Feb. 1, 1944. R. G. WILSON 2,340,785

METHOD AND APPARATUS FOR CASTING DIAMOND STUDDED TOOLS

Filed Nov. 4, 1941 3 Sheets-Sheet 1

Fig. 1

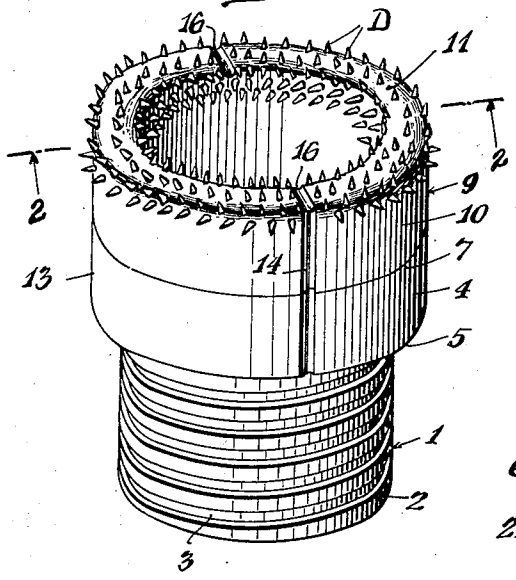


Fig. 2

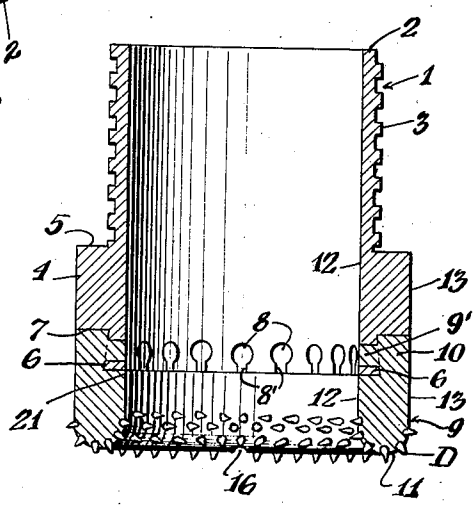


Fig. 3

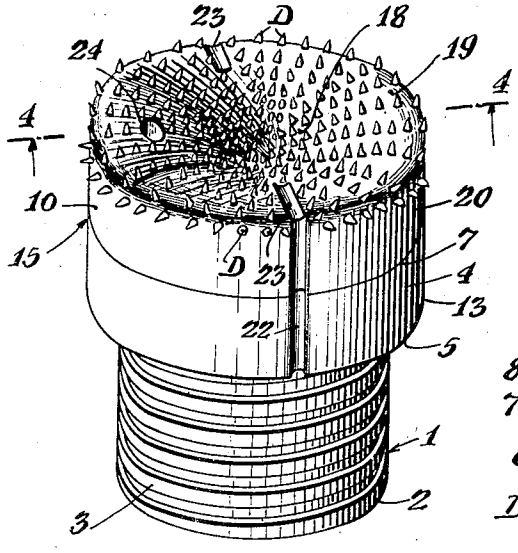
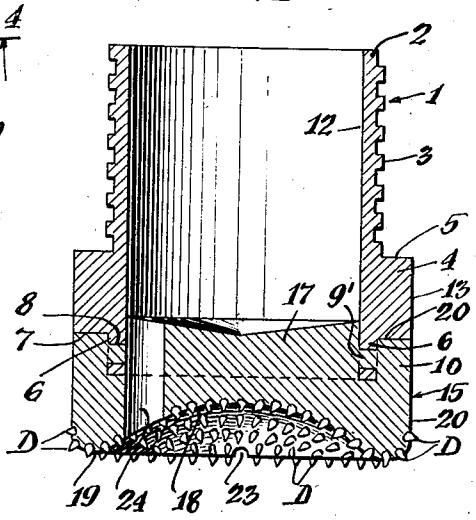


