April 28, 1959 I. E. HJELSTROM ET AL 2,883,804

BELT ABRADING MACHINES

Filed Nov. 14, 1955 3 Sheets-Sheet 1

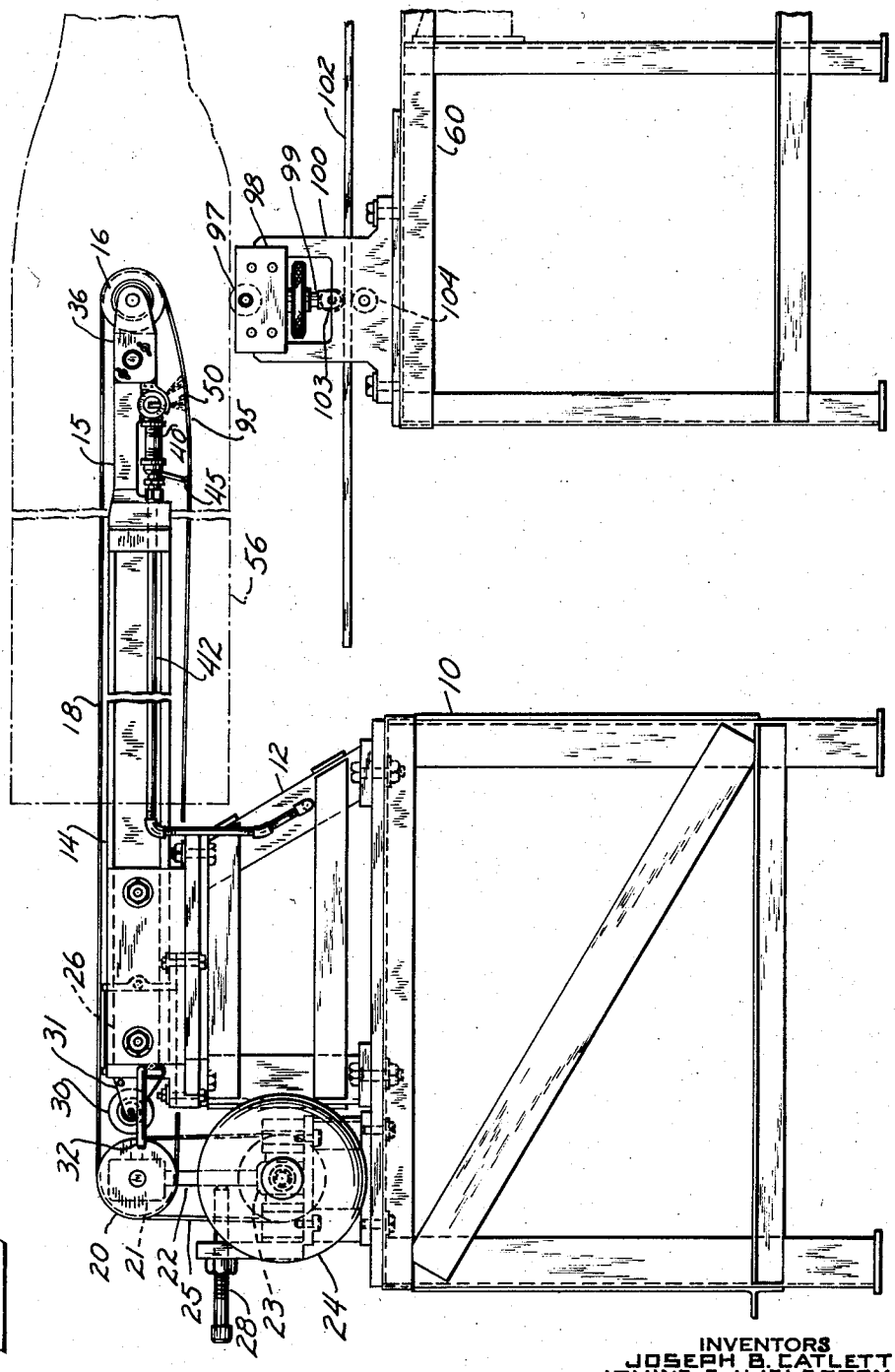


FIG. 1

