

June 15, 1954

R. O. PETERSON

2,680,938

APPARATUS FOR CONDITIONING METAL SHEETS AND THE LIKE

Filed Nov. 9, 1949

5 Sheets-Sheet 1

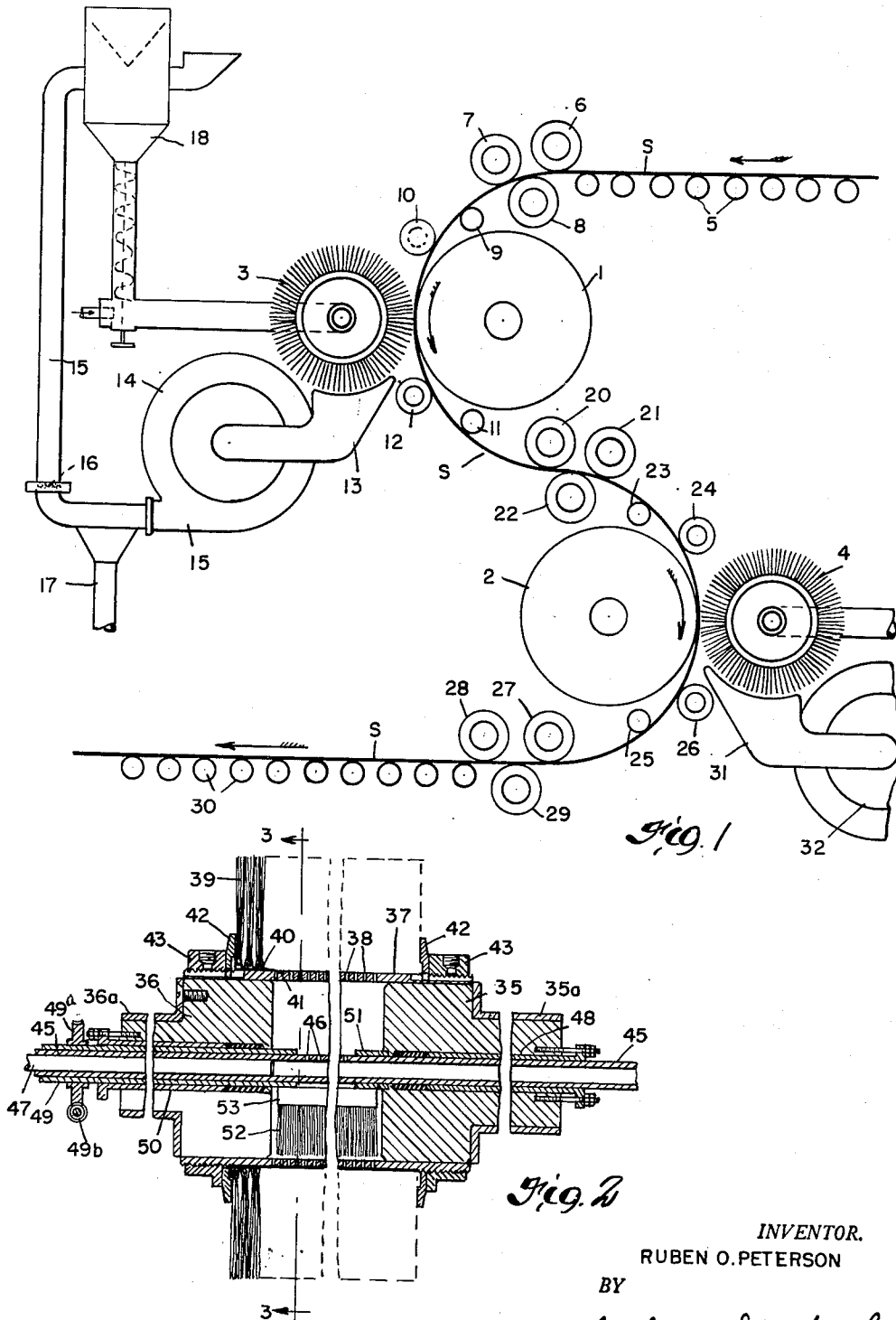


Fig. 1

Fig. 2

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5 Sheets-Sheet 2

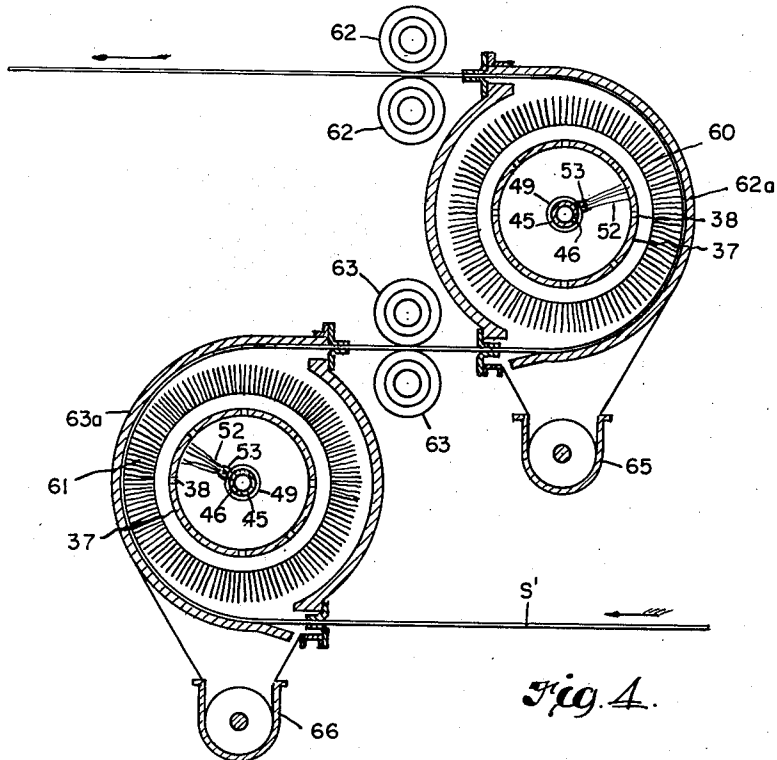


Fig. 4.

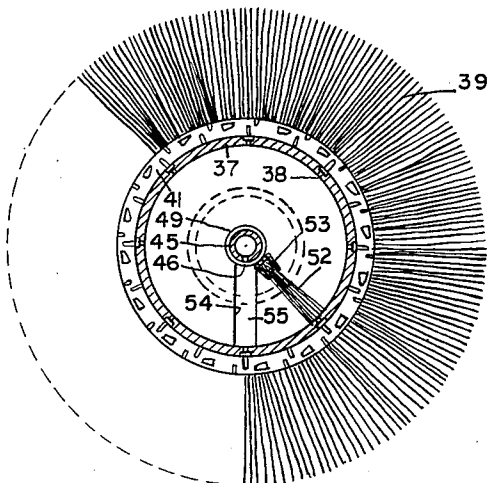


Fig. 3.

