MEANS CONTROLLING A FLEXIBLE GRINDING DEVICE


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This invention relates to grinding machinery and particularly to means for grinding on a high production basis a plurality of successively presented workpieces.

A particular problem out of which the herein disclosed invention arose was encountered in connection with the automatic bending and welding of sheets of steel to form cylinders which cylinders are subsequently utilized in the manufacture of such items as pipes and/or barrels. In preparing such sheets for welding, it is desirable to provide a clean surface along the edges which are to be overlapped and welded in order that such surfaces will be free from dirt, scale, corrosion or other foreign materials which might adversely affect the obtaining of a sound and reliable weld. This cleaning is conveniently and effectively obtained by grinding the surfaces which are to be in contact when a given sheet is overlapped and sometimes also grinding the opposite surfaces at which the welding electrodes are to make contact.

In this connection it has been found particularly advantageous to use as the grinding tool a device constructed from a plurality of flexible sheets arranged in a somewhat paddle wheel relationship to each other wherein the abrasive material is carried upon the leading faces of the several sheets and strikes the work as same is presented to the wheel. Therefore the invention will be described in terms of such a flexible abrading device applied to successively presented, spaced, sheets as further described hereinafter but it will be recognized that the apparatus involved is of broader applicability so that the specific example hereinafter further discussed is for illustrative purposes only and will be understood as intended only to illustrate the invention and not as limiting. In order to do this, said work is spaced from the axis of the wheel a distance somewhat less than the radial length of the abrasive sheets constituting the paddles of the paddle wheel construction whereby the sheets are suitably bent as they strike the work and their abrasive faces caused to abrade the work. Thus, when the sheets are fed automatically, but usually with some space between them, these abrasive blades tend to straighten between the sheets and thereby tend to cut themselves on the leading edge of the sheet next following. Accordingly, the first problem arising from the use of this type of equipment is to lift the abrading unit far enough away from the work between workpieces to avoid such tendency to cut the abrasive sheets.

A further problem arising from the use of this type of equipment or with any abrasive wheel utilizing flexible elements, comes from the fact that the amount of abrasive surface applied to the work is a rather critical function of the distance from the work surface to the axis of the paddle wheel structure. Hence, as the sheets wear it is desirable to move such axis progressively closer to the work to compensate for such wear within whatever limits are effective in a given case. Therefore, it is desirable to advance the abrasive paddle wheel structure toward the work in close conformity to the amount of work being performed in a given case.

Accordingly, the objects of the invention are:

1. To provide means for applying a wheel constituting a plurality of flexible, abrasive elements to a plurality of successively presented, spaced, workpieces.

2. To provide means, as aforesaid, adaptable particularly to conditions where the work surfaces on said workpieces are substantially coplanar with each other.

3. To provide apparatus, as aforesaid, wherein the abrasive wheel is retracted from the plane of said coplanar surfaces at periodic intervals, such as intervals which are synchronized with the spaces between the said spaced workpieces.

4. To provide apparatus, as aforesaid, wherein the abrasive wheel is periodically advanced closer to the plane of said coplanar work surfaces in order to compensate for wear of the flexible elements constituting the abrasive wheel.

5. To provide apparatus, as aforesaid, wherein said last-mentioned advancement is initiated by the occurrence of a predetermined number of the above-mentioned periodic retracting operations.

6. To provide apparatus, as aforesaid, wherein the advancing apparatus constitutes a serially connected portion of the retracting mechanism.

7. To provide apparatus, as aforesaid, wherein the advancing mechanism is provided with maximum simplicity and is an integral mechanical part of the retracting mechanism.

8. To provide apparatus, as aforesaid, having a high degree of simplicity and accordingly a low manufacturing cost and a low maintenance cost.

9. To provide means, as aforesaid, which will be accurate and reliable in operation, capable of accomplishing a high quality of work and capable of advancing the abrasive device toward the work to compensate for wear in a closely predetermined manner.

Other objects and purposes of the invention will be apparent to persons acquainted with devices of this general type upon reading the following specification and inspection of the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic, oblique view of apparatus embodying the invention together with a plurality of workpieces for illustrating the relationship of the apparatus to the workpieces.

