March 10, 1936. V. R. PALLAS 2,033,392

ABRASIVE MACHINE AND PROCESS

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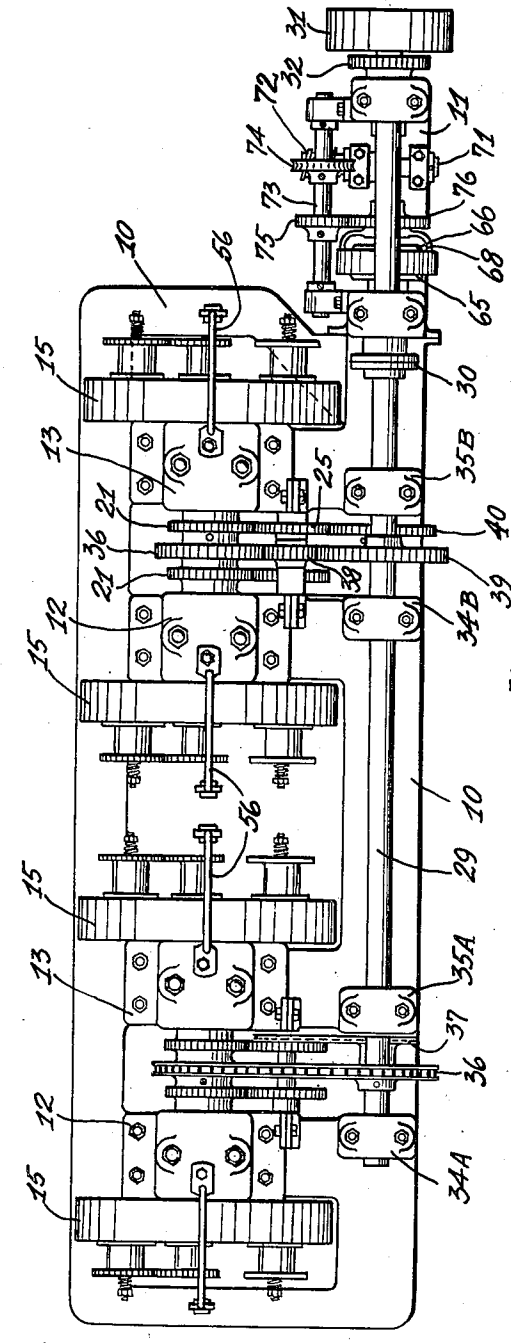


Fig. 1.

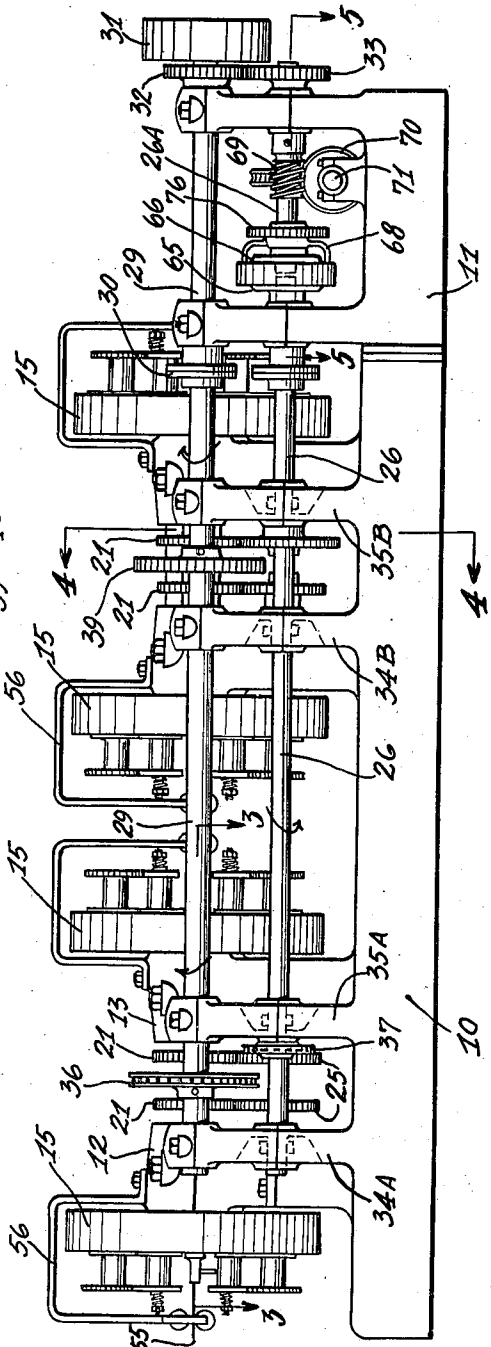


Fig. 2.

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Fig. 3.