Fig. 4



INVENTOR.
Robert G. Wilson
BY
Reuben T. Carlson
ATTORNEY

Feb. 1, 1944. R. G. WILSON 2,340,785

METHOD AND APPARATUS FOR CASTING DIAMOND STUDDED TOOLS

Filed Nov. 4, 1941 3 Sheets-Sheet 2

Fig. 5

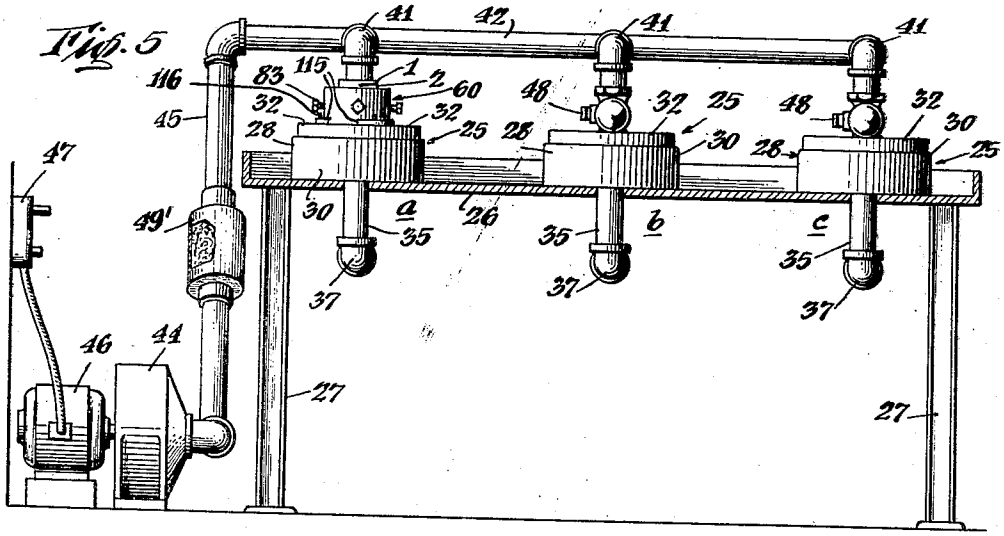


Fig. 6

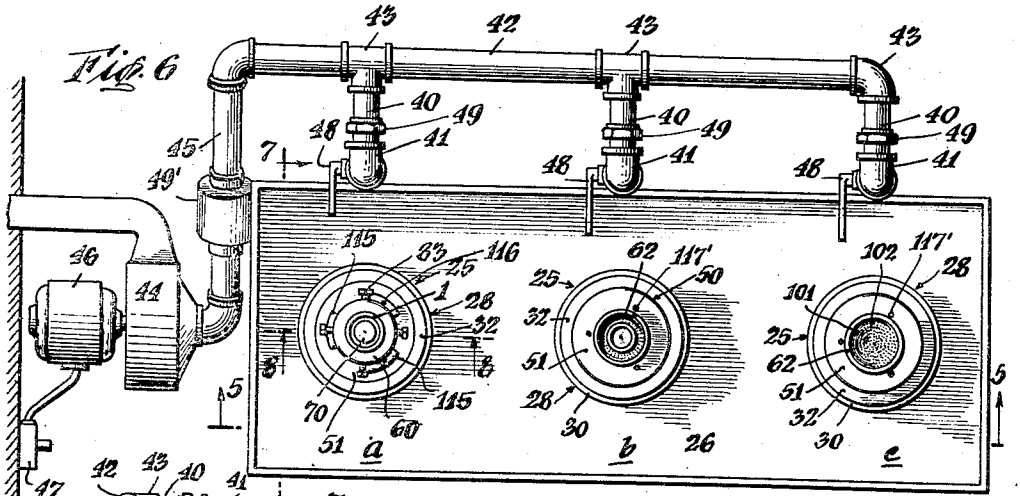


Fig. 7

INVENTOR.
Robert G. Wilson
BY
Reuben J. Carlson
ATTORNEY

Feb. 1, 1944. R. G. WILSON 2,340,785

METHOD AND APPARATUS FOR CASTING DIAMOND STUDDED TOOLS

Filed Nov. 4, 1941 3 Sheets-Sheet 3

Fig. 8

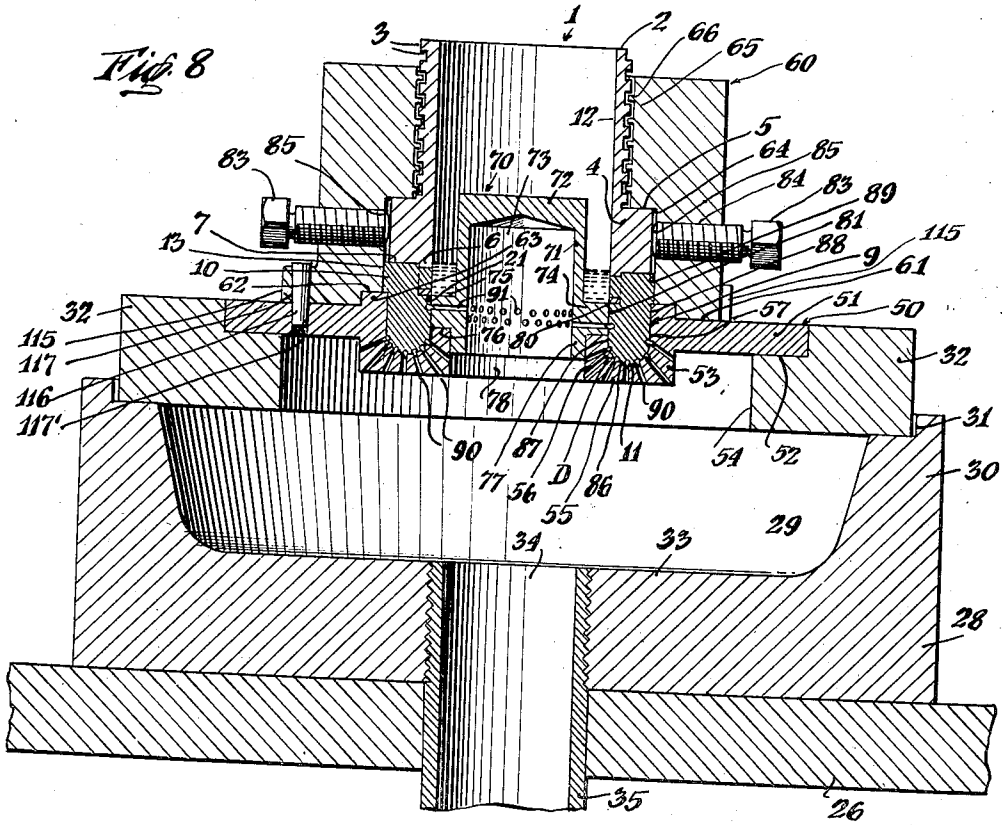
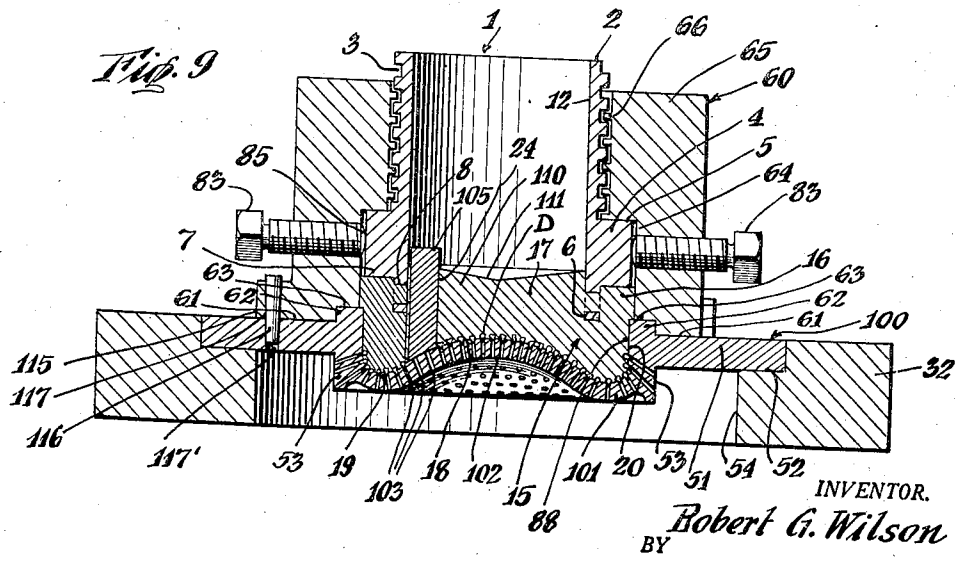


Fig. 9



INVENTOR.
Robert G. Wilson
BY
Reuben J. Carlson
ATTORNEY

Patented Feb. 1, 1944

2,340,785

UNITED STATES PATENT OFFICE

2,340,785

METHOD AND APPARATUS FOR CASTING DIAMOND STUDDED TOOLS

Robert G. Wilson, Brooklyn, N. Y., assignor, by mesne assignments to Anton Smit & Co. Inc., New York, N. Y., a corporation of New York

Application November 4, 1941, Serial No. 417,861

13 Claims. (Cl. 22—73)

This invention relates to an improved method and apparatus for casting diamond studded tools used for drilling, boring, cutting and shaping rock, stone, metals and other hard substances.