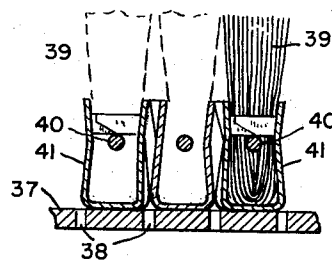


Fig. 2a

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5 Sheets-Sheet 3

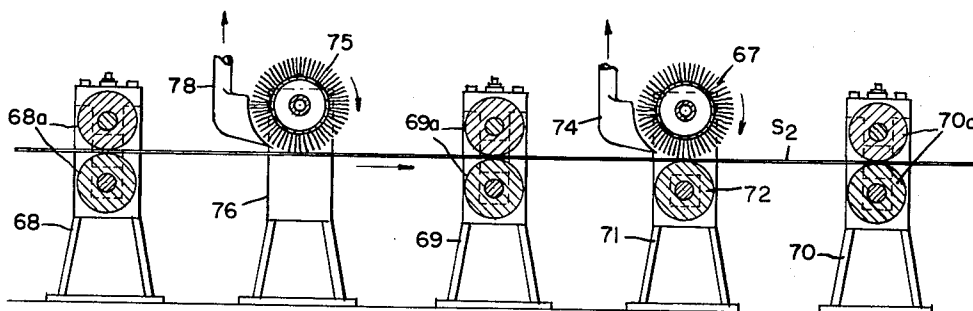


Fig. 5

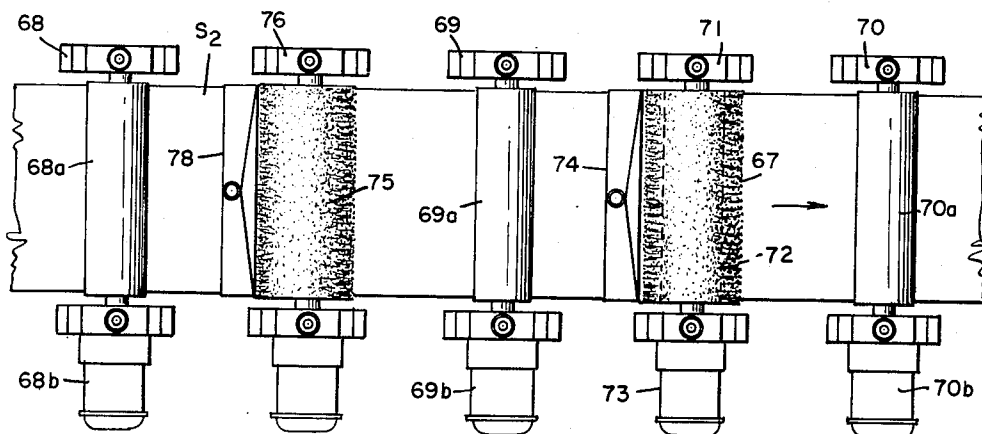


Fig. 6.