FIGURE 2 is a side elevational, broken view of apparatus embodying the invention with certain parts thereof broken away and shown in central, longitudinal section.

FIGURE 3 is a section taken on the line III—III of FIGURE 2.

FIGURE 4 is a top view of the apparatus of FIGURE 2.

FIGURE 5 is a fragmentary view of the abrasive wheel and showing its relationship to the workpiece and to the rocking axis.

FIGURE 6 illustrates typical circuitry for controlling the apparatus.

General Description

With the workpieces arranged on suitable conveying devices so that their working surfaces are presented in aligned, coplanar, spaced relationship, the flexible, abrading device is mounted at one end of a pivoted lever. Movement of said lever on its pivot moves said abrading device toward and away from engagement with the work and suitable driving means are provided to effect such movement in timed relationship with the presentation of said workpieces to said abrading device. Ratchet-driven screw means are provided in the driving train of said lever such that actuation of said screw means will act through said lever and move the abrasive device toward or away from the plane of the workpieces in which movement is effective equally in all cyclic positions of said
lever. Control means are provided for driving said ratchet in a direction to move said abrading device to-ward said plane by a predetermined increment upon the occurrence of a predetermined number of actuations of said lever.

Detailed Description

In the following description certain terminology will be used for convenience in reference and such terminol-ogy will be recognized as so used and will not be considered as limiting. For example, the terms "upwardly" and "downwardly" will designate directions with reference to the normal position of use of the apparatus. The terms "rightwardly" and "leftwardly" will designate directions with respect to the drawings. The terms "inwardly" and "outwardly" will designate directions to-ward and away from the geometric center of the appar-a-tus. All such terminology will include derivatives of the words above specifically mentioned together with words of similar import.

Referring first to FIGURE 1, there is shown a table 1 along which are being fed sheets 2 and 3 for the pur-pose of effecting polishing of the edges 4 and 5, re-spectively, of each thereof. A conveyor device 6 having driving lugs of which one is shown at 7 is provided in a presently well-known manner for urging said sheets along the table. Rollers 8 may be provided if desired for guiding the edges of said sheets.

At the side of said table 1 there is placed a grinding device generally indicated at 11 having a cleaning de-vic 12 mounted thereon.

Said cleaning device is comprised (FIGURE 5) of a plurality of strips 13 of flexible abrasive material such as that used for abrasive belts, the same being rigidly fastened into a hub 14 in any convenient manner, such as being received into slots therein and fastened by a suit-able adhesive. As said hub 14 rotates, said strips extend substantially radially thereof in response to centrifugal force until they strike a workpiece such as the sheet 3. When the workpiece 3 comes into line with the cleaning device 12, the strips will strike such sheet and will ac-cordingly be bent backwardly as indicated at 16, and the abrasive material on the leading face of the strips 13 will effect a cleaning action on the surface of the workpiece 3.

The cleaning device 12 is mounted upon a suitable spindle 17 (FIGURE 1) which in turn is mounted in any convenient manner through suitable bearing struc-ture 18 to a frame 18 which in turn is pivotally mount-ed onto a shaft 19. The driving motor 20 is also mounted onto the frame 18 and is arranged for acting through a belt 21 and sheave 22 to drive the spindle 17 and thereby the cleaning device 12. The pivotal shaft 19 is mounted by suitable bearings of which one appears at 24 onto a frame structure partly shown at 26 and thence to the table 1.

A lever arm 23 is affixed to the shaft 19 whereby actuation of said lever arm will rotate said shaft 19 and effect movement of the axis of spindle 17 toward or away from the surface of the workpieces.

Turning now to the apparatus by which the lever 23 is operated and the cleaning device 12 thereby caused to move toward and away from the surface of the workpieces, there is provided a supporting bracket 30 (FIG-UARE 2) including an arm 31 mounted as desired rigidly with respect to the frame 1 of the conveyor and support-ing all of plates 32 and 33 in spaced parallel relation-ship with respect to each other. Said plates, may if desired, be connected by suitable spacers 34 and 36 for rigidifying the structure.