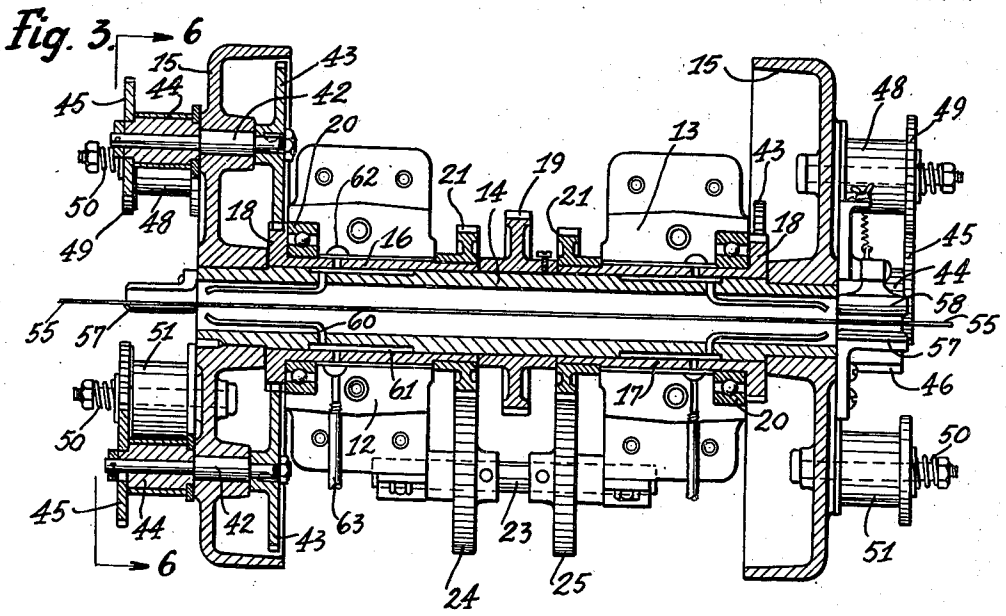


Fig. 6

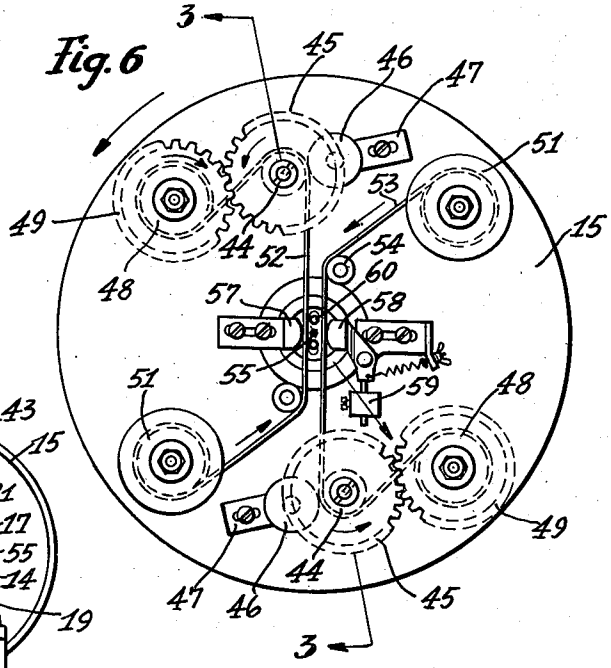
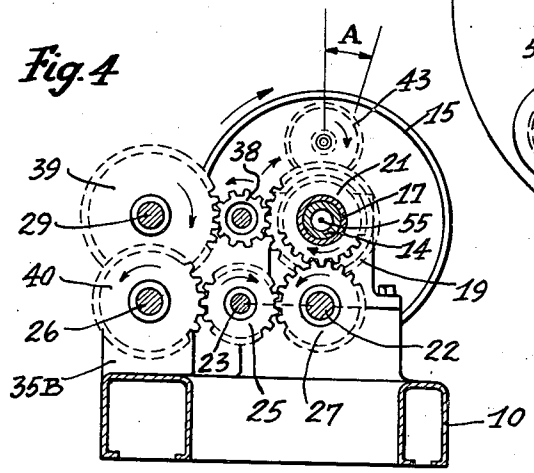


Fig. 4



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Fig. 5.

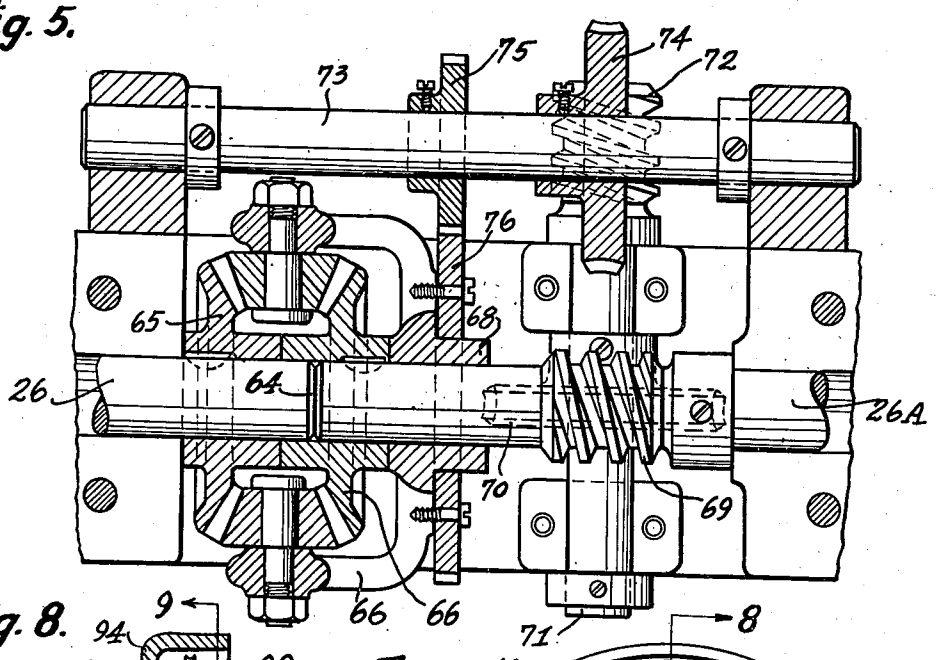


Fig. 8.

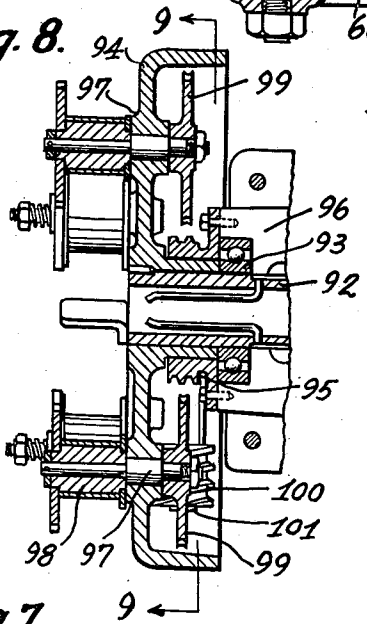


Fig. 9.

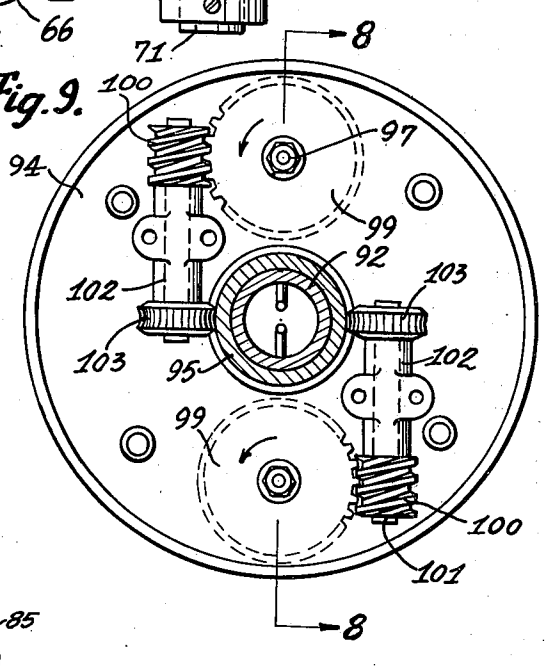
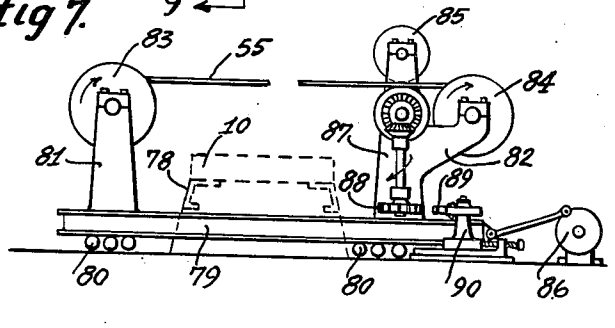


Fig 7.



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UNITED STATES PATENT OFFICE

2,033,392

ABRASIVE MACHINE AND PROCESS

Vernon R. Pallas, Cortland, N. Y.