Diamond studded tools have heretofore been made in which the diamonds or cutting stones are embedded in cast metal which forms the working end of the tool and which is shrunk or brazed onto a tool blank or shank. In order to produce a satisfactory tool of this character, it is important that the diamonds be tenaciously bonded and gripped by the cast metal so that they will not loosen under severe use and that the cast metal be sound throughout and free from blowholes or other lines or areas of weakness.

In accordance with this invention a base molding die of the proper shape and size to form the desired casting cavity is provided. The base die member is provided with one or more openings extending therethrough each of such diameter as to receive the selected cutting end of the diamond or cutting stone inserted therein. In forming core or drill bits which are to carry a considerable number of diamond or bortz fragments in the working end thereof, the pin-sized openings in the base die member are so arranged that when the inner ends thereof have received the diamonds, the diamonds will be arranged in the working face of the cutting tool along generally radial lines.

Where a core bit is to be formed, a carbon core is provided which is seated over an enlarged opening in the bottom wall of the base die. The core is preferably hollow and may be provided with spaced diamond-seating openings extending horizontally through the side wall thereof so that the diamonds may be set in the outer ends of these openings and thus provide reaming stones around the inner periphery of the working end of the cast core bit.

The apertured base die is positioned over a suction cup and a suitable suction pump is connected to the suction cup and operates to draw from two to four pounds suction pressure through the apertured base die and core. This suction is applied to the apertured base die and core prior to the setting of the diamonds therein and the suction continues uninterrupted until the molten casting metal has been poured. This suction facilitates the setting of the selected cutting points of the diamonds in the openings or apertures in the base die and core.

The tool blank or shank is mounted within a suitable collar member which is positioned to rest upon an upstanding shoulder of the base die. Suitable means, such as micrometer screws, extend through the walls of the tubular holder and are arranged to engage the blank or shank so that the lower end thereof may be accurately positioned and centered with respect to the casting cavity in the base die. The continuing suction exerted on the diamonds retains the diamonds firmly seated in the inner mouths of the openings provided in the base die and carbon core.

The molten casting metal is then poured into or around the tool blank or shank, which is so arranged with respect to the base die member that the molten metal may freely flow into the casting cavity and around the suction held diamonds supported upon the apertured base die member and apertured core. When sufficient molten casting metal has been poured into or around the tool blank or shank to fully fill the casting cavity, the suction is promptly cut off and the molten metal permitted to cool and harden. The lower end of the tool blank or shank may be provided with slots or notches to insure a firm bond between the blank or shank and the metal cast thereon.

The suction action, which continues until the metal has been poured, serves not only to firmly retain the diamonds in proper position in the mold cavity and prevents movement or flotation thereof in the poured metal, but the suction draws the casting metal closely to the outer surface of the diamonds so that when cast the diamonds will be rigidly bonded to the cast metal with only the selected cutting points of the diamonds projecting from the working face of the tool. The suction further operates to withdraw all the gas through the suction apertures of the base die member and apertured core, so that a firm and sound casting is produced which is free from blowholes, fissures, and other undesirable lines or areas of weakness.

The apparatus is so formed that it can easily and quickly be taken apart when the cast metal has sufficiently cooled. The same or identical suction cups may be provided to cast numerous different types of diamond studded tools, and the suction cups can be mounted upon a table and conveniently spaced apart to provide ample room for the operator or operators stationed at each suction cup. The suction cups are connected by suitable piping to the suction pump which may operate to supply suction to any desired number of suction cups. A quick action cut-off valve is provided in the branch suction line leading to each suction cup, which permits the suction to be cut off promptly after the molten metal has

been poured. It will be appreciated that if suction continues to be applied after the metal has been poured an undesirable quantity of cast metal will be drawn through the diamond-seating apertures and into the suction cup and will develop an undesirable quantity of metal strings extending from the cast end of the bit which must be removed.

Each suction cup is so formed as to support a heavy steel supporting ring which is snugly seated on the uper rim of the suction cup but is not secured thereto. The base die member has a laterally extending flange which snugly seats on the supporting ring, and by making the laterally extending flanges of all of the various die members employed in casting various diamond tools of the same size and diameter, it will be appreciated that the same suction cup and supporting ring may be used to support base die members of various shapes and forms for casting various diamond studded tools. The holding collar has an internal circular recess at its lower end shaped to embrace and snugly seat over an upstanding shoulder formed on the base die member so that the inner surface of the upstanding shoulder of the die member and a section of the inner surface of the holding collar together provide a mold wall which defines the outer surface contour of the cast metal. The same size holding collar may generally be employed for casting either core or drill bits having the same external diameter of working head. Since the tool blank or shank is held to the holding collar by easily adjustable micrometer screws, the tool blank or shank having the cast metal and diamonds associated therewith may be lifted off from the base die member and the completely cast tool easily removed from the holding collar by loosening the micrometer adjusting screws. Any excess of casting metal may be removed from the external and internal surfaces of the tool by boring, grinding, or by shaping in a lathe.

An object of this invention is to provide an improved method of casting diamond studded tools which can be economically and quickly performed to produce tools in which the diamonds or cutting stones are seated in the cast working face of the tool with great firmness and tenacity.

Another object of this invention is to provide improved apparatus for casting diamond studded tools which is simple in construction and operation, whose parts are adaptable to the manufacture of various types and kinds of diamond studded tools, which can be easily and quickly assembled before casting and disassembled after casting to permit quick and ready removal of the cast tools.

Another object of this invention is to provide improved apparatus for casting diamond studded tools in which means are provided for insuring accurate centering and positioning of the tool blank or shank with respect to the metal cast thereon to provide a tool which is true and efficient.

