March 8, 1955 A. H. BROOKES ET AL 2,703,512

WIRE SHAVING APPARATUS

Filed June 22, 1951 3 Sheets-Sheet 1

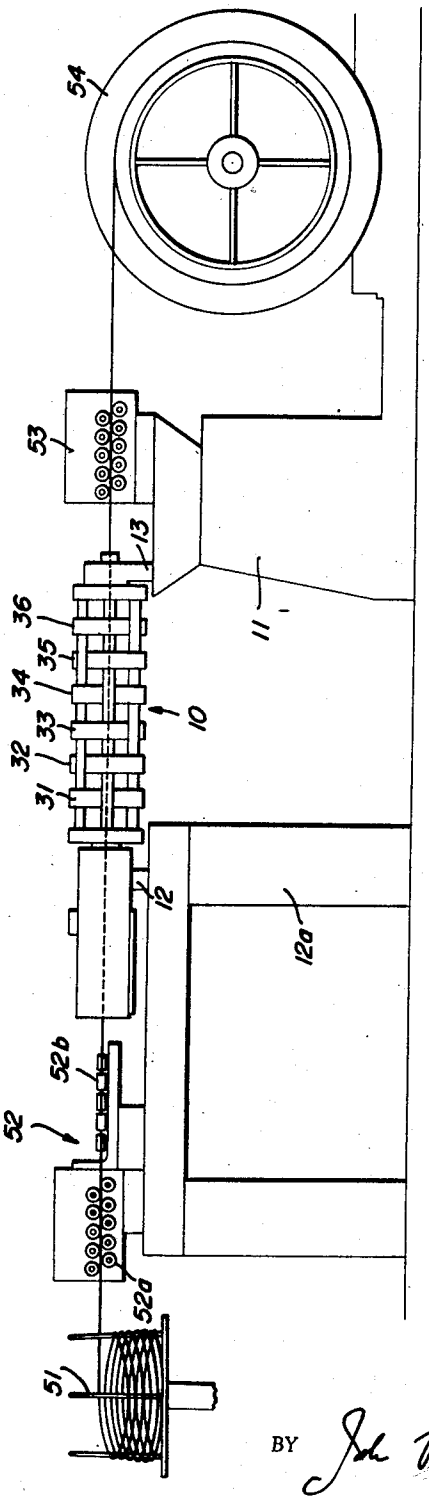



FIG. 1

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WIRE SHAVING APPARATUS

Filed June 22, 1951 3 Sheets-Sheet 2