Said plates are provided with suitable coaxial openings 37 and 38 therethrough in which are inserted bear-ings 39 and 41 respectively. In this embodiment, for reasons appearing hereinafter, the opening 38 and the bearing 41 associated therewith is considerably larger than the opening 37 and associated bearing 39. A hol-low sleeve 42 is rotatably arranged within said bearings and is held in place therein by shoulders 43 and 44 act-ing against the bearing strips 46 and 47, respectively. The sleeve, in addition to the shoulders 43 and 44 has two further shoulders arranged therebetween and indi-cated at 48 and 49. A gear 51 is affixed, as by welding, to the shoulder 49 for cooperation with the hereinafter mentioned pawl. A ratchet-driving arm 52 (FIGURE 3) is provided with an annular section 53 in its mid-section and a pawl supporting extension 54 at its other end. The annular mid-section 53 is arranged on the step 48 of the sleeve 42 and is separated from said sleeve by suitable bearing material indicated at 56 and 57. A spring urged friction drag brake 59 of any convenient type is arranged on the sleeve 42 at a convenient point, such as the point adjacent the supporting plate 33 and a manual adjusting device, such as a crank 61, is also arranged on said sleeve for manual rotation thereof.

A collar 62 is positioned adjacent the rightward end of the sleeve 42 and is held thereon in any convenient manner, such as by a plurality of bolts at which one is shown at 63. Said collar supports an internally bracketed sleeve or nut 64, which nut is fixed with respect to said collar, may be formed as a hub thereon and is positioned within the sleeve 42 for purposes appearing hereinafter.

An elongated screw 66 is threadedly received through the threaded sleeve 64 and one end extends into the central opening 67 of said sleeve 42. Its other end carries a collar 68 thereon. A bellows 71 is supported at one end on and by the collar 68 and at its other end by the collar 62.

The screw 66 extends rightwardly beyond the collar 68 and terminates in a fastened portion 72 which is re-ceived into a clevis 73. Said clevis is held in any con-vienient manner against rotation, in this case an abutment 75 bearing against said clevis is provided for this pur-pose. Said clevis is threadedly affixed at 74 to the plunger 76 of a hydraulic cylinder 77. The housing of said cylinder 77 carries suitable lugs 78 and 79 for re-ceiving the upper end of the lever 23 therebetween and said lever is pivotally fastened to said lugs in any con-vienient manner, such as by a pin 80.

Extending sidewardly from a portion of the bracket structure 30 adjacent the spacer 34 is further structure 81 (FIGURE 3), which supports a solenoid 82. The armature of said solenoid is connected by suitable linkage 83 to the pivot device 84 at the rightward end of the lever structure 52. A bracket 86 carries a thread-edly arranged stop member 87 which is provided for lim-iting the upward movement of the rightward end of the lever 52.

The leftward end 54 of the lever 52 pivotally supports a driving paw 91 whose tip 92 engages suitable ratchet teeth 93 on the periphery of the ratchet wheel 51. Said paw 91 has a depending portion 95 which is urged leftwardly by a spring 94, said spring being mounted in the opening of a suitable receptacle 96 and the latter being fastened, such as by welding, to the leftward end 54 of the lever 52. A spring 97 is affixed at its upper end to a convenient point 98 on the leftward end of the lever 52 and at its lower end to a suitable extension 99 of the base structure 30.

Energizing means of any suitable, conventional, form may be provided for energizing a solenoid valve 102 so that fluid pressure is supplied to cylinder 77 in synchronism with the approach of a workpiece to a point adja-cent the cleaning device 12. Preferably, the solenoid in-cluding a microswitch will be provided with the micro-switch positioned to close when a given sheet has reached a point slightly past the nearest edge of the cleaning de-vice 12 and to open when the trailing edge of said sheet reaches approximately the mid-point of said polling de-vice, the polling device 12, and 12.

For example, a pressure fluid source S (FIGURE 6)
is connected through the solenoid valve 102 and supplies a cylinder 77 through the conduit 103. Said solenoid valve 102 is suitably connected to a source of potential P and in series with the microswitch 101 whereby the fluid pressure cylinder 77 is energized upon closure of the microswitch 101 and is de-energized upon the opening of the microswitch 101.

