Sept. 25, 1962 M. C. SHAW ETAL 3,055,102

METAL FINISHING MEANS AND METHOD FOR USE OF SAME

Filed Oct. 11, 1956

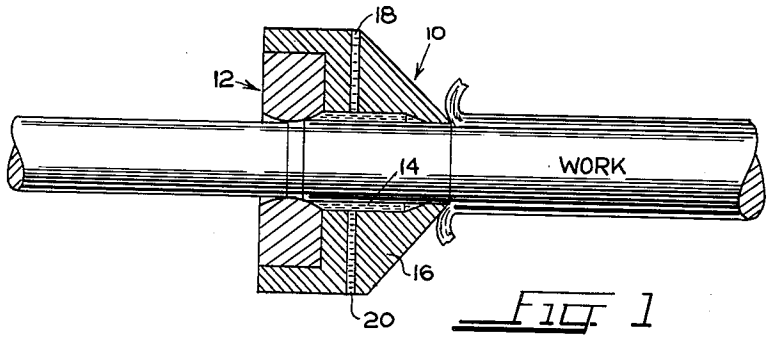


FIG. 1

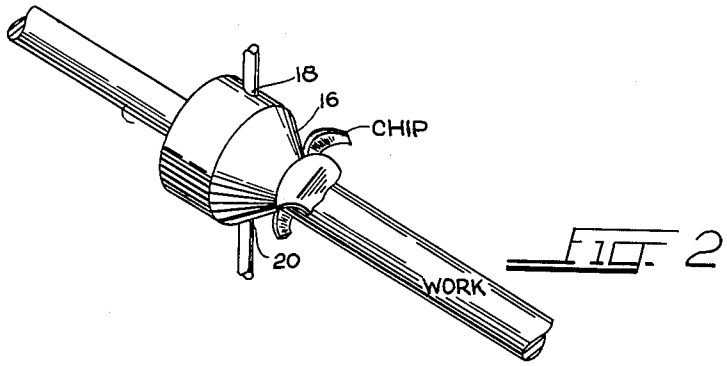


FIG. 2

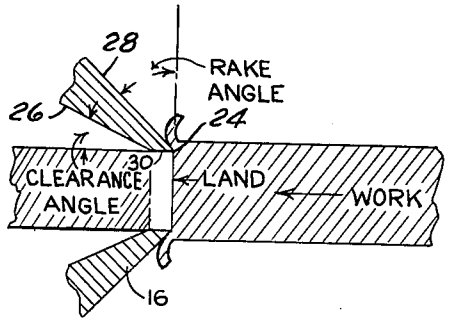


FIG. 3

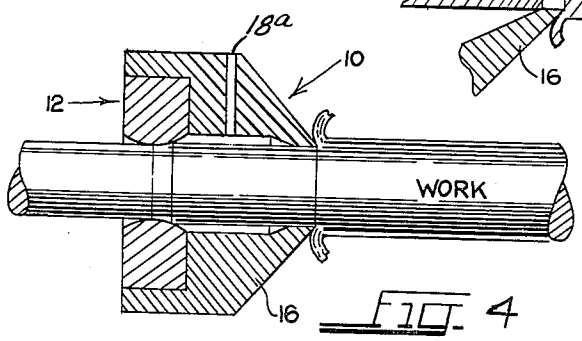


FIG. 4

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United States Patent Office

3,055,102

Patented Sept. 25, 1962

3,055,102

METAL FINISHING MEANS AND METHOD FOR USE OF SAME

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Filed Oct. 11, 1956, Ser. No. 615,328
3 Claims. (Cl. 29—547)

This invention relates to the cold finishing of metal and it relates more particularly to a method and apparatus for the removal of metal and for the finishing of metal bars, rods or wires.

