Feb. 4, 1941. T. F. GITHENS 2,230,455

DEVICE FOR FINISHING HOLES IN METAL

Filed Oct. 14, 1938 2 Sheets-Sheet 1

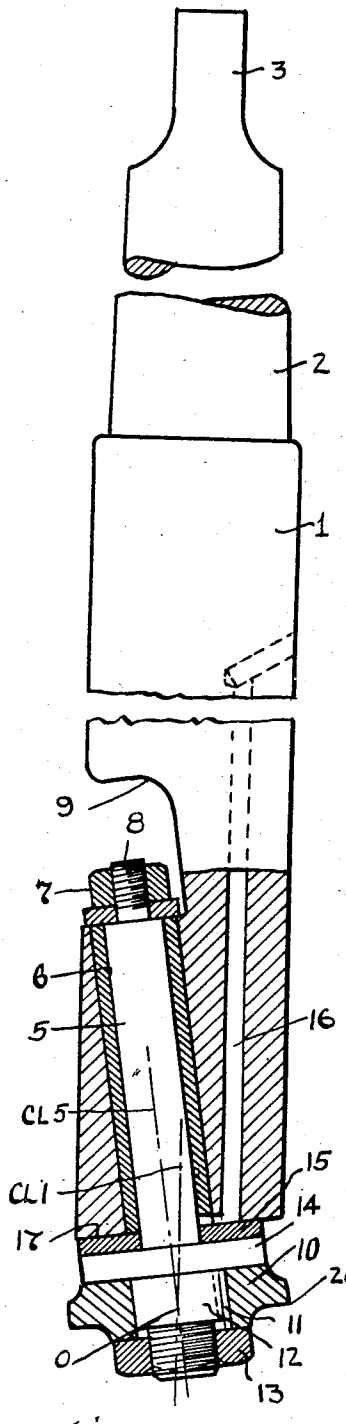


Fig. 2

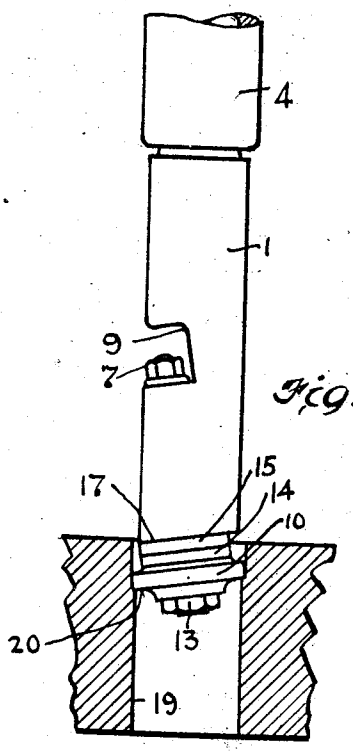


Fig. 1

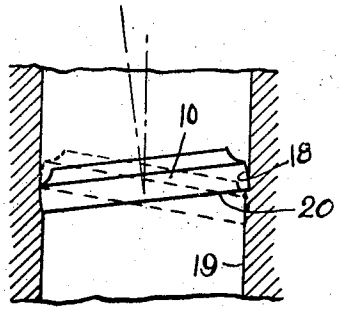


Fig. 4

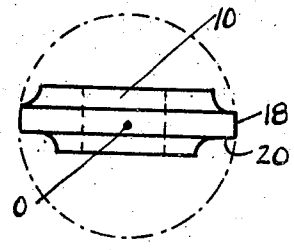


Fig. 3

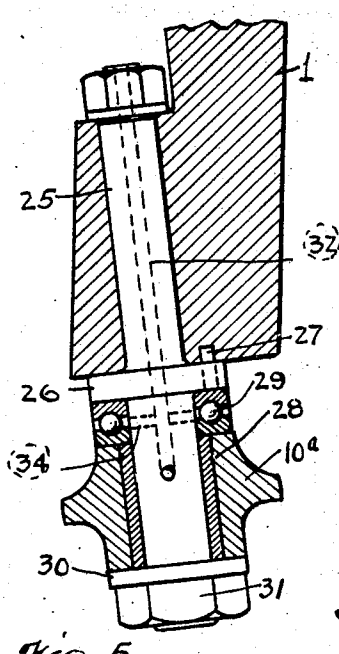


Fig. 5

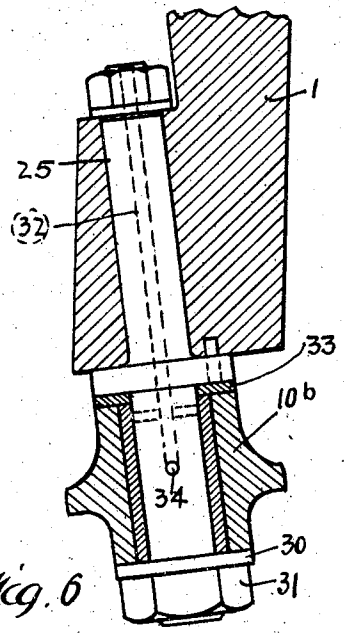


Fig. 6

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DEVICE FOR FINISHING HOLES IN METAL

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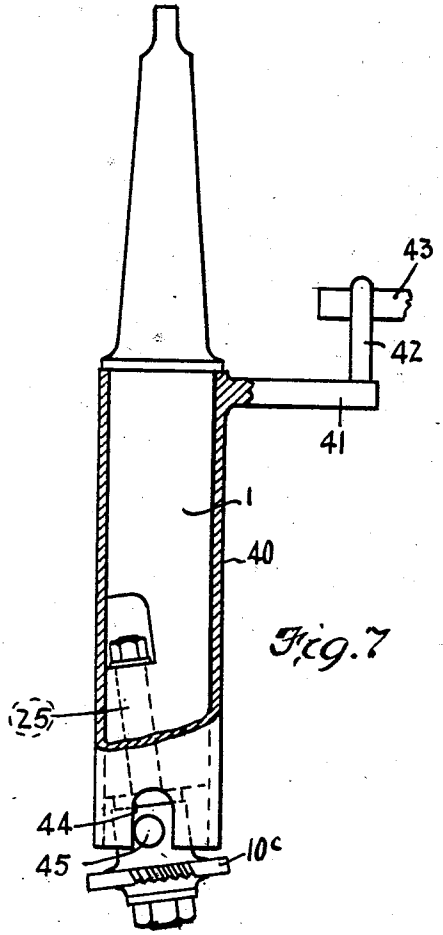


Fig. 7

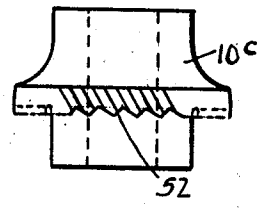


Fig. 8

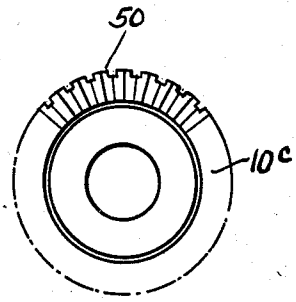


Fig. 9

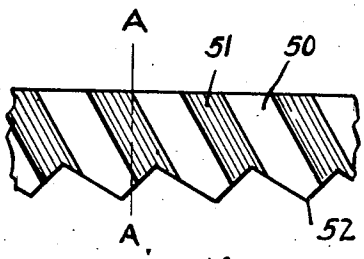


Fig. 10

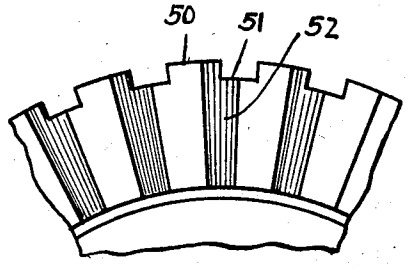


Fig. 11

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UNITED STATES PATENT OFFICE

2,230,455

DEVICE FOR FINISHING HOLES IN METAL

Thomas F. Githens, Cleveland Heights, Ohio, assignor to The Cleveland Twist Drill Company, Cleveland, Ohio, a corporation of Ohio

Application October 14, 1938, Serial No. 235,029

17 Claims. (Cl. 77—58)

The present invention relates to a tool particularly adapted to perform a finishing operation upon holes in metals, and wherein the metal in the wall of the hole is subjected to slight cutting action together with a burnishing or broaching action. The basic principle of operation of my tool has been previously disclosed in prior U. S. Patents Nos. 1,123,045 and 1,148,065, relating to methods and apparatus for generating holes in metal. Such principle of operation has also been utilized in rock and well drilling tools, as illustrated in Patents Nos. 1,254,268 and 1,702,757.