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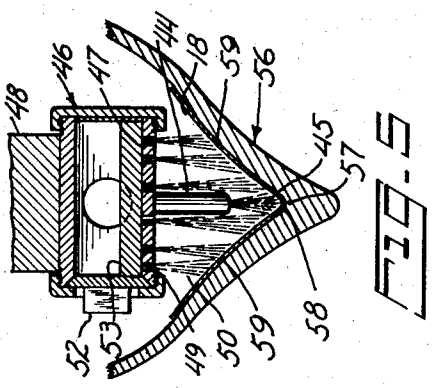


FIG. 5

FIG. 2

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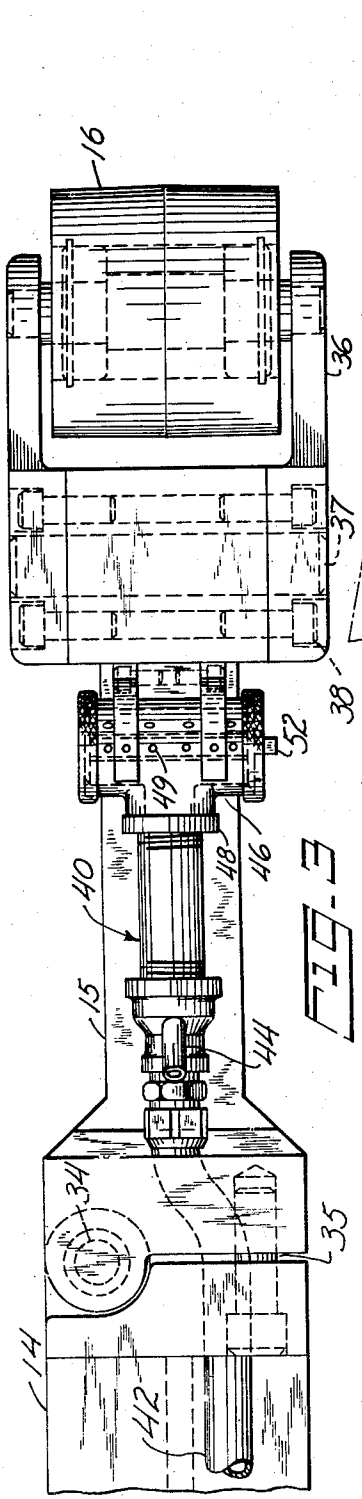