As used herein, the term "bars or rods" is meant to relate to metal elements of uniform cross-section including bars of round, oval, square, or of other curvilinear or polygonal cross-section. Reference will be made herein to the application of the invention for the cold finishing of round rods or wires but it will be understood that bars and rods of other cross-sectional shapes may be employed. The term "metal" is meant to include the metals fabricated for industrial, commercial or structural use, such as rods or bars of steel, copper, brass, aluminum, titanium, magnesium and the like metals. While steel may be specifically mentioned in the following discussion, it should be understood that the invention is equally applicable to other metals.

In the cold finishing of metal, such as steel bars or rods, use is generally made of a drawing or extrusion operation wherein the metal is advanced through a die to effect reduction in cross-sectional area. Bars are also cold finished by turning and grinding operations which reduce the metal bar in size by metal removal.

To the present, removal of unsound or other metal from the surface of a steel bar or rod has been effected by a machining or cutting operation separate and apart from the drawing or extrusion step. Metal removal as by means of a cutting lathe is not only slow and expensive but it requires the utilization of considerable amounts of additional labor and equipment and it requires utilization of a considerable amount of space for equipment and for the additional inventory that is required.

It is an object of this invention to provide a new and improved method and apparatus for use in the cold finishing of metal and it is a related object to provide a method and apparatus for the removal of metal in a manner which is substantially free of the objectionable features of processes heretofore employed.

Another object of this invention is to provide a method and apparatus for cold finishing metal at high speed and in an efficient and economical manner and it is a related object to provide a method and apparatus for producing a high finish on metal and to effect a reduction in cross-sectional area without the expenditure of space, labor and equipment heretofore required for equivalent results by processes heretofore employed.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawing in which—

FIGURE 1 is a sectional elevational view showing the essential features of an apparatus embodied in the practice of this invention;

FIGURE 2 is a perspective view of the apparatus as employed in the cold finishing of metal rods;

FIGURE 3 is an enlarged sectional elevational view of the metal cutting portion of the device shown in FIGURE 1; and

FIGURE 4 is a modification of the apparatus shown in FIGURE 1.

In accordance with the practice of this invention, the unwanted metal is removed from the surface of the bar or rod in a rapid and efficient manner by advancing the bar or rod continuously through a cutter which operates to shave the metal from the entire surface of the bar or rod as it is advanced therethrough. One difficulty which arises in the use of a shaving tool of this character stems from the inability to hold the bar or rod properly centered within the die. As a result, the bar or rod tends to wander from one side to the other of the die. This produces a wavy surface and sometimes the bar or rod may wander so far to one side or the other that the shaving tool cuts into wanted metal, while unwanted metal on the opposite side still remains on the bar or rod.

In addition to waviness, difficulties arise from the large amount of chattering and longitudinal vibration that takes place as the work is advanced in cutting relation through the shaving tool and from the galling that appears to have taken place on the surface of the metal which has been advanced through the shaving tool. This galling gives rise to an objectionable appendage on the cutting edge, known in the workshop as a "built-up edge." The sluffing off of this appendage is responsible for a torn surface on the metal. Chattering is evidenced by surface roughness on the metal and wear on the tool. Unless these difficulties are overcome along with waviness, the use of a shaving tool for the rapid removal of unwanted metal from the surface of bars or rods cannot be adapted to commercial practice.

To some extent, the problem of waviness has been overcome by the system described in the Weaver Patent No. 2,233,928, issued on March 4, 1941, and entitled "Wire Shaving Process and Fixture." In accordance with the teaching of the Weaver patent, the wandering capabilities of the wire are restricted by the use of a system of dies for guiding and reducing in combination with a cutting die. Many problems have been experienced in operation of the system of Weaver and the finish secured has been found wanting in many respects, especially when the system is used on bars and rods, as distinguished from wires. Galling is in fact so severe when processing steel by the system of Weaver as to render the process commercially impractical.