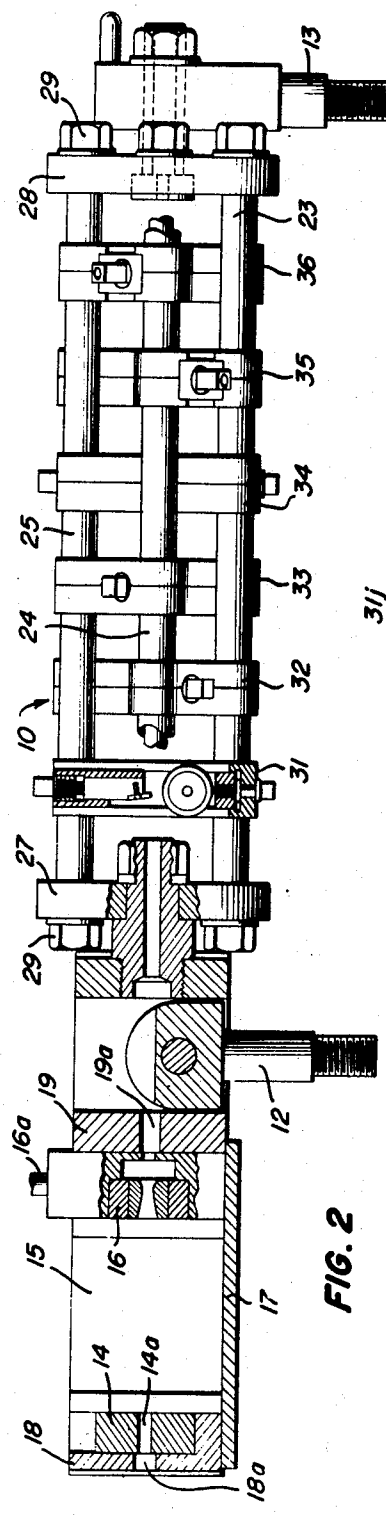



FIG. 2

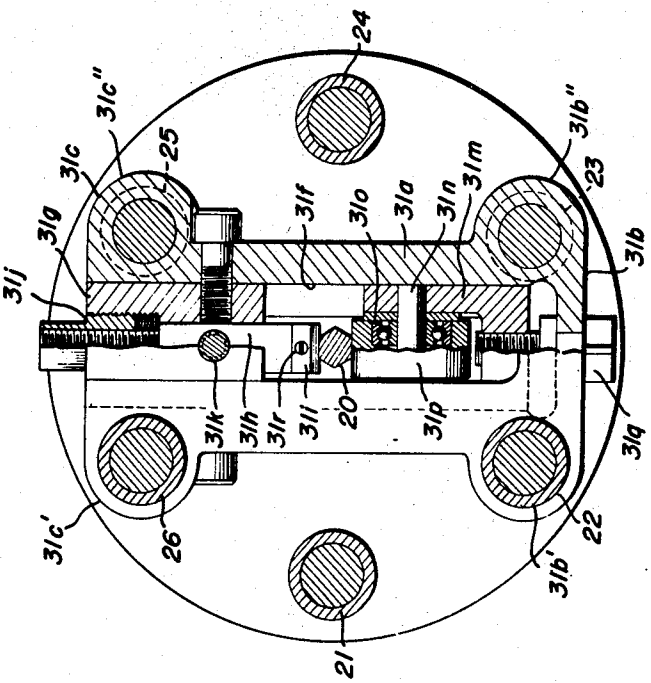



FIG. 3

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WIRE SHAVING APPARATUS

Filed June 22, 1951 3 Sheets-Sheet 3

FIG. 4

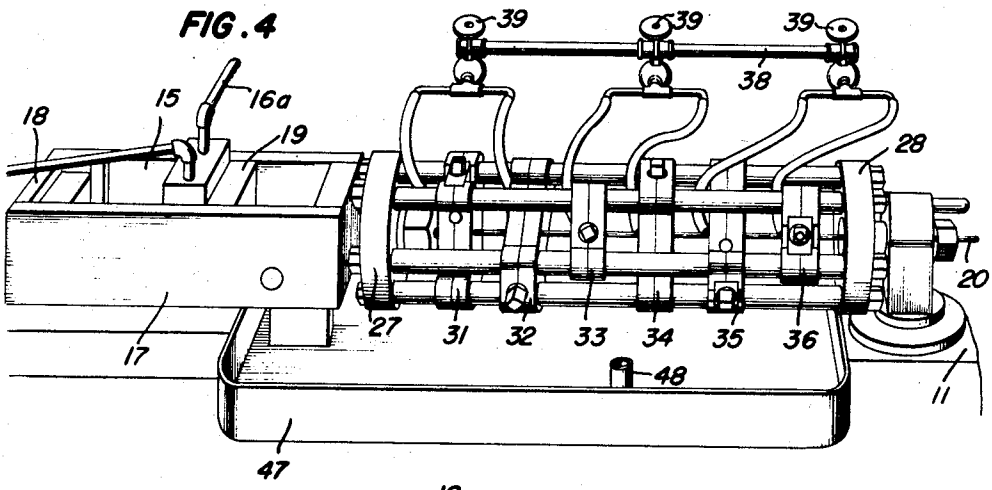
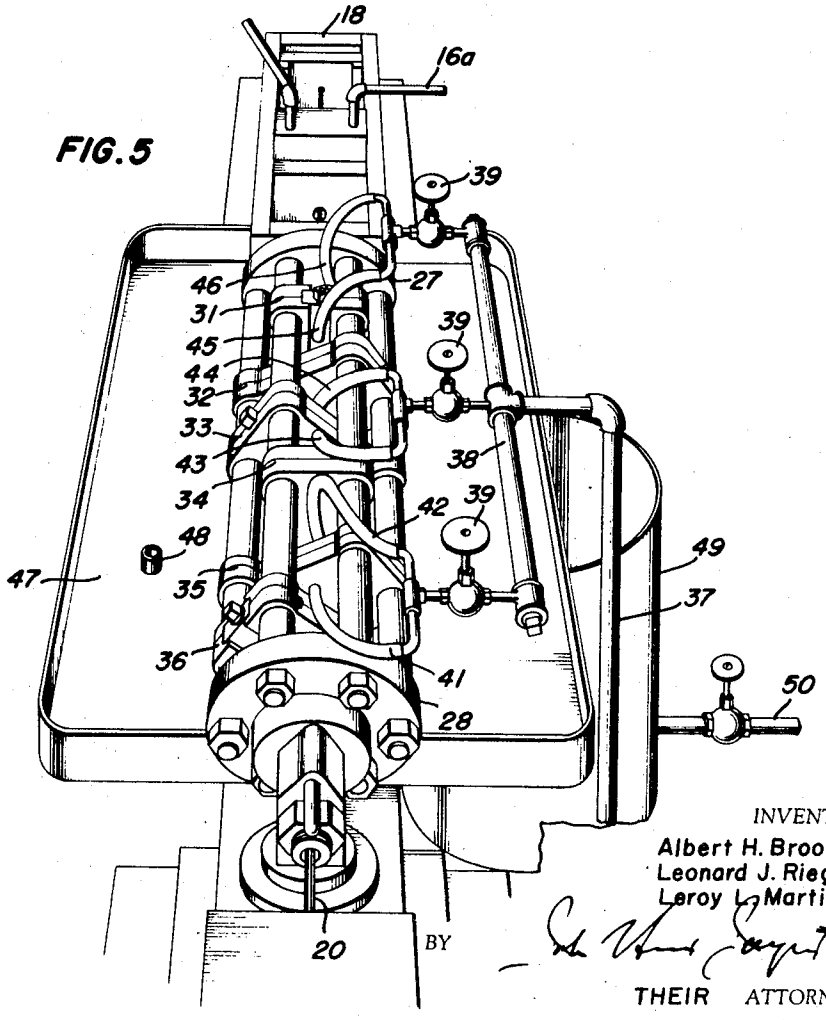