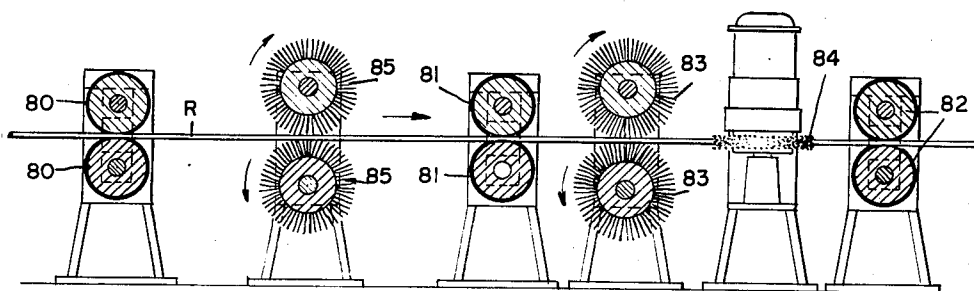


Fig. 7

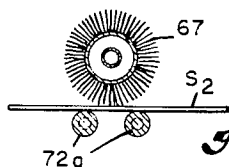


Fig. 8

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5 Sheets-Sheet 4

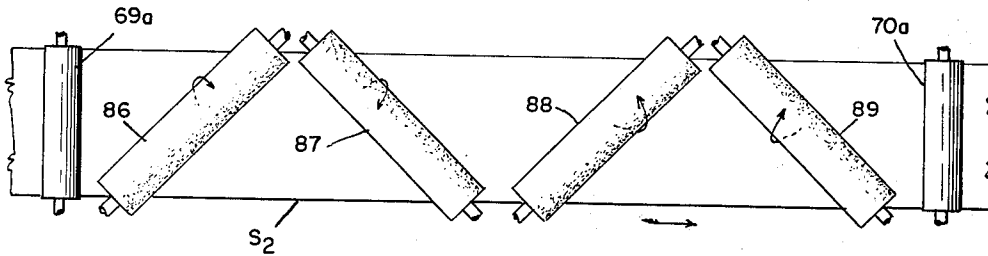


Fig. 9

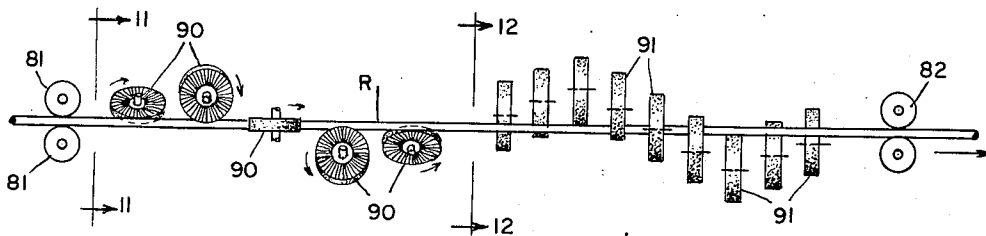


Fig. 10

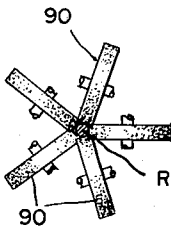


Fig. 11

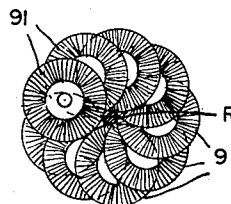


Fig. 12

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5 Sheets-Sheet 5

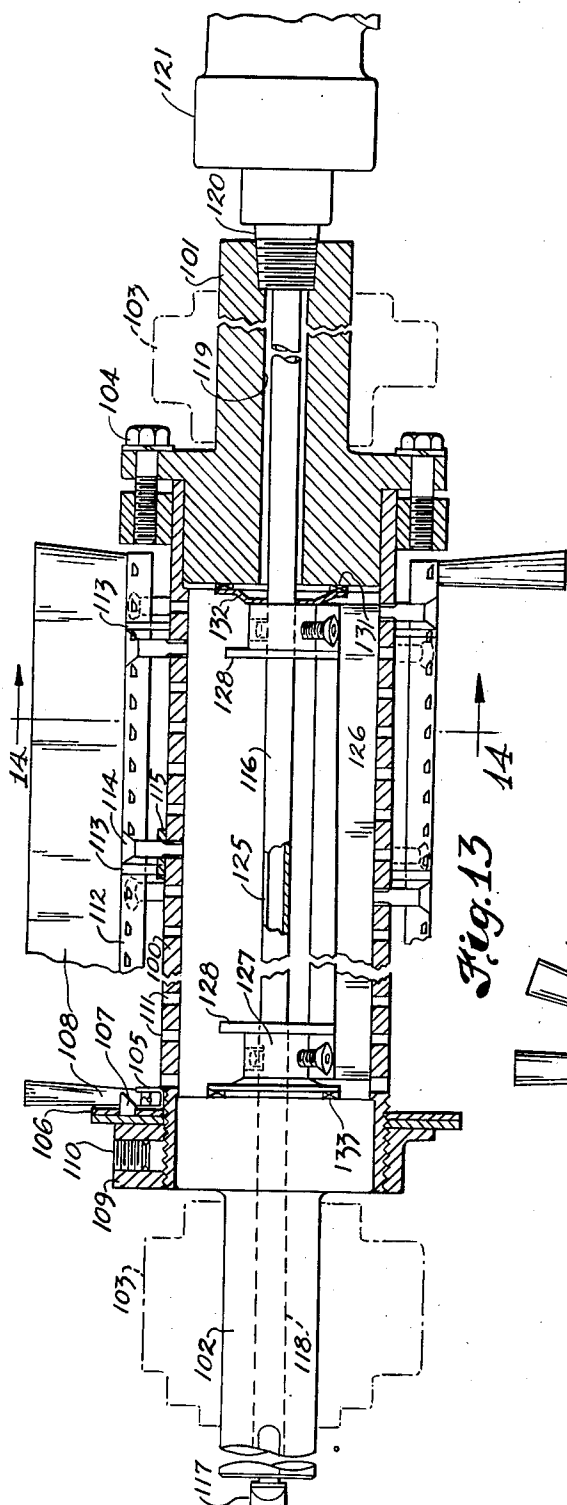


Fig. 13

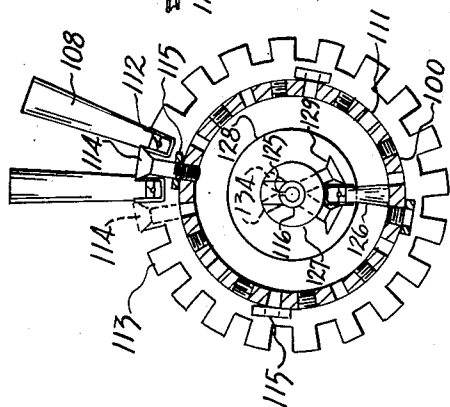


Fig. 14

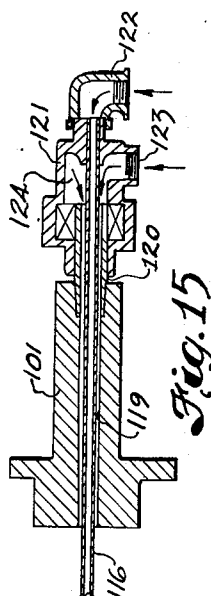


Fig. 15

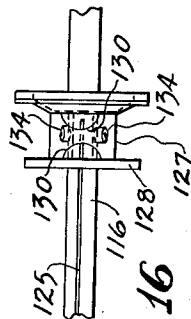


Fig. 16

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UNITED STATES PATENT OFFICE

2,680,938

APPARATUS FOR CONDITIONING METAL SHEETS AND THE LIKE

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Application November 9, 1949, Serial No. 126,408

11 Claims. (Cl. 51—5)

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The present invention relating as indicated to the conditioning of metal sheets and the like has more particular regard to means and methods for attaining such beneficiating effects as the removal of scale and other closely adherent coatings, cleaning and polishing the surface, and reducing surface tension on such articles by brushing action and by the conjoint action, on the surface being treated, of a brush and of auxiliary materials such as abrasive, peening pellets, cleaning and coating materials and coolants.

The addition of an abrasive to a brushing operation in order to clean the surface of a metal sheet or like article by an ordinary scouring operation is, of course, well known. Thus, floors have been long cleaned and polished in this manner. It has also been proposed to clean sheet metal plates (see Patent No. 451,263 to Buckman) by similarly supplying an abrasive, e. g. sand, to the surface of the sheet in advance of the application thereto of a rotary brush. However, such simple scouring treatment has not proved effective for the removal of closely adherent oxide coatings such as the scale on sheet or strip steel in order to prepare the surface of such sheet for plating with another metal such as tin or zinc, or to receive and retain a paint or lacquer coating, without employing the costly and objectionable pickling process. The continuing problem presented, of scale removal by a brushing operation, is evidenced by Patents Nos. 1,440,619 to Noyes et al., and 2,335,196 to Pecsok, which respectively disclose different methods of applying a brush to the surface of a sheet in an endeavor to secure complete scale removal.

As indicated above, one object of the present invention is to combine brushing action with application of an abrasive material in such a manner as will effectually accomplish the removal of scale and like closely adherent oxide coatings from metal sheets and similar articles. I have discovered that if such abrasive material be forcibly discharged onto the surface of a sheet simultaneously with the application of a brush thereto or immediately in advance of such application, not only is the cleaning action greatly improved but the power required for brushing greatly reduced. I have further discovered that where, as will be desirable, a rotary brush is employed, such brush itself may be utilized thus forcibly to discharge, by centrifugal action, the abrasive material onto the surface of the sheet without detracting from, but on the contrary greatly increasing, the efficiency of the brushing action proper.

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While in the case of metal sheets the latter will desirably be arcuately flexed to present a convex surface to the brush, as taught by the above-cited Pecsok patent, the present improved method of conditioning sheets, etc., is not limited to such procedure but may be utilized in connection with flat sheets or like articles or with sheets arcuately flexed to present a concave surface to the brush. Furthermore, in such method I may utilize abrasive material either in dry granular form having various degrees of fineness or such abrasive may be carried by a suitable liquid vehicle. The invention further comprehends improved means for conducting the abrasive in either such form to the brush in such manner as to utilize the centrifugal action of the latter to forcibly discharge the abrasive onto the sheet.

Independently of such conjoint action of a brush and granular abrasive material, I have discovered that while the effectiveness of brushing action in scale removal may be greatly increased by arcuately flexing the sheet on the line to which the brush is applied, such scale may be more advantageously and completely loosened, preparatory to being brushed off, by subjecting the sheet to a single stretching action.

To the accomplishment of the foregoing and related ends, said invention then consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain means and modes of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a diagrammatic side elevational view of one form of apparatus constructed in accordance with the present invention and showing a metal strip in process of being acted upon thereby;

Fig. 2 is a central longitudinal section of one of the brushes, shown as being utilized in such apparatus, wherein the centrifugal action of the brush is utilized to discharge granular abrasive material onto the sheet being treated;

Fig. 2a shows a detail of Fig. 2 on such larger scale;

Fig. 3 is a transverse section of such brush, the plane of the section being indicated by the line 3—3 of Fig. 2;

Fig. 4 is a view similar to Fig. 1 but showing another form of apparatus embodying the invention;

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Fig. 5 is a side elevation and Fig. 6 a plan view of still another form of apparatus, more or less diagrammatic in character, showing the invention as utilized in an apparatus designed to stretch a sheet instead of flex the same, as a preparatory step in the operation of removing scale therefrom;

Fig. 7 is a side elevation, similar to that of Fig. 5, showing the invention as applied to the removal of scale from elongated work-pieces such as rod or wire;

Fig. 8 is a detail view of the apparatus of Fig. 5 showing a modification in construction;

Fig. 9 is a plan view of an apparatus similar to that shown in Figs. 5 and 6, but illustrating a different disposition of brushes employed in a sheet beneficiating operation;

Fig. 10 is a side elevation of an apparatus similar to that shown in Fig. 7, but illustrating a different disposition of brushes employed in a wire or rod beneficiating operation;

Figs. 11 and 12 are transverse sectional views of such last-mentioned apparatus, the planes of the sections being indicated by the lines 11—11 and 12—12 respectively on Fig. 10;

Fig. 13 is a longitudinal sectional view of a brush somewhat similar to that of Fig. 2 but embodying certain additional features;

Fig. 14 is a transverse sectional view taken along the line 14—14 on Fig. 13;

Fig. 15 is a longitudinal sectional view of the mounting means for the right-hand end of the brush of Fig. 13; and

Fig. 16 is a fragmentary detail view of one component of such brush.