We have succeeded in overcoming many of the difficulties previously experienced in the process of continuously shaving metal from the surface of a metal bar, rod, tube or wire without excessive chattering, without excessive galling, and without excessive waviness. We have succeeded in the development of a system capable of use commercially rapidly and efficiently to remove unwanted metal from the surfaces of bars, rods, tubing or wire, and in the preparation of the surface of the metal for a subsequent drawing or extrusion operation. We have succeeded in combining the metal cutting and metal drawing or extrusion operations to provide for a continuous process in which metal removal is effected in a simple and efficient manner and in which metal drawing or extrusion is improved thereby to provide a unitary process which overcomes many of the difficulties heretofore encountered in the cutting and drawing operations separately carried out in metal finishing.

These objectives have been achieved by the combination which makes use of a shaving tool **10** immediately in advance of and in axial alignment with a draw or extrusion die **12** with a space **14** in between being confined by a housing **16** and which makes use of a fluid **22** filling the confined space **14** between the shaving tool **10** and die **12**. The housing **16** can be provided with a single inlet **18***a* in communication with the space **14** through which the fluid **22** can be supplied in an amount to maintain the confined space between the cutter and die filled

with the fluid, as illustrated in FIGURE 4 of the drawing, or the housing can be provided with an inlet 18 and an outlet 20 in communication with the confined space for the flow of fluid through the confined space between the shaving tool and die, as illustrated in FIGURE 1 of the drawing. It will be sufficient if fluid is supplied to the confined space without pressure, but the supply of fluid under pressure offers certain advantages, and in the subsequent description of the invention reference will be made to the use of pressure fluid as filling the confined space. It will be understood, however, that the concepts of this invention include the use of fluid without pressure to fill the space between the shaving tool and die. The combination of a cutter and draw die with fluid under pressure acting on the elements in between operates to effect removal of unwanted metal from the surfaces of the work and to effect reduction in cross-sectional area without longitudinal vibration, chattering or waviness while, at the same time, conditioning the cutter and the die for their respective cutting and drawing or extrusion functions.

The ability of the fluid materially to affect chattering, longitudinal vibration, galling and wandering as the work passes continuously into operative engagement with the cutting tool and the subsequent extrusion or draw die, and the ability of the lubricant to provide desired lubrication both for the shaving or cutting operation and the drawing or extrusion operation, would indicate that the fluid reacts in combination with the forces existing between the work and die or cutter to center the work and to cushion the work with respect to the die and cutter. It may be that the fluid, preferably under pressure, flows to provide a layer of liquid between the work and the cutter or die, thereby to cause the work to float during passage through the cutter or die whereby the desired lubrication is secured all around and whereby the work is cushioned in the cutter or die in a manner to minimize wandering or vibration during passage through the cutter or die. Whatever the reason, it has been found that the combination of a cutter and a draw or extrusion die with fluid filling the space in between provides an assembly capable of use commercially for rapid and efficient removal of unwanted metal concurrently with the drawing or extrusion operation for size reduction or surface finish without development of the difficulties and objectionable features heretofore experienced.

With reference now to the cutting tool, use can be made of a tool having a cutting edge 24 formed of high speed steel, sintered carbide or the like. The angle defined by the axis of the tool and the slope of the wall 26 defining the bore through the tool, referred to hereinafter as the clearance angle, can range from 1 to 15 degrees. Since lower clearance angles tend to lead to galling, it is preferred to make use of a clearance angle greater than 3 degrees and preferably within the range of 3 to 6 degrees.

The angle which the outer wall 28 of the tool makes with the perpendicular to the axis of the work, hereinafter referred to as the rake angle, can range from 10 to 40 degrees. It is preferred to make use of a rake angle as large as possible consistent with the ability of the tool to resist chipping at the cutting edge. For carbide tools, it is preferred to make use of a rake angle greater than 15 degrees and preferably within the range of 15 to 25 degrees. For tools formed of high speed steels, it is preferred to make use of a rake angle greater than 20 degrees and preferably within the range of 25 to 40 degrees.

While it is not essential to provide a land or flat 30 on the clearance face, the tendency towards waviness can be reduced when the cutting tool is formed with a land which reduces the clearance for a length no greater than 0.020 inch and preferably for a length within the range of 0.004 to 0.014 inch.

