each ridge being in transverse section a replica of the thread desired to be formed in the work.

6. In a rotating thread cutting tool, the combination of a substantially flat polygonal cutting element provided with a transverse slot and a cutting surface located in a substantially radial plane adjacent said slot, and reserve perimetral material at the rear of said cutting face for providing successive resharpened surfaces said material having the form of a plurality of parallel ridges each ridge being in transverse section a replica of the thread desired to be formed in the work.

7. In a rotary cutting tool, the combination of a rotatable support, cutting elements mounted upon said support in spaced relation, securing means connected to said cutting elements and passing through said support for firmly securing and maintaining said elements in operative position on said support, said means comprising tapered means relatively longitudinally movable for firmly attaching said securing means to said support.

8. In a rotary cutting tool, the combination of a rotatable support, cutting elements mounted upon said support in spaced relation, securing means connected to said elements and passing through said support for rigidly securing and maintaining said elements in operative position on said support, said support being provided with a central bore adapted to receive a mandrel of a metal working machine, a setting gauge provided with radially extending gauge projections, and an axial shank adapted to fit in said bore and means for adjusting said gauge in position for setting the cutting elements for a predetermined cutting operation.

9. A thread milling cutter comprising a base, a plurality of separated cutting elements disposed on said base, each of said elements having a cutting surface and a plurality of parallel ridges each having a transverse sectional form similar to that of the thread to be formed in the work and extending around the cutter from said surface

and means for operatively rigidly securing said elements upon said base.

10. A thread milling cutter comprising a base, a plurality of separate cutting elements each having a cutting surface arranged on said base and a plurality of parallel ridges each having a profile similar to that of the thread to be cut in the work extending from said cutting surface round the element, the longitudinal axes of all of said elements being equidistant from the center of said base, and means for securing said elements in rigid operative adjusted position with respect to said base.

11. A milling cutter comprising a base, a plurality of independent spaced cutting elements disposed equidistantly from the center of said base, each of said elements having a cutting surface and means, comprising a tapered sleeve and means for causing movement of said sleeve axially of each of said elements, for securing each of said elements to said base in fixed operative relation therewith.

12. A cutting element for a thread milling cutter comprising on its exterior a plurality of parallel ridges, each of said ridges having a profile similar to that of the thread which is to be cut and a cutting surface extending across said ridges in a plane parallel to the longitudinal axis of said element.

13. A cutting element for a thread milling cutter comprising a plurality of ridges on its exterior, said ridges forming a replica of the thread which is to be cut but having no pitch, and a cutting surface formed across said ridges and lying in a plane parallel to the longitudinal axis of said element.

In witness whereof, I have hereunto set my hand this 22nd day of March, A. D. 1920.

PETER P-G. HALL.