Application January 22, 1934, Serial No. 707,693

25 Claims. (Cl. 51—71)

The present invention broadly relates to the art of abrasive or finishing machinery, and more particularly pertains to an improved surface stroking machine of the multiple head type that is especially adapted to apply a so called honed or superior smooth finish to filler impregnated cords or braided fish lines, also to waterproofed or other varnish coated fibrous strands and the like diametrically small, cordlike members. In a filamentary product of this kind, the solidified filler medium is likely to leave its coated surface rough in spots, out of round, irregularly glossy and otherwise in need of a more perfect finish; my devices process such inherently pliable, strandlike articles to rectify surface imperfections and thereby enhance the quality and marketability of such goods.

The object of my improvements is to provide for a relatively simple, high speed machine of the indicated character that shall be capable of rapidly and economically processing certain coated textile and other work piece surfaces of annular profile and to hold such articles in long lengths to a given diametral size irrespective of the attrition rate at which the abrasive material wears down or otherwise becomes spent, also to overcome the prevailing inherently slow operative limitations that have heretofore restricted productive capacity of conventional stroking instrumentalities of this kind, especially when working upon softer articles that tend quickly to clog or load the abrasive material. To this end, a plurality of head means are devised, each equipped with complementary rolls or the like supply of slowly fed sanding tapes. Being laterally yieldable, such tapes duly compensate for anticipated changes in the original diametral size of the processed strand. Through one or more such tape pairs, an impregnated fish line or a similar oil coated strand may be suspended under tension to impart the desired superior facing to the treated product that shall be truly circular while said work piece is being steadily moved longitudinally onward. The engagement of the tape with the work piece is confined to a localized cutting zone and an adequate supply of virgin tape is regularly advanced toward said zone to renew the abrasive tape as fast as it becomes spent.

In honing the surface of coated lines or the like intrinsically frail textiles, the abrasive tape action is most advantageously carried on in a series of steps. In so far as any one grinding or honing step is concerned, this is herein kept commensurate with the twistable nature and lack of lateral rigidity on part of the treated cord, although my abrasive machine is also applicable to other work pieces such as inherently rigid metallic rods or the like. My improvements in part rely upon the use of a relatively rapid rate of longitudinal work piece travel so as to permit of effectively treating an extensive surface in a given time but without need of any reciprocative head stroking movement in the direction of the spindle axis. By compactly storing a liberal supply of sanding tape, I am enabled to slowly feed such abrasive for hours at a time, while continuously grinding on a corresponding long strand at a high productive rate without having to contend with a reduction in the initial cutting properties throughout the life of the tape.

It is therefore, preferred to work with a plurality of rotating, rocking or otherwise actuated spindle heads which successively operate upon a continuous strand in order that the reduction in strand size by combined abrasion on part of all my honing tapes, may still be kept sufficient in magnitude to impart the desired uniformly smooth or satinlike finish to the processed product without cutting through the solidified coating of a fish line and into the fibrous core strands thereof. Such stepwise procedure at the same time allows of a relatively high rate of properly finished line travel through the respective heads without however, exerting a longitudinal line drag falling in excess of the tensile strength of such treated product. It is emphasized however, that the abrasive speed of such tape pairs as measured circumferentially around a common line, is less essential than is the rate of longitudinal travel of the line itself, since the latter velocity component is primarily instrumental in providing for the desired relatively fast wiping speed required to give my slowly advanced tapes ample abrasive capacity or cutting action as confined to a localized cutting zone. The provision for multiple heads assumes outstanding importance because the rate of line travel may be intensified in direct ratio to the number of heads and the aggregate width of their respective tapes which are herein cooperatively employed.

Considered from another angle, the use of my multiple heads afford a sufficient number of revolutions in proportion to the unit length of finished line fed therethrough to insure a substantially round and otherwise perfect surface finish free from flats or other polygonal profile shape. In addition, for heads of a given size, the combined storage capacity for sanding tape is proportionately increased, which in turn, permits my abrasive machine to run continuously at a high speed for a correspondingly longer period of time without need of tape replacement because of abrasive wear or loading. The rate of crossfeed on part of such distributed tape supply may be maintained at substantially fixed gross footage of virgin tape per unit length of processed line irrespective of the number of heads resorted to.

Considered from a process aspect, my method contemplates bringing an inherently pliant strand into operative tangential engagement with

a virgin portion of a sanding tape or other abrasive face, and then drawing a coated strand thereover at a relatively rapid linear rate of travel to establish the desired intensive cutting action which is purposely confined to a localized abrasive zone that extends longitudinally of the strand but allows for a remaining initially unused tape portion. Said abrasive zone is simultaneously turned around the strand axis and the resulting abrasive action generates a helix with respect to the strand surface. The rotative speed of such tape is herein kept in a commensurate relationship to the rate of strand advance in order that the pitch of said helix shall not exceed the tape width used. This procedure in turn insures an overlapping, even grinding along the entire processed strand length and effects a round surface finish that is devoid of irregularities or ground flats. The unused tape portion is then gradually fed into said abrasive zone so as to maintain a substantially uniform cutting action on part of my tape throughout the life thereof.

A principal item of fabrication expense, resides in the cost of honing or sanding tapes and it is the further object of my invention to utilize such abrasive material to the utmost advantage by positively and uniformly advancing the tape slowly to the work piece approximately corresponding to the rate at which the abrasive tape becomes substantially spent. The accompanying problem of extreme speed reduction as applied to such tape feed purposes, is herein solved by the use of positive reduction gearing that may be directly connected to a high speed spindle in preference to the use of a ratchet driven or other intermittently operated feed mechanism. While it is also preferred to move the treated line continuously onward, my disclosure further contemplates the longitudinal reciprocation or the spinning of the line itself while being processed through a plurality of spindle heads.

Embodied herein are other improved constructive features designed to feed complementary abrasive tapes crosswise of the line axis in a continuous and definite ratio to the rate of processed line travel, and particularly to facilitate the manufacturing aspects of honed strands that are impregnated with solidified drying oil, such for instance, as has been baked in accordance with my process Patent No. 1,999,170 issued April 23, 1935, and all of which additional features will hereinafter be set forth in detail.

Reference is had to the accompanying three sheets of drawings which are illustrative of certain specific embodiments of my invention, and in which drawings:

Fig. 1 represents a plan arrangement of my multiple head type honing machine, and Fig. 2 an elevational side view thereof.

Fig. 3 is a horizontal cross-sectional view of the head spindle assembly taken along line 3—3 of Figs. 2 and 6, while Fig. 4 is a transverse sectional view along 4—4 of Fig. 2.

Fig. 5 depicts certain control details as seen from line 5—5 of Fig. 2.

Fig. 6 shows an elevational end view of the Fig. 3 head assembly.

Fig. 7 schematically illustrates in elevation, certain devices for reciprocatively feeding the treated line through my machine.

Fig. 8 is similar to Fig. 3 but directed to an alternative style of head structure in which the abrasive tape is regularly fed by different gear means, while Fig. 9 shows an end view along 9—9 of Fig. 8.