FIG. 3

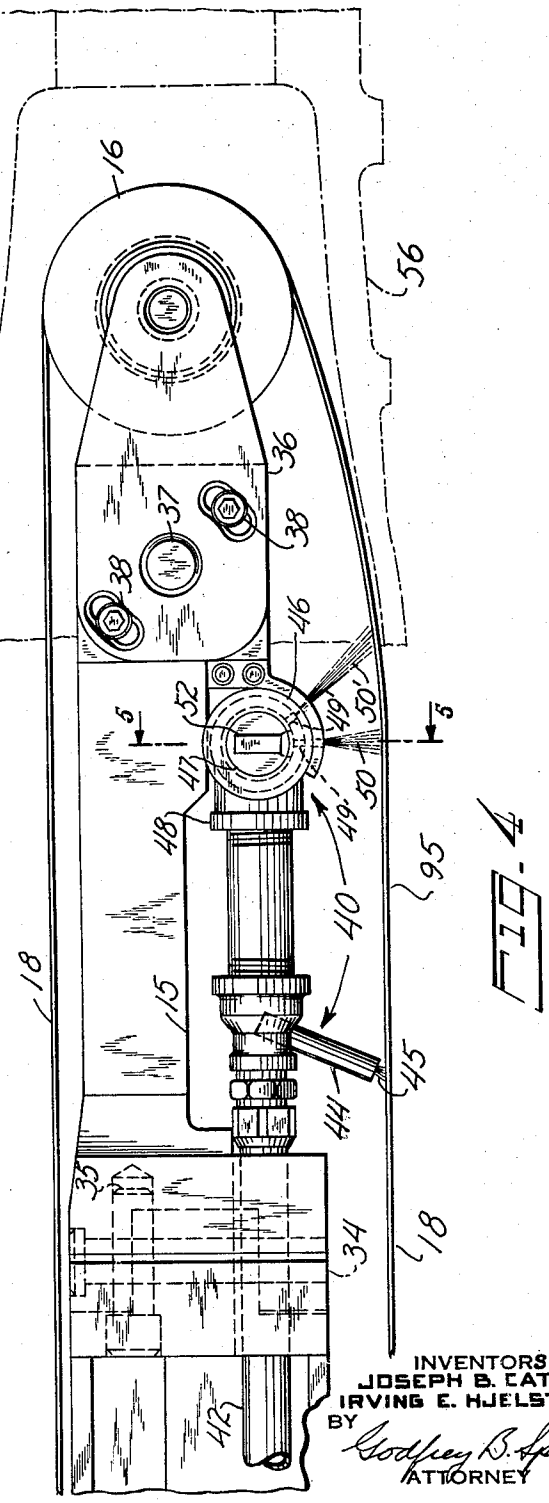


FIG. 4

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United States Patent Office 2,883,804 Patented Apr. 28, 1959

2,883,804

BELT ABRADING MACHINES

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Application November 14, 1955, Serial No. 546,619

13 Claims. (Cl. 51—141)

This invention relates to belt abrading machines and is concerned particularly with a machine adapted for polishing or surface finishing irregularly shaped articles or workpieces. Essentially, the machine is adapted for surface polishing, where no precisely dimensioned depth of cut is essential.

In conventional belt abrading machines, the belt is engaged with a workpiece through the medium of a pressure pulley or shoe, of either hard or soft material, which bears upon the inside of a run of the belt and presses the rough surface of the belt into workpiece engagement. Where soft pressure applying means are used, the belt may be partly conformed to slightly irregular workpiece surfaces but the resilience of the pressure means is usually not enough to enable application of uniform unit pressure on the area of the belt which engages the workpiece.

The present invention consists essentially of pressing a resilient abrasive belt into workpiece engagement by directing fluid jets, such as air jets, against the inside run of an abrasive belt. One or more jets may be used, depending upon the area to be covered, and the fluid pressure distribution resulting from the jets may be adjusted to provide the optimum desired effect on the workpiece by varying the jet pressure, jet angle, area, and the number of jets and the arrangement. The use of jets enables an abrasive belt to weave, warp and bend within the limits of its own flexibility and conform to the irregular surface of a workpiece, while a predetermined or uniform unit pressure is maintained over the entire area of the belt which engages the workpiece.

Depressions, grooves, protuberances or ribs in a workpiece may be easily conformed to, where they are aligned with the direction of the belt travel and tension; to a lesser degree such conformity is maintained across the direction of belt travel.

Objects of the invention will be appreciated from the foregoing general comments and from the ensuing detailed description. In addition, objects of the invention are to provide for high speed polishing or abrading of large metal articles such as tubes, sheets, or other pieces. Another object is to provide concurrent cooling of, as well as pressure on, an abrasive belt running over a workpiece. The heat generated by high speed polishing or abrading is great, and dissipation of heat from the belt in the working area lengthens belt life and minimizes breakdown of the adhesive or resin bond of abrasion particles on the belt proper.