Referring to the construction of apparatus illustrated in Fig. 1, such apparatus will be seen to comprise two rolls 1 and 2, about which the metal strip S is passed in such manner that each side of the strip will be respectively subjected to the action of rotating cylindrical brushes 3 and 4 which are disposed with their axes respectively parallel to the corresponding rolls and so spaced in relation thereto that the brushes will contact with the arcuately flexed portions of the sheet as it passes over and is supported by said rolls respectively. The rolls 1 and 2, of course, are rotated in the same direction as that in which the sheet S moves in passing thereover and the brushes 3 and 4 will be rotated in a direction opposite to that of the rolls, i. e. in the same direction as that in which the strip moves while in contact with the latter. The rolls and brushes will be power driven, either by direct motor drive or otherwise as found desirable or convenient, the brushes preferably being rotated rapidly, for example at approximately 3000 R. P. M. while the strip of course moves at a much lower speed, relative to speed at which the contacting brush surfaces travel.

For the purpose of feeding the sheet to the rolls 1 and 2, as it is received from roller conveyor 5 it passes between relatively adjustable bending rolls 6, 7 and 8 which serve to arcuately bend the strip to a curve of somewhat greater diameter than that of roll 1. The strip then passes between guide rollers 9 and 10, which direct it into substantially tangential relationship to the surface of the roll directly opposite brush 3. Beyond the roll 1 the strip passes between rollers 11 and 12, which are disposed in a relationship to said roll complementary to that of rollers 9 and 10.

As a result of the disposition of the two pairs of guide rollers, the area of contact of the sheet

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S on its concave side with the roll 1 is limited substantially to that of the area of contact of its convex side with the opposed rotating brush 3. While the brush will be set no more tightly against the sheet or strip S than necessary to obtain the desired effect, since the coefficient of friction between the brush and the strip increases more rapidly than the square of the pressure, the power consumption is of course a factor of importance and it has been found that by such arrangement of guide rollers or similar means whereby the area of contact of the sheet or strip with the roll 1 is limited the diameter of such roll may be kept relatively small and the friction of the sheet therewith correspondingly reduced.

Directly below the point of tangency of roll 1 and brush 3 is an exhaust collector 13 adapted to receive the particles of scale removed from the sheet by the action of brush 3 as well as additional granular abrasive material which, as will be presently described, will be supplied to the brush for use as in the treatment of the sheet. A suction fan 14, connected with collector 13, serves to convey the abrasive including of such scale along a duct 15 in which is interposed a screen 16 whereby the larger particles are caught and collected in a trap 17. The remaining, finer particles of scale are delivered by duct 15 to a hopper 18 located conveniently adjacent brush 3 from which such abrasive particles may be supplied to the brush in the manner presently to be described.

Returning to the progress of the sheet S, after leaving guide rollers 11 and 12 it then continues between bending rolls 20, 21 and 22, whereby it is arcuately bent in the opposite direction from that given it by the first-mentioned set of bending rolls and caused to tangentially engage roll 2 where its other side, now convex, is subjected to the action of brush 4. Disposed on opposite sides of roll 2 are complementary pairs of guide rollers 23, 24 and 25, 26, which, like the previously mentioned pairs of guide rollers, serve to limit the area of contact which the strip or sheet S has with roll 2. Finally, the sheet is received between straightening rolls 27, 28 and 29 which straighten the strip and enable it to continue in its original direction along the roller conveyor 30. Associated with brush 4 is a collector 31 and suction fan 32, which are connected with a suitable hopper associated with brush 4 through a duct (not shown), in the same manner as in the case of the collector and hopper associated with brush 3.

As indicated, the rotary brushes 3 and 4 which are disposed to operate on the convexly flexed surface of the sheet as it moves through the apparatus will in effect be duplicates of each other, being designed to perform the same operation on opposite sides of such sheet; furthermore, each such brush is so constructed as to adapt the same to forcefully project abrasive material onto such convexly flexed surface of the sheet. A preferred construction of brush designed to operate in the manner just referred to is shown in Figs. 2, 3 and 2a, which will now be described. As there shown, the body of the brush comprises two oppositely disposed hub members 35 and 36 respectively provided with bearing sleeves 35a and 36a whereby said members may be rotatably supported in suitable journals. Fitted to said hub members is a cylindrical shell 37 that is provided with a suitable number of properly spaced perforations 38 through the portion thereof of lying between the hub members to permit the

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discharge outwardly through such shell of abrasive material supplied to the interior thereof. Mounted in turn on shell 37 is a body 39 of radially extending stranded brush material. This material may consist of crimped wire of varying degrees of fineness, or any of the other materials usually employed in brushing operations of the character involved, and may be secured to the shell in any approved manner. As illustrated, such brush material is disposed in the form of doubled layers held by a retaining wire or ring 40 in a channel-form base 41 which may be either in the form of an annulus or wound helically about the shell. Retaining rings 42, 42 held in place by means of lock rings 43 threaded on the respective ends of the shell press against the corresponding sides of the assembled body of brush material and serve both to secure the latter to the shell and compact the same to the desired degree.

Where the brush material is held in a channel-form base 41, the sides of the latter, as shown in Fig. 2a, are formed with alternate depressed areas and intermediate lands so that radial passages will be left between adjacent bases (or sections of the base where helically wound on the shell) and the number and disposition of the perforations 38 in the shell 37 will be such that a substantial portion, if not all, of the passages thus provided will coincide in location with such perforations so that abrasive supplied in the manner previously referred to may pass through the latter and such passages and thence outwardly in between the stranded brush material. Such relatively free flow of abrasive is further facilitated by rounding the lower corners of the channel-form bases so that circumferential passages are provided between adjacent bases which will further insure connection between the perforations in the shell and such radial passages.

The specific construction just described, whereby provision is made for the flow of abrasive from within the shell 37 into the body of stranded brush material, forms the subject matter of my Patent No. 2,409,309, and it will be understood that where different methods of attaching the stranded brush material to the brush body are employed, other means for providing for such flow may require to be used. In other words, the illustrated construction is to be considered merely as constituting one form of brush body wherein provision is made for such flow of abrasive from the interior thereof radially outwardly into the stranded brush material.

Further referring to Figs. 2 and 3, it will be seen that a tubular shaft 45 extends axially through the body of the brush, the ends of such shaft projecting beyond the respective hubs 35 and 36. The intermediate portion of the shaft, i. e. that lying between such hubs within shell 37, is provided with a longitudinally aligned series of apertures 46 through which abrasive or other flowable material may be introduced into the hollow interior of the brush body. Such material may be supplied from any suitable source to the tube through either end thereof, the right-hand end being shown as selected for the purpose in Fig. 2. A solid rod 47 inserted in the other end of the tubular shaft serves to close off such end and being reciprocable said rod may be utilized for the further purpose of cleaning out the interior of the shaft should it, or the openings 46 therein, become clogged.

