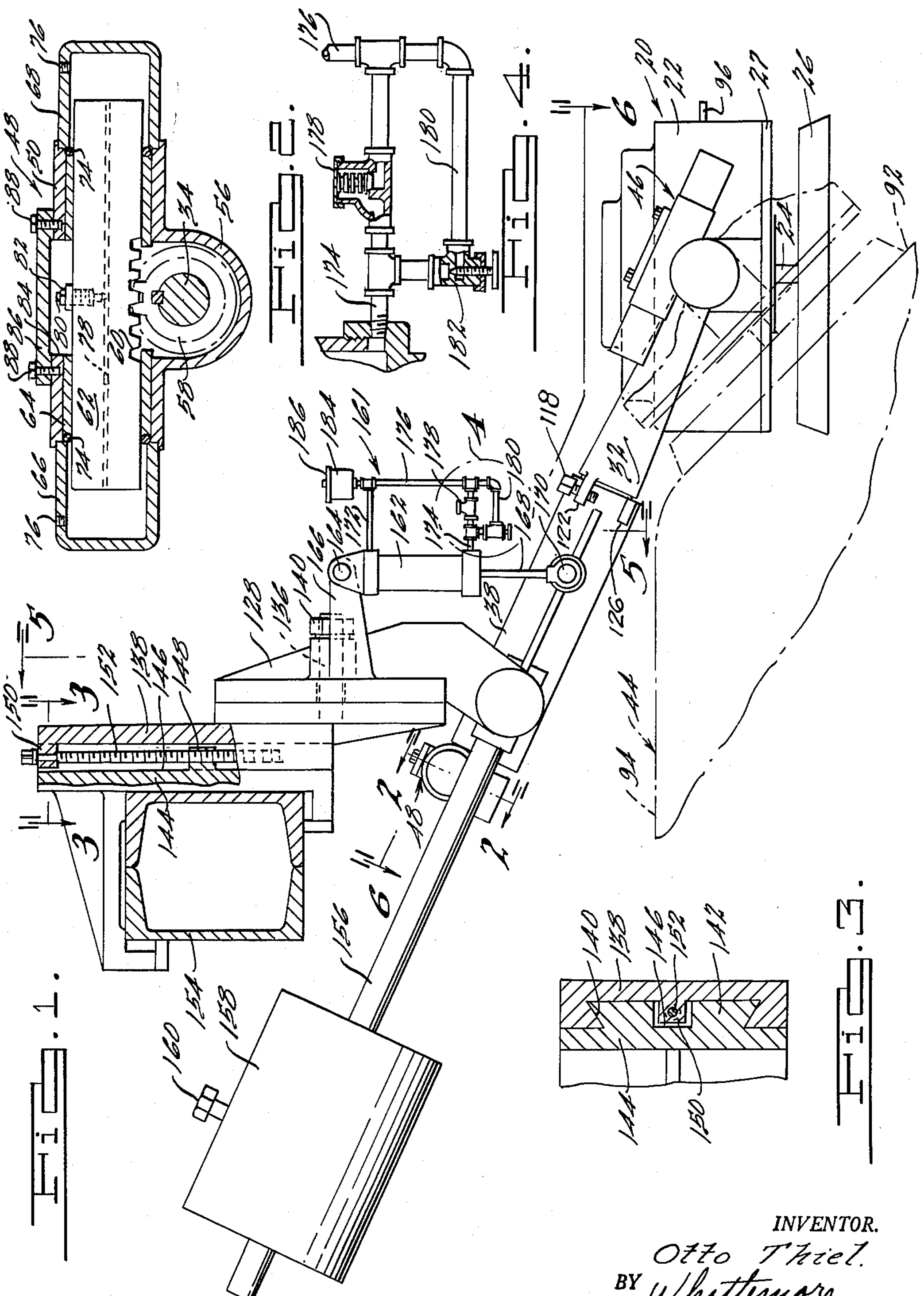
Nov. 8, 1955 O. THIEL 2,722,784

BUFFING HEAD

Filed Sept. 10, 1951 5 Sheets-Sheet 1



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BUFFING