

Jan. 13, 1959

H. A. MEYER
PROCESS AND APPARATUS FOR FINISHING METAL
AND PRODUCTS RESULTING THEREFROM

2,867,949

Filed Aug. 10, 1955

4 Sheets-Sheet 1

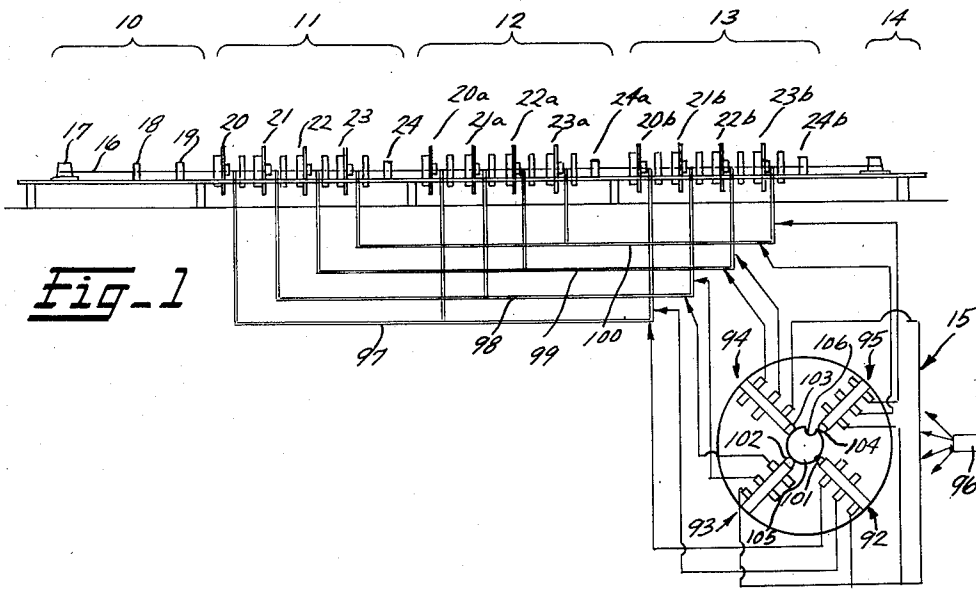
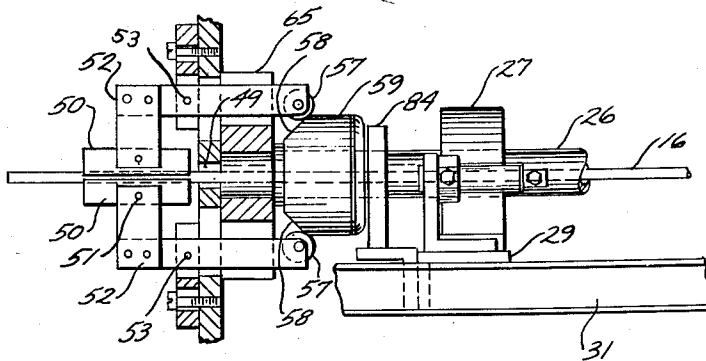


Fig. 7



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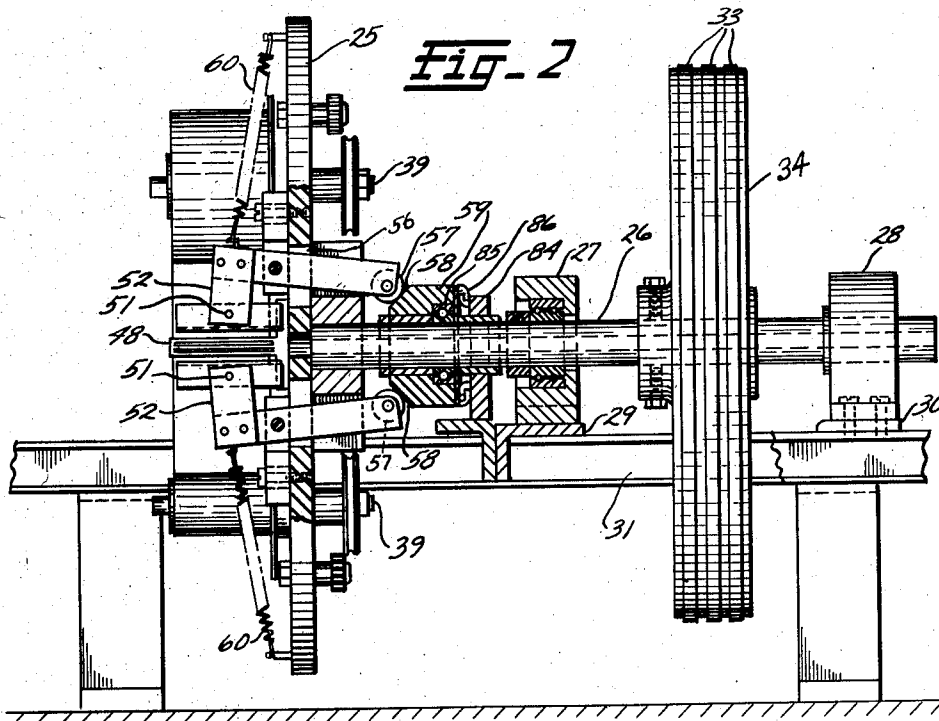
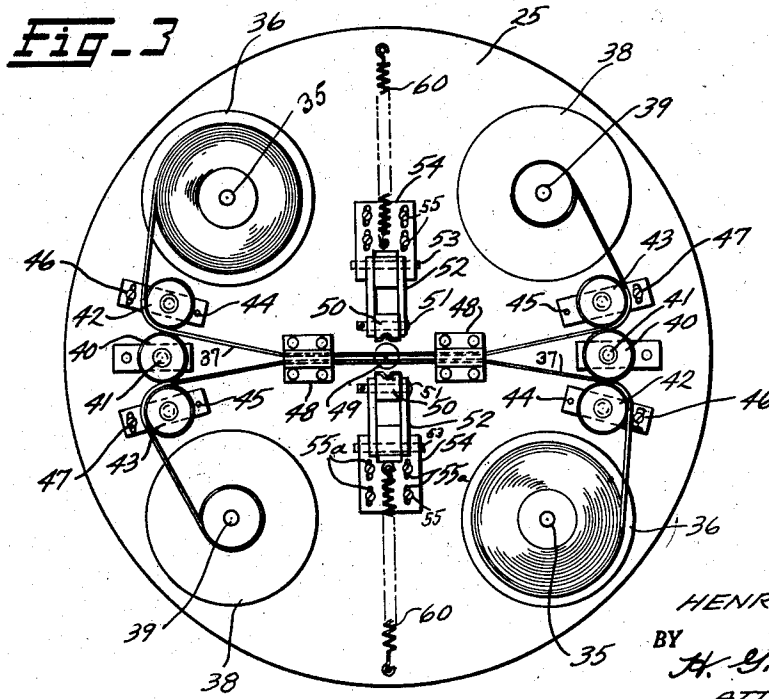
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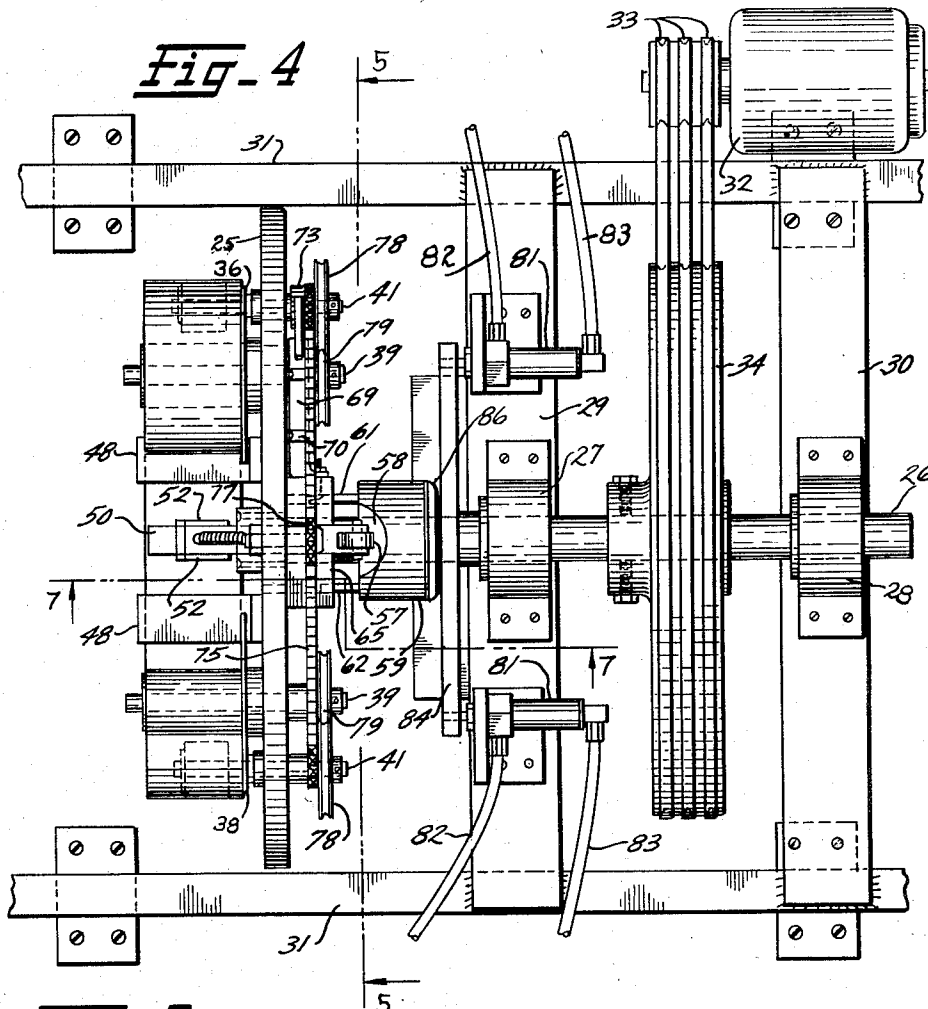
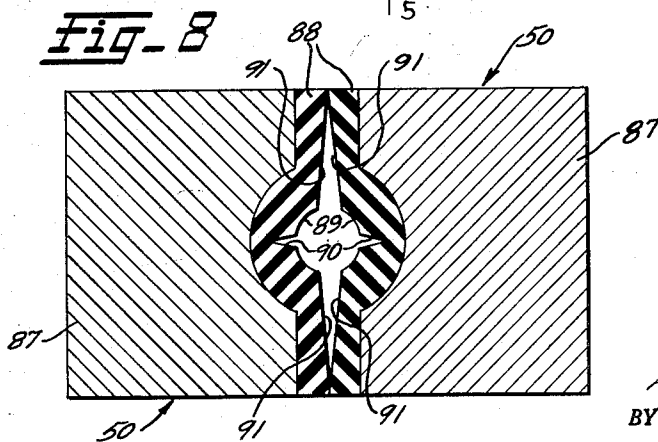
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Fig. 5