Tube 45 is not directly in contact with the openings in the hubs 35 and 36, but the portion

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thereof lying within hub 35 is surrounded by a second tubular shaft, or rather sleeve, 48 which serves as a close fitting sealing bushing within which such tube may be angularly adjusted, i. e. rotated about its axis so as correspondingly to vary the angular position of the series of perforations 46 in relation to the axis of the shaft. The portion of the shaft 45 which lies within hub 36 is similarly surrounded by a closely fitting tubular shaft 49 and said shaft 49 is in turn surrounded by a second tubular shaft or sleeve 50, the function of which is the same as that of sleeve 48 except that, as indicated, said shaft 49 is interposed therebetween and the innermost tubular shaft 45. Said shaft 49 projects into the hollow interior of the brush body and desirably includes an axially spaced extension in the form of a separate ring 51 that lies adjacent the inner face of hub 35, and fixedly attached to these portions of said shaft 49 is a radially projecting wiper 52. While the latter may take on various forms, it will desirably consist, as best shown in Fig. 3, of a straight channel-form base 53, similar to the base employed to hold the brush material comprised in brush body 39, and a doubled layer of stranded brush material which is secured in such base just as the previously mentioned brush material is secured in the channel bases 41. The wiper thus constructed extends substantially across the space within shell 37 lying between the two hubs 35 and 36 and is of such radial extent that its outer edge, which, where the blade is formed of stranded brush material, will consist of the ends of such strands, will frictionally engage with the inner face of said shell.

Shaft 49 is normally held against rotation by suitable means and as a result rotation of the inner face of the shell 37 about such wiper serves to clear the perforations 38 in such shell should they become clogged while the brush is in use. However, when desired, tubular shaft 49 which carries the wiper 52 may be rotated, or rather adjusted angularly, about the axis of said shaft so as to correspondingly vary the angular position of the wiper within said shell. Any suitable means may be provided for thus rotatably adjusting said shaft 49 and for retaining the same against rotation as desired, e. g. a worm gear 49a attached to the projecting outer end of the shaft and a worm 49b engaging said gear.

In order to facilitate insertion and removal of shaft 49 with the wiper thus carried thereby, a radial slot 54 is cut in hub 36, such slot being of proper width to permit the ready passage therethrough of the blade, however constructed. When the blade is in its operative position, as shown in Figs. 2 and 3, such passage will be closed by a plug 55 that is held in place by means of a flange on the bushing 36a.

While the wiper assembly must necessarily be inserted before the brush is placed in its bearings, thereafter the angular adjustment of the wiper can be made without disturbing the brush mounting. Likewise the feeder tube 45 can be inserted and removed, as can also the reciprocable clean-out shaft or plug 47, all without disturbing the brush set-up.

The manner in which a brush constructed as just described is utilized in a brushing operation such as that illustrated in Fig. 1 will now be set forth. Assuming the open end of feed tube 45 to be connected with a suitable supply of granular abrasive, or other material such as more fully set forth later herein, which may be carried by

a stream of air or other suitable vehicle moving at proper velocity, such abrasive or the like will be carried into the hollow interior of the brush body and there be subjected to the centrifugal force occasioned by the high rate of rotation of such body when the brush is in operation. The effect will be to cause the abrasive to flow through the perforations 38 in shell 37 and thence to discharge the same at an accelerated rate of movement through the stranded body of brush material. The direction of such discharge can be effectively controlled by rotating the feed tube so as to vary the angular direction of the openings 46 therein, through which such abrasive is supplied to the hollow interior of the brush. Thus, for example, as such material is discharged from the stranded brush body, it can be directed onto the surface of the sheet being brushed along the line of contact of the brush therewith, or in advance of such line, as desired. Such direction of discharge may be further controlled by utilizing the wiper 52 as a deflector, to which purpose it is equally well adapted. In other words, by proper angular adjustment of the feed tube and of such wiper thus serving as a deflector, the angle at which the major portion of the abrasive will be discharged from the brush can be fairly closely controlled.

It is not necessary, of course, that all of the particles of abrasive should fall within a defined area on the sheet, but merely that the major portion thereof should do so. In order to catch such particles as may be thrown beyond the desired area, any suitable form of enclosure or guard may be employed. It will be further understood that while reference has been made in the foregoing description of the operation of my improved brush to the use of a granular abrasive conveyed by a stream of air, other media, including a suitable liquid, may be employed, such liquid carrying the abrasive being discharged in the same manner. Moreover, for certain purposes the material supplied to the brush for the purpose of thus being centrifugally discharged therefrom may consist wholly of a liquid medium capable of having a beneficiating effect on the surface of the sheet as it is being brushed.

Where the surface conditioning of a sheet does not involve the removal of scale or equivalent tightly adherent oxide coating, a brush constructed and operating as just described may still be advantageously utilized to treat the surface of the sheet. In such event, the sheet instead of being flexed to present a convex surface to the brush, may be flexed to present a concave surface to the brush, thus increasing the area of contact between the latter and the sheet surface, or the sheet may be presented flatwise to the brush, particularly where, as will be later described herein, my new and improved method of loosening scale or like adherent coating thereon is broken, preparatory to the brushing operation, by a stretching operation.

In Fig. 4 there is shown, more or less diagrammatically, two rotary brushes 60 and 61 in combination with paired rolls 62 and 63 which, together with a series of fixed curved guides 62a and 63a, serve to direct the sheet S' around such brushes so as to present first one side thereof and then the other in concavely flexed form to the face of the brush. Depending upon the contour of the fixed guides, the area of contact between the brush and sheet may of course be varied, such area as shown being equal to approximately one-quarter of the brush face. By

employing a brush constructed as hereinbefore described, abrasive or other desired surface treating compound, and fluids such as coolants and the like may be applied to the sheet in conjunction with each such brushing step, collector troughs 65 and 66 being provided in association with each brush to receive the excess material discharged therefrom. This material, as in the case of the apparatus illustrated in Fig. 1, may, if desired, be utilized over again either in whole or in part by being returned to the feed pipes connected with the respective brushes.

Figs. 5 and 6 illustrate still another form of apparatus in which a brush 67, such as hereinbefore described, is applied to the beneficiation of the surface of a sheet S² that instead of being flexed either concavely or convexly in relation to such brush is carried past the same in flat condition. However, in order to facilitate the removal of scale or equivalent tightly adherent oxide coating from the surface being treated, means are provided whereby the sheet is subjected to a longitudinal stretching operation prior to such brushing operation.

The simple form of apparatus employed for the purpose of illustration comprises three aligned roll stands 68, 69 and 70, such stands being shown diagrammatically only, between the paired rolls 68a, 69a and 70a of which the sheet moves continuously in a substantially straight line. Said paired rolls may be driven in any suitable manner, as by motors 68b, 69b and 70b individually connected with each pair, as indicated in Fig. 6; however, the rate of rotation of the rolls will be regulated so as to impose a definite stretching action on the section of sheets S² lying between rolls 68a and 69a while the section lying between rolls 69a and rolls 70a will be subjected only to a normal degree of tension required to hold the sheet approximately in a straight line.

It is to the surface of this last-mentioned section of the strip S², i. e. the section thereof which has been previously subjected to the described stretching action between the rolls 68a and 69a, that brush 67 is applied. Said brush may be conveniently mounted on a stand 71 similar to the stands in which the rolls are mounted and in order to hold the moving sheet against the brush with the proper degree of pressure a roll 72 is also provided in stand 71 with its axis aligned with that of the brush and located directly therebeneath. A motor 73 may be utilized to rotate brush 67 at the desired speed and also the cooperating roll 72 so as to avoid any frictional drag between the face of the sheet opposed to such roll. The direction of rotation of the brush will desirably, although not necessarily, be such as to move its surface in a direction opposite to that in which the contacting surface of the sheet travels. A suction boot 74, similar to those illustrated in Fig. 1, will also be properly positioned in relation to brush 67 to collect the scale removed from the sheet as well as added abrasive material applied thereto through the medium of the brush, it being understood that in the case where the latter is utilized in the manner previously described it will serve to discharge abrasive in selected direction onto the sheet.