HEAD

Filed Sept. 10, 1951 5 Sheets-Sheet 2

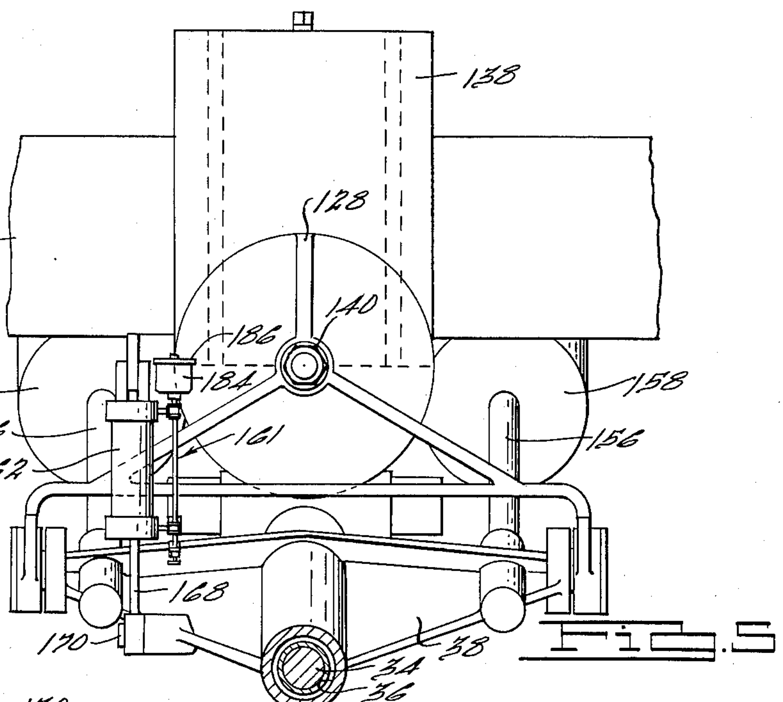

FIG. 5.

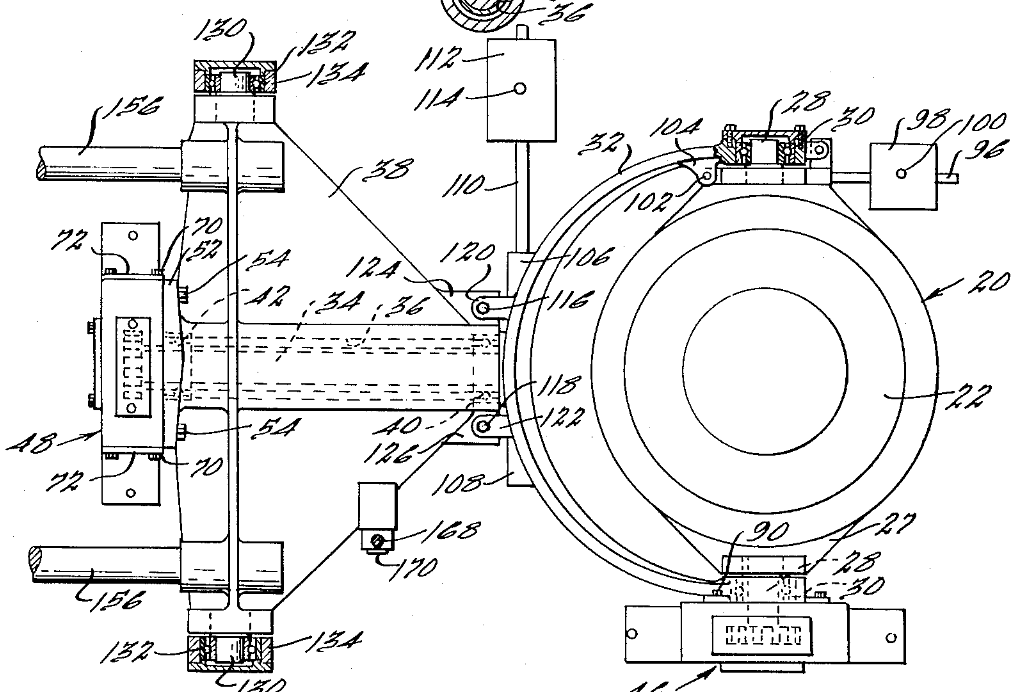

FIG. 6.