Briefly summarized, this basic principle consists in the method wherein a hole cutting tool is gyrated about an axis angularly disposed to the axis of the hole or work piece, the work piece and the tool either being intended to be rotated at equal velocities, or held stationary whereby there is none or very little relative rotative movement between the two. In any event, the ultimate result is that the periphery or cutting edge of the hole cutting tool has a "wobbling" movement with respect to the work piece. My present invention constitutes an improvement in a metal hole finishing tool operating with such a wobbling action.

It is the general object and nature of my invention to provide a metal hole finishing tool, operating upon the gyratory principle, wherein the parts are made sufficiently strong and efficient to withstand the unusual forces and stresses imposed. My invention also provides an improved construction for holding the cutting element of the tool stationary with respect to rotative movement while at the same time permitting its gyratory or oscillatory movement about the axis of the work piece. A further object of my invention is to provide a novel and improved form of cutting element wherein the cutting action is enhanced and a chip breaking action imparted to the tool.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is an elevational view of a metal hole finishing tool embodying the principle of my invention and showing the tool in operative position in a metal hole; Fig. 2 is an enlarged, partially sectioned view of the tool shown in Fig. 1; Fig. 3 is a side elevational view of the cutting element alone; Fig. 4 is a more or less diagrammatic view representing various positions of operation of the cutting element; Fig. 5 is a detailed sectioned view showing a modified form of construction; Fig. 6 is a detailed sectioned view showing still another modified form of construction; Fig. 7 is an elevational view, partially in section, showing means for positively locking the cutting element of the tool against rotation; Fig. 8 is an elevational view of an improved form of cutting element; Fig. 9 is a bottom plan view of the cutting element shown in Fig. 8; Fig. 10 is an enlarged detailed view of a portion of Fig. 8; and Fig. 11 is an enlarged detailed view of a portion of Fig. 9.

Now referring more particularly to Figs. 1 and 2, the tool construction shown therein consists of a tool holder 1 having a tapered tank 2 terminating in the tank 3, which is adapted to be mounted in the spindle or chuck 4 of a drill press or similarly operated machine tool.

A mounting or bearing pin 5 is journalled in the bearing or bushing 6 whose axis is inclined at an angle to the axis of the tool holder 1. A nut 7 engaging with the threaded end 8 of the pin 5 removably mounts the latter in the tool holder 1. A niche or recess 9 in the tool holder 1 provides a clearance space giving access to the nut 7. The cutting element or tool proper 10 is mounted by means of the locking key 11 to the enlarged diameter portion and projecting end portion of the pin 5. The nut 13 clamps the tool 10 against the integral collar 14 of the pin 5. A bearing washer or bushing 15 is mounted between the collar 14 and the end of the tool holder 1. A lubricating duct 16 leads from the outer surface of the upper portion of the tool holder 1 to a point adjacent the contact area of the bushing 6 and of the bushing 15, and is for the purpose of facilitating the lubrication of these parts.

It will be noted that the axis or center line C. L. 5 of the pin 5 is disposed at an angle to the axis or center line C. L. 1 of the tool holder 1. The plane of the end face 17 of the tool holder 1 is disposed at a corresponding angle to a plane perpendicular to the axis C. L. 1, in order that a proper supporting surface for permitting rotation between the pin 5 and the tool holder 1 will be provided.