An embodiment of a machine incorporating the teachings of this invention is shown in the attached drawings wherein similar reference characters designate similar parts and wherein:

Fig. 1 is a side elevation of part of a belt abrading machine,

Fig. 2 is a side elevation of another part of the machine, this part being a left-ward continuation of the part shown in Fig. 1,

Fig. 3 is an enlarged view, looking from the bottom of the working end, of part of the machine of Fig. 1,

Fig. 4 is a side elevation, enlarged, of the part of the machine shown in Fig. 3, and

Fig. 5 is a fragmentary section on the line 5—5 of Fig. 4, including a fragmentary section of a workpiece.

In Fig. 1 of the drawings we show a table or support 10 upon which is securely mounted a superstructure 12 on which, in turn, is securely mounted a beam 14 which extends rightwardly from the support. At the right end of the beam as shown, a head 15 is pivotally secured for adjustment and on this head an idler pulley 16 is journalled on a substantially horizontal axis. An abrasive belt 18 passes around the pulley 16. One run of the belt lies above the beam 14 and the other run of the belt passes below the beam 14. The belt passes over a driving pulley 20 disposed to the left of the left end of the beam 14, the driving pulley being journalled in a bearing 21 carried by a swingable arm 22 journalled at its lower end in a bearing 23 mounted on the support 10. The pulley 20 is driven by a motor 24, concentric with the bearing 23, and a driving belt 25. The arm 22 is swingable under the influence of a conventional pneumatic ram 26 to exert tension in the abrasive belt 18, in a manner well known in the art. The tension of the belt may be adjusted by varying the pneumatic pressure in the ram 26. Against the possibility of belt breakage, an adjustable stop 28 is mounted on the support 10 to limit the leftward movement of the arm 22.

Where the belt 18 is adapted to polish grooved structures, as will be described, a forming wheel 30 is journalled in a bracket 31 pivoted on the left end of the support for the beam 14. This wheel may be raised into belt engagement by a handle 32 when a new belt is installed on the machine. The wheel 30 has its periphery formed with an annular rib which, when brought into engagement with the running belt, forces the center portion of the belt outwardly in a V configuration whereby the transverse stiffness of the belt is broken down. This enables the belt, when engaged with a V-grooved workpiece, to conform to the workpiece groove and to polish or abrade the surface thereof.

Now referring to Figs. 3, 4 and 5, along with Fig. 1, the beam head 15 is pivoted to the beam 14 at 34 toward one lateral edge of the two members. An adjusting screw 35 is provided adjacent the other lateral edge of the members which enables adjustment of the alignment of the head 15 relative to the beam 14. This adjustment enables proper tracking of the belt 18 over the pulley 16.

The idler pulley 16 is journalled on an adapter 36 which is adjustably secured to the head 15, whereby the pulley 16 may be raised or lowered relative to the head to accommodate it to different types of work pieces. This adjustment includes a trunnion 37 and securing screws 38 joining the adapter 36 to the head 15.

On the underside of the head 15 a nozzle system 40 is secured, which is fed by a conduit 42 extending along the beam 14 to the superstructure 12, where it is connected to a compressed air or compressed fluid supply. The fluid supply as such is not shown but may comprise a conventional compressor and pressure balancing tank arrangement with suitable valves well known in the art.

The particular nozzle arrangement shown in the drawings, which may be modified as necessary according to the character of the work to be accomplished, includes a single nozzle 44 of fairly large size along the centerline of the belt and acutely angled relative to the lower run of the belt 18. Compressed air issuing from the nozzle 44 comprises a jet 45 which impinges upon the inside of the belt run forcing it away from the head 15 and into engagement with a workpiece lying on the other side of the belt. The nozzle 44 is angular to the belt run so that the jet 45, as it impinges upon the belt, may diffuse easily without adversely affecting the small

area of initial contact of the jet with the center of the belt.