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BUFFING HEAD

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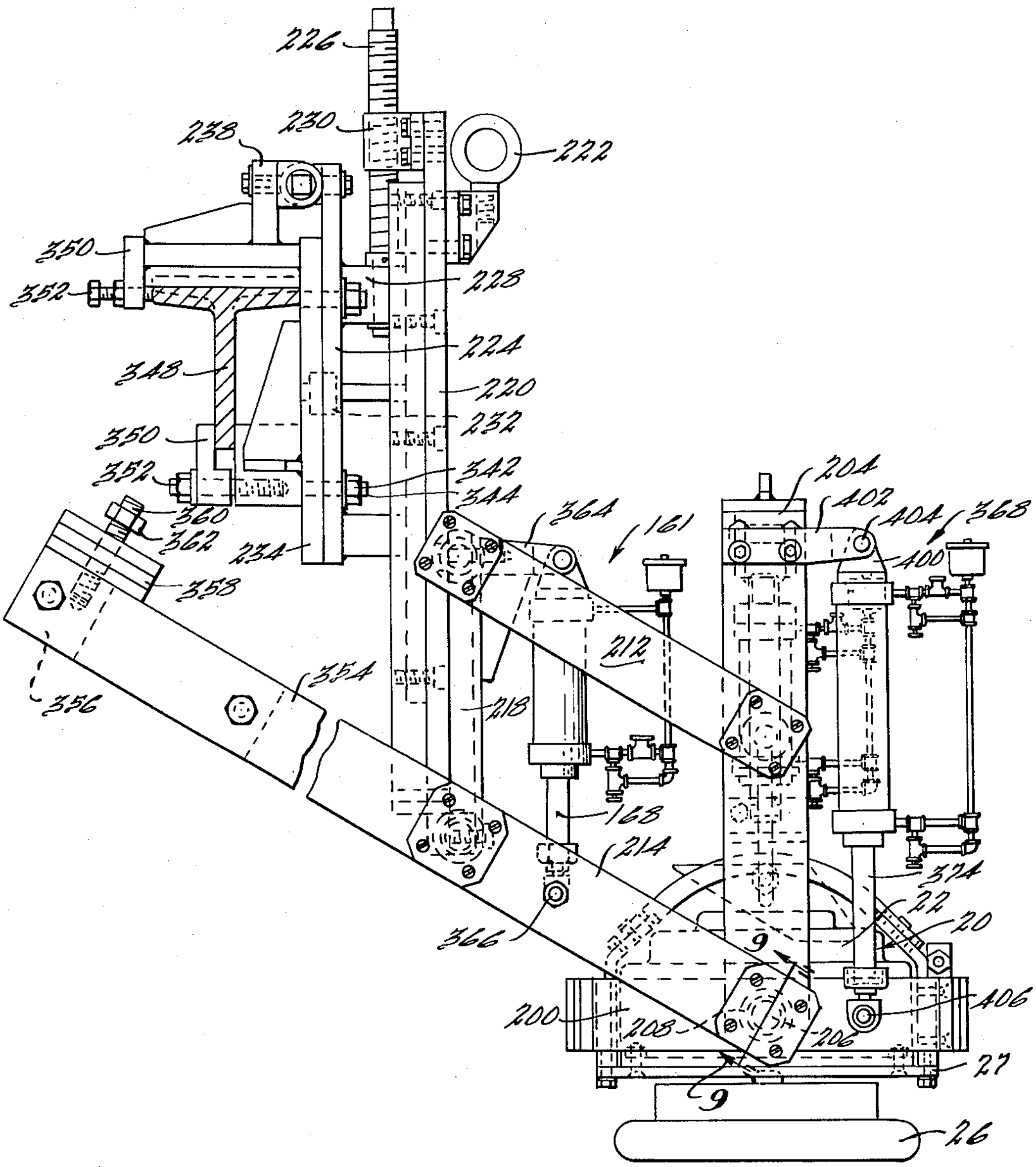

FIG. 7.