Referring first in detail to the Figs. 1 and 2 arrangement, this particular machine disclosure embodies a girderlike bed plate 10 having a supplementary framework 11 attached to the rear end thereof. Spacedly disposed crosswise of such bed plate, are one or more pairs of axially aligned bearing pedestals such as 12 and 13, of which the contiguous bored end faces may be kept spaced apart for the reception of control and drive means.

Mounted between each such pair of cooperating pedestals is a tubular spindle 14 having a tensioned strand or line 55 continuously threaded centrally therethrough as in Fig. 3. A flanged disclike head 15 may be applied to each spindle end, which oppositely disposed heads are shown angularly displaced into quadrature relation. Each set of complementary heads constitutes a forward and a rearward spindle unit, it being obvious that any desired number of such units can be similarly incorporated.

A separate adjustable sleeve such as 16 or 17, may rotatably encircle the respective end regions of each spindle and the outermost ends of such complementary sleeves may respectively terminate in a master spur gear such as 18 that is disposed concentrically about the spindle axis. The innermost sleeve ends are kept spaced apart and interposed therebetween, is a spindle drive gear 19. Said spindle may be horizontally mounted within and axially retained by ball bearings such as 20, which circumscribe the respective sleeves that are centered within a different pedestal.

Carried at each innermost sleeve end is a drive gear such as 21. As embodied in the given exemplification, two parallelly disposed idler shafts may extend between each pair of pedestals 12 and 13; one such countershaft designated 22, is located directly beneath the spindle 14 and the similar other shaft 23 is laterally offset as shown in Fig. 4. The complementary gears 24 and 25 may be fixedly mounted upon the offset idler shaft 23 (see Fig. 3) and thereby cause both of the sleeves 16 and 17 to be rotated in unison by the control shaft 26 through the idler gear 27, which latter is here carried by the countershaft 22.

For present purposes, it is preferred to rotate successive spindles in reverse directions; to this end, a gear shaft 29 may be run lengthwise of the bed plate, said shaft bing superimposed over the sectionalized control shaft 26 to reach the rear frame end as in Fig. 1. Said gear shaft may be provided with a coupling 30 and extended to receive the overhanging main drive pulley 31. Adjacent to the pulley is a pair of similar spur gears 32 and 33 of which one is keyed to the gear shaft 29 and the other secured to the control shaft section 26A so as to drive the respective rear shaft ends at approximately identical speeds but in opposed directions as indicated by arrows in Fig. 2.

Said gear and control shafts may be alignedly mounted by a series of split pillow blocks such as 34A and 35A, or 34B and 35B. A head sprocket and chain 36 is interposed between the blocks 34A and 35A to drive the forward spindle gear 19 in the same direction as the gear shaft 29. In a like manner, the control shaft 26 carries an auxiliary sprocket and chain 37 which rotates its cooperating offset idler shaft 23 in a direction opposite from the shaft 29. By virtue of the intermediate idler gear 27, the forward spindle 14 to-

gether with both of its sleeves will rotate in a common direction.

The drive gearing for the rearward spindle unit is similarly arranged between the pillow blocks 34B and 35B, except that instead of a chain drive, a reversing gear 38 is now interposed between the main drive gear 39 and its spindle gear 19 (see Fig. 4). Likewise the control shaft gear 40 here meshes directly into the intermediate gear 25, hence both of the rear spindle sleeves 16 and 17 will rotate reversely from the forward spindle sleeves.

Each of the spindle heads 15 carries its own supply of abrasive tape, preferably as stored upon duplicate rolls of striplike lapping material. It is to be understood however, that while the illustrated spools carry a supply of tape thereon in the preferred convolute formation, my invention is not confined to this particular formation, since the same result may be attained when the stored tape is compactly stacked in plaited instead of a spiral configuration, which multiple courses respectively typify a specific mode of vernation as used in its broader sense to embrace all such kindred laid courses affording a tape supply commensurate for present purposes.

As disclosed in Figs. 3 and 6, the web plate or disc of each head is journaled to receive a pair of driven roller trunnions or pintles 42 which are parallelly disposed with respect to the spindle axis. Each interiorly overhanging pintle end may be provided with a planet gear such as 43 while each opposite pintle end is slidably embraced by a feed roller 44 of which the perimetric surface is preferably sheathed by a felt covering or other gripping medium. The outermost free end of each roller may be equipped with a feed gear 45 and the roller pinned or otherwise removably keyed to facilitate roller replacement having a different cushioned surface diameter. Cooperating with each such roller is an idler mate 46 that is bracketed upon the retractible flange 47 (see Fig. 6), said flange being slotted to permit of adjustably modifying the pintle centers to accommodate a differently sized feed roller 45 and also to facilitate threading a renewed tape between such feed roller means.

Adjacent to each such feed roller is placed a tape take-up spool such as 48, preferably mounted upon a stanchion extending outwardly from the head face and rotating bodily with the head 15. Bearing frictionally against the outermost flange of the spool 48, is a disc gear 49 that meshes with the feed gear 45, said disc gear being yieldably pressed toward the spool flange by the spring 50. A pair of similar but gearless supply spools 51 may as in Fig. 6, be symmetrically located upon the same disc face. The abrasive or honing tapes 52 and 53 are supplied by the respective spools 51 and separately threaded over suitable guide means 54, thence carried to the axial center of the head disc in superimposed relation with the abrasive sides facing each other, and whereupon the respective tapes are interposed between their mated feed rollers 45 and 46 to be independently wound upon their respective take-up spools 48. For this purpose, each leading tape end is suitably fastened to its actuated takeup spool so as to be dragged around therewith into a transferred roll formation.

It is emphasized that my take-up means essentially reside in the positively actuated feed roller 44 and its mated idler 46, since these elements alone will function to unwind the supply spool and continuously advance the tape to the work piece without need of any additional spool 48 to take up the spent tape thereon. The term "feed roller means" as used in the claims, is intended to cover any of such take-up elements embodied either singly or in combination.

As will presently be explained, rotation of the feed roller about its own axis is purposely kept extremely slow to bring about a corresponding low rate of tape advance. The rotation of the roller gear 45 is however, kept somewhat faster than the restricted rate of tape travel with the result that the slipping disc gear 49 tends to drag along the take-up spool 48. The braking action on part of the supply spool 51 is utilized to maintain the tape in a uniformly taut condition. The respective tapes are independently advanced into operative position in a crosswise relation to the line axis and each tape continuously restores a fresh virgin cutting surface to its abraded line region. At any fixed spindle speed, the described tape feed devices provide for a substantially uniform tape advance throughout the entire tape length. As a substitute for such companion tapes, a single tape might be sharply returned upon itself and likewise arranged to grip the interposed line therebetween.