Conductors 104 and 105 are connected in parallel with the solenoid valve 102 and activate a counter “C.” Said counter, upon the occurrence of a predetermined number of energizations or counts will then energize the solenoid 82. Thus, if the microswitch 101 is placed substantially under the mid-point of the cleaning device 12, it will be closed as a workpiece, such as the sheet 3, enters the cleaning position and it will be released as said sheet leaves the cleaning position. Thus, said circuitry is activated upon the approach of a workpiece for energizing both the solenoid valve 102 and for sending a pulse to the counter C, and the solenoid valve will be de-energized when said sheet has passed.

**Operation**

The operation of the foregoing described apparatus has been somewhat indicated in connection with the description appearing above but such operation will be set forth fully to insure a complete understanding of the invention.

In starting the apparatus, the proper position of the cleaning device 12 with respect to the working surface of the workpiece is determined by rotation of the sleeve 42, in this embodiment by manually actuating the crank 23. With the sleeve rotated, and the screw 66 held against rotation at and by the crivel 73, the screw and sleeve will move axially with respect to each other. The sleeve being held against axial movement by the bracket 30 with respect to the table 1, the relatively axial movement of the sleeve 42 is actuated through the clean and the pressure fluid cylinder 77 to actuate the upper end of the crank 23. This effects pivotal movement of the shaft 19 and thus causes the cleaning device to move upwardly or downwardly with respect to the workpiece as above described. In this manner the cleaning device can be adjusted upwardly or downwardly with respect to the workpiece to place it in the proper operating position for commencement of a given operation.

With each closure of the microswitch 101 by the leading edge of the work sheet, the solenoid valve 102 is energized and pressure fluid conducted to the pressure fluid cylinder 77. With pressure fluid supplied to pressure cylinder 77, the housing and plunger thereof become extended. With the plunger being held against axial movement by its connection to the screw 66 which in turn is held against axial movement by its threaded connection to the sleeve 42 which in turn is held by and between the plates 32 and 33 of the frame structure, the housing of the pressure fluid cylinder 77 will move rightwardly and thereby actuate the crank 23 in a clockwise direction as shown in FIGURE 2. This moves the cleaning head downwardly against the workpiece. The placement of the microswitch 101 as above mentioned insures that by the time the cleaning head moves downwardly against the workpiece, the leading edge thereof will have moved far enough that the flexible abrasive strips will not bear appreciably against such leading edge and accordingly the readily destructible flexible strips 13 will not be damaged. At the same time, said flexible strips will make into contact with the workpiece at the beginning edge thereof sufficiently to effect a satisfactory job of cleaning.

Similarly, the release of said microswitch at the trailing edge of the workpiece will de-energize the solenoid valve 102 and thereby de-energize the pressure fluid cylinder 77. Said cylinder is then caused to retract by any convenient means such as a return spring, and the cleaning head is lifted away from the workpiece. Again, the placement of the microswitch 101 at approximately the mid-point of the cleaning head, will insure the cleaning of the workpiece all the way to the trailing end thereof before the cleaning head is lifted and at the same time it will effect such lifting while the cleaning head is still at least substantially supported by the work so as to prevent excessive damage to said cleaning head by the trailing edge of said workpiece.

Each time the microswitch 101 closes, it also delivers a pulse through the conductors 104 and 105 to the counting mechanism C. Upon the accumulation of a suitable number of pulses at the counting mechanism C, said counting mechanism delivers a pulse to the solenoid 82. This moves the lever 52 clockwise as appearing in FIGURE 3 by which the pawl 91 engages the ratchet wheel 51 to rotate the sleeve clockwise by an increment measured by the engagement of the pawl with the ratchet wheel 51 which in turn is determined by the setting of the screw 87. This effects rotation of a sleeve 42 which acts through the threaded sleeve 64 to move the screw 66 axially with respect to said sleeve. Where the apparatus is being used, as it normally will be, to adjust the cleaning head 12 to compensate for wear on the flexible strips 13, this motion of the screw 66 will be rightwardly as same appears in FIGURE 2 and the movement of the wheel 12 will be toward the tool. However, it will be recognized that if the apparatus is applied to a different type of use, such as if it is desired to apply progressively lighter contact of the cleaning head against the workpiece, for example, where the workpiece is being reciprocated repeatedly under the cleaning head, then the hand of the screw 66 of the arrangement of the pawl and ratchet wheel will be reversed to move the screw leftwardly with respect to the sleeve the same as illustrated in FIGURE 2.