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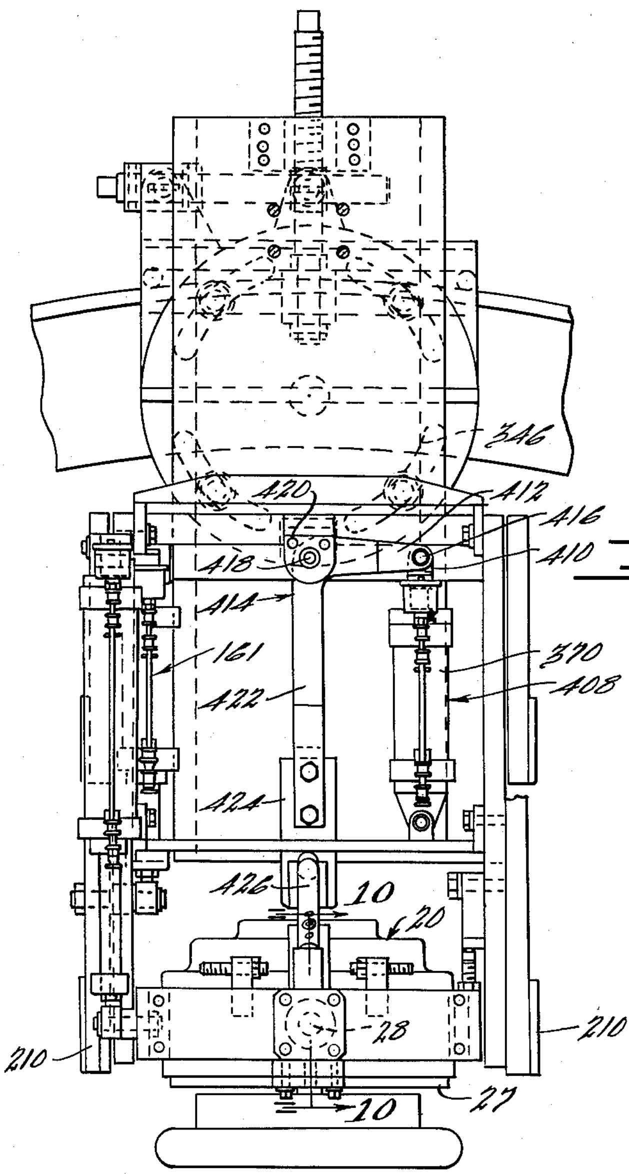

FIG. 8.

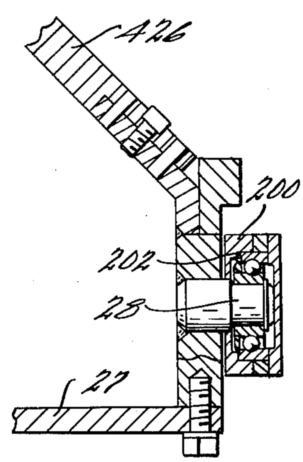

FIG. 10.

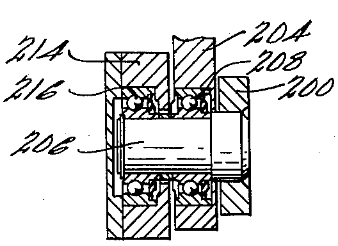

FIG. 9.