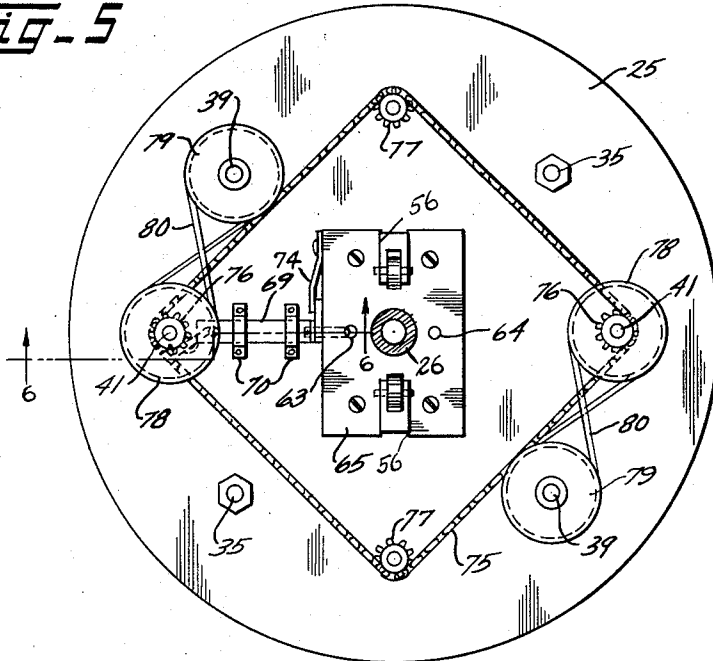
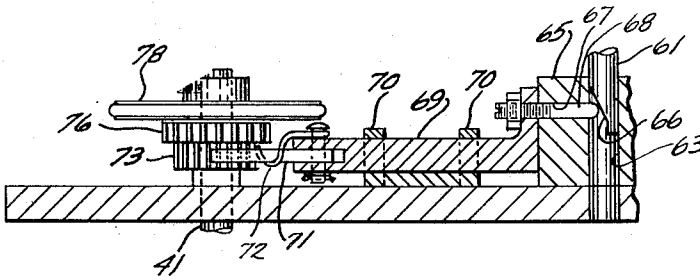


Fig. 6



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2,867,949

PROCESS AND APPARATUS FOR FINISHING METAL AND PRODUCTS RESULTING THEREFROM

Henry A. Meyer, Oakville, Conn.

Application August 10, 1955, Serial No. 527,439

22 Claims. (Cl. 51—5)

This invention relates to the art of metal working, and more particularly to a process and apparatus for the treating and finishing of metal rod or wire.

One object of this invention is to provide a process and apparatus of the above nature for producing a highly polished smooth finish on the surface of rod, wire, pipe, tubes or the like.

Another object is to provide a process and apparatus by means of which so-called "green" rod or wire may be mechanically processed without the necessity of first undergoing the usual pickling or de-scaling operations which are commonly required prior to drawing operations.

Another object is to provide apparatus capable of producing a highly polished finish on the surface of a rod or wire, which can be readily adjusted to stock of widely varying diameters.

Still another object is to provide apparatus which is adaptable for use with metal rods or wire which may be furnished either in the form of coils or in straight lengths of stock.

Still another object is to provide apparatus which is capable of drawing scouring, scoring, polishing, or burnishing continuous lengths of metal rod or wire.