FIG. 5




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United States Patent Office 2,703,512
Patented Mar. 8, 1955



2,703,512

# WIRE SHAVING APPARATUS

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Application June 22, 1951, Serial No. 232,964

5 Claims. (Cl. 90—24)

Our invention relates in general to the finishing of metal stock. More particularly it concerns imparting an adequate finish to wire stock, rods, bars and the like formed of stainless steel and other metals of substantial hardness, and especially of polygonal section.

An object of our invention, therefore, is to provide a method of nicely finishing metal bar, rod and wire stock, and this substantially without regard to cross-section and particularly suited for hexagonal stock, which method requires but few procedural and manipulative steps, each simple and rapid, and demanding only conventional and readily available equipment, and which is characterized by a basic simplicity, low cost of production and rapidity of operation.

Another object is to provide apparatus for finishing hard metal stock of small cross-sectional dimensions, imparting high finish detail with close adherence to small permissible tolerances, and while effectively and rapidly finishing stock of intricate cross-section, is simple in design and ready and economic of production, which apparatus displays long useful life in the substantial absence of constant supervision and attendance, and which, while in use, is characterized by absence of moving parts.

A further object is to provide apparatus for achieving all the foregoing wherein the resulting product displays excellent finish detail, with no chatter marks, galling or weld marks, scarring, gouging, tearing or the like, and wherein shock, wear, clogging and the like of the apparatus are effectively minimized.

All these, as well as the many other highly practical objects and advantages which attend upon the practice of our invention will in part be obvious and in part pointed out during the course of the following description.

Accordingly, our invention resides in the combinations of elements, features of construction and arrangement of parts; and in the several procedural and manipulative steps, and cooperation of each of the same with one or more of the others, the scope of the application of all of which is more fully set forth in the claims at the end of this specification.

In the several views of the accompanying drawing, which disclose that embodiment of our invention which we presently prefer, and wherein like reference characters denote like constructional parts:

Fig. 1 is a schematic showing of wire finishing apparatus in accordance with our invention;

Fig. 2 is an elevation of the wire-shaving apparatus of Fig. 1, partially in section;

Fig. 3 is an elevation, on enlarged scale, with parts shown in section, of one of a series of tool holders employed in our new wire-shaving head;

Fig. 4 is a perspective of the apparatus of Fig. 2; and

Fig. 5 is a perspective view, somewhat skeletonized, disclosing the cooling and lubricating system for the cutting tools of our apparatus.