Other objects of this invention will become apparent as the disclosure proceeds.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part hereof, in which

Fig. 1 is a perspective view of a core bit made in accordance with the method and apparatus of this invention;

Fig. 2 is a vertical cross-sectional view through the core bit as it apears when looking in the direction of the arrows **2—2** of Fig. 1;

Fig. 3 is a perspective view of a drill bit which may be made in accordance with this invention;

Fig 4 is a longitudinal cross-sectional view of the drill bit as it appears when looking in the direction of the arrows **4—4** of Fig. 3;

Fig. 5 is a front elevational view of the casting apparatus showing the casting table having a plurality of spaced suction cups mounted thereon, one of the suction cups having the base casting die and holding collar mounted thereon and the other cups having only the base casting die mounted thereon, this view showing the apparatus as it appears when looking in the direction of the arrows **5—5** of Fig. 6;

Fig. 6 is a top plan view of the casting apparatus illustrated in Fig. 5;

Fig. 7 is a transverse cross-sectional view of the casting apparatus as it appears when looking in the direction of the arrows **7—7** of Fig. 6;

Fig. 8 is an enlarged vertical cross-sectional view through the assembled suction cup, base die, carbon core and holding collar used for casting a core bit of the type illustrated in Figs. 1 and 2, and as they appear when viewed along lines **8—8** of Fig. 6; and

Fig. 9 is an enlarged vertical cross-sectional view of the assembled base die and holding collar for casting a drill bit of the type illustrated in Figs. 3 and 4.

Similar reference characters refer to similar parts throughout the several views of the drawings and the specification.

While it will appreciated that my improved method and apparatus may be employed for casting various shapes and types of diamond studded tools, to more clearly illustrate the method and apparatus there is shown in Figs. 1 and 2 one type of core bit and in Figs. 3 and 4 one type of drill bit, which may be made by following the teachings of the method and apparatus disclosed in this application. It will therefore be understood that the core bit and drill bit are shown in Figs. 1 to 4 for illustrative and explanatory purposes only, since the method and apparatus which constitute this invention are not limited to the casting of only this particular core bit and drill bit as illustrated but may be employed in the casting of various shapes and types of diamond studded tools.

The core bit shown in Figs. 1 and 2 for purposes of illustration, is formed from a steel blank **1** of tubular form having a threaded shank portion **2** provided with strong external threads **3** so that the bit may be firmly secured to the drill rod. The shank has an enlarged body portion **4** provided with a top shoulder **5** against which the end of the drill rod seats. The lower end of the shank has a reduced leg portion **6** defining an external circular recess **7**. The leg portion **6** is perforated by a plurality of spaced round holes **8** which lead into slots **8'** which extend to the lower edge of the leg portion. The round holes **8** and slots **8'** will hereafter be referred to as bayonet slots. The leg portion **6** of the blank may be provided with any desired number of conveniently spaced bayonet slots designed to permit the molten bit metal which is to form the working

end of the bit to flow therethrough and lock the end of the cast bit to the blank.

The working end 9 of the bit is cast to the lower end of the bit blank and when formed defines a circular collar 10 which fills the external recess 7 at the lower end of the bit blank. The lower working face of the casting 9 preferably has an arcuate contour 11 in which the diamonds D are partially embedded but have their sharp points protruding so as to grind away the rock or material being cored. It will be noted by referring more particularly to Fig. 1 that the diamonds D are preferably arranged on the working end of the bit in radial rows so as to provide passages between the diamond rows through which water or other liquid may move during the coring operation. It will also be noted that the ends of the diamond rows extend well into the inner periphery and into the outer periphery of the working face of the bit so as to insure sufficient reaming of both the periphery of the hole being bored and the core being formed, so that the metal parts of the bit may be rotated during the coring operation without excessive friction or wear between the metal parts of the bit and the rock being cored. The interior surface 12 of the bit is truly cylindrical and presents a smooth wall except where the marginal diamonds project. The outer surface 13 of the bit is also truly cylindrical and presents a smooth wall except where the peripheral diamonds project. Waterways are formed by providing vertical shallow grooves 14 in the outer cylindrical surface of the bit body which lead to radial grooves 16 in the working face of the bit.

The drill bit illustrated in Figs. 3 and 4 is formed from a steel blank 1 of tubular form of the proper size and shaped similarly to the blank forming a part of the core bit above described. The working end 15 of the drill bit is cast to the bit blank and when formed provides a circular collar 10 which fills the external circular recess 7 at the lower end of the bit blank. The molten casting metal also fills the lower end of the blank to provide a cast metal bottom wall 17 which has a concave working face 18 surrounded by a convex working rim 19. The diamonds D are set in the concave working face 18 and in the convex working face of the rim 19. The molten coating metal flows through the bayonet slots in the leg portion 6 of the blank, thus firmly locking the cast bit metal to the leg portion 6 of the blank. The exterior surface 20 of the bit as formed is truly cylindrical and presents a smooth cylindrical wall except where the marginal diamonds project. A vertical water hole 24 is cast in the bottom wall 17 of the bit and the rim portion 19 may be provided with shallow radial water grooves 23 which lead into vertical water grooves 22 in the cylindrical outer surface of the bit.

The cast metal from which the working end of the tools is made may comprise a metallic alloy which is tough, strong and resistant to wear, and of such a character that it can be reduced to molten form for pouring into the casting cavity.

The apparatus employed for casting the tools is illustrated more particularly in Figs. 5 to 9 inclusive and comprises a series of molds 25 which are positioned in convenient spaced relationship on a steel table 26 having supporting legs 27. The construction of the mold for forming the core bit above described is illustrated in Fig. 8 and the mold for casting the drill bit above described is illustrated more particularly in Fig. 9.

The same general apparatus is used for casting various types of diamond studded tools and comprises a suction cup 28 of circular form which may be shaped from a solid steel casting which rests on the table 26. The suction cup 28 has a concave suction chamber 29 therein of generally saucer-shaped form and its vertical wall 30 is provided with a circular recess 31 which supports a heavy steel mold-supporting ring 32.

The bottom wall 33 of the suction cup is provided with a threaded opening 34 into which the threaded end of the downwardly extending steel suction pipe 35 is threaded. Each suction pipe 35 is connected to a horizontally extending suction pipe 36 positioned under the table top 26 by means of a coupling 37, as shown more particularly in Fig. 7. A riser suction pipe 38 is connected to the horizontal suction pipe 36 by a coupling 39, and the upper end of the riser pipe 38 is connected to a horizontally extending branch suction pipe 40 at the back edge but above the top of the table 26 by a coupling 41. Each of the branch suction pipes 40 is connected to a main suction line 42 which extends parallel to the table length by a coupling 43. The main suction line 42 is connected to a suction pump 44, which may rest on the floor, by a downwardly extending main suction line 45. The suction pump 44 is driven by a motor 46 with a power switch box 47 conveniently located adjacent the table. A quick acting suction control valve 48 is located in each riser pipe 38 adjacent the rear edge of the table.