Yet another object of the invention is to provide means whereby metal rod or wire may be provided with a highly polished cylindrical surface finish wherein the diameter of the finished product may be controlled within extremely close limits.

Still another object is to provide a process and apparatus whereby long lengths of metal stock having irregular variable cross-sectional and axial dimensions may be continuously treated to provide the stock with a uniform cylindrical surface.

Still another object is to provide apparatus capable of continuously treating the surface of metal rod or wire stock with abrasive material in the form of a strip or web, whereby successive portions of the surface of the stock will be treated by unused portions of abrasive material.

Still another object is to provide apparatus employing abrasive strip material formed in a roll wherein successive portions of said strip may be unrolled and brought into contact with said stock, said contact being maintained continuously around said stock.

Yet another object is to provide apparatus capable of supporting an unwinding and taking up roll of abrasive strip material for continuous movement in a rotary path surrounding a length of stock to be abraded by said strip.

A still further object is to provide apparatus capable of supporting a pair of strips of abrasive material in roll form for continuous rotary movement in a circular path surrounding a length of stock the surface of which is to be abraded by said abrasive strip, and wherein successive portions of unused strip material are brought into contact with the surface of the stock during said rotary movement, said apparatus including means to hold the

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abrasive strips in contact with opposite sides of the stock under tension.

Yet another object is to provide a process and apparatus whereby surface imperfections in metal rod or wire may be removed mechanically by scoring and burnishing the cylindrical face thereof.

A still further object is to provide a new and novel article of commerce comprising metal rod or wire having a distinctive surface finish.

A still further object is to provide a device of the above nature which will be relatively simple in construction, inexpensive to manufacture, easy to install and manipulate, compact, ornamental in appearance, and very efficient and durable in use.

Since the beginning of the eighteenth century, when continuous rod rolling mills of various types were developed, very little improvement, basically speaking, has been made in the art of making metal rods, and hot rolling is still today a necessary preliminary step in the commercial production of ferrous rods. However, the most detrimental result of modern rod rolling is the formation of scale caused by heat and oxidation of the surface of the material, and the formation of this scale necessitates expensive and time consuming operations for its removal before the rod may be commercially usable.

In the case of ferrous metals, this so-called surface scale comprises three more or less distinct concentric layers, the outer-most layer (which is the thickest and most brittle) being composed of ferric oxide (Fe_2O_3), while the innermost layer generally comprises ferrous oxide (FeO), and the intermediate layer being composed of ferric-ferrous oxide (Fe_3O_4). In general, the outermost layer of scale may be removed by a simple mechanical process of subjecting the rod to a bending and twisting operation, which may be accomplished by drawing such rod in a zigzag path formed by a series of concave or V-shaped rollers which are arranged in an alternately offset relation to each other.

Some of the intermediate layers of scale is also removed during this operation, and this is generally considered to be the cause of "spotted" rod, after the process of pickling has been completed. The pickling process generally comprises treatment of the rod with a chemical solution which dissolves the remaining innermost layer of scale. However, a great deal of difficulty may be experienced in the pickling process because of the fact that various alloys and mixtures react differently with any given solution, and because of the fact that as increasing amounts of scale are dissolved in the solution, the latter may become weakened, resulting in non-uniformity of the rod surface.

A further step after pickling is also considered necessary in the present day practice of preparing rod for drawing. This usually comprises some form of coating the surface, such as liming and baking it, coating it with borax or with a light plating, or oiling the surface. However, even after all the foregoing operations have been performed, the rod, whether it be ferrous or non-ferrous, may still have certain surface imperfections, which will make it unsuitable for use wherever the rod must have cross-sectional uniformity along its entire length. Thus, the surface of the rod may be pitted, or there may be minute air spaces in the metal just under the surface. In general, these imperfections will not be removed when the rod is drawn through the usual drawing die which effects a substantial reduction in diameter. On the contrary, such a drawing operation will merely serve to elongate a cavity on the surface, and force deeper into the interior any imperfection lying below the surface. Attempts have been made in the past to remove such surface imperfections by abrading the surface with

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various types of apparatus. In general, such apparatus may be divided into two basic categories, in one of which the abrasive means comprises a conventional grinding wheel, and the other of which the abrasive material is applied by an endless web or sheet. However, I have found that none of the prior types of apparatus were successful in completely removing surface imperfections without a substantial and unnecessary reduction in the diameter of the rod.

In the practice of the present invention, it has been discovered that an entirely new result can be achieved in the treatment of metal rod, when successive portions of the surface of the rod are brought in contact with fresh abrasive material which has not been previously used. Such a condition cannot be fulfilled by the usual grinding wheel or a conventional endless belt, since shortly after such abrasive means have first come in contact with the stock to be abraded, the spaces between individual particles of grit become filled with particles of metal, which have already been removed. Furthermore, the individual particles of grit themselves lose their sharp edges and become partially dulled, with the result that these abrasive particles no longer cut uniformly into the surface of the metal with a scoring action, but tend to merely rub over the surface with a polishing action, and without scraping away the metal.

I have therefore found it advantageous to employ a relatively long strip of flexible material, the surface of which is coated with abrasive grit.

Means have also been provided whereby this strip of abrasive material may be brought into contact with the surface of a rod while circumferential motion is imparted to the strip with respect to the surface of the rod. Fresh portions of the strip may successively be brought into such contact without interrupting the circular motion of the strip as a whole, so that succeeding lengths of the rod will be acted upon by fresh particles of abrasive grit.

The importance of this invention lies in the fact that the surface of the rod may be cut or scored by a multiplicity of minute but sharply defined grooves which may be controlled to follow a helical pattern along the length of the rod. Furthermore, since the individual grooves are thus sharply defined, it is thereafter possible to pass the rod through a burnishing die, which, while not substantially reducing the diameter of the rod will be effective to cause the surface metal between these grooves to flow, whereupon the grooves will be filled in, and a highly polished surface will result. Furthermore, due to the fact that only the surface material is affected, there is only a slight reduction in the cross-sectional area. Moreover, imperfections which have not been removed by the abrasive material, or those imperfections which lie just below the surface, will not be forced toward the interior of the rod.

While the above statements briefly describe the features of the present invention, it should be understood that in actual practice, a number of variations of the basic principles thereof may be employed, which will be explained later in detail.

With these and other objects in view, there has been illustrated on the accompanying drawing one form in which the invention may conveniently be embodied in practice.

In the drawings,

Fig. 1 represents a diagrammatic view of an arrangement of apparatus suitable for performing the process embodying the present invention.

Fig. 2 is a side elevation, partly in cross-section of one form of rotary abrading head, employed in the present invention.

Fig. 3 is a front view of the apparatus shown Fig. 2.

Fig. 4 is a plan view of the same.

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Fig. 5 is a rear view of the same, taken on the line 5—5 of Fig. 4.

Fig. 6 is a fragmentary view of a portion of the feeding mechanism shown on an enlarged scale, taken on the line 6—6 of Fig. 5.

Fig. 7 is a fragmentary view, showing the presser plate mechanism, taken on the line 7—7 of Fig. 4.

Fig. 8 is a cross-section of the presser plate, on a greatly enlarged scale.

Referring now to the drawings in which like reference numerals denote corresponding parts throughout the several views, the numeral 10 indicates a unit for feeding reel and straightening material such as wire or rod stock. The numeral 11 indicates generally a first scoring and burnishing unit, and additional scoring and burnishing units are indicated generally by the numerals 12 and 13. A take up unit is indicated by the numeral 14, and a control unit is indicated at 15.