It will be helpful to a full understanding of our invention to point out at this point that difficulty has confronted the industry in achieving superior finish for elongated metal stock of small cross-sectional dimensions such as bars, rods and wire, and displaying a high degree of hardness. Particularly is this true where in section, the metal periphery is polygonal, illustratively hexagonal. Moreover, especial difficulty is encountered in the processing of bar, rod or wire stock formed of stainless steel.



Because of the important use of stainless steels in the fabrication of articles in which surface perfection is mandatory, heavy emphasis is placed upon the initial production of wire stock free from known and not unusual defects, illustratively seams, minute slivers, imbedded scale, pits, laps and the like. And this, without concession whatsoever to the intricacy of section, of which hexagonal configuration is illustrative. The distressing frequency of occurrence of these defects has long been recognized, and they have been the subject of widespread and intensive studies by those skilled in the art. This is particularly so where the nature of the section will not permit the removal of surface defects by conventional grinding equipment.

Despite the processing heretofore resorted to, the sought-after highly polished, lustrous and pleasing appearance has proved elusive; and the actual product has displayed itself as streaked, frosty and dull. At most, costly after-treatment, such as grinding, polishing or buffing, where it is possible, has had to be resorted to. While frequently where intricate shapes are required, the impracticability of after-treatment has made impossible the achievement of the desired excellent appearance of the fabricated metal stock.

Much study has been given to properly processing stainless steel and generally similar hard-metal wire stock, rods and bars, premised in part on prior work with softer metals such as copper. None of the many proposals suggested, however, has proved entirely adequate.

An important object of our invention, therefore, is to provide a method and apparatus for mechanically shaving stainless steel bar, rod, wire, and the like, particularly those of non-circular section and especially hexagonal stock, so as to eliminate substantially all surface defects, and this without necessity of preliminarily straightening the wire, wherein close tolerances are achieved, with smooth bright metallic finish; in which method and apparatus a hexagonal or other non-circular sectional is achieved true throughout its extent and provided with sharp edges or corners and this with required high accuracy of dimension and in the substantial absence of slivers or tears; and in which method and apparatus comparatively high operational speeds can be resorted to with required good results, such wear as does occur being directed largely towards readily replaceable parts.

In the practice of our invention we find that for effective and rapid processing, and this with economy and through the use of simple and standardized equipment, it is required that simple, standardized cutting tools be employed having regular unbroken cutting edges. And this is required no matter how complicated be the configuration in section of the wire, rod or other stock undergoing finishing.

Accordingly, we provide a separate, bladed cutting tool for each face of the wire, rod, or other metal stock undergoing processing. And we back up the stock at a point opposite the cutting tool. We operably pair these tools in so far as is possible, in opposed relationship to minimize and even balance out the resultant effective stresses. We apply the cutting tools simultaneously against the metal stock throughout the shaving process. This is expedient both for proper and effective distribution of stress and for maintaining cutting speeds at highest practical limits. Moreover, it makes possible reduction of the wire stock through shaving operation and under cold-drawing conditions, down to required pleasing surface appearances and required finish dimensions. In this manner we can successfully employ cutting tools of simple and unrelieved configuration.

Effective means are provided for preventing the burning of the metal stock as a result of friction loading; the cutter blades are relieved against "biting" into the metal stock, and thus retain their sharpness. Welding of the freshly cut metal to the cutting tool is suppressed. Undesired and progressive "gumming" of the metal, so frequently encountered in the drawing of high alloy steel, is effectively suppressed.

Thus, in practice we resort to a scraping action of the cutting tool, rather than a true cutting movement. We accomplish this by imparting a negative rake to the cutting tool or cutter bar, frequently referred to as a die.

It is apparent at once, however, that we are not restricted to scraping action alone, and a true cutting stroke is within the contemplation of our invention. Accordingly, we use the term "cutting" to indicate either a cutting or a scraping action.

With the foregoing in mind, reference will now be made to the specific embodiment of our invention shown in the several views of drawings. While this embodiment, with slight modifications, can be adapted to shaving stainless steel or other refractory metal stock of varied cross-sectional configuration, it has particular utility in shaving wire stock of hexagonal section. Moreover, while readily adaptable to the treatment of wire stock which in section, possesses an odd number of faces, say three, five, seven or the like, it has particular utility in working wire possessing an even number of faces, with opposed faces paired with each other, illustratively four, six, eight faces and the like, this, for the reason that the substantial stresses which can be applied from opposite sides against the paired faces tend to balance out each other.