Where the suction pump 44 is connected to a plurality of suction cups 28, uniform suction pressure on each cup can be maintained by inserting a suction regulator valve 49 in each of the branch suction pipes 40. An air filter 49' is also preferably provided to prevent particles of cast metal from being drawn into the suction pump 44. The air filter may be conveniently inserted in main suction line 45.

The steel base die for casting the desired tool has a laterally extending circular flange 51 which seats snugly within a circular recess 52 formed in the heavy supporting ring 32, as shown more particularly in Fig. 8. In casting core bits for example, the bottom die 50 is provided with a cylindrical external wall 53 which extends downwardly into the enlarged circular opening 54 formed in the supporting ring 32. An annular bottom forming wall 55 extends horizontally inwardly from the downwardly projecting cylindrical wall 53 and a short internal riser wall 56 of cylindrical form extends upwardly from the annular bottom forming wall 56.

A steel holding collar 60 of cylindrical form has its lower end 61 resting on the flange 51 of the base die 50 and is also provided with an internal recess 62 which snugly seats over the top edge of a short external riser wall 63 which forms a rising continuation of the external wall 53. The lower body portion of the holding collar has an internal cylindrical recess 64 which shapes a part of the external cylindrical surface of the cast working end of the core bit. The upper end portion 65 of the holding collar 60 is internally threaded at 66 to receive the threaded portion 2 of the shank 1 of the core bit. It will be noted that the internal threads 66 on the upper body portion 65 of the holding collar 60 are so formed as to have a rather loose threaded connection with the external threads 3 on the upper threaded portion of the bit shank 1, so as to permit micrometer adjustment of the lower end of the

bit shank 1 with reference to the casting cavity 57 in the base die plate 50.

A hollow carbon or graphite core 70 is positioned within the bit shank 1 and comprises a cylindrical side wall 71 and a top wall 72, defining a hollow interior 73. The side wall 71 has a laterally extending collar portion 74 formed integrally therewith whose flat horizontally extending top surface 75 is substantially in line with the adjusted lower edge of the leg portion 6 of the bit shank. The lower horizontal wall 76 of the collar portion 74 is designed to seat on the flat upper edge of the internal riser wall 56 of the bottom die plate 50. The lower end 77 of the side wall 71 seats within the circular hole 78 in the base die plate 50 and against the internal cylindrical face of the riser wall 56. Thus the carbon core 70 firmly seats on the riser wall 56 but is not secured thereto.

The bit shank is so adjusted that the lower internal corner 21 of the leg portion 6 of the bit shank 1 is positioned closely adjacent the upper external corner 80 of the core body 74, with the cylindrical internal surface 12 of the bit shank 1 in accurate alignment with the vertical external surface 87 of the internal riser wall 56 of the die plate 50.

Accurate alignment of the internal cylindrical surface 12 of the bit shank 1 with respect to the external surface 87 of the die plate riser wall 56, is effected by four finely threaded adjustment screws 83 which are threaded into corresponding threaded openings in the lower portion of the side wall of the holding collar 60. The inner ends 85 of the screws 83 are arranged to abut the external cylindrical surface of the body portion 4 of the bit shank 1. By proper adjustment of the setting screws 83 the lower end of the bit shank can be swung a limited extent to a position where the internal cylindrical surface 12 thereof accurately aligns with the external cylindrical side wall surface 87 of the riser wall 56. The extent of the adjustment required to effect accurate and true alignment of the internal cylindrical surface 12 of the bit shank with the external cylindrical surface 87 of the riser wall 56, will be visibly indicated to the operator when he looks down into the bore of the shank 1.

The bull nosed end of the core bit is shaped by the arcuate contour of the inner bottom face 86 of the annular bottom wall 55 of the die plate 50, the internal cylindrical face of the core bit is shaped in part by the inside face 87 of the internal riser wall 56 of the bottom die plate 50 and in part by the external cylindrical wall 81 of the core, and the external face of the bit is shaped in part by the inside vertical face 88 of the peripheral walls 53 and 63 of the bottom die plate 50 and in part by the inside cylindrical face 89 of the holding collar 60.

The annular bottom forming wall 55, the downwardly extending outer wall 53 and the inner riser wall 56 of the bottom die plate 50 is punctured by a series of pin-sized suction openings or ports 90 which may extend at various angles and preferably are arranged along radial lines. The diamonds D are seated in the internal ends of the suction openings 90.

The hollow carbon core 70 is also provided with one or two rows of pinhole suction openings or ports 91 which extend generally horizontally through the collar portion 74 of the carbon core 70. Diamonds D are seated in the external ends of the horizontally extending suction ports 91 in the carbon core.

It will be noted that the diamonds D are set directly over the mouth of the suction ports 90 and 91 and are held in place by suction exerted by the suction pump 44 only without the use of other diamond holding devices. The suction force draws the air from the interior of the casting chamber 57 through the ports 91 in the carbon core and through the ports 90 in the die plate 50, through the suction cup 28 and out through the suction pipe 35.

The mold for the drill bit illustrated more particularly in Fig. 9 comprises a bottom die plate 100 formed of steel which has the usual flange 51 seating within the recess 52 of the steel supporting ring 32, and also has a downwardly extending cylindrical casting wall 53 and a short upwardly extending riser wall 63 whose inside face 88 forms in part the external cylindrical surface of the cast working end of the bit. The holding collar 60 has its lower end 61 seating on the flange 51 of the base die 100 and is provided with the internal groove 62 which seats on the external riser wall 63 of the die plate 100.

The bit shank 1, having the threaded stem portion 2 and enlarged body portion 4, is loosely threaded into the holding collar 60. The micrometer adjusting screws 83 are provided to align the lower end of the bit shank, The casting metal 110 is poured into the bit shank 1 and flows freely into the mold cavity 111 and through the holes 8 in the bit shank.

The bottom wall of the die mold 100 has a concave rim-forming portion 101 and a convex center portion 102. A large number of rather closely spaced pinhole openings or ports 103 extend in radial rows through the concave rim-forming portion 101, and the convex center portion 102 and the cylindrical casting wall 53 of the die plate 100. A carbon pin 105 may be set into the shank and the lower end of the pin is shaped to rest upon the concave bottom wall portion 101 of the die mold 100 so as to provide a water hole 24 for the bit. The pin is held in erect postion by the suction exerted through the suction openings 103 beneath the pin.