It is preferred to work with a relatively wide honing tape of about 2 inches in width and to so control the feed rate thereof that the tape abrasive may be substantially spent in a single passage between such take-up and supply spools. This aspect assumes particular importance when operating upon fish line coatings or the like soft mediums because such abrasive tends to load and thereby shorten the effective life of a sanding tape. The use of a conventional endless abrasive of the short span, open belt type would require frequent renewals to similarly retain its virgin cutting properties. As sharply distinguished therefrom, my preferred practice consists in advancing each of the several tapes toward their respective high cutting zones at a comparatively slow feed rate, the rate of line travel longitudinally through the driven head, being preferably kept at least five hundred times faster than the corresponding tape advance so as to maintain an effective cutting speed therebetween. It is also intended to provide for an ample, distributed supply of honing tape in order that my machine may be given a correspondingly augmented processing capacity and kept in continuous operation for a prolonged period without requiring any shut down for tape replacement.

The compact storing of tape supply in multiple courses, permits of uniformly and repeatedly grinding treated strands to an exact predetermined diametral size. Furthermore, the intensity of the tape cutting action is kept inherently restricted and not allowed to ruin such coated strands. In the present instance, the abrasive effect of the tape is self-regulating and maintained in a proportionate relationship to the rate of line travel, which procedure materially reduces the hazard in wastage of treated line material as compared to the use of a fast moving abrasive.

As will be understood, all these associated and axially offset spools rotate or oscillate rapidly in unison with each such head and which several heads may be angularly shifted or staggered with respect to the common spindle axis so that the successive tape pairs impart a truly round finish to the treated product. The line 55 is threaded and tensioned through the whole series of tubular spindles 14 and may be upheld against undue

sag by the use of a plurality of sustaining guides such as 56 (see Fig. 1). The suspended line is then regularly dragged between the several pairs of honing tapes at a predetermined rate of travel that is partly dependent upon the finish requirements and the diametral line size, since a lesser line surface may be properly ground at a corresponding faster linear rate of production.

As a further refinement, I provide for an upstanding backing jaw 57 of the radially adjustable type such as is disclosed in Fig. 6, of which the centrally inward face definitely positions the non-abrasive side of the tape 52 with respect to the spindle axis and with due regard to the relatively small diameter of the treated line. Opposed thereto and pressing behind the non-abrasive side of the complementary tape 53, a similar but pivotally mounted jaw 58 may be provided with a radially adjustable counterweight 59 adapted to exert a predominating centrifugal force whose direction is indicated by an arrow. This counterbalanced force is sufficient to squeeze the operative sides of said tapes against the longitudinally movable line 55 but such force may be supplemented or replaced by spring pressure as shown. Said spring together with the adjustable counterweight, control to a nicety the abrasive grip exerted upon the ground line; the best results are usually obtained by applying a relatively thin cut during each successive grinding step. The provision of a pair of companion honing tapes for each spindle head, also serves to neutralize the opposed lateral thrusts against the pliant line. It will be observed that the respective rotating tapes are herein kept spaced about the interposed work piece so as to leave opposed radial clearance gaps therebetween through which the abraded material may be freely thrown off centrifugally without accumulative or other tape pocketing effects.

Where such multiple spindle heads are employed, it is expedient to hold both the resulting longitudinal and perimetric line drags within moderate limits that shall be commensurate with the frail and inherently flexible nature of the treated line product. By oppositely rotating or otherwise actuating adjacent head spindles, the line twist effect is counteracted and not allowed to build up accumulatively. In order to further prevent any heaping or other collection of abraded substances, the interior of the spindle 14 may additionally be provided with one or most blast tubes such as 60 which as indicated in Fig. 3, direct a stream of compressed air or other gaseous cleansing fluid toward the line 55 to clear the operative or grinding region thereof. The spindle may be recessed as at 61 and the pedestal bearing counterbored at 62 to conduct the necessary air to each such tube. A pipe 63 supplies air to said counterbore and the sleeve 16 may be drilled with a series of registering apertures serving to maintain communication between the pipe 63 and the rotating tube 60. It will be obvious that similar blast feed devices may be resorted to without an interposed sleeve. The use of such air blast means is not essential.

Attention will now be directed to certain control devices for selectively changing the rate of tape feed from a centralized point located in the supplementary rear frame 11. Referring to Fig. 5, the control shaft 26 is purposely made sectional and split at 64 and a supplementary shaft section 26A extends rearwardly from said split for engagement with its pulley gear 33. The abutting ends of the shafts 26 and 26A may be coupled by a differential drive unit comprising a pair of oppositely disposed bevel gears 65 and 66 that are respectively keyed to a different shaft end and provided with one or more conventional idler gears therebetween such as 67. The last named gears are shown housed within a yoke member 68 having a hub that rotatably surrounds a contiguous portion of the shaft section 26A.

A main worm 69 is mounted rearwardly of the yoke hub to engage a cooperating worm gear 70 as carried upon the cross-shaft 71 and which shaft is equipped with a supplementary reduction worm 72. Angularly superimposed upon the last named worm, is a lay shaft 73 that runs parallel to the control shaft 26. Said lay shaft carries the supplementary worm gear 74 and also a change gear or driver 75. A mated driven change gear 76 may be mounted around the yoke hub to finally mesh with the gear 75. The intent of such control gearing is to slightly alter the rotative speed between the sectional shafts 26 and 26A from a centralized point. The speed of the rear shaft end 26A is fixed by the spur gears 32 and 33 which at the same time, rotate the worm 69. The latter operates the lay shaft 73 and consequently actuates the driver 75 and its mated change gear 76, which serves to slowly rotate the yoke 68 around the sectional shaft 26A. Because of the well-known planetary principle underlying the described gear structure, the forward shaft section 26 may be made to run at a somewhat faster or slower speed relative to the rear shaft section 26A, depending upon the relative direction of rotation given to the yoke member 68.

Referring further to Fig. 6, it will be seen that the head 15 there shown, rotates in counterclockwise direction while the planet gear 43 may be made to rotate in a like or reverse direction depending upon the differential speed ratio prevailing between the split sectional shafts 29 and 29A. Said planet gear is preferably made of a diametral size identical with the master spur gear 18 upon which it rolls. Hence assuming the differential control yoke 68 could be held stationary so as to impart the same speed to both control shaft sections, then whenever the head 15 of Fig. 4 advances through an angle marked "A", the master gear 18 will advance to exactly the same extent, with the result that no rotation will be imparted to the planet gears 43 about their respective roller pintles; that is to say, no relative movement will occur between the teeth of the gears 18 and 43. On the other hand, if the master or sleeve gear 18 could be held stationary with respect to the revolving head 15, then the planet gears 43 would revolve at a comparatively fast rate and thus bring about a corresponding rapid feed of abrasive tapes from their respective supply spools 51 on to their cooperating takeup spools 49.

By running the control shaft 26 at a speed slightly slower than its coupled shaft section 26A, the tape may be selectively fed across the line at an extremely slow rate of advance; in the present instance, the required slight differential shaft speed is positively brought about by the use of the double worm gear assembly disclosed in Fig. 5. By suitably modifying the reduction ratio between the change gears 75 and 76, this will simultaneously change the rate of tape travel in all the several rotating head units. For different kinds of work piece, it is preferred to maintain a definite predetermined rate of tape feed that shall

be continuous and proportionate to the spindle movement. Each component tape is throughout its length, advanced to the work piece at a uniform feed rate while the spindle speed remains constant, it being the intent to correspondingly speed up the work piece travel without wastage of tape material.