Such movement of the screw 66 will effect a corresponding movement of the entirety of the pressure fluid cylinder 77 and a corresponding movement of the crank 23 and parts connected thereto including the pivot rod 19. This adjusts the cleaning head 12 with respect to the working surface of the workpiece as desired and without disturbing the intermittent motion provided by the pressure fluid cylinder 77 for the cleaning head toward and away from the working surface of the workpiece.

It will be recognized that merely by adjusting the setting of the counter C, any desired number of actuations of the microswitch 101 can be utilized for effecting one actuation of the solenoid 82 together with the actions resulting therefrom.

It will be recognized that the device set forth herein is capable of a wide variety of uses and capable of ready adaptation to a wide variety of cleaning, polishing or other material-working machines. Further, the specific embodiment herein set forth for illustrative purposes will be recognized as capable of many modifications, which modifications will be within the scope of the hereinafter pending claims excepting as said claims may by their own terms expressly require otherwise.

**What is claimed is:**

1. A position compensating device for a material working tool, comprising in combination:  
   a base;  
   positive feeding means movable a predetermined distance and operable in response to a predetermined position of a workpiece with respect to said tool for effecting movement of said tool relatively with respect to said workpiece into and out of engagement therewith;  
   means including screw thread means connecting said feeding means to said base;  
   counting means responsive to a selected number of actuations of said feeding means and arranged for delivering a signal upon the occurrence of a predetermined number of feeding actuations;  
   means effecting relative rotation of said screw thread means upon the appearance of a signal from said counting means whereby said screw thread means
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changes its effective length and thereby changes the relative positioning of said feeding means with respect to said base; whereby, even though the size of said tool may vary, said tool is caused to move into and out of engagement with said workpiece without changing the extent of movement of said feeding means.

2. In a device for compensating for wear of the abrasive components of a flexible cutting head while providing movement of said head toward and away from a workpiece, comprising the combination: a base; means including a movable reference element for effecting movement of said cutting head toward and away from a workpiece in response to movement of said reference element; a pressure fluid cylinder having a plunger and a housing which are relatively reciprocable, one of the plunger and housing thereof being affixed to said reference element for effecting movement of said reference element in response to energization of said cylinder; first elongated threaded means affixed to the other of said plunger and housing; second elongated threaded means mounted on said base and threaded associated with said first threaded means whereby relative rotational movement between said threaded means will effect axial movement of one of said threaded means with respect to the other; counting means actuated to provide a signal upon the occurrence of a predetermined number of energizations of said pressure fluid cylinder; indexing means responsive to the delivery of a signal from said counting means for effecting relative rotation between said first and second threaded means; whereby said reference element will be moved with respect to said base and thereby change the position of the cutting head with respect to said workpiece but without changing the stroke of said pressure fluid cylinder.

3. In a device for compensating for wear of the abrasive components of a flexible cutting head while providing movement of said head toward and away from a workpiece, comprising the combination: a base; means including a movable reference element for effecting movement of said cutting head toward and away from a workpiece in response to movement of said reference element; a pressure fluid cylinder having a plunger and a housing which are relatively reciprocable, one of the plunger and housing thereof being affixed to said reference element for effecting movement of said reference element in response to energization of said cylinder; first elongated threaded means affixed to the other of said plunger and housing; second elongated threaded means threaded associated with said first threaded means whereby relative rotational movement between said threaded means will effect axial movement of one of said threaded means with respect to the other; counting means actuated to provide a signal upon the occurrence of a predetermined number of energizations of said pressure fluid cylinder; indexing means responsive to the delivery of a signal from said counting means for effecting relative rotation between said first and second threaded means; whereby said reference element will be moved with respect to said base and thereby change the position of the cutting head with respect to said workpiece but without changing the stroke of said pressure fluid cylinder.