The shaving head, indicated generally at **10** in Figs. 1 and 2 is mounted to a standard wire-drawing bench, indicated generally at **11**. Since the particular bench employed does not in itself, form part of our invention, no detail description of it is made in the drawings, this for simplicity and clarity. Bench posts **12** and **13** are employed on which to carry shaving head **10**. Both posts are formed of heavy metal to suppress play, with possibility of resultant chatter.

Post **12**, provided at the left end of the shaving head, Fig. 2 pivotally carries that end of the shaving head and attaches to the floor mount **12***a*. The post **13** near the right end of the shaving head in Fig. 2, and disposed perpendicularly to bench **11** carries the shaving head **10** near the tail or exit end thereof.

We provide a guide block **14** of wood, having a central opening **14***a* through which the wire passes. Thence the wire is lead across chamber **15**, containing soap or generally similar solid lubricant. As a final preliminary, the wire is drawn through a hexagonal cold-drawing die indicated generally at **16** and disclosed in Figs. 2 and 4 as provided with a water-cooling system **16***a*. Here the final cold reduction of the metal stock to calibrated oversize is achieved.

Conveniently wooden block **14**, soap chamber **15** and die **16** are contained in metal holder **17**, which is sufficiently massive to suppress all tendency toward vibration or other undesired bodily movement of either the wire stock or the shaving head. Entrance and exit through holder **17** respectively are had through plates **18** and **19**, each with a corresponding central orifice **18***a* and **19***a*.

When shaving stock of hexagonal section, six tool holders are employed, one for each face of the metal stock. The assembly of six tool holders is best shown at the right in Fig. 1. Six rods **21**, **22**, **23**, **24**, **25** and **26** are carried between corresponding headers **27** and **28**, these headers in turn, being carried from the posts **12** and **13**. These rods are made of heavy metal stock to suppress vibration and chattering, and extend through the headers **27** and **28** and are made fast thereon by suitable conventional lockdown means such as lock nuts **29**.

The tool holders, six in number, are indicated generally at **31**, **32**, **33**, **34**, **35** and **36** in Fig. 2. Each tool holder is carried on a corresponding four of the horizontally extending rods and separated from the other by cylindrical sleeve spacers. Each tool holder is substantially like the other tool holder, the object being to present the cutter blade of a particular tool holder against that face of the wire stock which is to be shaved by that cutter. Thus, any particular tool holder is carried by that four of the six rods which, when the tool holder is properly positioned thereon, will result in its shaving blade being automatically brought against the proper and intended face of the metal stock. Thus, with the hexagonal stock being fed longitudinally through the shaving head in Fig. 2, and with one hexagonal face thereof disposed topmost and horizontally, tool holder **31** will be so disposed that the shaving blade thereof will be brought into contact with the upper and horizontal face of the metal stock.

A typical tool holder **31** is disclosed in Fig. 3. It is evident therefrom that each such tool holder comprises a body portion **31***a*. This body portion, elongated and massive, extends between particular rods of the rod system **21** through **26** which supports this particular tool holder. As shown in Fig. 3, these rods are paired at each end of the body portion **31***a*, and in the embodiment undergoing description and disclosing tool holder **31**, the body portion **31***a* is wider at extremities **31***b* and **31***c*, to provide enlarged bosses **31***b'* and **31***b''* for the one end and **31***c'* and **31***c''* for the other whereby the holder may be received on the appropriate rods. Illustratively, holder **31** is mounted on rods **22**, **23** and **25**, **26**. Body portion **31***a* is machined as at **31***f* to provide containing surfaces throughout most of its longitudinal extent. We provide a tool post holder **31***g* in the upper part of slot **31***f*. Through this tool post holder and extending longitudinally of the body portion **31***a* passes a tool post **31***h*. We mount a shaving tool **31***i* bodily on the post **31***h* and this post is adjustable longitudinally through tool post holder **31***g* relative to the wire stock indicated generally at **20**, Fig. 3. While any suitable adjustment can be provided, in the preferred embodiment we provide threads on post **31***h* so that it may be threaded lengthwise along and relative to an adjusting nut **31***j* which in turn is threaded into tool post holder **31***g*. Hence by turning nut **31***j* relative to holder **31***g*, the shaving tool **31***i* can be adjusted with the utmost nicety relative to the metal stock **20**. Once adjusted to its proper position, the cutter tool **31***i* may be locked in such position by suitable means, here shown as lock-down set screws **31***k* threaded laterally through the holder **31***g* and seating against the tool post **31***h*.