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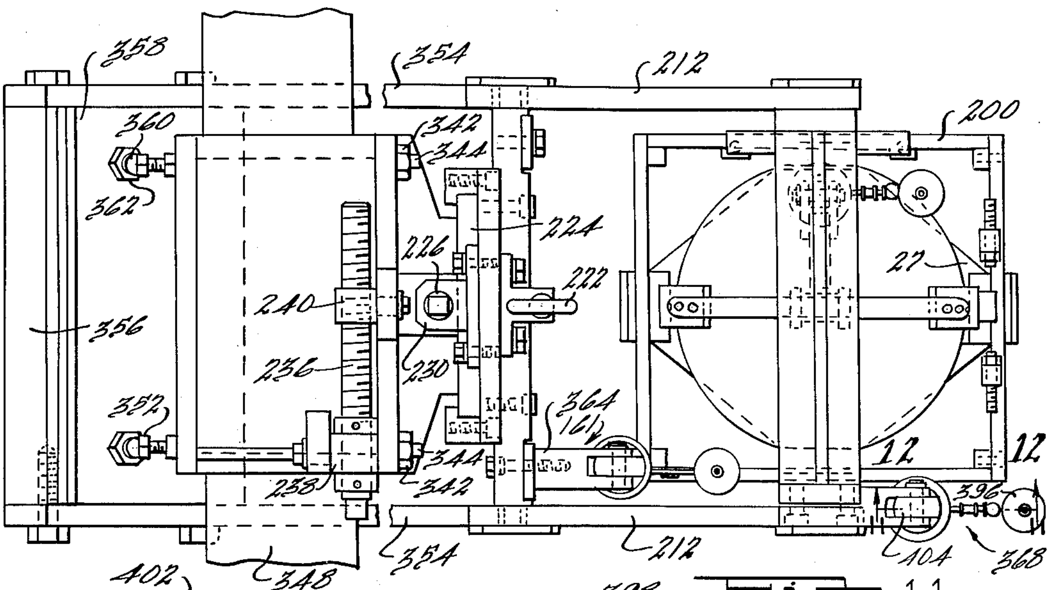

FIG. 11.

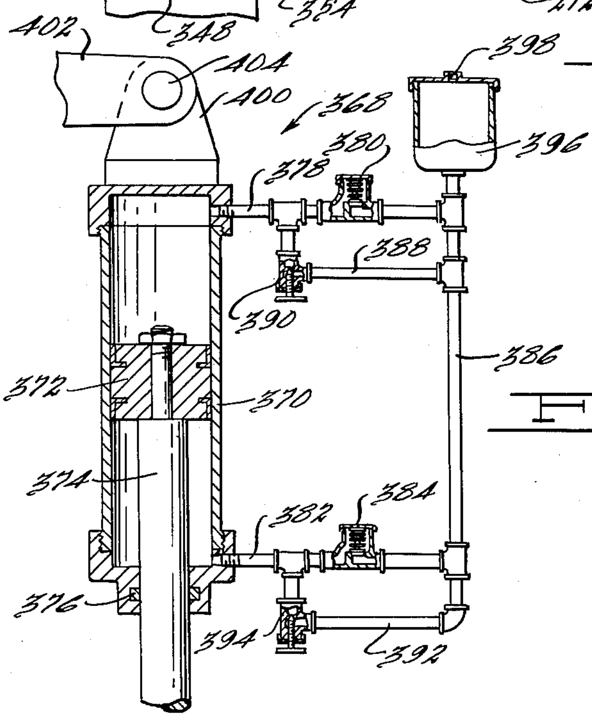

FIG. 12.

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2,722,784

BUFFING HEAD

Otto Thiel, Detroit, Mich., assignor to Midwest Supply and Manufacturing Company, Ferndale, Mich., a corporation of Michigan

Application September 10, 1951, Serial No. 245,832

11 Claims. (Cl. 51—110)

This invention relates to new and useful improvements in polishing and buffing machines.

In industrial processes, many parts are subjected to a buffing and polishing operation; and, in the case of parts produced on a high production basis, this operation must be done automatically in order not to interfere with the production schedule and to maintain production costs at a minimum. Further, in the manufacture and fabrication of many things, such as automobile bodies for example, the parts are carried by an assembly line, and it is necessary that the buffing and polishing machine be constructed to buff or polish the parts as they move along the line. For larger parts, it may be necessary to arrange a plurality of buffing heads in such relation to each other that each head engages a predetermined area and so that the heads, by their collective action, buff and polish the entire surface of the part. If the surface being processed is irregular, the polishing and buffing heads must follow and intimately engage the surface at all times. In addition to the above, buffing heads, after finishing one operation, may not be positioned to properly engage the next piece of work, and means must be provided for automatically turning the heads to a predetermined initial position.

In order for the buffing heads to function properly as described above, it has heretofore been the practice to provide a universal mounting for each head. This permits the head to pivot as required to maintain the buffing element in contact with the work regardless of irregularities in the surface being processed. However, when the heads are mounted in this manner, there has been a tendency for the buffing element to wobble, so that only the rim of the element engages the work. This phenomena is particularly pronounced in situations where the buffing element is required to make a quick change in position as when the element encounters an abrupt rise or fall in the engaged surface of the work. If the head begins to wobble, an imperfect or faulty buffing job results.