While only one brush 67 applied to the upper surface of the sheet S² is shown in Figs. 5 and 6, in a commercial installation it will ordinarily be found desirable to utilize a plurality of such brushes which will contact the upper surface of the sheet at suitably spaced intervals between rolls 69a and 70a. Also, in order to condition

the underside of the sheet, rolls similar to brushes 67 and rolls 72 may be employed except their relation will be reversed. Finally, in order to insure that the surface will be free from foreign matter other than scale or similar adherent coating, the section of the sheet lying between rolls 68a and 69a may be subjected to a preliminary brushing operation by applying thereto an ordinary rotary brush 75 carried by a stand 76 similar to that which carries brush 67. A suction boot 78, as before, will be desirably associated with such brush 75 to insure complete removal of any such foreign matters.

The general operation of the apparatus last described has been sufficiently indicated in describing the operation of its component parts. It need merely be added that I have found that by subjecting the sheet, preliminarily to the brushing operation performed by one or more brushes 67, to a stretching operation whereby the sheet is elongated approximately 7%, a fine bright, scale-free and satin finish can be produced upon four passes under the brush; and that a lesser degree of stretching has a very considerable loosening effect on the scale. A single stretching, of course, serves equally to prepare both sides of the sheet for the subsequent brushing operation and the amount of working of the metal involved will obviously be very considerably less than that which occurs where the sheet is convexly flexed first in one direction and then the other.

The utilization of such a stretching step to loosen scale or equivalent closely adherent oxide coating preparatory to brushing or other surface treatment is not limited to sheets such as have heretofore been referred to, but may be carried on with corresponding advantageous results in the surface treatment of other elongated forms of metal work-pieces such as rod or wire, and in Fig. 7 an arrangement of apparatus is diagrammatically illustrated for thus handling a rod or wire R. The latter, just as in the case of sheet S², passes through an aligned series of paired rolls 80, 81 and 82, which will be driven at rates of speed such as to subject the section of the work-piece between rolls 80 and 81 to a definite stretching action and then draw the following section lying between rolls 81 and 82 past opposed pairs of brushes 83 and 84 (only one of the latter appearing in Fig. 7). These brushes will be positively driven in the same manner as brush 67 and may or may not include means for supplying abrasive or other material to the work-piece. Also the latter will be desirably subjected to a preliminary brushing operation by passing the first section thereof, that lying between rolls 80 and 81, between a pair of opposed brushes 85.

The same action so far as regards the loosening of scale or like adherent coating on the work-piece will be produced in the case of such rod or wire as in the case of sheet S² where the degree of stretch to which the workpiece is subjected is of corresponding degree. As in the case of the apparatus illustrated in Figs. 5 and 6, so in the case of that illustrated in Fig. 7 it will be understood that the number of opposed paired brushes 83 and 84 which are applied to the second, stretched, section of the workpiece may be increased as may be found desirable; also that where more than two such pairs are utilized successive pairs instead of being set at right angles to each other may be disposed at various intermediate angles so as to insure thorough brushing

action around the entire circumference of the work-piece.

The modification illustrated in Fig. 8 relates to the form of rolling support for the work-piece, whether sheet or wire, where it is opposed to brushing action for the purpose of final removal of the previously loosened scale. Instead of a single roll 72 directly opposed to the brush, a pair of rolls 72a may be employed, one located slightly before and the other slightly beyond a line vertical to sheet 2 and passes through the axis of the brush.

As previously indicated in the general description of the drawings, Fig. 9 illustrates diagrammatically a modified form of apparatus for the surface beneficiation of a sheet similar to that shown in Figs. 5 and 6. Actually there appears in Fig. 9 only that portion of the mechanism as lies to the right of roll stand 69 in Fig. 5, it being understood that the sheet will have been previously subjected to a stretching operation, just as before, in the section thereof that lies in advance of said stand 69, i. e. between the two pairs of rolls 68a and 69a.

However, in the modified construction, instead of employing one or more transversely disposed brushes 67, a minimum of at least four similar brushes 86, 87, 88 and 89 is applied to the surface of the sheet during its passage between rolls 69a and 70a, these brushes being of the same construction as previously described, whereby abrasive or other suitable material will be centrifugally discharged therefrom onto the surface of the sheet at the same time that the latter is being operated upon by the brushes. Furthermore, said brushes, instead of being disposed at right angles to the line of travel of the sheet, are disposed in angular relation thereto, the brushes being alternately inclined in opposite directions. Finally, as indicated by the direction arrows, said brushes alternately rotate in opposite directions; thus brush 86 rotates in a clockwise direction as viewed in Fig. 9 while brush 87 rotates in a counterclockwise direction, and brush 88 rotates in a clockwise direction while brush 89 rotates in a counterclockwise direction.

As likewise previously indicated in the general description of the drawings, Figs. 10, 11 and 12 show a modification in the apparatus illustrated in Fig. 7 for beneficiating an elongated metal work-piece such as a rod or wire R. Here again only the portion of the apparatus to the right of the second pair of rolls 81 is shown, but it will be understood that the section of the work-piece lying to the left of said rolls will be subjected to a stretching action such as produced in the apparatus illustrated in Fig. 7 by the difference in rate of rotation of said rolls 81 and the preceding pair of rolls 80.

While the brushes employed to beneficiate the surface of the wire may be employed in opposed pairs, as in the case of brushes 83 and 84 illustrated in said Fig. 7, this may not prove desirable, particularly in treating rod or wire of relatively small diameter, since such opposed brushes would tend to interfere with each other. Particularly after a period of use the brushing surfaces will be worn into transversely concave form, so that the lateral portions of the brushes will overlap and engage with each other. Accordingly, an arrangement of brushes such as shown in Figs. 10, 11 and 12 is preferred, wherein two series of brushes 90 and 91 is employed, it being understood that the number, shown as five in such

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first series and ten in the second, may be increased or decreased as desired to obtain the best results.

Referring to such series of brushes 90, these it will be seen are all disposed with their axes transverse (preferably at right angles) to the line of travel of the work-piece, just as in the case of brushes 83 in the apparatus illustrated in Fig. 7. However, such brush axes instead of being located opposite to each other are spaced successively along such line of travel so that the brushes will successively contact with the work-piece at fairly closely spaced intervals, without interfering with each other. Furthermore, the axes of successive brushes, while all lying transversely of the line of travel of the work-piece, are inclined relatively to each other, as best shown in Fig. 11. Thus, as the work-piece passes through the series of brushes 90, its entire circumferential surface is subjected to the action of the brushes; in fact the longitudinally extending areas covered by the successive brushes will overlap to a certain extent, thus insuring uniformity of treatment about the entire circumference of the work-piece.

While in Fig. 10 all of the brushes 90 are indicated as rotating in the same direction so that the contacting surface of the brush moves oppositely to the direction of travel of the work-piece, such direction of travel may be reversed in the case of certain brushes of the series, or preferably a second series (not shown) similar to the one thus illustrated will be employed in which all of the brushes thus rotate in the opposite direction.

Referring to the series of brushes 91, which will desirably be larger in number than those comprised in the first series, the axes of these brushes are disposed in substantial parallelism with the direction of travel of the work-piece so that the faces thereof which contact with the latter will be applied crosswise instead of longitudinally. As best shown in Fig. 12, the axes of the successive brushes 82 are spaced circularly about the path of travel of the work-piece at approximately equal distances, such axes being sufficiently close together so that the longitudinally extending areas of the work-piece respectively affected by the corresponding brushes will overlap at least to some extent and thus insure complete and uniform treatment of the work-piece about its entire circumference. Here again all of the brushes of the series may rotate in the same direction or certain thereof oppositely to the others, but preferably two series of brushes similar to the one series illustrated will be utilized, the brushes of the second series operating in a reverse direction to those of the first.