In order that the micrometer screws 83 may properly perform their function of centering the tool shank over the casting cavity in the die plates 50 or 100, it will be appreciated that the holding collar 60 must be held immovable and accurately seated on the die plate. This result can be obtained by providing a laterally extending flange section 115 on the lower end of the holding collar 60, which flange section 115 snugly rests on the flange 51 of the die plate. Three equally spaced metal tapering pins 116 are driven into aligned openings 117 and 117' in the flanges 115 and 51 respectively, which keys are easily removable and yet serve to firmly and accurately retain the holding collar 60 accurately centered with respect to the casting cavity in the die plate.

The method of casting the diamond studded tools is substantially the same for all such tools to be formed. To facilitate description the process of casting will be described more particularly in reference to the core bit illustrated in Figs. 1 and 2.

In casting the core bit the bottom die plate 50 is placed on the supporting ring 32 and the carbon core 70 placed in seating position on the riser wall 56 of the die plate 50. The suction pump is put into operation so as to draw atmospheric gas or air through the suction ports 90 and 91, at two to four pounds suction pressure. The selected sharp points of the diamonds D

are set directly into the mouth of the ports 90 and 91, which diamond placing operation is facilitated by the suction which helps to draw the diamonds into the ports and hold them in position. The diamond setting operation can generally be performed in ten to twenty minutes by a skilled operator.

The proper holding collar 60 and bit shank 1 is then selected and the threaded portion 2 of the bit shank is screwed into the holding collar 60, which provides a rather loose threaded connection. The holding collar 60 with the bit shank 1 is then placed upon the bottom die plate 50 and the tapering pins 116 are driven into the aligned openings 117 and 117' so as to rigidly secure the collar 60 in the proper die casting position.

The lower end of the bit shank 1 is then adjusted by the four micrometer screws 83 so as to bring the inner cylindrical wall 12 of the bit shank into accurate and true alignment with the inside face 87 of the internal die wall 56. The inner corner edge 21 of the bit shank is also screwed down so as to seat closely adjacent the outer corner 89 of the collar portion 74 of the core. The suction continues to hold the diamonds D in place during placement of the collar 60 and bit shank 1 in position.

With the full two to four pounds suction continuing, which pressure is regulated by suction regulator valve 49, the molten casting metal is poured into the interior of the bit shank 1, which itself serves as a pouring flask, and the metal flows into the molding cavity until the molten metal has risen in the bit shank 1 to a point where the holes 8 are covered with molten metal. The suction is continued with full force during the pouring operation. The suction, however, is cut off promptly after pouring by manipulating the cut-off valve 48. It is important that the suction be cut off promptly after pouring or the poured metal will continue to be sucked through the ports 90 and 91. The air filter 49', however, prevents any particles of metal from being drawn into the suction pump 44 which particles might otherwise damage the pump.

The suction ports 90 and 91 accomplish three purposes; first, they hold the diamonds rigidly in the mouth of the ports so that they are at all times in proper position and are not disturbed during the adjustment of the bit shank 1 in position and during the pouring and hardening of the molten metal; second, the suction is sufficient to draw the metal compactly around each of the diamonds so that a firm diamond setting is secured; and, third, the suction draws out the molding gases and insures a sound and dense working end casting.

As soon as the metal is sufficiently cooled, the holding collar 60 and die plate 50 is lifted off from the ring 32. The keys 116 are driven out, the core 70 pushed out, and the base die is removed from the holding collar and cast bit. The set screws 83 may then be loosened and the holding collar 60 screwed off from the bit shank 1.

It will be found that a small amount of metal may have been drawn through the ports 90 and 91 and has dropped down into the interior of the suction cup 28, which can be recovered and remelted. Also, strings of metal formed by the ports 90 and 91 may project from the end of the bit, which can be broken off or they may be left in the ports 90 and 91 where they can be easily pricked out by a pricking tool. The cast bit as formed requires very little machining. There may be some metal deposited on the inside cylindrical surface 12 of the bit shank which can be quickly cut off on a lathe or a grinder and the outer peripheral surface 13 of the cast bit end 9 may also be ground smooth with the outer cylindrical surface of the body portion 4.

The drill bit is made by the same operations as the core bit, except that a drill bit die 100 is positioned on the steel supporting ring 32. The diamonds D are set into the mouths of the ports 103 and the carbon pin 105 is placed in position. The lower end of the carbon pin 105 may be ground to conform to the inner contour of the concave bottom wall portion 101 of the die plate 100, so that the carbon pin 105 is also held in erect position by the suction ports positioned therebeneath.

After the diamonds have been set, the holding collar 60 is secured onto the bit shank 1 and this assembly is positioned on the base plate 100 and is properly centered by the keys 116. The micrometer screws 83 permit the operator to properly align the bit shank 1 with respect to the casting cavity.

With the suction still applied, the molten metal 110 is poured into the shank 1 until the metal rises well above the holes 8 in the leg portion 6 of the bit shank. The suction is then cut off and the cast bit is removed from the die plate 100 and the holding collar 60.

The carbon pin 105 is then driven out and excess metal can be easily bored or reamed out of the interior of the bit shank 1 so as to provide a smooth and slightly concave bottom 111. The outer peripheral surface 20 of the working end 15 may be cut or ground to present a smooth surface which aligns with the cylindrical periphery of the body portion 4 of the bit shank 1.

The apparatus for casting diamond studded cutting tools herein described is readily adaptable and interchangeable for the manufacture of various different types of diamond studded tools. The suction cups 28 may be conveniently arranged on the casting table 26 so that several operators may be employed simultaneously or so that the diamonds may be set in one base die member while metal is being poured into another mold or while the poured metal is cooling in still another mold. For example, while metal is being poured or is cooling in the mold stationed at *a*, as shown in Figs. 5 and 6, the operators may be placing diamonds in the ports of die plate 50 stationed at *b* and in the ports of the die plate 100 stationed at *c*.

The suction cups are all connected to a single suction pump 44 designed to draw from two to four pounds suction pressure and each branch suction line 40 leading to the individual suction cups is provided with conveniently located cut-off valve so that the suction pressure may be promptly cut off immediately after pouring of the cast metal. It will be appreciated that the same suction cup 28 and the same supporting ring 32 may be used to support a number of different base die members and shank supporting collars. Thus a number of tools of different shapes may be cast on the same working table by providing only a base die member for each tool to be cast and, if necessary, the proper shaped core member. It will be found that the same size core or drill bits, for example, may be cast by the use of the same holding collar 60, but obviously a different holding collar will be required for the casting of different sizes of core or drill bits.