Directing attention to Fig. 3, it will be seen that the outer peripheral surface 18 of the tool

10 constitutes a portion of a spherical surface, or a spherical zone whose center is located at the point 0. This center 0 of the spherical zone surface 18 coincides with the point of intersection between the axis or center lines C. L. 1 and C. L. 5. The diameter of this spherical surface or spherical zone is equal to the finished diameter of the hole 19. The operation of the above described device is as follows:

The hole 19 is first drilled in the metal stock or work piece and is of a diameter slightly less than that of the desired finished diameter. The work piece is clamped or held in a suitable manner, such as on the table of a drill press. Rotary motion is then imparted to the tool holder 1 as it is fed in a direction toward and through the hole 19. As soon as the tool 10 engages with the walls of the hole 19, there will be generated sufficient frictional force to hold the tool 10 and pin 5 against rotation about its own axis. Continued rotation of the tool holder 1, however, imparts a gyratory or wobbling motion to the tool 10 whereby the latter produces a continuous and progressive shearing or cutting action by the leading or cutting edge 20 and a burnishing or broaching action by the spherical zone surface 10. This combined cutting and burnishing or broaching action of the tool is illustrated in Fig. 4 wherein the dotted lines illustrate the position of the tool 10 after rotation of the tool holder 1 through an angle of 180° from the position corresponding to the full line position. In this Fig. 4 of the drawing it will be seen that the cutting edge 20 in the right hand portion of the tool 10 is about to make a cut from the wall of the hole 19, followed by the burnishing action of the surface 18 sliding over and compressing or ironing out the metal behind the cut.

During such operation of the tool, it will be appreciated that unusual bending and shearing stresses are exerted in the region between the tool 10 and the tool holder 1. The provision of the removable support and bearing pin 5 produces a construction wherein these forces and stresses can be readily compensated for, either by making the pin 5 of a relatively strong material, or by replacing the pin 5 in the event of failure or wear. In this manner, the operation and life of the entire tool may be maintained, and it is not necessary to discard the complete assembly after a period of usage.

In the modified form of construction shown in Fig. 5, the pin 25, although removably mounted in the tool holder 1, is not rotatable, but its integral collar is locked to the tool holder 1 by means of the dowel pin 27. The tool 10*a* is rotatably mounted on the projecting end of the pin 25 by means of the bearing washer 28 and the roller bearing 29 mounted between the collar 26 and the inner end or face of the tool 10*a*. A bushing 30 and a retaining nut 31 hold the tool 10*a* on the end of the pin 25.

In the modified construction shown in Fig. 6, a bushing 33 is substituted for the ball bearing 29, for rotatably mounting the tool 10*b* on the pin 25. In both the constructions shown in Figs. 5 and 6, the lubricating duct 32 leads down through the center of the pin 25 with radial branches such as indicated at 34 to the bearings and bushings mounting the tools 10*a* and 10*b*.

In the construction shown in Fig. 7, means is provided for positively locking the cutter element or tool 10*c* against rotation, without relying upon the frictional engagement between the tool and the metal. In this latter construction, a sleeve 40 fits loosely over the tool holder 1 and has a laterally extending arm 41 which is held stationary by the pin 42 engaging a fixed part 43 of the drill press or similar machine. A longitudinal slot 44 is provided in the end of the sleeve 40 and receives the pin 45 carried by the tool 10*c*. Thus, in operation, the sleeve 40 holds the tool 10*c* against rotation, but permits gyratory or wobbling movement of the latter due to the fact that the pin 45 can move back and forth in an axial direction in the slot 44.

In order to improve the cutting and metal finishing action of the cutting element or tool, my invention also provides the toothed form of construction shown in Figs. 8 to 11. Teeth 50 of rectangular cross-section and of helical disposition, or inclined at an angle to the axis of the tool 10*c*, are provided in the spherical zone surface thereof. The spaces 51 between the teeth 50 operates as chip breakers so that the removed metal does not clog the operation of the tool and is in the form of continuous pieces, although the cutting action of the tool is continuous. Teeth 52 are also provided upon the cutting edge of the tool 10. The teeth 52 thus enhance the cutting action of the tool, since they not only present a larger cutting edge for a given size tool, but also are inclined at an angle to the direction of feed or advance of the tool. Since the trailing ends of the teeth 50 overlap, or at least are in axial alignment with, a portion of the leading ends of the next adjacent teeth as indicated by the parallel axial line A—A, the burnishing action of the tops of the teeth 50 through the metal hole is also continuous.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, and a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool.