A second nozzle array 46 also comprises part of the nozzle system 40 and includes a cylindrical member 47 secured to a support 48. The cylinder 47 is provided with two rows each having a plurality of laterally spaced drillings 49 and 49¹ (Fig. 5) which comprise a plurality of small nozzles through which air jets 50 and 50¹ issue from the support 48 fed from the supply conduit 42. The cylindrical member 47 is provided with a boss 52 and valve bar 53 so that the drillings 49 or 49¹, or both sets, may be turned on or off to enable jets to be activated in a direction normal to the belt run or acutely angled relative thereto or both. The jets 50 and/or 50¹ impinge upon the inside of the lower run of the belt 18 to drive the belt 18 into engagement with a workpiece providing a substantially uniform pressure on the inside of the belt run which in turn yields a substantially uniform unit pressure on the abrasive belt on the workpiece across nearly its entire width. Drillings 49 and 49¹ may be segmental jet slots, and valve bar 53 may be adjusted to cover any part of the slots to control jet area and direction.

Referring to Fig. 5, we show the invention used in conjunction with a substantially tubular member 56 having an internal V groove therein. The abrasive belt is adjusted so that its center portion runs along the bottom of the groove as at 57. The bent portion of the belt 18, which fits closely to the groove portion 57, is identified at 58. The lateral portions of the belt 18, on either side of the bent portion 58, are shown at 59 and these conform to the slight curvature of the workpiece portions. The jets 50 or 50¹ drive the lateral portions 59 of the belt into engagement with the slightly curved parts of the workpiece, while the single central nozzle 44 drives the belt portion 58 into engagement with the workpiece groove bottom at 57. By this arrangement, a substantial area of the workpiece is engaged by the abrading belt to provide effective polishing of the irregular workpiece section being worked upon. It may further be noted that the jets 50 or 50¹ do not extend to the extreme lateral edges of the belt 18 so that the pressure upon the belt edges is somewhat less than that across the middle of the belt. This permits the polishing action to be faired off gradually toward the edges of the belt so that the edges do not abrade grooves or shoulders in the workpiece.

The configuration of the nozzles and jets may be modified as required according to the shape of the workpiece to be polished or abraded. If, for instance, the workpiece had two laterally spaced grooves therein, there could be two laterally spaced nozzles 44 directed toward the bottoms of the grooves.

Reference may now be made to Fig. 2 in conjunction with the other figures, which shows a table 60 having long tracks 62 thereon which are generally parallel to the runs of the belt 18. A carriage 64 is movable along the tracks 62 through wheels 65 journalled in the carriage. The carriage includes a platform 66 supported by posts 67, and the platform may be raised or lowered upon the posts by a screw 68 on the carriage, engaged by a nut 69 rotatable relative to the platform 66. Rotation of the net 69 may be accomplished by a conventional worm and wheel arrangement 70. Bearings 72 are mounted on the platform 66 which tiltably hold a barrel 74 upon which a workpiece chuck 76 is mounted.

Since, in the machine here disclosed, the workpiece comprises an aircraft propeller blade 78, the butt 79 of the blade is secured to the chuck 76 and the blade 78 extends leftwardly therefrom for engagement, on its inner surface, by the abrading belt 18. The long overhang of the blade 78 is counterbalanced, at least in part, by adjustable weights 80 shiftable along a shaft 82 extending rightwardly from the barrel 74.

The table 60 is equipped with a motor 84 driving a cable 85 through a reverse gear 86 and belts 87 and 88. The upper run of the cable 85 is secured to a lower extension bracket 90 on the carriage 64 so that as the cable run moves to the right or left, the carriage is moved with it. Limit switches 91 and 92 are mounted adjacent the tracks 62, which are contacted at times by a member 93 on the carriage at the ends of the carriage traverse. Limit switches 91 and 92 control the action of the reverse gear 86 so that the carriage is moved back and forth between the switches to enable traverse of the workpiece along the abrading belt 18. With the belt 18 travelling at normal speed, it is pressed downwardly by the air jets previously described to engage the inner surface of the propeller blade, enabling complete polishing of the inner surface of the blade from end to end.