It will thus be appreciated that only three different kinds of interchangeable parts are required

for casting numerous different types and kinds of diamond studded tools; namely, base die members in the required sizes and shapes, carbon cores in the required sizes and shapes, and holding collars in the required sizes and shapes. Thus a minimum of equipment is required for the casting of numerous different diamond studded tools.

It will further be appreciated that the operating parts may be quickly assembled before pouring of the metal and quickly disassembled to permit easy removal of the cast tool. The supporting ring **32** is unattached to the rim portion of the suction cup **28** and readily lifts off. The base die member also readily lifts off from the supporting collar **32** when the keys **116** are removed. The base die member can be easily pulled off from the cast end of the tool as soon as the cast metal has cooled sufficiently to permit handling thereof. The completely cast tool need then only be removed from the holding collar **60** by loosening the micrometer screws **83**. Since the threaded connection between the bit shank and holding collar **60** is very loose these parts can be easily unscrewed and separated by a simple turn of the hand.

The contacting surfaces between the supporting ring **32** and the rim portion **30** of the suction cup **28** and the contacting surfaces between the supporting ring **32** and the flange portion **51** of the base die member, are smoothly ground and fitted so that there is substantially no leakage of air or atmospheric gas therebetween. The sealing effect can be further enhanced by oiling the contacting surfaces. There is thus substantially no loss of suction pressure except the necessary suction which draws the atmospheric air or gas through the diamond holding suction openings.

By continuing the suction pressure from the very beginning to the end of the casting operation, the diamonds or cutting stones are not only firmly held in place during setting of the diamonds in the mouths of the suction openings but the arranged position of the diamonds is in no way disturbed when the holding collar and tool blank or shank is placed in position. The continuing suction not only withdraws all gases from the cast metal during pouring so that a sound and dense casting is assured, but the suction serves the additional important function of drawing the cast metal firmly around the surfaces of the seated diamonds so that the diamonds are firmly and tenaciously locked in the cast metal.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. An improved method of forming cutting tools characterized by cutting stones bonded to the tool shank by cast metal, which method comprises, providing a stationary base die member having stone receiving openings in the cavity-forming wall thereof, drawing atmospheric gas through said openings, positioning cutting stones in the cavity ends of said openings during continuance of said suction pressure, positioning the tool shank over said suction cavity and adjusting the lower end of said tool shank with respect to the casting cavity during continuance of said suction pressure, pouring molten metal into the casting cavity between the lower end of the tool shank and the cutting stones positioned therein during continuance of said suction pressure, and promptly releasing said suction pressure immediately upon completion of the metal pouring operation.

2. An improved method of forming cutting tools characterized by cutting stones bonded to the tool shank by cast metal, which method comprises, providing a stationary base die member having stone seating openings in the cavity-forming wall thereof, drawing atmospheric gas through said openings at from two to four pounds suction pressure, positioning cutting stones in the cavity ends of said openings during continuance of said suction pressure, positioning the tool shank over said suction cavity and adjusting the lower end of said tool shank with respect to the casting cavity during continuance of said suction pressure, pouring molten metal into the casting cavity between the lower end of the tool shank and the cutting stones positioned therein during continuance of said suction pressure, until said casting cavity has been filled with molten metal, and promptly releasing said suction pressure immediately upon completion of the metal pouring operation.

3. An improved method of forming drill bits characterized by cutting stones bonded to the tool shank by cast metal, which method includes, providing a stationary base die member having stone-seating openings extending through the cavity-forming walls thereof, drawing atmospheric gas through said openings at from two to four pounds suction pressure, positioning cutting stones in the cavity ends of said openings during continuance of said suction pressure, positioning the tool shank over said suction cavity and adjusting the lower end of said tool shank to align the tool shank with respect to said casting cavity during continuance of said suction pressure, pouring molten metal into the casting cavity between the lower end of the tool shank and the cutting stones positioned therein during continuance of said suction pressure, and promptly releasing said suction pressure immediately upon the completion of the metal pouring operation.

4. An improved method of forming core bits characterized by cutting stones bonded to the tool shank by cast metal, which method includes, providing a stationary base die member having stone-seating openings extending through the cavity-forming walls thereof, positioning a hollow carbon core having radial stone-seating openings extending through its walls centrally on said base die member, drawing atmospheric gas through the openings in said base die member and carbon core at from two to four pounds suction pressure, positioning cutting stones in the cavity ends of said openings during continuance of said suction pressure, positioning the tool shank over said suction cavity and adjusting the lower end of said tool shank to align the tool shank with respect to said casting cavity during continuance of said suction pressure, pouring molten metal into the casting cavity between the lower end of the tool shank and the cutting stones positioned therein during continuance of said suction pressure until said casting cavity has been completely filled with molten metal, and promptly releasing said suction pressure immediately upon the completion of the metal pouring operation.

5. An improved apparatus for casting cutting tools characterized by cutting stones bonded to an externally threaded tool shank by cast metal,

said apparatus including, a suction cup, means for applying suction to said suction cup, a base die member seated on said suction cup having a casting cavity formed therein, diamond-seating openings extending through the cavity-forming wall of said die member and leading to said suction cup, a holding collar seated on said base die member having an internally threaded opening into which the tool shank may be inserted, the internal threads on said holding collar being so constructed and arranged as to provide a loosely threaded connection with the external threads on the tool shank whereby said tool shank is loosely supported by said holding collar, and adjustable means associated with said collar for adjusting said shank with respect to the casting cavity to accurately align said shank with respect to the casting cavity.

6. An improved apparatus for casting core bits characterized by cutting stones bonded to the tool shank by cast metal, said apparatus including, a suction cup, a ring member supported on the rim of said suction cup and having a central opening communicating with the suction cavity in said suction cup, means for applying suction to said suction cup, a base die member having a peripheral flange seated in a receiving recess formed in the inner rim of said ring member, said base member having a casting cavity formed therein, a hollow carbon core centrally supported on said base die member, diamond-seating openings extending through the cavity-forming wall of said die member and the walls of said carbon core leading to said suction cup, a holding collar seated on said base die member into which the tool shank may be inserted, and adjustable means associated with said collar for adjusting said shank with respect to the casting cavity to accurately align said shank with respect to the casting cavity.