In the normal operation of this process, wire or rod stock 16 will be supplied in the form of a coil on a standard wire reel 17. It should be understood that the practice of this invention is not limited to the use of rod stock which has previously been subjected to descaling treatment, but that it is possible to provide a high polish on so-called "green" rod which has not undergone treatment for descaling or degreasing. In the usual case, where the rod has first been descaled, the rod stock 16 first passes through a conventional ring guide 18 which assists in straightening and steadying it in its further passage through the apparatus.

The rod 16 then is pulled through a standard drawing die 19 of circular cross-section which reduces the rod to the desired diameter, after which the rod passes through the first scoring and burnishing unit which comprises a series of planetary abrading heads, 20, 21, 22 and 23, followed by a passage through a burnishing die 24.

Thereafter, the rod may go through a second scoring and burnishing unit, comprising planetary abrading heads 20a, 21a, 22a and 23a, followed by passage through a burnishing die 24a, and a further passage through a third successive unit including planetary abrading heads 20b, 21b, 22b, 23b, 24b, followed by passage through a final burnishing die 24b as may be desired.

However, in the case of processing "green" rod, the stock may be first passed through a series of abrading heads, such as 20, 21, 22 and 23 without first being subjected to a drawing operation, the succeeding steps being similar to those just described.

Each of the abrading heads 20, 21, 22, 23 which comprise the first scoring unit, as well as the abrading heads comprising the successive scoring units are substantially identical in construction.

A rotatable disk shaped member 25 is concentrically fixed to one end of a hollow shaft 26 which is supported for rotation about a horizontal axis by a pair of journal members 27, 28 which are supported on a pair of cross members 29 and 30, respectively, of a frame work 31.

The shaft 26 and the disk shaped member 25 may be driven by any suitable means, such as an electric motor 32, connected by V-belts to the pulley 34. Extending forwardly from the front face of the disk member 25 are a pair of spindles 35 positioned diametrically across from each other, and equidistant from the central rotating axis of said member 25.

Each of the spindles 35 serves to support a flanged feed spool 36 containing a roll of unused abrasive tape 37. Provision is also made of a pair of flanged takeup spools 38 upon which the abrasive tape is wound as it is used. These spools 38 are mounted on shafts 39 which are journaled in the disk-shaped member 25 so as to project therethrough and extend outwardly from the rear face thereof.

The shafts 39 are also positioned so as to be diametrically opposite from each other and equidistant from the central axis of the disk member 25.

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It will thus be seen that the feed spools 36 containing unused tape, and the take-up spools 38 upon which the abrasive tape is gradually wound during the course of operation of the machine, will counterbalance each other, so that while there will be a change in the distribution of the weight of the tape as it accumulates on the take-up spools 38, nevertheless the distribution of this weight will always be symmetrical with respect to the rotating axis of the disk member 25.

Movement of each of the abrasive tapes 37 from the feed spools 36 to the take-up spools 38 is accomplished by means of a pair of driving rolls 40 (Fig. 3) which are rotatably journaled on shafts 41 mounted in the disk shaped member 25 and projecting outwardly from the back thereof.

The cylindrical surface of the driving rolls 40 should be such as to establish frictional contact with the tapes 37, and such contact may be maintained by means of guide rollers or idlers 42 and 43. Adjustable mounting plates for such guide rollers are provided, said guide plates having pivotal connection with the disk-shaped member 25, at 44 and 45, respectively, at one end, and having a slotted opening at their other end to receive mounting screws 46 and 47 respectively. This construction will permit adjustment of the guide rollers 42 and 43 with respect to the driving roll 40 by a limited movement of said guide rollers about their respective axis 44 and 45 so as to regulate the frictional engagement between the driving roll 40 and the abrasive tape 37.

A pair of slotted guides 48 are also provided, adjacent to and at opposite sides of a central opening 49 in the disk member 25, through which opening, a wire or rod 16 is moved so as to pass between the two abrasive tapes 37, during the operation of the machine.

A pair of presser blocks 50 are provided to bear against the back of the tapes 37 to hold them in engagement with the wire or rod 16. These presser blocks are pivotally connected, as at 51, to a pair of bell crank levers 52 which in turn are pivotally mounted at 53 on a pair of adjustable mounting blocks 54 (Figs. 2, 3). The mounting blocks 54 are attached to the disk-shaped member 25 by means of screws 55, slots 55a are provided in the mounting blocks 54 through which the screws 55 pass, so as to permit the adjustment of the position of the mounting blocks 54 with respect to the central opening 49 whereby the distance between the presser blocks 50 may be varied in accordance with the size of the material being handled by the machine.

The bell crank levers 52 extend rearwardly through openings 56 provided in the disk member 25 and are provided at their extremities with cam-engaging rollers 57, disposed adjacent the inclined surfaces 58 of a cam member 59, which is axially movable on the shaft 26, coil springs 60 are connected to the crank levers 62 to hold the presser blocks 50 in their retracted position. Means is also provided for maintaining relative alignment between the inclined faces 58 and the rollers 57 during rotation of the disk member 25, which includes a pair of indexing pins 61, 62, which project forwardly for slidable engagement in suitable openings 63, 64 provided in a block member 65 attached to the rear face of the disk 25.

The forward end of one of the indexing pins 61 is provided with an inclined face 66. Projecting through an opening 67, disposed in the member 65 at right angles to and intersecting the opening 63, is a pin 68, one end of which is thereby placed in camming engagement with the inclined surface 66. The pin 68 is threadedly connected to one end of the slide 69 which is received in the guide members 70. The other end of the slide 69 is provided with a pivotally connected pawl 71, which is urged by the spring member 72 into engagement with the teeth of a circular ratchet member 73 attached to one of the shafts 41. The arrangement of the teeth on the ratchet 73

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is such that rotation of the shaft 41 will take place only when the slide 69 is moved inwardly toward the central axis of the disk member 25 under the influence of the spring member 74. Motion thus transmitted to one of the shafts 41 is also transmitted to the other shaft 41 by means of the chain 75 which is in engagement with the identical sprockets 76 attached to each of these shafts. The chain 75 also passes over a pair of idler sprockets 77 so as to keep it clear of the mechanism disposed at the center of the disk 25. Shafts 41 are also provided with pulleys 78, each of which drives a pulley 79 attached to the takeup shafts 39 by means of the frictional belt 80. It will thus be seen that rotation of one of the shafts 41 will result in an identical amount of rotation of the other shaft 41 through the chain 75, while at the same time, the connection between pulleys 78 and 79 through friction belt 80 will also tend to rotate the shafts 39. However, the relationship between the pulleys 78 and 79 should be such that the movement imparted to the takeup reels 38 will always be sufficient to take up the slack in the abrasive tape 37.

As previously mentioned the cam member 59 is axially movable on the shaft 26. This movement may be controlled by a pair of air cylinders 81 mounted on the cross member 29, and having compressed air connections 82, 83 at their respective opposite ends. The pistons of the cylinders 81 are connected to a cross bar 84, which in turn is connected to the cam member 59 by means of a thrust bearing 85 and an interlocking circular flange means 86, whereby movement of the cam member 59 in both directions is under the positive control of the cross bar 84.