Instead of relying on preliminary stretching to "crack" the scale on the surface of the metal sheet, rod, or the like, a cooling fluid such as water may be delivered to the brush for forceful radial discharge against the heated work. The force of such discharge need not be sufficient actually to remove the scale since the simultaneous action of the brush effectively serves this purpose while the cooling fluid also prevents overheating and deterioration of the brush material. As will be understood, work such as steel, for example, will normally be heated above "red" temperature, for this purpose, being sufficiently hot to ensure fracture of the scale by application of the coolant. The action of the brush material engaging the work also assists considerably in accomplishing such fracture as well as ensuring

removal thereof without the necessity of employing very high pressures or excessive volumes of fluid.

While my improved method and apparatus for surface beneficiating metal sheets and the like has been described with special reference to the removal of scale and like closely adherent coatings, no limitation to such particular use is to be implied. Thus, by employing other forms of discrete hard particles instead of granular abrasive, e. g. peening pellets of properly selected size, such method and apparatus may be equally well employed in the peening treatment of sheets and like metal articles.

In peening practice as at present carried out, while the impact of the pellets or "shot" has the desired effect of relieving surface tensions and otherwise beneficiating the surface of the article being treated, there is at the same time produced a disadvantageous effect arising from the presence of the crushed cementite and other constituents of steel. Where the broken fragments of such materials, which are relatively hard, remain on the surface, not only is the peening action interfered with but the surface itself may be permanently marred. However, by combining with the impact action of peening pellets a brushing action such as I am able to obtain, these objectionable products are immediately removed and a much more perfect surface condition obtained.

Where peening pellets are employed, they will of course be fed onto the work-piece by means of the brush so as to be projected therefrom by centrifugal action of the latter in the same manner as the granular abrasive material previously referred to. Furthermore, as has hereinbefore been pointed out, my improved construction of brush and the method involved in its use may be found quite advantageous where instead of thus feeding discrete hard particles through the brush, other kinds of beneficiating materials, e. g. in liquid form, are thus applied to the surface of the article being treated, without carrying any granular abrasive or other additional material.

While the means and method hereinbefore described for centrifugally discharging abrasive or other beneficiating material onto the surface being treated, viz. by feeding the same into the interior of a brush rotating at high speed, thence to pass radially outwardly through the stranded brush material, are considered preferable, I have found a like effect may be obtained by supplying such material at the proper point or points on the surface of such a brush.

The term "surface beneficiation" as employed herein is to be understood as comprehending any of the several forms of treatment mentioned, e. g. cleaning, polishing, scale removal and relieving surface tension. In addition to the latter, the application of brushing action, with or without the conjoint application of material as described, has been found effective to reduce stress concentration characteristics in the surface of the treated article, where the brushing action is applied in at least four angularly related directions, since by brushing in this manner all of the upstanding edges of so-called "craters" will be smoothed down, or substantially removed.

The surface irregularities of metal sheets, such as minute craters, have their marginal edges effectively smoothed and rounded by the ends of the brush bristles passing in at least three angularly related directions thereacross. This

brushing action, by blending such sharp margins serves to relieve stress concentrations at such points on the metal surface and by the same action reduces susceptibility to corrosion as well as performing the function of cleaning the surface. The ends of the brush bristles have a definite peening, wiping and polishing action which it has been found, however, must be in at least three angularly related directions to be effective on the entire circumference of each minute surface irregularity.

Now referring more specifically to Figs. 13-16 inclusive of the drawing, the rotary brush structure there illustrated is particularly suited for the brushing of metal sheets and strips of stainless steel, for example. Such brush comprises a tubular core 100 having shaft extensions 101 and 102 suitable for operation in bearings 103. Such extension 101 is shown as detachably secured to the end portion of tubular core 100 by means of screws 104, the interfitting ends of such core and extension being accurately machined to insure proper alignment. While extension 102 is shown welded to such core, it will be understood that it may also be attached in the same manner as extension 101.

The portion of the drawing to the left of the break in Fig. 13 illustrates the manner in which a length of brush strip 105 of the type shown in Fig. 2a, for example, may be helically wound upon core 100, being held in place by flat annular end plates 106 provided with teeth 107 projecting inwardly through brush material 108 and overlying the lip of the channel-form back of such brush strip 105. Such end plate is held in place by means of nut 109 which is in turn secured in adjusted position by means of set screw 110.

It will, of course, be seen that tubular core 100 is provided with a large number of openings 111 therethrough adapted to feed fluid, entrained abrasive and the like radially outwardly, being generally similar to perforations 33 of the embodiment illustrated in Figs. 2-3 inclusive. Instead of employing a strictly tubular core member, the two extensions 101 and 102 may simply be joined by a plurality of rods in a cylindrical arrangement corresponding to core 100 and the brush elements mounted thereon.

The portion of Fig. 13 to the right of the break therein illustrates the manner in which lengths of brush strip 112 may be mounted upon the tubular core 100, extending in a direction generally parallel thereto (see also Fig. 14). A plurality of annular discs 113 mounted upon core 100 are provided with peripheral notches adapted to receive and seat brush strip 112. Screws 114 having heads bearing upon the lips of the adjacent channel backs of such brush strip serve to secure the latter in position against radially outward movement. Keys 115 secured to core 100 hold discs 113 against rotation relative to such core. Instead of mounting the brush strip 112 exactly parallel to core 100, the former may be given a somewhat helical conformation by seating the same in progressively offset notches in the several supporting discs 113.

A feed tube 116 extends axially through core 100 and the latter's extensions 101 and 102. A cap 117 bears a rod 118 adapted to be inserted in the end portion of tube 116 lying within extension 102 for the purpose of preventing the entry of abrasive or the like. In other words, such cap and rod constitute a removable plug. Such plug may be removed for the purpose of inserting cleaning tools such as brushes, when desired.

The right-hand end of tube 116, as viewed in Figs. 13 and 15, extends through an axial passageway 119 in extension 101, being spaced from the wall of such passageway, and then through a tubular sealing member 120 and housing 121 to fluid inlet 122. A further fluid inlet 123 leads to chamber 124 within such housing and thence through rotary coupling member 120 to passageway 119 concentric with tube 116.

The right-hand end of tube 116 is press fitted in housing 121 so that the two may be turned together about the axis of tube 116 to angularly position the latter relative to the brush assembly as a whole for a purpose explained below.