If there are irregularities on the inner blade surface they are conformed to by the abrasion belt through the action of the air jets which place the belt into contact with the workpiece. If these irregularities are large the abrasion belt may be loosened somewhat on its pulleys to give it greater flexibility, enabling it to conform well to the longitudinal contours. If, on the other hand, the blade is fairly free of longitudinal irregularities, the tension of the belt 18 may be increased.

In order that the position of the working belt portion 95 may be held as stable as possible, it is desirable that the part of the workpiece being abraded is held in a fairly constant position as to height, with respect to the belt run. For this purpose, referring to Fig. 1, an external part of the workpiece beneath the working part 95 of the belt is supported on a roller 97 journalled in a member 98 which is adjustable vertically by a screw 99 in a bracket 100 carried on the table 60. Further, if there is a substantial taper or other thickness deviation along the workpiece in the distance or dimension from the inside surface of the workpiece to the outside surface of the workpiece, uniform travel of the inside of the workpiece relative to the abrasion belt is afforded by a cam bar 102. This cam bar runs between a roller 103 on the bottom of the screw 99 and a roller 104 journalled in the member 100. This cam bar is secured, as shown in Fig. 2, to an end of the carriage 64, the cam bar being tapered or shaped in complement to the thickness along the length of the workpiece between its inside and outside surfaces.

For instance, if the workpiece is thin at its leftward end and thick at its rightward end, the cam bar would be made thick at its leftward end and thin at its rightward end so that the inner surface of the workpiece will be held at a substantially constant height at the point where the inner workpiece surface is to be enegaged by the belt 18.

We have now described the construction of a specific machine for the purpose of polishing the inner surfaces of long tubular structures such as propeller blades, and have also described the particular feature of the invention which includes engaging a polishing or an abrading belt with the workpiece through the use of pressure jets. The latter essential structure of the invention, while peculiarly applicable in the propeller blade polishing machine described, may be used in other environments where suitable. The invention is not to be construed as being limited to a propeller blade polishing machine but rather, is to be construed as applicable to any appropriate type of belt abrading or polishing equipment regardless of the configuration of the machine itself or of the work piece.

While the invention has been shown in a present embodiment, it is subject to various modifications and changes while still coming within the scope of the broader aspects of the invention. Definition of the limits of the invention will be found in the following claims.

What is claimed is:

1. A belt abrading machine comprising two spaced pulleys, means to drive one said pulley, an abrasive belt running over said pulleys, means to move a workpiece in proximity to one run of said belt between said

pulleys and in spaced relation to the normal straight belt run, a nozzle substantially disposed between the runs of said belt and directed toward the inside of the run of belt proximate to said workpiece, and means to supply said nozzle with a pressurized fluid for flow from the nozzle against the inside of the belt run, to drive the belt from its normal line between said pulleys and forming the sole means to yieldingly enforce engagement of the belt with said workpiece.

2. A belt abrading machine comprising two spaced pulleys, means to drive one said pulley, an abrasive belt running over said pulleys, means to move a workpiece in proximity to one run of said belt between said pulleys and in spaced relation to the normal straight belt run, a nozzle substantially disposed between the runs of said belt and directed toward the inside of the run of belt proximate to said workpiece, means to supply said nozzle with a pressurized fluid for flow from the nozzle against the inside of the belt run, to drive the belt from its normal line between said pulleys and forming the sole means to yieldingly enforce engagement of the belt with said workpiece and means to adjust the nozzle relative to said belt to change the direction of the fluid stream directed against said belt.

3. A belt abrading machine comprising two spaced pulleys, means to drive one said pulley, an abrasive belt running over said pulleys, means to move a workpiece in spaced relation to one run of said belt between said pulleys, a nozzle substantially disposed between the runs of said belt and directed toward the inside of the run of belt proximate to said workpiece, means to supply said nozzle with a pressurized fluid for flow from the nozzle against the inside of the belt run forming the sole means to drive said belt run from its normal line and to enforce engagement of the belt with said workpiece, said nozzle comprising a plurality of orifices through which fluid passes, said orifices being arranged spanwise of said belt and having their axes at an acute angle to the run of said belt.