In Fig. 8 there is shown a detailed cross-sectional view of the construction of the presser blocks 50. The main body portion 87 is preferably formed of metal, whereas the working faces 88 will be formed preferably of some resilient material such as neoprene, or the like. A central longitudinally-extending portion 89 is formed with a generally cylindrical profile, and extending along the middle of this central portion there is provided a generally V-shaped longitudinally-extending recess 90. On either side of the central portion 89 are wing portions 91, said wing portions being outwardly and forwardly inclined, so that when the presser blocks 50 move toward each other, the initial contact between the blocks will take place at the extremity of the wing portions 91. Due to the fact that the working faces 88 are made of yieldable material, further inward movement of the presser blocks 50 will be possible, which will consequently result in an outward displacement of the extremities of the working faces 88 away from the central portion, the extent of this lateral displacement being dependent upon the force which is exerted upon the presser blocks 50. This outward displacement will also be aided by the fact that the effects of the longitudinally extending grooves 90 is to separate each of the wing portions 91 into substantially independent elements. It should be apparent therefore, that when the presser blocks 50 are moved toward each other into engagement with the abrasive tapes 37, disposed on opposite sides of the rod 16, that continued inward pressure exerted upon the presser blocks, and a lateral displacement of the working faces 88 will tend to place the abrasive tapes under tension which will insure effective engagement between the tape and the surface of the stock.

In Fig. 1 there is shown diagrammatically one arrangement whereby a control unit, indicated generally at 15, may be employed to control a plurality of abrading heads embodying the present invention. In this arrangement four double-acting air valves 92, 93, 94, 95 are connected to a common source of air under pressure 96. The valve 92 is connected by a suitable conduit means to the air cylinders 81 of the abrading heads 20, 20a and 20b, respectively, comprising the first operative element of the scoring and burnishing units 11, 12, and 13. Similarly, the valve 93 is connected by a conduit means 98 to the

cylinders 81 of abrading heads 21, 21a, and 21b comprising the second operative unit of the respective scoring and burnishing units 11, 12, and 13. In a similar manner, the double-acting valves 94, 95 are connected by conduit means 99 and 100 respectively, to the air cylinders 81 of abrading heads 22, 22a, and 22b in the one case, and in the other case, to the cylinders 81 of abrading heads 23, 23a, and 23b, respectively.

The valves 92, 93, 94 and 95 are of conventional construction having slidable pistons 101, 102, 103, 104, respectively which are movable selectively into one or the other of two positions in order to connect the source of air pressure 96 to one or the other of the air connections 82 and 83 of the cylinders 81. In order to provide for sequential operation of the valves 92, 93, 94, and 95, they may be conveniently arranged about a common operating member 105, which member may be continuously or intermittently rotated by means not shown, such as by a synchronous electric motor, or the equivalent. At one point on the cylindrical periphery of the operating member 105 there is provided an inwardly directed arcuate recess 106. The respective pistons 101, 102, 103 and 104 may be appropriately spring biased so that they bear against the peripheral surface of the operating member 105 at all times during its rotation. Furthermore, the connections to the valves 92, 93, 94, and 95 may be arranged so that as long as their respective pistons bear against the cylindrical surface of the operating member 105, air from the source 96 will be connected with the respective air connection 93 of each of the respective abrading heads which these valves control. However, as each of the pistons becomes engaged with the arcuate portion 106 of the operating member the piston will be urged radially inwardly toward the axis of the member 105, in which position the particular valve affected will disconnect the source of air 96 from the connection 83 and transfer it to the connection 82 of the particular group of abrading heads which that valve controls. It will therefore be observed that during rotation of the member 105 and as long as each of the pistons 101, 102, 103, and 104 are in engagement with the cylindrical surface of the operating member 105, a connection will be established between the source of air 96 and the air connection 83 of all of the abrading heads and that under such conditions the respective cam member 59 of each head will be disposed in its forward position, and that as each of the pistons comes to dwell on the arcuate portion 106 a connection will be established between the source of air 96 and the connection 82 leading to only one of the abrading heads of the four which comprise each of the scoring and burnishing units 11, 12 and 13. Therefore, while the cam member 59 of the abrading heads so affected will thereby be rearwardly displaced the remainder of the cam members 59 on the other abrading heads will remain in their forward position.

OPERATION

The practice of the present invention may be readily understood after the description of the operation of one of the abrading heads has first been given.

To begin with, the abrasive strip or tape 37 is a material which is in common use today and is prepared in the form of a long roll or coil.

Before commencing use of the apparatus a fully wound roll of unused abrasive strip should be placed on each of the unwinding spindles 35. It is important that both of these rolls contain strips of approximately equal length, so that they will counterbalance each other during rotation. Each of the strips is then carried over the adjacent guide roller 42, thence through the slotted guides 43 and around the guide roller 43, and finally the ends of the tape will be attached to the hub of take-up spools 38. Each of the guide rollers 42 and 43 may then be shifted by rotation about their respective axes 44 and 45, so as to hold the respective tapes 37 in frictional contact with

the driving rolls 40. These adjustments having been made, the guide rollers 42 and 43 can be held in position by tightening the respective screws 46 and 47.

Air under pressure will then be admitted to the pistons 81 through the air connection 82 so as to position the cam member 59 in its rearward position, causing the presser blocks 50 to be retracted by the spring members 60.

The material 16 to be finished will then be introduced through the center of the hollow shaft 26 so as to project through the opening 49 in the disk 25 and pass forwardly thereof between the abrasive strips 37.

The next step is to determine the proper position of the mounting blocks 50, according to the thickness of the stock 16.

The blocks 54 should be set so that when the cam member 59 is moved forwardly by the release of air from the connections 82, and the admission of air pressure to the connections 83, the presser blocks 50 will be moved inwardly to hold each of the abrasive strips 37 in frictional engagement with substantially one half of the circumference of the stock 16.

Preferably the presser blocks 50 should be held together sufficiently to cause lateral deformation of the resilient wing portions of the presser blocks 91 so as to provide tension in the abrasive tapes 37 as previously described.

Once the proper position of the mounting blocks 54 has been determined, they may be secured in place by means of the screws 55, and it will not thereafter be necessary to change their position unless the apparatus is to be used with stock of substantially greater or less diameter than that for which the original adjustment has been made.

Means should also be provided for imparting continuous uniform axial movement to the stock 16.

In the case of a short length of rod it may be either pushed or pulled by a suitable arrangement such as conventional draw bench. If the stock is furnished in the form of a reel, or if a number of successive operations are to be performed on it, it will obviously be preferable to employ some conventional apparatus to exert a continuous pulling force on the stock 16.

With the rod 16 in position as described, the electric motor 32 may then be energized from a source of current, not shown, to institute rotation of the disk member 25, which rotation will thereafter be maintained more or less constantly during the operation of the apparatus.

Thereafter, as long as the cam member 59 is in its forward position, as a result of air pressure being supplied to the piston 81 through connections 83, the presser blocks 50 will hold the abrasive strip 37 in engagement with the circumferential surface of the stock 16.

If at the same time the stock 16 is subjected to continuous axial movement, the net result will be that the circumferential surface of the rod 16 will become covered with a series of closely spaced spiral grooves or score marks resulting from the action of sharp surface of each of the individual grit particles adhering to the tape 37.