Also carried within slot **31***f*, we provide a roll yoke **31***m* fitting snugly within the bottom thereof, this being U-shaped as illustrated in Fig. 3. A shaft **31***n* is mounted laterally within the roll yoke **31***m* and carries suitable anti-friction bearings, one being shown as roller bearing **31***o*, which extends well into the slot **31***f*. Finally, a back-up roll **31***p* is carried on roller bearings **31***o*. This back-up roll is made of hard bronze.

Roll yoke **31***m* is made bodily movable within the bore **31***f* so that the back-up roll **31***p* may be made adjustable relative to the metal stock **20**. Such adjustment is accomplished by means of a set screw **31***q* which extends through the bottom web **31***b* of the body portion of the tool holder and is threaded into yoke **31***m*. Upon rotation of set screw **31***q* this roll yoke is carried bodily along the slot **31***f* relative to the metal stock **20**.

While of course cutter **31***i* may be formed of any suitable cutting steel or other material displaying required physical properties, in the preferred embodiment here disclosed we employ a cutter form of Tantung G alloy. The cutters are about three-quarters of an inch in width and about one-eighth of an inch thick. They are screwed to the tool post, shown as screw **31***r* for cutter **31***i* on post **31***h*. It will be seen therefore that the cutters easily may be removed for sharpening and replacement.

Other advantages of our invention, as have already been referred to, reside in the fact that the construction is such that the cutting edge of the tool is regular, unbroken and linear across its face, requiring no contouring to the cross-sectional shape of the metal stock **20**. Thus, the cutting tool can be readily produced from available cutting tool stock with rapidity and at a minimum of operating steps, and when required, can be re-edged with minimum shut-down. In order to provide the scraping action which we find most advantageous we impart a 5° negative rake to the cutting tool. This provides an 85° angle between the cutter tool **31***i* and the particular surface of the metal stock **20** which is being shaved.

Back-up roll **31***p* applies the metal stock **20** under requisite loading against the cutter tool **31***i*. For reasons pointed out later in this disclosure, these back-up rolls are formed of hard metal stock, illustratively hard Ampco bronze, or some other metal displaying a hardness of at least Rockwell B 80–90.

During the cutting action we apply a suitable lubricant against the cutting edge of the various cutters and metal stock **20**, supplying the same through main supply pipe **37**, Fig. 5, into header **38** with control valves **39**. Thence the lubricant is led to the separate tool holders **31** through **36**, through lateral supply ducts feeding conduits **41** through **46**. Each conduit in turn leads to region of contact between the particular cutting tools and the work **20**, and supplies a cutting lubricant to the work. This lubricant is employed to cool and lubricate the corresponding cutting tool. Preferably we employ that typical cutting lubricant known as Lusol, diluting this with 20 parts of water. This coolant is projected directly and at some pressure, against the cutting tool and work stock, effec-

tively preventing undue heating and carrying away the metal chips from the region of cutting.

Following discharge onto the cutting tool and work, the cooling liquid flows into the overflow pan 47 carried by the draw bench and displayed beneath the shaving head 10, and drains off through overflow pipe 48 to collecting reservoir 49. Thence it is drawn off through the valved discharge outlet 50. The used lubricant is screened and recirculated for further use. By proper control of the quantity and temperature of the coolant, both the cutting tool and metal stock may be maintained at safe permissible temperatures throughout the shaving operation.

The tool holder 31 is shown in Fig. 3 as being applied to the topmost face of the metal stock 20. As shown in Fig. 2, the tool holder 32 is applied to the top left face of hexagon 20 as shown in Fig. 3 and to this end, body portion 32*a* of holder 32 is mounted on rods 23, 24 and 26, 21. Similarly tool holder 33 is applied to the bottom left face of the work stock 20, and to this end, the body portion thereof is mounted on 24, 25 and 21, 22. Likewise tool holder 34 is applied against the bottom hexagonal face of the work and to this end, the body portion thereof, is mounted on rods 25, 26 and 22, 23. And it being desired to apply the cutter of tool holder 35 against the bottom right face of work stock 20, the body portion of this holder is mounted on rods 26, 21 and 23, 24. Finally, it being desired to mount the tool holder 36 so that its shaving blade is applied to the upper right face of the metal stock, this tool holder is mounted on rods 21, 22 and 24, 25.