4. A belt abrading machine comprising two spaced pulleys, means to drive one said pulley, an abrasive belt running over said pulleys, means to move a workpiece in spaced relation to one run of said belt between said pulleys, a nozzle substantially disposed between the runs of said belt and directed toward the inside of the run of belt proximate to said workpiece, means to supply said nozzle with a pressurized fluid for flow from the nozzle against the inside of the belt run forming the sole means to drive said belt run from its normal line and to enforce engagement of the belt with said workpiece, said nozzle having a single orifice whose axis intersects substantially the centerline of said belt run at an acute angle to the belt run.

5. A belt abrading machine comprising a fixed beam having an idler pulley journalled at one end, and a drive pulley adjacent its other end, an endless abrasive belt running over said pulleys so that the beam lies between the belt runs between said pulleys, means to adjust one said pulley to tighten said belt, a nozzle secured to said beam having its orifice directed toward the inside of one of said belt runs, and a pressure fluid supply connected to said nozzle whereby the nozzle directs a stream of said fluid to impinge on the inside face of said belt, said fluid stream being the sole means to drive said belt outwardly from its normal line into yielding workpiece engagement.

6. A belt abrading machine comprising a fixed beam having an idler pulley journalled at one end, and a drive pulley adjacent its other end, an endless abrasive belt running over said pulleys so that the beam lies between the belt runs between said pulleys, means to adjust one said pulley to tighten said belt, a nozzle secured to said beam having its orifice directed toward the inside of one of said belt runs, a pressure fluid supply connected to said nozzle whereby the nozzle directs a stream of said fluid to impinge on the inside face of said belt, said fluid stream being the sole means to drive said belt outwardly from its normal line into yielding workpiece engagement, a movable workpiece holder, and means to move said holder to and fro along the line of said belt runs in spaced relation to said belt runs.

7. A belt abrading machine for the inner surfaces of tubular workpieces comprising a workpiece holder, means to secure a workpiece on said holder whereby the tubular workpiece is maintained substantially coaxial at all times, a beam supported on the general line of the workpiece axis, means to move said beam and holder relative to one another while said beam and workpiece axis remain aligned, said beam entering into said workpiece through an open end thereof, an idler pulley at the end of said beam which enters into said workpiece, an abrasive belt running over said idler pulley having belt runs along said beam normally out of contact with the workpiece inner surface, a nozzle secured to said beam, spaced from said idler pulley, having its orifice directed toward the inner surface of one of said belt runs, and a pressure fluid supply connected to said nozzle, said pressure fluid being directed by said nozzle to impinge on the inner surface of said belt run forming the sole means to yieldingly move the run of said belt into abrading engagement with the interior surface of said workpiece.

8. A machine according to claim 7 wherein said nozzle orifices are plural in number, one thereof being directed toward the center of said belt run to urge the center of the belt into acute convex shape and into workpiece engagement, and others thereof being directed across the belt run to urge the entire width of the belt into curved shape and into workpiece engagement.

9. The method of polishing the surface of a metal workpiece which consists in passing an abrasive polishing belt at high speed over the metal surface, with the abrasive surface of the belt spaced from but in close proximity to the metal surface, and driving the belt from its normal run into elastic engagement with the workpiece solely with the application of a high speed fluid jet to the other side of the belt.

10. The method according to claim 9 which includes moving the workpiece relative to the belt and fluid jet.

11. The method according to claim 9 wherein a plurality of high speed fluid jets distributed laterally across the abrasive belt drive the belt into engagement with the workpiece.

12. The method according to claim 9 wherein the fluid jet is directed at an acute angle against the abrasive belt.

13. The method according to claim 9 wherein a plurality of high speed fluid jets directed at an acute angle against the abrasive belt drive the belt into engagement with the workpiece.

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