It should be noted at this point that while there is circumferential movement of the abrasive grit with respect to the surface of the stock nevertheless a portion of abrasive material which is in contact with the stock will remain unchanged, and therefore the relative position of each individual particle of grit will not be altered as long as the presser blocks 50 are holding the tapes 37 in position.

This means that whereas all of the score marks may not be identical in cross-sectional configuration and the actual distance between these markings may vary, there will, however, be produced a distinct pattern of parallel spiral score marks which could not be accomplished by prior apparatus using grinding wheels or endless belts.

On the other hand, the fact that the individual particles of grit in the abrasive will become worn and lose their sharp edges makes it necessary to renew the abrasive material after a certain period of contact with the surface of the material 16.

This may be accomplished as a result of a certain sequence of operations which is initiated by releasing the air pressure in the connection 83, and introducing compressed air into the connection 82 so that the pistons 81 will move the cross bar 84 away from the surface of the disk 25 causing a similar axial movement of cam member 59.

This movement of the cam member 59 will permit the presser blocks 50 to be withdrawn from the stock under the influence of the springs 60 and will release the abrasive tapes 37 from engagement with the surface of said stock 16.

In addition the retraction of the presser blocks 50, the rearward movement of cam member 59 will also cause a partial withdrawal of the indexing pin 61 from its opening 63 in the member 65.

During the latter portion of this withdrawal, the pin 68 coming in contact with the inclined face 66 of pin 61 will permit the slide 69 carrying the pawl 71 to turn the shaft 41 by its engagement with the circular ratchet 73.

The amount of rotation of shaft 41 can be controlled by adjustment of the pin 68, and as previously explained, the consequent rotation of both the driving rolls 40, due to their interconnection by means of the chain 75 will cause a portion of each of the abrasive strips 37 to be unwound from the spindles 35 and taken up on the take-up spools 38. Immediately thereafter, the air pressure may be released from the connection 82 and switched to the connection 83 to move the cam member 59 forwardly, causing the presser blocks 50 to re-engage with the unused portion of each of these abrasive tapes 37, and to press this fresh portion of the tapes into engagement with the stock 16.

In addition, the forward movement of the cam 59 will again slide the indexing pin 61 forwardly in the opening 63, whereupon the slide 69 will be forced radially outwardly away from the member 65, carrying the pawl 71 over one or more teeth of the circular ratchet 73 in which position it will be prepared to institute further rotation of shaft 41 and the feeding of additional unused abrasive tape 37, whenever the cam member 59 is rearwardly moved during the succeeding cycle of operation.

In Fig. 1 there has been illustrated one form of machinery embodying the apparatus just described. In this form, it has been assumed that the rod on the reel 17 has first been descaled and degreased, in which case it will first be passed through a die 19.

On the other hand, if the rod 16 were "green" stock which had not been descaled, it would pass directly to the first scoring and burnishing unit indicated by the numeral 11.

For the sake of illustration only, the scoring and burnishing units 11, 12, and 13 have been shown as including four abrading heads followed by a burnishing die, but it should be understood that the number of abrading heads employed in carrying out this process may be varied and that in certain cases, it is not essential that the stock be drawn through a burnishing die, either before or after a surface scoring operation performed by a rotary abrading head.

In Fig. 1 longitudinal motion will be transmitted to the rod stock 16 by the takeup unit 14 so that the stock will move through each of the various scoring and burnishing units in a lengthwise direction at a substantially uniform rate of speed.

If the successive abrading heads 20, 21, 22, and 23 are rotated in the same direction and at the same rate of speed the surface appearance of the stock 16 could not readily be distinguished from stock which had passed through only a single head. However, for reasons which will be explained below, it is preferable to alternate the direction of rotation of successive abrading heads and, under certain conditions, it may be desirable to operate the various heads at different rates of speed.

In any event it has been found in practice that if, for example, the abrading heads 20 and 22 are rotated in a

clockwise direction, and the heads 21 and 23 are rotated in a counterclockwise direction, a greater amount of surface metal or scale will be removed from the rod 16 than if all of the heads 20, 21, 22 and 23 were rotated in the same direction.

This can be best illustrated by reference to the following two tables, the first of which indicates a reduction in diameter of an actual sample of metal which has been treated by successive heads rotating in opposite directions. The second table shows the amount of metal removed from a similar sample treated by the same number of abrading heads, all of which rotated in the same direction.

Table 1

Direction	Diameter of Rod	Reduced to—	Reduction
1 R.....	.352	.3518	.0002
2 L.....	.3508	.3508	.0010
3 R.....	.3508	.3505	.0003
4 L.....	.3505	.3496	.0009
5 R.....	.3496	.3492	.0004
6 L.....	.3492	.3485	.0007
Total Reduction.....			.0035

Table 2.—All heads revolving in same direction

Direction	Diameter of Rod	Reduced to—	Reduction
1 R.....	.352	.3518	.0002
2 R.....	.3518	.3510	.0002
3 R.....	.3510	.3514	.0002
4 R.....	.3514	.3512	.0002
5 R.....	.3512	.351	.0002
6 R.....	.351	.3509	.0002
Total reduction.....			.0012

All of these tests were made with heads rotating at 1600 R. P. M.—rod speed 200 F. P. M.—air pressure 100# per sq. in. and tape grit #80.

In the foregoing tables, it should also be observed that the type of abrasive material employed during each pass of the stock through an abrading head was similar with respect to the hardness and size of the grit particles, but such similarity is of course, not necessary in all cases.

If, for example, the first abrading head 20 were to be provided with an abrasive strip having relatively coarse grit, while a second abrading head 21 was provided with abrasive strips having a grit particle of substantially smaller size and the abrading heads 20, 21 were to be rotated in opposite directions during the axial passage of the stock through both of the heads, the result would be to produce an ornamental pattern of score marks on the surface of the rod resembling a multiplicity of tiny diamond shaped check marks.

This is due to the fact that the grit particles on the second abrading head being finer than the particles on the first abrading head will not cut as deeply as the particles on the first abrading head, and therefore the second abrading head will remove only a portion of the metal lying between the individual parallel score marks produced by the first abrading head, and the helical pattern formed by the second abrading head would in effect be overlaid on the helical pattern of the first abrading head, moreover as the rotation of the particles in each case would be reversed, the spiral grooves of one head would angularly intersect the spiral grooves formed by the other head. The resulting product represents an article of commerce which is new and novel and may be useful for decorative purposes without further treatment, although its appearance can be enhanced if it is given additional finishing treatment, such as a light chromium plating. Generally speaking, it will be preferable, where the purpose of the apparatus is to remove surface imperfections, to use the same grade of abrasive

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tape on each of the oppositely rotating heads such as the heads 20, 21, 22 and 23.

In this case, the effect of each of the succeeding abrading heads will be to remove substantially all of the metal extending inwardly substantially to the bottom of the helical score marks produced by the previous abrading head, in which case only the spiral scoring marks made by the last abrading head through which the rod 16 has passed will be visible.

Generally speaking, it is preferable to use abrasive material having a coarser grit when treating stock whose surface is severely pitted, or upon which a certain amount of scale remains such as would be the case as the rod enters the first scoring and burnishing unit 11.