4. In a device for compensating for wear of the abrasive components of a cutting head which is rotatable about an axis wherein said components are flexible elements radially arranged for rotation about said axis and simultaneously providing for back and forth movement of said axis toward and away from a plurality of successively presented, spaced, workpieces, comprising in combination: a base; means including a movable reference element for effecting movement of said axis toward and away from a workpiece in response to movement of said reference element; a pressure fluid cylinder having a plunger and a housing which are relatively reciprocable, one of the plunger and housing thereof being affixed to said reference element for effecting movement of said reference element in response to energization of said cylinder; first elongated threaded means affixed to the other of said plunger and housing; second elongated threaded means threaded associated with said first threaded means whereby relative rotational movement between said threaded means will effect axial movement of one of said threaded means with respect to the other; counting means actuated to provide a signal upon the occurrence of a predetermined number of energizations of said pressure fluid cylinder; indexing means responsive to the delivery of a signal from said counting means for effecting relative rotation between said first and second threaded means; whereby said reference element will be moved with respect to said base and thereby change the position of the cutting head with respect to said workpiece but without changing the stroke of said pressure fluid cylinder.

5. The device defined in claim 4 wherein said first elongated threaded means is a threaded rod and said second elongated threaded means is a sleeve telescoping said threaded rod and having an internally threaded portion in threaded engagement with said threaded rod.

6. The device defined in claim 5 wherein said sleeve supports a ratchet wheel in fixed relationship thereof and wherein said electro-responsive means includes an electro-responsive pawl which upon energization will act through said ratchet wheel for effecting rotation of said sleeve.

7. In a device for compensating for wear of the abrasive components of a flexible cutting head while providing back and forth movement of said head toward and away from a workpiece, comprising the combination: means including a reference element effecting back and forth movement of said cutting head toward and away from a workpiece in response to back and forth movement of said reference element; a pressure fluid cylinder having a plunger and a housing which are relatively reciprocable, one of the plunger and housing thereof being affixed to said reference element for effecting movement of said reference element in response to energization of said cylinder; a fixed bracket;
a pair of bearing supports on said bracket and a sleeve rotatably received within said bearing supports; an elongated screw in telescopic and threaded relationship with said sleeve; and means connecting said screw with the other of the plunger and housing of said pressure fluid cylinder; a ratchet wheel mounted fixedly on said sleeve for rotation therewith; a rocker arm mounted on said sleeve for pivotal movement with respect thereto, one end of said rocker arm carrying a pawl for actuating said ratchet wheel for effecting rotation of said sleeve upon oscillatory movement of said arm; electro-responsive means mounted on said bracket for effecting oscillatory movement of said arm; counting means responsive to a predetermined number of energizations of said fluid pressure cylinder and effective for actuating said electro-responsive means upon the occurrence of said predetermined number of energizations of said pressure fluid cylinder.

8. A device for compensating for wear of a tool which is movable toward and away from workpieces, comprising: a base; linkage including an adjusting device, a piston and cylinder, and actuating means mechanically connected in series between said base and said tool; said actuating means being connected to one of said piston and cylinder so that fluid pressure supplied to said cylinder will effect movement of said actuating means and thereby said tool toward and away from the workpiece; said adjusting device including relatively movable members connected, respectively, to said base and to the other of said parts of said positive feeding means whereby the distance between said base and said positive feeding means is determined by the relative positions of said members; counting means and means for actuating said counting means each time fluid pressure is supplied to said cylinder whereby said counting means provides a signal after fluid pressure has been supplied to said cylinder a predetermined number of times; and means responsive to said signal for adjusting the positions of said members.

9. A device for compensating for wear of a tool which is movable toward and away from workpieces, comprising: a base; linkage including an adjusting device, positive feeding means comprising a pair of relatively movable parts, and actuating means mechanically connected in series between said base and said tool; said actuating means being connected to one of said parts of said positive feeding means so that operation of said positive feeding means will effect movement of said actuating means and thereby said tool toward and away from the workpiece; said adjusting device including relatively movable members connected, respectively, to said base and to the other of said parts of said positive feeding means whereby the distance between said base and said positive feeding means is determined by the relative positions of said members; counting means and means for actuating said counting means each time said positive feeding means is energized whereby said counting means provides a signal after said positive feeding means has been energized a predetermined number of times; and means responsive to said signal for adjusting the positions of said members.

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