Tube 116 is provided with a lengthwise slot 125 extending the length of the cavity formed within tubular core 100 and through which an abrasive bearing fluid or the like introduced at inlet 122 is adapted to be discharged. It is ordinarily preferred that the total area of the opening formed by such slot shall be less than 75% of the cross-sectional area of tube 116 to cause the fluid supplied under pressure to tube 116 to spray out with sufficient force to impinge against the inner surface of core 100 rather than merely to run out of such slot into the cavity within such core. By varying the relative area of slot 125 and the inner cross-sectional area of tube 116, and the pressure of the fluid supplied to tube 116, the delivery of the fluid within the brush core may be satisfactorily controlled. Centrifugal force imparted by the rapidly rotating brush will be an important factor in the proper discharge of the abrasive bearing fluid but I have also provided two additional means for controlling such flow. Compressed air may be admitted through inlet 123 and passage 119 to the interior of core 100 thereby to create a pressure of any desired degree within the brush core. The flow of such compressed air out through the ports 111 in the brush core will tend to bear with it droplets of abrasive bearing fluid which will accumulate at such port openings. To facilitate such accumulation and to avoid incrustation of abrasive intermediate such ports, a length of brush strip 126 is mounted to operate against the inner surface of core 100. Such strip is mounted on a plurality of collars 127 having radially extending flanges 128 slotted to receive such strip. Such collars are fixedly positioned on tube 116 by means of set screws or the like and strip 126 is held in the slots in annular flanges 128 by means of screws 129. Slot 125 in tube 116 may conveniently be made by means of a saw and then collapsed to the desired transverse dimension. Collars 127 also serve the additional purpose of preventing such slot from thereafter opening out again.

While the number of such collars will depend upon the length of the brush, there will be at least two of the same adjacent the respective extensions 101 and 102. As shown in Fig. 16, portions of the collar will desirably be cut away at 130 so that slot 125 will be obstructed as little as possible. As shown in Fig. 14, brush 126 will ordinarily be mounted diametrically opposite to slot 125 and in any case positioned so as not to obstruct such slot.

A seal 131 is carried by a dished disc 132 mounted on the end of collar 127 adjacent extension 101 and serves to prevent entry of any abrasive from the interior of core 100 to passageway 119. Compressed air admitted at inlet 123 is effective to escape past such seal into the interior of core 100 and thereby further insures that

no abrasive will enter passageway 119 or on the bearing surface of such seal.

A similar seal 133 is provided on the collar adjacent extension 102 for a similar purpose, but in this case the air pressure within the core acts to close such seal and prevent entry of abrasive to the passages therebeyond.

The set screws 134 holding collars 127 in place will desirably be located to bear on tube 116 closely to either side of slot 125 so that the lateral dimension of such slot may be closely controlled and prevented from widening.

It will be noted that the method of mounting the brush strip 112 as shown in the right-hand side of Fig. 13 and in Fig. 14 spaces such strip from core 100 and also spaces the lengths of strip one from another to facilitate outward discharge of the abrasive or like material with a minimum opportunity for clogging.

This application is a continuation-in-part of my co-pending applications Serial No. 632,831, filed December 5, 1945, and Serial No. 668,391, filed May 9, 1946, which are in turn continuations-in-part of Serial No. 437,648, filed April 4, 1942, such applications having now become abandoned.

Certain subject-matter disclosed but not claimed herein is, moreover, disclosed and claimed in my co-pending applications Serial No. 404,431, filed January 13, 1954, and Serial No. 404,680, filed January 18, 1954.

Other modes of applying the principles of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In apparatus for removing scale from metal sheets, the combination of a revoluble roll, a rotary brush mounted opposite said roll on an axis parallel to the axis thereof, and means for progressively flexing a metal sheet with the concave surface thereof engaging said roll and the corresponding convex surface engaging said brush, said means including bending rolls located on opposite sides of said first-named roll and disposed arcuately to bend such strip to a curve of greater diameter than the diameter of said first-named roll.

2. In apparatus for removing scale from metal sheets, the combination of a revoluble roll, a rotary brush mounted opposite said roll on an axis parallel to the axis thereof, and means for progressively flexing a metal sheet with the concave surface thereof engaging said roll and the corresponding convex surface engaging said brush, said means including bending rolls located on opposite sides of said first-named roll and disposed arcuately to bend such strip to a curve of greater diameter than the diameter of said first-named roll whereby the area of contact of such sheet with said roll is limited approximately to the area of contact of said brush with such sheet.

3. Apparatus for removing scale and the like from elongated metal articles comprising driven rolls operative continuously to advance such article, spaced sets of pinch rolls adapted to grip such advancing article and means operative to drive said sets of rolls at different speeds uniformly to stretch such article to loosen such scale, power driven rotary brushes arranged to engage and brush the same surface of such stretched advancing article in at least two substantially differ-

ent angularly related directions, and power means operative to drive said brushes.

4. Apparatus for removing scale and the like from elongated metal articles comprising means operative continuously to advance such article, means operative to stretch such advancing article, and rotary brushes arranged and disposed to brush the same surface of such stretched advancing article in at least four directions, at least two of such directions being angularly related to each other.

5. Apparatus for removing scale and like superficial coatings from elongated metal articles comprising means operative to stretch the surface of such article to loosen such superficial layer, and two pair of rotary brushes adapted to engage such surface, the brushes of each pair having parallel axes and being driven in opposite directions, and the axes of one said pair being disposed at an angle to the axes of the other said pair, whereby each point on such surface may be brushed in four different directions.

6. In combination, means operative continuously to advance an elongated article such as a metal sheet or the like, means adapted to bend such advancing article to stretch the convex surface of the same, a rotary drum brush disposed and arranged to engage with its peripheral surface such convex surface, and means operative to project a blast of discrete abrasive particles forcefully and generally radially against such convex surface in the same region simultaneously engaged by said brush to abrade the same.

7. Apparatus for surface conditioning elongated articles such as steel rods and the like comprising drive rollers engaging such rod continuously to advance the same, spaced sets of said drive rollers being adapted for operation at different speeds to stretch such rod longitudinally therebetween, a plurality of rotary brushes arranged about such stretched rod on axes transverse thereto and adapted to engage and together brush the entire peripheral surface of such rod longitudinally thereof, and a plurality of rotary brushes arranged about such stretched rod on axes substantially parallel thereto and adapted to engage and together brush the entire peripheral surface of such rod circumferentially thereof.

8. Apparatus for surface conditioning elongated articles such as steel rods and the like comprising means operative continuously to advance such rod longitudinally, a plurality of rotary brushes arranged about such rod on axes transverse thereto and adapted to engage and together brush the entire peripheral surface of such rod longitudinally thereof, and a plurality of rotary brushes arranged about such rod on axes substantially parallel thereto and adapted to engage and together brush the entire peripheral surface of such rod circumferentially thereof.

9. Apparatus for conditioning elongated metal articles comprising two spaced sets of driven rolls operative frictionally to grip and continuously to advance such article in the same direction, means operative to drive the second set of said rolls at a rate to advance such article more rapidly than the rate which the first set of said rolls affords, thereby to stretch such article in a region intermediate said sets of rolls, and a plurality of power driven rotary brushes located to engage and brush the surface of such advancing article in such intermediate region.

10. Apparatus for treating the surface of elongated metal articles such as strip and the like

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comprising means operative continuously to advance such article, means operative to stretch the surface of such advancing article, at least three power driven rotary brushes arranged sequentially to engage the same portions of such surface at positions subsequent to the location of such stretching operation by said stretching means, the axes of said brushes extending transversely of the path of travel of such advancing strip and angularly related to each other where engaging the same portions of the surface, and drive means for said brushes operative to rotate the latter at high speeds and to drive two of said brushes in opposite rotative directions.

11. Apparatus for treating the surface of elongated metal articles such as strip and the like comprising means operative continuously to advance such article, means operative to stretch the surface of such advancing article, at least two power driven rotary brushes arranged sequentially to engage the same portions of such surface at positions subsequent to the location of such stretching operation by said stretching means, the axes of said brushes extending transversely of the path of travel of such advancing strip and both being angularly related to each other and to such path where engaging the same

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portions of the surface, and drive means for said brushes operative to rotate the latter at high speeds and in opposite rotative directions.

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