It is also preferable, after the stock has passed through one or more of the abrading heads 20, 21, 22, 23 etc. to polish the surface of the rod by passing it through a burnishing die 24.

While there is no definite line of demarcation between a burnishing die and a drawing die, inasmuch as both types of die will reduce the cross sectional area of the stock, for the purposes of this invention it can be assumed that a drawing die is one which effects a substantial reduction in the cross sectional area, generally on the order of 30%, in which case the stock tends to become plastic throughout its interior resulting in a flow of metal and a complete rearrangement of the structure tending to embed the surface material, including any imperfections at or near the surface, further in towards the interior.

For the purpose of this invention a burnishing die may be considered one, which while producing a certain amount of reduction in cross-sectional area, will not, however, induce a flow of metal in the interior of the stock but will merely cause an axial flow of material near the surface. The effect of the passage of the rod 16 through burnishing die 24 subsequent to treatment by the abrading heads will be to fill in the score marks which have been produced and to elongate any surface defects such as pit marks or cavities, and to expose such imperfections such as fractures or air holes lying just below the surface of the rod. The surface is thus given a highly polished finish as a result.

If surface imperfections remain after treatment by one scoring and burnishing unit, it may then be desirable to pass the rod through a second scoring and burnishing unit 12. The arrangement and operation of such a unit will be substantially identical with the first such unit, with the exception that it will generally be preferable to use abrasive tapes in the second group of scoring machines having a somewhat finer grit particle size than in the tapes of the first scoring unit.

After the rod has been scored by passage through one or more of the abrading heads 20a, 21a, 22a and 23a, it should be drawn through a second burnishing die 24a, again causing a slight axial flow of the surface material which will fill in the score marks produced by the second group of abrading heads, and resulting in producing a highly polished finish on the rod.

If the surface just produced is still not sufficiently free of imperfections, the rod may then pass through a third scoring and burnishing unit 13 comprising abrading heads 20b, 21b, 22b, 23b, followed by passage through a burnishing die 24b.

The results of the operation just described will be to produce rod stock having uniform circular cross section extending along its entire length, having a surface free from imperfections and of a mirror like smoothness and having an internal crystalline structure which is substantially homogeneous.

Inasmuch as this invention is primarily concerned with the treatment of the exterior surfaces it will be apparent that tubular materials, such as conduits or pipes, are equally susceptible to treatment in accordance with the present process, or by the machinery and apparatus disclosed in connection therewith as would solid materials.

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Furthermore, while it is intended that the final product will have a cylindrical exterior surface, it should be understood that the original stock to be treated may be of some irregular cross-section, such as oval or even rectangular; in the foregoing description and in the appended claims, for the sake of convenience, the words "rod" or "wire" may be used interchangeably to include any and all such materials.

While there has been disclosed in this specification one form in which the invention may be embodied, it is to be understood that this form is shown for the purpose of illustration only and the invention is not limited to the specific disclosure but may be modified and embodied in various other equivalent forms without departing from its spirit. In short, the invention includes all the modifications and embodiments coming within the scope of the following claims.

Having thus fully described the invention, what is claimed as new and for which it is desired to secure Letters Patent is:

1. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counter balanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in diametrically counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of said driving roll to respectively hold a portion of strip in the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strips of each unwinding roll will be moved by said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely opposed presser plates rockably mounted on radially adjustably pivoted rocker arms to hold said abrasive strips in operable contact with stock positioned at the rotary axis of the head, positive drive means to move the driving rolls in synchronism, said drive means including yieldable means to drive the takeup spindles, ratchet means biased to move the positive drive means one step in step by step operation, an axially movable cam member having a pair of cam faces engageable with said rocker arms to actuate said presser plates, said cam member being provided with an index pin to position the cam faces into the rocker arms, said index pin having an inclined end for camming engagement with said biased ratchet means, whereby axial movement of the cam member in one direction will move said presser plate toward the stock and will initiate operation of the positive drive means, and movement of the cam member in the opposite direction will release said presser plate and will permit said biased ratchet means to complete one step of said step by step operation of the driving rolls, and means to move said cam member axially.

2. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting a pair of unwinding rolls of unused abrasive strips positioned in diametrically opposed counter balanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of each driving roll to respectively hold a portion of strip from the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strip from each unwinding roll will be moved by said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely disposed presser blocks

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rockably mounted on radially adjustable pivoted rocker arms to hold said abrasive strips in operative contact with stock positioned at the rotary axis of the head, positive drive means to move the driving rolls in synchronism, said drive means including yieldable means to drive the takeup spindles, ratchet means biased to move the positive drive means one step in step-by-step operation, an axial camming means engageable with said rocker arm to actuate the pressure blocks, said camming means including a cam engageable with said ratchet means to initiate said step-by-step operation when the pressure blocks are actuated to hold said strip against the stock, and to permit the ratchet means to complete one step of said step by step operation of the driving roll when the pressure blocks are released.

3. In a device of the character described, a rotary abrasive head including a pair of spindles for unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, an idler roll disposed on each side of each driving roll to respectively hold a portion of strip from the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strip from each unwinding roll will be moved by said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely disposed presser blocks rockably mounted on radially adjustable pivoted rocker arms to hold said abrasive strips in operative contact with stock positioned at the rotary axis of the head, positive drive means to move the driving rolls in synchronism, said drive means including yieldable means to drive the takeup spindle, and camming means including intermediate motion transmitting means to actuate said presser blocks to hold abrasive strips in contact with the stock and to operate said positive drive means to move said strip when the presser blocks are released.

4. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of each driving roll to effectively hold a portion of strip from the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strip from each unwinding roll will be moved intermittently by said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely disposed pressure blocks rockably mounted on radially adjustable pivoted rocker arms to hold said abrasive strips in operative contact with stock positioned at the rotary axis of the head, means to actuate said driving rolls to move succeeding portions of unused strip into position to be held against the stock by said presser blocks, and means to move the presser blocks to hold said strip and to release the presser blocks for movement of the abrasive strip.

5. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in

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diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of each driving roll to respectively hold a portion of strip from the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strip from each unwinding roll will be moved intermittently by said driving roll to a takeup roll in opposite parallel directions, and means to hold a portion of said abrasive strips in engagement with the stock including means to progressively turn said driving rolls to advance portions of unused strip into position to be thus held.

6. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, feeding means to progressively transfer strips from each unwinding roll to a takeup roll in equal amounts to maintain said counterbalanced condition, presser block means intermediate said unwinding and takeup rolls to hold unused strip in engagement with the surface of the stock, and means to intermittently actuate said feeding means to move unused strip into engagement with the surface of the stock.

7. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in diametrically opposed counterbalanced relation with respect to rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of each driving roll to respectively hold a portion of strip on the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strips from each unwinding roll will be intermittently moved by said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely disposed presser blocks to hold said abrasive strips in operative contact with a longitudinal surface of stock positioned between said strips means to actuate said presser blocks to hold abrasive strips in contact with the stock and to operate said positive drive means to move said strips when the presser blocks are released.