Having described the essential features of the cutting tool, reference will now be made to the die 12 used in combination therewith. A draw die or an extrusion die of conventional construction may be employed in which the draw die, for example, is of conventional construction having a bell portion followed by an approach which leads into a bearing and a back relief section. Whether large reductions are to be taken or whether a finished reduction is to be taken, the draw or extrusion die 12 is mounted in the housing in endwise alignment with the cutting tool 10 and in closely spaced relation therewith. In the preferred practice, the die can be spaced from the tool by as little as 1/64 inch or as much as 1/8 or 1/2 inch without loss of control in operation. Distances greater than 1/8 to 1/2 inch can be used where more time is desired for use of the fluid to cool the metal between operational steps and to chemically react with the freshly cut surface of the metal to provide improved lubrication. The lubricating characteristics of the fluid are sometimes enhanced by the reactions available between the fluid and the metal which is freshly cut and in a more reactive state as compared to metal previously cut and exposed to the atmosphere prior to lubrication.

A shaving tool which cuts the entire surface of a bar at one time is a particularly difficult tool to lubricate. The motion of chip tends to carry the fluid away from the cutting edge when the fluid is applied along the tool face, while the motion of the finished work surface tends to carry fluid introduced along the clearance face away from the cutting edge. Fluid can be driven down the rake and clearance faces of the tool against these adverse chip and workpiece motions only when applied under high pressure. When a shaving tool is used in the conventional manner there is no way of supplying fluid under high pressure along either of the two faces. A free stream of fluid can only be supplied at high velocity in order to make it penetrate which leads to much splashing and proves to be an impractical way of getting the fluid to penetrate to the cutting edge. By using a shaving tool and die simultaneously and confining the space between the two, it is possible to supply fluid to the clearance surface of the tool and to the front face of the die under pressure without great flow and a costly pumping loss. The cutting edge limits the flow from one end of the confined space while the draw die tends to seal the other end. A desirable static pressure may be maintained in the confined space between tool and die by a simple hand pump. Or, the fluid in the confined space may be circulated by providing both inlet and outlet connections, external piping and a suitable circulating pump. The use of cutter and die with intervening space confined makes it possible to obtain sufficiently high pressure at the clearance face of the tool to drive the fluid to the cutting edge and hence prevent formation of the build-up edge which makes ordinary attempts to produce smooth skinned and drawn rods unsuccessful.

The fluid supplied to the confined space also tends to reduce chattering, longitudinal vibration and wandering. In addition, the fluid, when circulated, can be used to extract heat from the metal to cool the metal during passage from the cutter to the die in process. Further, the fluid can be selected for imparting lubricating characteristics to lubricate the cutting operation and to provide lubrication for the draw or extrusion die, since fluid is forced under pressure into intimate communication between the surfaces of the work and the cutter and between the surfaces of the work and the draw or extrusion die. In the practice of this invention, use can be made of phosphated fluids, Freons and other conventional drawing fluids.

As previously pointed out, the concepts of this invention are made available but the use of fluids without pressure by flow of fluids to provide all of the advantages described is best secured by the use of fluids under positive pressure. In practice, the fluid can thus be supplied to fill the confined space with the fluid under a

pressure range from 0 to 10,000 pounds per square inch. The optimum range has been found to reside in the use of fluid under a pressure within the range of 100 to 5,000 pounds per square inch. Pressures greater than 10,000 pounds per square inch can be employed but without proportional influence on lubrication, waviness, chattering or longitudinal vibration. Pressures in the higher portion of the range described have been found to be beneficial where it is desirable to make greater reductions in the drawing or extrusion step. In any event, pressures in excess of 10,000 pounds per square inch would seldom be employed.