It is to be noted that in the disposition of the rods and tool holders the following pattern has been adopted; the rods 21 through 26 are disposed symmetrically with respect to the longitudinal axis of the shaving head and are arranged at the apices of a symmetrical and equi-angle hexagon; that is in section the rods are 60° apart from each other. The rods are spread at such distance apart from each other and are formed of metal of such gauge as to impart substantial rigidity to the structure without adding to the initial cost thereof. To the same end of achieving substantial rigidity, we make the rods of sufficient length and space the tool holders at equal distances therealong and with such distances between adjacent tool holders as is best calculated to eliminate undue torsional stresses resulting in play, whip and the like. As a final precaution we disposed the tool holders symmetrically, both around and along the rods, so that with tool holder 31 applied against the upper face of work stock 20, the tool holder 34 will be the fourth removed along the length the rods and will be paired with tool holder 31, and is applied against the opposite or under-face of work stock 20 (Fig. 3). Similarly tool holders 32 and 35, four removed from each other along the length of rods, are paired and applied against the bottom right and upper left faces respectively, of the work. Finally, tool holders 33 and 36, likewise four removed from each other along the rods are paired and applied against the upper right and lower left faces, respectively, of stock 20. In this manner stresses, both torsional and longitudinal, are minimized and neutralized in so far as possible, by balancing out.

In operation, the wire stock, carried on an appropriate reel 51 at the head end of the bench, is led through a straightener 52 having a plurality of horizontal rolls 52*a* and a plurality of vertical rolls 52*b*, through guide plate 18, through orifice 14*a* of wood block 14, through soap chamber 15 and through hexagonal cold-drawing die 16. And from die 16 the metal rod 20 is led through the set of tool holders 31 through 36 of the shaving head, and is thence carried by horizontal rolls guides 53 to the power drum 54 of the drawing bench. We find it to be highly advantageous to employ a series of vertical rolls as a guide between the shaving head and the power block in order that the wire at all times may be centered as it leaves the shaving head. The power block also serves to coil the finished wire.

While our invention has particular application to finishing hexagonal stock sizing between ¼ inch and ½ inch across flats, it is also applicable to various other sizes of stock. In a typical employment we treat a coil of wire 310 pounds in weight, and which has been brought through cold-drawing technique to 0.406" hexagonal size. The wire displays minor surface imperfections as it passes to our new shaving head. In the present embodiment,



therefore, the die 16 conveniently takes the form of an 0.386" hexagonal cold-drawing roughing die.

To achieve best results with our apparatus the exercise of certain precautions is necessary. Thus, it is particularly important that the faces of the wire to be shaved are prepared so as to lie exactly parallel to the cutting edges of the cutter blade. To this end, we find it necessary to point the lead end of each coil providing thereon a long tapered point, round in section, and approximately six feet in length. This lead point is prepared with great care, following which the coils of wire are pickled and lime-coated. In preparing the six feet long lead spike care must also be taken to prevent twisting the wire. We found the use of the roll straightener to be helpful in this connection in that it not only removed the kinks from the wire, but facilitated maintaining non-kinking by providing at least some degree of back tension on the wire stock. Our experience has shown that the long lead point should be as straight as possible and that in particular, no twist whatsoever can be tolerated where the rounded section of the point merges at its base into the hexagonal shape of the wire proper. We find that such a twist, will turn the wire in the die or under the cutter and will cause gouging of a corner of the wire.

With the foregoing precautions observed, we then back off all six cutters and rolls of the tool holders by letting off the set screws, respectively. Under these conditions we are enabled readily and easily to thread the elongated lead point of the wire stock through the shaving head 10. Several wraps of wire are first drawn from the take-off reel 51 (see Fig. 1) onto the drawing bench 54 with only the drawing die 16 in contact with the wire. With the wire maintained under tension and under steady flow conditions of the wire stretched across the shaving head, the first cutter of the series, that of shaving tool 31 (see Fig. 2), is adjusted against the metal stock 20 so as to make a light cut on the corresponding or top face of the metal. The set screws of cutter 31 are then locked down for proper operation. Next, the back-up roll of the tool holders is moved in to bear against the opposite surface of wire 20, for light contact thereagainst. Thereupon, tool holder 34, paired with holder 31, is applied against the bottom face of the metal stock and its back-up roll is applied against the top surface. Static balance is thus achieved. Cutting tools of tool holders 32 and 35 and their respective back-up rolls are then applied with equal tension against the corresponding faces of the metal stock. Following this, cutting tools of tool holders 33 and 36 and their back-up rolls are applied so as to make a cut. We prefer to make all cutting adjustments while the wire is in motion to achieve dynamic balance.