An alternative mode for positively changing the rate of said tape feed resides in the use of substitute rollers **44**, as described. In such practice, the Fig. 5 differential worm gear assembly together with its split sectional shaft **26A**, may be dispensed with; in lieu thereof, a train of suitably proportioned spur gears (not shown) may be substituted for the pulley gears **32** and **33** and adapted to run a continuous, non-split control shaft such as **26**, at some fixed differential speed with respect to the cooperating gear shaft **29**. As a further modification, the main drive gear **39** as carried by the shaft **29**, may readily be changed over into a cam or crank mechanism adapted to rockingly tilt or otherwise actuate the several heads **15** about their respective spindle axes while the tape pairs thereof are being simultaneously fed crosswise of the line in radially different directions.

As intimated, it is the intent to regularly pass the line **55** through the several heads as fast as proper processing will permit and where any unusually heavy surface grinding is to be undertaken, it is preferred to repeatedly run the treated line through my machine in order that its rate of linear travel may be upheld at a velocity sufficient to provide adequate cutting capacity on part of the respective tapes. Suitable line feed means are schematically represented in Fig. 7. These devices not only advance the line **55** onward but are at the same time adapted to impart a bodily reciprocative movement thereto. Should it be desired to reciprocate the line, the previously described bed plate **10** may be upheld upon a subbase **78** designed to straddle a pair of laterally spaced carrier bars such as **79** which are respectively mounted upon rollers or other antifriction means **80**. The respective cratelike carrier ends are provided with reel supports such as **81** and **82** which pivotally mount a supply reel **83** and an offtake reel **84**, these being gear actuated and equipped with braking devices in a conventional manner. The feed rollers such as **85** correspond in purpose to the similarly driven tape rollers **44** and **46** of Fig. 6. Said carrier bars may be reciprocated in unison by the crank mechanism **86** which is preferably geared to run in synchronism with the drive pulley **31** of my honing machine. All reciprocative members are kept light in weight as possible to obviate excessive inertia pressures when actuated at high speed.

For line feed purposes, the reel support **82** may be provided with a vertically disposed gear shaft **87** having a ratchet wheel **88** at the lower end thereof. A spring retained pawl **89** may be adjustably mounted upon a stationary but shiftable prop **90** and the pawl may be arranged to adjustably strike the ratchet teeth when the carrier approaches one extreme of its travel. The reciprocated line **55** may thereby be gradually fed under tension from one reel to the other while threaded through a series of tape carrying heads such as **15** which rather closely simulates a hand honing operation as applied to line finish purposes. I have found that substantially the same results may however, be attained without such reciprocative line movement, in which event the crank mechanism **66** may be discarded and the roller **85** actuated by other suitable means in synchronism with the main drive pulley **31**. As an alternative, such carrier may also be bodily mounted between actuated trunnions so that the line may be made to spin around its own axis while traveling through stationary or axially tiltable spindle head or heads.

It now remains to discuss a further modification in the head structure depicted in Figs. 8 and 9. In this simplified disclosure, each spindle head disc such as **94** is provided with an independent feed reduction gear which eliminates the need for the differential gear drive shown in Fig. 5, and also the split control shaft sections such as **26** and **26A**. When discarding the supplemental rear frame **11** and its associated parts, the main drive pulley **31** may be disposed contiguous to the gear shaft coupling **30**.

In the Fig. 8 head assembly, no spindle sleeves are required but the spindle proper now designated as **92**, may again be mounted in ball bearings **93** and otherwise made to conform to the pedestal mounting more specifically described in connection with Fig. 3. As a structural departure, the hub of the modified head **94** is loosely circumscribed by an annular worm **95** which may be overhangingly fixed to the bearing pedestal **96**, as shown. Each driven roller pintle **97** may be journaled through the head disc and its outermost terminal provided with a feed roller **98**. Said roller serves the same purpose as the corresponding element **44**; in fact, all the tape feed elements located upon the outermost face of the head **94** preferably follow the showing of Fig. 6. Each innermost end of the pintle **97** is equipped with a supplementary worm gear **99**. As illustrated in Fig. 9, said gear cooperates with the worm **100** carried by a transversely disposed intermediate shaft **101** as mounted at the rear of the head disc in the journal **102**. The opposite end of each such intermediate shaft is provided with another or main worm gear **103** and both of which respectively mesh with the annular worm **95**.

Assuming the Fig. 8 head and its associated parts to be rotated about the stationary worm **95**, this will actuate both gears **103** and thereby slowly drive each feed roller **98** through its respective double reduction worm gear drive at a rate commensurate with present tape advance requirements. When using such individual head gearing, any desired change in the rate of tape advance, may still be brought about by suitably altering the diametral size of the various feed rollers such as **98** The symmetrical arrangement afforded by my duplicate feed gearing in either Fig. 6 or 9, is such that all members including the cooperating tape spools fall within the circular head perimeter and are especially designed for balanced high speed spindle rotation.

It is thought that the foregoing rather explicit machine disclosure and its ramifications, will make evident to those skilled in this art, the outstanding advantages of my improved grinding appliances, which may also be made to serve for polishing purposes. It is further emphasized that certain aspects of the described head units and the operation thereof may with advantage be utilized for purposes other than the surface grinding of pliant fish lines or the like textile products, also that the plural head assemblies may be increased to any desired number, preferably to four or more instead of the single pair of such units that are specifically disclosed in Figs. 1 and 2. Furthermore, as used in the claims, the

"head" element for the spindle is intended to be broadly directed to any housing means adapted to incorporate suitable honing tape means together with its associated feed mechanism, it being understood that I further reserve the right to likewise modify any other of my illustrative embodiments, all without departing from the spirit and scope of my invention heretofore described and more particularly pointed out in the appended claims.

I claim:

1. In a surface finishing machine, the combination of a rotatable tubular head adapted to have an elongated work piece freely extend therethrough, supply spool means and mated actuated feed roller means carried in duplicate by said head, a roll of abrasive tape mounted upon each of the duplicate supply spools with one roll end region disposed to cooperate with the mated feed roller thereof and which pair of abrasive tapes are respectively brought into operative engagement with opposed surface regions of the work piece, means driving said head together with the aforesaid spools about said work piece, and means for actuating the feed rollers to unwind said tapes off their respective supply spools and advance said tapes toward the work piece while the head is driven.

2. In a surface finishing machine of the multiple type, the combination of a plurality of tubular heads that are rotatably mounted and adapted to have a common elongated work piece entered therethrough, separate supply spool means together with actuated feed roller means carried by each such head, a roll of abrasive tape mounted upon each supply spool with one roll end region respectively disposed to cooperate with the mated feed roller thereof and which tapes are respectively brought into operative engagement with a different surface region as measured lengthwise of the work piece, drive means rotating the several heads, and means for actuating the respective feed rollers to regularly advance the aforesaid tapes toward the work piece while the several heads are rotated about said work piece.