8. In a device of the character described, a rotary abrasive head including a pair of spindles for supporting unwinding rolls of unused abrasive strips positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of takeup spindles for used portions of the strip positioned in diametrically opposed counterbalanced relation with respect to the rotary axis of the head, a pair of driving rolls positioned in diametrically opposed counterbalanced relation, each of said driving rolls being disposed between an unwinding spindle and a takeup spindle, an idler roll disposed on each side of each driving roll to respectively hold a portion of strip from the adjacent unwinding spindle and a portion of strip being fed to the adjacent takeup spindle in frictional contact with each of said driving rolls, whereby the strip from each unwinding roll will be intermittently moved from said driving roll to a takeup roll in opposite parallel directions, a pair of oppositely disposed presser blocks to hold said abrasive

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strips in operative contact with a longitudinal surface of stock positioned between said strips, positive drive means to move the driving rolls in synchronism, and means to actuate said driving rolls to move succeeding portions of said strip into position to be held against the stock by said presser blocks, to hold said strip and to release the presser blocks for movement of the abrasive strip.

9. In a device of the character described, a rotatable carrier, a pair of unwinding rolls and a pair of takeup rolls for pairs of abrasive strips supported on said carrier to engage opposite sides of stock to be moved axially with respect to the carrier, including means to feed unused strips into area of engagement of the stock and to counterbalance the variation of the weights of the unwinding and takeup rolls with the used and unused strips respectively, resulting from the feeding of said strip, and a pair of oppositely disposed radially movable presser members positioned respectively behind each of said strips to press said strips into engagement with the stock, the opposing faces of said presser members comprising resilient material having a lateral width substantially greater than the thickness of the stock and being provided with a longitudinally extending circular channel portion to conform generally with the configuration of the stock, the bottom of each channel having a V-shaped longitudinally extending groove, said faces including outwardly converging inclined wing portions disposed on each side of the channel portion, whereby said abrasive strips will be frictionally gripped on opposite sides of the stock first by the extremity of said forwardly inclined wing when said presser members are moved toward each other, and whereby further movement of said presser members will cause laterally outward distortion of said wing portions to draw said strips into engagement with the stock under tension, said wing portions being further yieldable under said continued movement to permit the channel portions to bear against the back of the strips partially enclosing the stock.

10. In a device of the character described, a rotatable carrier, means to support unwinding rolls and takeup rolls for pairs of abrasive strips to engage opposite sides of stock to be moved axially with respect to the carrier, including means to feed unused strip into the area of engagement with the stock and to counterbalance the variation in the weights of unwinding and takeup rolls of unused and used strips respectively resulting from said feeding of strip, and a pair of oppositely disposed radially movable presser members to be positioned respectively behind each of said strips to press said strips into said engagement with the stock, the opposing faces of said presser members comprising material having longitudinally extending wing portions extending laterally on each side of the stock, the lateral extremities of said wing portions projecting forwardly on the longitudinally extending central portion, whereby said abrasive strips will be frictionally gripped on opposite sides of the stock first by said extremities when the presser members are moved toward each other and further inward movement of said presser member will cause lateral outward distortion of said opposing faces to draw said strips into engagement with the stock under tension.

11. In an apparatus for helically scoring the surface of stock, the combination comprising a rotatable carrier, means to position said stock concentrically with the axis of rotation of said carrier, means to support a roll of abrasive strip material on said carrier, means on said carrier to hold successive portions of said abrasive strip against the surface of the stock for scoring said surface by rotation of said carrier, intermediate feeding means on said carrier to advance fresh portions of said abrasive strip and to counterbalance said unwinding roll as said strip is unwound therefrom, and means to move said

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stock axially during engagement with said abrasive strip material.

12. In machinery for treating the surface of cylindrical metal stock, the combination including replenishable abrading means and means to produce relative revoluble movement between stock to be treated and said abrading means, and means to operatively engage said abrading means with the cylindrical surface of the stock to revolutely score said surface and to intermittently actuate said replenishable abrading means step-by-step during said relative revoluble motion between the stock and the abrading means.

13. In machinery for treating the surface of cylindrical metal stock, the combination including replenishable abrading means and means to produce relative helical movement between stock to be treated and said abrading means, means to engage said abrading means intermittently with a step-by-step action with said stock to helically score the cylindrical surface thereof, and die means to thereafter axially flow the surface metal of the stock to replace metal removed by scoring, whereby the surface of the stock will be smoothed.

14. In machinery for treating the surface of cylindrical metal stock, the combination including replenishable intermittently operated abrasive scoring means, means to produce relative compound helical movement between stock to be treated and said abrasive scoring means, said compound movement including components of two oppositely revoluble directions, means to engage said scoring means with the cylindrical surface of the stock during said compound relative movement therebetween and means to move said stock axially.

15. In a machine for treating the surface of cylindrical metal stock, the combination including means to move said stock axially, and means to abrasively deliberately score the cylindrical surface of the stock in two oppositely helical directions to form helical grooves therein, and burnishing die means to axially flow the surface metal of the stock and thereby to smoothing said grooves.

16. In a machine for treating the surface of cylindrical metal stock, the combination including means to move said stock axially, and first and second stationary means to successively abrasively helically intermittently score the cylindrical surface of the stock, said scoring being produced in the same axial direction by both of said means but successively by each of said means in opposite circular directions, the coarseness of the abrasive substance of the first means being greater than that of the second scoring means, whereby the scoring produced by the first means will not be obliterated by the scoring produced by the second means.

17. In a machine for treating the surface of cylindrical metal stock, the combination including means to move said stock axially, and first and second means to successively abrasively helically score the cylindrical surface of the stock with an intermittent action, the coarseness of the abrasive substance of the first means being greater than that of the second means, whereby the scoring produced by the first means will not be completely obliterated by the scoring produced by the second means, and burnishing die means thereafter to axially flow the cylindrical surface metal of the stock to partially smooth said surface.

18. In a method of finishing the surface of cylindrical metal stock, the steps including axially moving said stock, and unidirectionally revolubly scoring the surface of the stock with an intermittently applied stationary unused abrasive strip to produce helically scored grooves therein, and axially unidirectionally flowing only the surface metal comprising the lands between said scoring to remove said grooves.

19. In a method of finishing the surface of cylindrical metal stock, the steps including axially moving said stock, and unidirectionally revolubly scoring the surface of the stock with an intermittently applied unused stationary

abrasive strip to produce scored helical grooves therein, unidirectionally but oppositely revolubly scoring the surface of the stock with an intermittently applied stationary unused abrasive strip, and axially unidirectionally flowing and burnishing the surface metal comprising the lands between said scoring.

20. In a method of finishing the surface of cylindrical metal stock, the steps including axially moving said stock, and unidirectionally revolubly scoring the surface of the stock with an intermittently applied stationary unused abrasive strip, and axially unidirectionally flowing by burnishing means the surface metal comprising the lands between said scoring.

21. In a method of finishing the surface of cylindrical stock, the steps including axially moving said stock, and scoring the stock with abrasive strip material by maintaining continuous relative unidirectional axially helical motion therebetween, and intermittently advancing unused abrasive strip into contact with said stock.

22. In a method of finishing the surface of cylindrical stock, the steps including axially moving said stock, and

scoring the stock with stationary abrasive strip material while maintaining continuous relative unidirectional axially helical motion therebetween, scoring the stock with abrasive strip material while maintaining continuous relative unidirectional axially helical motion in opposing circular direction, and intermittently advancing unused abrasive strip into contact with said stock.

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