When so operated we find that, for the typical embodiment noted above, the shaved wire finished to a hexagon of 0.381"–0.382" across flats. A smooth clean metallic finish was observed. The cutting operation imparted sharp corners to the hexagon and this with no tear. The section of the wire was nicely controlled from the dimensional standpoint. All adjustments to both the tool and the back-up roll were easily made, and this during operation. By merely guiding the chips away from the region of cutting and from contact with the back-up rolls all tendency toward gouging was effectively avoided.

Our observations disclose that a wide range of speeds is available within which desired good results can be achieved. The best operating speeds for the example noted range from about 70 to 90 feet per minute. We observed that when the shaving speeds were too low a ragged and torn edge was produced. Where the speed was too great, chatter marks on the wire were observed, along with tendency toward vibration. By proper choice of metal of the cutting tool and of the back-up roll and by proper choice of composition, temperature, quality and rate of flow of the combined lubricant-coolant, a rather wide variation in the permissible rate of speed can be achieved.

Through the practice of our method, particularly with reference to our new shaving assembly, the rapid production of shaved wire of non-circular section is rendered expedient. Such wire displays a highly desirable finish details satisfying the most exacting requirements. Moreover, care has been exercised in eliminating and avoiding the necessity of highly specialized equipment. As a result, investment in plant is minimized and this factor is contributed to by the

large output of each work station in the plant. Labor requirements are appreciably reduced, and this from both quantitative and qualitative standpoint. Shutdown due to replacement and repair is brought to a minimum.

While the invention has particular application to wire formed of stainless steel, it is also applicable to stainless steel straight-length bar and rod stock of substantially larger diameter, resulting in superior finish thereof.

With the foregoing in mind, it will be readily appreciated that many modifications of our invention will suggest themselves to those skilled in the art, accordingly, therefore, we intend the foregoing description to be considered as illustrative, and not by way of limitation.

We claim:

1. Apparatus for mechanically finishing wire stock of refractory metal comprising in combination, a multiplicity of cutting elements, each of regular, unbroken edge, spaced from each other and supported about the stock; roller means backing up the stock opposite each of said cutting elements; and means for drawing the stock in one pass through a shaving zone, across all said cutting elements.

2. Apparatus for mechanically finishing metal stock of polygonal sections, comprising in combination, means for drawing the metal stock, under tension, and in once-through pass, through a shaving region; a shaving head disposed in said shaving region and through which the said metal stock passes; and a series of cutter tools provided on said shaving head in spaced relation to each other, both longitudinally and angularly, about said stock in said shaving zone, one for each face of stock, and each cutting tool carrying thereon and as part thereof a cutter blade having a regular cutting edge of unbroken surface, and possessing negative rake.

3. Apparatus for mechanically finishing multi-faced metal stock comprising, in combination, a die; means for drawing the metal stock through said die and under tension in once-through pass through a shaving region; a shaving head disposed in said shaving region and through which the said metal stock passes; a series of cutter tools provided on said shaving head in spaced relation to each other, both longitudinally and angularly, about said stock in said shaving zone, one for each face of the stock, each cutting tool carrying thereon and as part thereof a cutter blade having a regular cutting edge of unbroken surface; and means for playing a coolant and lubricant on both the cutting blades and the metal stock in the region of shaving.



4. A shaving head for simultaneously and mechanically finishing, in a once-through pass, all faces of metal stock of multi-faced section, comprising a corresponding multiplicity of rods extending longitudinally of said shaving head and disposed in regular polygonal pattern when viewed in section; and a like number of like cutter tools carried along the length of said rods and each carrying a cutter blade of smooth, unbroken and continuous cutting edge, there being one such cutting tool for each face of the metal stock.

5. A shaving head for simultaneously and mechanically finishing, in a once-through pass, all faces of metal stock of hexagonal section, comprising six support rods extending longitudinally of said shaving head and disposed in regular hexagonal pattern when viewed in section; and a like number of like cutter tools carried along the length of said rods and each carrying a cutter blade of smooth, unbroken and continuous cutting edge, there being one such cutting tool for each face of the metal stock, the cutter tools being paired, so that those tools which are three removed from each other along the rails are applied against opposite faces of the metal stock.


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