3. In a surface finishing machine of the multiple type, the combination of a series of tubular heads that are rotatably mounted and adapted to have a common work piece entered therethrough, actuated feed roller means carried by each such head, a roll of abrasive tape also carried upon each such head with one roll end region respectively disposed to cooperate with the mated feed roller thereof and which tapes are respectively brought into operative engagement with a different surface region of the work piece, means for driving the several heads about said work piece, means actuating the respective feed rollers to advance their cooperating tapes toward the work piece while said heads are driven, and means for progressively moving the work piece axially through the several driven heads at a rate of travel not less than five hundred times faster than the mean rate of tape advance.

4. In a surface finishing machine, the combination of a series of tubular heads that are rotatably mounted and adapted to have a common elongated work piece entered therethrough, a roll of abrasive tape carried by each such head in an offset relation to the axis of head rotation, feed means for advancing the respective abrasive tapes into engagement with a different surface region lengthwise of the elongated work piece, means for driving the aforesaid heads about said work piece, and centralized control means for changing the rate of advance of the several feed means.

5. In a surface finishing machine, the combination of a spindle, a head member carried by the spindle to rotate in unison therewith and which head is equipped with pintle means, a rotatably mounted sleeve surrounding the spindle in telescopic relationship intermediate the spindle ends and having an annular gear disposed to circumscribe the spindle and which gear extends radially beyond the spindle confines, a planet gear mounted upon the head pintle and which gear cooperatively meshes with the annular sleeve gear to rotate the pintle, and drive means rotating the spindle and the sleeve at different speeds whereby to reduce the rate of pintle rotation with respect to that imparted to the spindle.

6. In a surface finishing machine, a pair of spaced bearing pedestals, a spindle mounted between and extending outwardly beyond the respective pedestals, a head carried by each extended spindle end, a drive medium located between said pedestals and serving to rotate the spindle, complementary sleeves each provided with gear means surrounding the spindle and which sleeves are respectively interposed between said drive medium and one of the spindle heads, a pintle carried by each such head, a separate gear for each head pintle and which gears respectively mesh with a contiguous sleeve gear, and means for rotating said sleeves at a different speed rate from that of the spindle.

7. In a surface finishing machine, a pair of tubular spindles disposed in alignment, a head mounted upon each such spindle and which heads are respectively provided with pintle means, a sleeve rotatably surrounding each such spindle and which sleeves are respectively equipped with an annular gear disposed to circumscribe its spindle axis, a planet gear mounted upon each such head pintle and meshed to travel around a contiguous sleeve gear, a rotatable gear shaft and a rotatable control shaft respectively extending lengthwise of the spindles, means for simultaneously rotating both of the spindles from the gear shaft, and means for rotating both of the spindle sleves from the control shaft, said shafts being respectively operated at different speeds.

8. In a surface finishing machine, a pair of tubular spindles disposed in axial alignment, a head mounted upon each such spindle and which heads are respectively provided with pintle means, a sleeve rotatably surrounding each such spindle and which sleeves are respectively equipped with an annular gear disposed to circumscribe its spindle axis, a planet gear mounted upon each such head pintle and meshed to travel around a contiguous sleeve gear, a gear shaft and a control shaft respectively extending lengthwise of the spindles, drive means carried by the gear shaft to simultaneously rotate both of said spindles, independent drive means carried by the control shaft to simultaneously rotate both of the spindle sleeves, driven pulley means for the gear shaft, and shaft interconnecting gear means including a planetary gear for driving the control shaft in unison with the gear shaft.

9. In a surface finishing machine of the multiple type, a plurality of tubular heads that are rotatably mounted and adapted to have a laterally pliant and axially twistable work piece suspended therethrough, separate supply spool means together with actuated feed roller means

carried by each such head, a roll of abrasive tape mounted upon each supply spool with one roll end region respectively disposed to cooperate with the mated feed roller thereof and which tapes are respectively brought into operative engagement with the work piece in a different surface region therealong, means for actuating the several feed roller means and serving to advance the respective tapes toward the work piece, and drive means rotating the respective heads in opposite directions about the work piece suspended therethrough.

10. In a surface finishing machine, the combination of a rotatable tubular head adapted to have an elongated work piece entered therethrough, a supply of abrasive tape of finite length carried by said head and of which tape one end region is brought into operative engagement with the work piece, feed means for advancing the tape toward the work piece, a backing jaw and a pivoted companion jaw that are oppositely disposed about the tubular head axis and arranged to receive the tape and work piece therebetween, and counterweight means carried by the pivoted jaw to exert a centrifugal force that squeezes the last named jaw inwardly toward the backing jaw.

11. In a surface finishing machine, a tubular head that is rotatably mounted and adapted to have a work piece entered therethrough, drive means rotating said head about the work piece, actuated feed roller means together with a supply of abrasive tape of finite length carried by the rotating head and of which tape a constituent portion is disposed to cooperate with the feed roller and another such portion of which tape is brought into operative surface engagement with the work piece, and means for actuating the feed roller, said means including a reduction gear drive serving to continuously actuate the feed roller means in a proportionate relation to the head speed.

12. In a surface processing machine, a rotatable tubular head adapted to have a work piece movably entered therethrough, actuated feed roller means carried by said head, a roll of abrasive tape rotatably mounted upon said head with one roll end region disposed to cooperate with the feed roller and a medial portion of which tape is brought into operative engagement with the work piece, means for driving the head about said work piece, means for actuating the feed roller to unroll the aforesaid tape at a certain rate of travel toward the work piece, and means moving the work piece longitudinally through said head at a rate of travel not less than five hundred times faster than the aforesaid certain rate of tape travel.

13. In a surface finishing machine, a tubular spindle provided with head means and which spindle is adapted to have a longitudinally movable work piece entered therethrough, duplicate supply spools together with mated actuated feed roller means carried by said head, a roll of abrasive tape mounted upon each of the supply spools with one roll end region respectively disposed to cooperate with the mated feed roller means thereof and which pair of abrasive tapes are respectively brought into operative engagement with the work piece, means for driving the head means about said work piece, means for actuating the respective feed roller means in unison and thereby advancing the respective tapes with reference to the work piece, and means progressively moving the work piece through the spindle while said tapes are being advanced.

14. In a surface finishing machine, a spindle, a disclike head mounted upon the spindle and having a pintle journalled through the disc portion of said head, supply spool means and mated take-up spool means located at one side of the head disc, a roll of abrasive tape mounted upon the supply spool with one roll end portion fastened to the mated take-up spool, feed means including roller means cooperating with one end of said pintle and serving to transfer said tape from the supply spool on to the take-up spool, roller actuating means located at the opposite side of the head disc and transmitting through the pintle, and drive means for rotating said head, said means being positively interconnected with the roller actuating means.