7. An improved apparatus for casting cutting tools characterized by cutting stones bonded to the tool shank by cast metal, said apparatus including, a suction cup, a suction pump adapted to develop two to four pounds suction pressure connected to said suction cup, a supporting ring snugly seated on the upstanding rim of said suction cup, a base die member snugly seated on said supporting ring and having a casting cavity formed therein, diamond-seating openings extending through the cavity-forming wall of said die member and leading to said suction cup, a holding collar seated on said base die member for loosely supporting the tool shank over said casting cavity, a riser wall and a cooperating receiving recess associated with said holding collar and die member for centering the holding collar on said die member, and adjustable means associated with said collar for adjusting said shank with respect to said casting cavity to accurately align said shank with respect to the casting cavity.

8. An improved apparatus for casting cutting tools characterized by cutting stones bonded to the tool shank by cast metal, said apparatus including, a suction cup, a suction pump adapted to develop two to four pounds suction pressure, suction piping connecting said pump to said suction cup, a suction cut-off valve in said piping adjacent said suction cup, a supporting ring snugly seated on the upstanding rim of said suction cup, a base die member snugly seated on said supporting ring and having a casting cavity formed therein, radially arranged diamond-seating openings extending through the cavity-forming wall of said die member and leading to said suction cup, a holding collar seated on said base die member for loosely supporting the tool shank over said casting cavity, removable key elements for removably securing said collar member on said base die member and for centering said holding collar on said base die member, and a plurality of adjustable micrometer screws associated with said collar and adapted to engage said shank for accurately aligning said shank with respect to the casting cavity.

9. An improved apparatus for casting cutting tools characterized by cutting stones bonded to the tool shank by cast metal, said apparatus including, a suction cup, means for applying from two to four pounds suction pressure to said suction cup, a base die member seating on said suction cup and having a casting cavity formed therein, a central aperture in said base die member, a hollow carbon core having a shoulder portion seating on the peripheral rim of said aperture and a flange portion extending into said aperture, diamond seating openings extending through the cavity forming wall of said die member and leading to said suction cup, diamond seating openings extending through the peripheral wall of said core and communicating through the hollow interior thereof with said suction cup, a holding collar seated on said base die member for supporting the tool shank over said casting cavity, and a plurality of adjustable micrometer screws associated with said collar and adapted to engage said shank with respect to the casting cavity.

10. An improved apparatus for casting cutting tools characterized by cutting stones bonded to the tool shank by cast metal, said apparatus including, a suction cup, means for applying from two to four pounds suction pressure to said suction cup, a removable supporting ring snugly seated on the upstanding rim of said suction cup, a removable base die member snugly seating on said supporting ring and having a casting cavity formed therein, a central aperture in said base die member, a hollow carbon core having a shoulder portion seating on the peripheral rim of said aperture and a flange portion extending into said aperture, diamond seating openings extending through the cavity forming wall of said die member and leading to said suction cup, diamond seating openings extending radially through the peripheral wall of said core and communicating through the hollow interior thereof with said suction cup, a holding collar seated on said base die member for supporting the tool shank over said casting cavity, and a plurality of adjustable micrometer screws associated with said collar and adapted to engage said shank for accurately aligning said shank with respect to the casting cavity.

11. An improved apparatus for casting core bits characterized by cutting stones bonded to the tool blank by cast metal, said apparatus including, a suction cup, means for applying from two or four pounds suction pressure to said suction cup, a removable supporting ring snugly seated on the upstanding rim of said suction cup, a removable base die member snugly seated on said supporting ring having a rim-forming casting cavity formed therein, said casting cavity including a depressed annular bottom-forming wall having an arcuately curved internal casting surface, an internal upstanding forming wall defin-

ing the inner periphery of said casting cavity and an upstanding forming wall defining the external periphery of said casting cavity, and a central opening in said base die member defined by said inner upstanding wall, a removable hollow carbon core seating on said internal upstanding wall, a plurality of diamond-seating openings extending through the cavity-forming bottom wall, the internal peripheral wall and the external peripheral wall of said base die member and through the peripheral wall of said core and leading to said suction cup, and a removable holding collar seated on the upstanding wall of said die member for supporting the tool shank in position over said casting cavity.

12. An improved apparatus for casting core bits characterized by cutting stones bonded to the tool blank by cast metal, said apparatus including, a suction cup, means for applying from two to four pounds suction pressure to said suction cup, a base die member seated on said suction cup, said die member having a supporting flange portion, a central aperture and a casting cavity positioned between said central aperture and said flange portion, said casting cavity being defined by a depressed annular bottom wall portion, an internal cylindrical rim portion and an external cylindrical rim portion rising above said bottom wall portion, a hollow carbon core having a cylindrical side wall and a closed top wall, said cylindrical side wall having an enlarged body portion adapted to seat on the internal cylindrical side wall portion of said die member, a plurality of radially arranged diamond-supporting suction openings extending through the bottom wall portion and through the internal and external side wall portions of said casting cavity communicating with said suction cup, laterally extending diamond-supporting suction openings extending through the enlarged body portion of said core and communicating with the hollow interior thereof, and a holding collar seated on the external side wall portion of said die member for supporting the tool shank in position over said casting cavity.

13. An improved apparatus for casting core bits characterized by cutting stones bonded to the tool blank by cast metal, said apparatus including, a suction cup, means for applying from two to four pounds suction pressure to said suction cup, a removable supporting ring snugly seated on the upstanding rim of said suction cup, a removable base die member, said die member having a flange portion snugly seating on said supporting ring, a central aperture and a casting cavity positioned between said central aperture and said flange portion, said casting cavity being defined by a depressed annular bottom wall portion, an internal cylindrical rim portion and an external cylindrical rim portion rising above said bottom portion, a hollow carbon core having a cylindrical side wall and a closed top wall, said cylindrical side wall having an enlarged body portion removably seated on the internal cylindrical side wall portion of said die member, a plurality of radially arranged diamond-supporting suction openings extending through the bottom wall portion and through the internal and external side wall portions of said casting cavity communicating with said suction cup, laterally extending diamond-supporting suction apertures extending through the enlarged body portion of said core and communicating with the hollow interior thereof, and a removable holding collar seated on the external side wall portion of said die member for supporting the tool shank in position over said casting cavity.

ROBERT G. WILSON.