2. In a device of the character described, the combination of a tool holder, a removable pin non-rotatably mounted in said tool holder at an angle to the axis of the latter, said pin extending beyond the end of said tool holder and a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, the latter being journalled on the end of said pin, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool.

3. In a device of the character described, the combination of a tool holder, a removable pin non-rotatably mounted in said tool holder at an angle to the axis of the latter, said pin extending beyond the end of said tool holder, and a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, the latter being journalled on the end of said pin, the axes of said holder and of said pin being inclined to each other and

intersecting at the center of said spherical zone shaped surface of said tool, and a thrust bearing mounted on said pin between said tool and the end of said tool holder.

4. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cuting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, an integral collar on said pin abutting against the end of said tool holder, and a thrust bearing mounted between said collar and said tool.

5. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, an integral collar on said pin abuting against the end of said tool holder, a thrust bearing mounted between said collar and said tool, and means for locking said collar against rotation to said tool holder.

6. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, an integral collar on said pin abutting against the end of said tool holder, and a ball bearing thrust bearing mounted between said collar and said tool.

7. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, an integral collar on said pin abutting against the end of said tool holder, a ball bearing thrust bearing mounted between said collar and said tool, and means for locking said collar against rotation to said tool holder.

8. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a mounting pin for non-rotatably carrying said tool, and means for removably and rotatably mounting said pin at the end of said tool holder at an angle to the axis of the latter, the center of said spherical zone shaped surface of said tool coinciding with the point of intersection of the axes of said tool holder and of said pin.

9. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, and locking means for holding said tool against rotation but permitting oscillation of the latter with respect to the axis of said tool holder.

10. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cuting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, and a stationary sleeve loosely engaging said tool holder and slidably engaging said tool for locking the later against rotation.

11. In a device of the character described, the combination of a tool holder, a removable pin non-rotatably mounted in said tool holder at an angle to the axis of the latter, said pin extending beyond the end of said tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, the latter being journalled on the end of said pin, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, a thrust bearing mounted on said pin between said tool and the end of said tool holder, and locking means for holding said tool against rotation but permitting oscillation of the latter with respect to the axis of said tool holder.

12. In a device of the character described, the combination of a tool holder, a removable pin non-rotatably mounted in said tool holder at an angle to the axis of the latter, said pin extending beyond the end of said tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, the latter being journalled on the end of said pin, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, a thrust bearing mounted on said pin between said tool and the end of said tool holder, and a stationary sleeve loosely engaging said tool holder and slidably engaging said tool for locking the latter against rotation.

13. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, a removable bearing pin for rotatably mounting said tool on said tool holder, the axes of said holder and of said pin being inclined to each other and intersecting at the center of said spherical zone shaped surface of said tool, an integral collar on said pin abutting against the end of said tool holder, a thrust bearing mounted between said collar and said tool, means for locking said collar against rotation to said tool holder, and a stationary sleeve loosely engaging said tool holder and slidably engaging said tool for locking the latter against rotation.

14. In a device of the character described, the combination of a tool holder, a tool having a single spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, said tool being rotatably mounted on said tool holder with its axis inclined to and in-

tersecting the axis of said tool holder, and a series of axially extending teeth formed in the cutting edge of said tool.

15. In a device of the character described, the combination of a tool holder, a tool having a single spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, said tool being rotatably mounted on said tool holder with its axis inclined to and intersecting the axis of said tool holder, and a series of radially extending teeth formed in said spherical zone shaped surface of said tool.

16. In a device of the character described, the combination of a tool holder, a tool having a single spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, said tool being rotatably mounted on said tool holder with its axis inclined to and intersecting the axis of said tool holder, a series of axially extending teeth formed in the cutting edge of said tool, and a series of radially extending teeth formed in said spherical zone shaped surface of said tool.

17. In a device of the character described, the combination of a tool holder, a tool having a spherical zone shaped surface terminating in a cutting edge lying in a plane normal to the axis of said tool, said tool being rotatably mounted on said tool holder with its axis inclined to and intersecting the axis of said tool holder, a series of axially extending teeth formed in the cutting edge of said tool, a series of radially extending teeth formed in said spherical zone shaped surface of said tool, said axially and radially extending teeth being in registry with each other around the circumference of said tool.

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