15. In a surface finishing machine, a rotatably mounted head, supply spool means and actuated feed roller means carried by said head, a roll of abrasive tape mounted upon the supply spool with one roll end region disposed to cooperate with the feed roller means, drive means for rotating said head, and means serving to actuate the feed roller means and thereby unwind said roll of tape off the supply spool, said means including a fixedly held drive gear disposed concentrically with the axis of head rotation and further including a driven gear that is operatively carried by the head around said drive gear in intermeshed relationship.

16. In a surface finishing machine of the multiple type, a pair of rotatable tubular heads adapted to have a common strand suspended therethrough, a separate supply spool and feed roller means carried by each such head, a roll of abrasive tape mounted upon each supply spool with one roll end respectively disposed to cooperate with the mated feed roller means thereof and an intermediate portion of which tapes are respectively brought into operative engagement with a different strand surface region, means for driving the several heads, a carrier supporting the respective ends of the aforesaid strand, means reciprocating said carrier, and reel means for the carrier progressively moving the reciprocated strand onwardly through the several driven heads.

17. In a surface finishing machine, a plurality of tubular head means adapted to have a fibrous strand suspended through the several heads, actuated feed roller means carried by each such head, a separate supply of abrasive tape laid in superimposed courses and mounted upon each such head with one tape end region respectively disposed to cooperate with the mated feed roller means thereof and an intermediate portion of which tapes are respectively brought into operative engagement with a different strand surface region, jaw means serving to retain the respective tapes in operative engagement with the strand in each such different surface region, and means for longitudinally moving said strand onwardly through the several heads, the combined jaw drag being kept within the tensile strength limits of the fibrous strand.

18. The method of processing on an intense productive basis, a strand having a diametrically irregular surface, and which method consists in bringing an inherently pliant strand into operative tangential engagement with a laterally yieldable virgin abrasive face, then continuously drawing the strand in one pass over such virgin face at the hereinafter stipulated rate of linear

travel while confining the active portion of said face to a localized abrasive zone extending lengthwise of the strand but leaving a remaining unused face portion and which zone is simultaneously moved around the axis of such drawn strand to generate a helix whose lead pitch is kept shorter than the length of said zone, and thereupon bodily advancing said remaining unused face portion into said localized zone at a restricted feed rate that shall wholly restore said zone approximately as fast as the abrasive thereof becomes substantially spent, the linear travel rate of said strand being kept not less than five hundred times faster than the mean feed rate given to said abrasive and thereby impart a substantially uniform surface finish to the strand having a round profile free from flats.

19. The method for processing on an intense productive basis, a fibrous core strand coated with solidified filler medium and interposed between a pair of laterally yieldable virgin abrasive faces, and which method consists in pressing said virgin faces toward the interposed strand into operative engagement with the strand coating and drawing the strand in one pass at the hereinafter stipulated rate of linear travel through such virgin faces while confining the active portion of each such abrasive face to a localized zone thereof that is disposed lengthwise of the strand and which zones are simultaneously moved around the axis of such drawn strand to generate helices of which the lead pitch is shorter than the combined zone lengths; and thereupon independently feeding to bodily advance a remaining unused portion of each abrasive face into their respective zones at a restricted rate of advance that approximately corresponds to the rate at which the abrasive action of the respective zones becomes substantially loaded with filler medium without allowing the abrasive to cut through the filler coating into the core strand, the linear rate of strand travel being kept not less than five hundred times faster than the mean feed rate imparted to the respective abrasive faces and which strand is thereby given a substantially uniform surface finish throughout the processed length thereof.

20. In a surface processing machine, a rotatably mounted head, supply spool means and actuted feed roller means carried by said head, a roll of abrasive tape mounted upon the supply spool with one roll end region disposed to cooperate with the feed roller means, drive means for rotating said head, and means for actuating the feed roller means in unison with the head rotation, said means serving to unwind the major portion of said tape off the supply spool at a substantially uniform rate of travel while the head speed remains constant.

21. In a surface processing machine including rotatable head means, an actuated feed roller and a mated idler roller carried by the rotatable head, abrasive tape of finite length mounted upon said head with one end region threaded between the feed roller and its mate, adjusting means for retracting the axial center of the idler roller with respect to that of the feed roller, means for driving the head, and means for actuating the feed roller while the head is being driven.

22. In a surface processing machine, the combination of a plurality of tubular head means that are cooperatively mounted and adapted to have entered therethrough a common strand coated with a filler medium, a separate supply of virgin abrasive tape of finite length carried by each such head with one end region of the respective tapes brought into operative engagement with the coated strand surface in different localized cutting zones, means driving the heads together with their tapes perimetrically about the strand, feed means cooperating with the aforesaid tape end regions and thereby advancing the respective tapes toward their zones to restore virgin abrasive action as fast as said tapes become substantially spent, and means for progressively moving the strand onwardly through the several heads.

23. The method for processing on an intense productive basis, a strand originally having a diametrically irregular surface, and which method consists in extending a common inherently pliant strand between a series of virgin abrasive faces that are laterally yieldable and distributed in succession lengthwise along and in operative tangential engagement with the irregular surface of said strand, then continuously drawing said strand in one pass over such virgin faces at the hereinafter stipulated rate of linear travel while confining the active portion of each such face to a localized abrasive zone that leaves a remaining unused portion for each such face and which zones are simultaneously moved to generate complementary helices around the axis of such drawn strand; and thereupon advancing said remaining unused portion of each virgin face axially crosswise of said strand at a restricted rate that shall wholly restore the respective localized zones approximately as fast as the abrasive thereof becomes substantially spent, said strand being drawn lengthwise through and successively processed in such several zones at a linear travel rate kept at not less than five hundred times faster than the mean feed rate imparted to the respective abrasive faces and which strand is thereby given a substantially uniform surface finish throughout the processed length thereof.

24. In a surface finishing machine, a rotatably mounted tubular head adapted to have a work piece entered axially therethrough, a supply of abrasive tape means carried by said head and which tape is brought into operative engagement with the work piece, feed means serving to advance the tape means toward the work piece, a pair of relatively movable backing jaws that are oppositely disposed upon the head in a straddling relation about the head axis to yieldingly grip the work piece and tape therebetween, a counterweight for one such jaw, and drive means actuating the head and imparting a rotative movement to the jaws about the head axis, said counterweight being thereby subjected to centrifugal force that presses the movable jaw radially inward toward the head axis.

25. In a surface finishing machine, head means adapted to treat an elongated work piece, a supply of virgin abrasive tape of finite length for the head means and a localized portion of which tape is brought into continuous operative engagement with the work piece surface to constitute a cutting zone, actuated feed roller means serving to advance an unused portion of such tape toward said zone at a certain feed rate and thereby restore the virgin abrasive properties approximately as fast as the tape becomes spent, and means for continuously moving the engaged work piece longitudinally at a rate of travel not less than five hundred times faster than the mean rate of tape advance.

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