In the combination described, the depth of cut taken from the metal can range from 0.001 to 0.020 inch depending upon the speed of the work through the die and the cross-sectional dimension of the work. Similarly, the amount of reduction will depend somewhat on these same factors plus the type and pressure of the fluid and it may vary from a finished draft of 0.002 to 0.01 inch or a reduction draft of 0.002 to 0.06 inch or more depending upon the above factors. It will be understood that the concepts of this invention are not limited by the depth of cut or the amount of reduction taken during passage through the dies. When like cuts are taken at low speeds, use can be made of tools having a larger rake angle limited only by the tendency for the tool to chip. In general, cutting speeds in the range of 5 to 1000 feet or more per minute can be employed for the combination of cutting and the drawing or extrusion operation.

In one specific illustration, use was made of a cutting tool of high speed steel having a 30 degree rake angle, a 5 degree clearance angle with no flat on the clearance face. The tool was selected to provide a depth of cut within the range of 0.003 to 0.005 inch. The draw die, mounted $\frac{1}{64}$ inch from the cutter, was dimensioned to take a reduction of 0.003 to 0.005 inch for finishing the metal. In another instance, the draw die was dimensioned to take a larger reduction of about 0.06 inch. A phosphate drawing fluid or Freon 112 was supplied to the housing through the space between the dies at a pressure of about 1000 p.s.i. The work, a C–1018 steel, was advanced through the system at a speed of 50 feet per minute. In operation, the metal was shaved smoothly and at a uniform depth from all around the rod and a finished piece of good quality and appearance was produced.

It has been found that a tandem die system with fluid under pressure operating upon the dies and upon the areas in between the dies is effective also in the combination which makes use of a draw die or extrusion die in substitution for the cutter thereby to provide a tandem draw die system in which one die can be selected for one reduction or in various other combinations. It will be apparent also that the die system may be further extended to add more dies to the combination with a confined spaced relation therebetween through which fluid under pressure can be suplied but, when use is made of a cutter, location of the cutter is, for the present, limited to the head of the system only because of the difficulty otherwise of disposing of the chips. When means are provided for disposal of chips, the system can make use of various combinations of dies and cutters in numerous arrangements.

It will be apparent from the foregoing that we have provided a new and improved device for the cold finishing of metal bars and rods whereby metal removal is effected in a simple and efficient manner accurately to remove the unwanted metal from the surface of the bar or rod prior to immediate and continuous entrance of the cut metal through a subsequent die for processing as through a draw die or an extrusion die to effect reduction in cross-sectional area.

It will be understood that changes may be made in the details of construction and operation of the device without departing from the spirit of the invention, especially as defined in the following claims.

We claim:

1. The method of cold finishing metal bars and rods, comprising the steps of advancing the metal bars and rods continuously through a shaving tool dimensioned to have a rake angle within the range of 10–40 degrees and a clearance angle within the range of 1–15 degrees for shaving metal from the surfaces of the bars and rods advanced therethrough and then through an extrusion die axially aligned with the cutting tool and spaced a short distance therefrom to effect a reduction in cross-sectional area, confining the space between the cutting tool and the extrusion die, and supplying lubricating fluid under high pressure to fill the confined space whereby fluid flows into the cutting area between the edge of the cutter and the work for stabilizing the cutting operation while simultaneously lubricating the freshly cut surface of the metal during passage from the cutter through the die.

2. The method as claimed in claim 1 in which the fluid is a pressure fluid supplied to maintain the pressure within the confined space within the range of 100–10,000 pounds per square inch.

3. The method of cold finishing metal bars and rods, comprising the steps of advancing the metal bars and rods continuously through a shaving tool dimensioned to have a rake angle within the range of 10–40 degrees and a clearance angle within the range of 1–15 degrees for shaving metal from the surfaces of the bars and rods advanced therethrough and then through a draw die axially aligned with the cutting tool and spaced a short distance therefrom to effect a reduction in cross-sectional area, confining the space between the cutting tool and the draw die, and supplying lubricating fluid under high pressure to fill the confined space whereby fluid flows into the cutting area between the edge of the cutter and the work for stabilizing the cutting operation while simultaneously lubricating the freshly cut surface of the metal during passage from the cutter through the die.

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