Heretofore some attempts have been made to counteract the wobbling tendency of the heads by pressing them downwardly hard against the work. This solution, however, has not been entirely satisfactory and in many instances it is utterly impractical because excessive pressure burns or otherwise mars the work. There are many instances where the pressure exerted by the head against the work must be carefully controlled and where pressures in excess of a predetermined amount ruin the finish of the work.

Some attempts also have been made to damp movements of the head by the use of conventional shock-absorber-type mechanisms, but these attempts have been unsuccessful.

It has now been discovered that the polishing heads can be controlled to engage the work properly at all times without imposing excessive destructive pressures on the work by damping oscillatory movements of the buffing heads in both directions; i. e., in both clockwise and counterclockwise directions with respect to the pivotal axes. This result is somewhat unexpected in view of the failure of the shock-absorber-type damping mechanisms heretofore used. Actual tests have shown, however, that if the oscillatory movement of the heads is damped in both directions, the buffing elements flatly engage the work at all times, and the tendency to wobble is overcome even in the case of the most adverse conditions encountered.

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From the foregoing it will be readily apparent that an important object of the present invention is to provide means for controlling automatically operated buffing heads so as to prevent wobbling of the heads under certain conditions of use.

Another object of the invention is to provide a mechanism of the above-mentioned character than can be readily adapted to buffing and polishing machines currently in use.

Still another object of the invention is to provide a mechanism of the above-mentioned character that is simple in construction and efficient in operation.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the drawings forming a part of this specification and wherein like numerals are employed to designate like parts throughout the same:

Fig. 1 is a side elevational view of a buffing head and supporting means embodying the instant invention uniquely constructed to prevent wobbling of the head;

Fig. 2 is an enlarged, generally vertical, sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged, horizontal sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary enlarged view of the portion of Fig. 1 enclosed in the circle 4, parts thereof being broken away and shown in section for clearness of illustration;

Fig. 5 is a vertical sectional view taken on the line 5—5 of Fig. 1;

Fig. 6 is a fragmentary horizontal sectional view taken on the line 6—6 of Fig. 1;

Fig. 7 is a side elevational view showing a modified form of the invention;

Fig. 8 is a front elevational view thereof;

Fig. 9 is an enlarged, fragmentary sectional view taken on the line 9—9 of Fig. 7;

Fig. 10 is an enlarged sectional view taken on the line 10—10 of Fig. 8;

Fig. 11 is a top plan view of the modification; and

Fig. 12 is an enlarged sectional view taken on the line 12—12 of Fig. 11.

The preferred form of the invention shown in Figs. 1–6 is first described. A buffing head **20** therein shown comprises a motor housing **22**, and a driven shaft **24** depending from the housing carries and rotatably drives a buffing and polishing element **26**. The element **26** may be an abrasive element, a cloth covered element, an element including fleece or other polishing material, or in fact may be any rotatable element adapted to operate at high rotational speeds against a selected surface of a work piece to finish the surface. The motor housing is fastened to a supporting plate **27**, and pivots or trunnions **28** on the plate at diametrically opposite sides of the housing are journaled in bearings **30** in the arms of a yoke **32** which carries the head **20**. The yoke **32** is provided substantially midway between the yoke arms with a rearwardly extending pivot or journal **34** which is received within a bore **36** of a support **38**. As perhaps best shown in Fig. 6, the pivot **34** extends entirely through the bore **36** and is supported at opposite ends of the bore by bearings **40** and **42**.

The specific structure which carries the support **38** will be hereinafter described in detail, but it is sufficient to say here that it is supported to position the buffing and polishing element 26 for proper engagement with a workpiece designated generally at 44.

It will be readily apparent that the pivots 28 are disposed at right angles to the rotational axis of the buffing and polishing element 26 and that the pivot 34 is disposed at right angles to both the pivots 28 and the rotational axis of the element 26. Further it will be observed that the pivots 28 and 34 collectively comprise a universal mounting for the head 20; i. e., they mutually co-operate to permit the head to pivot in any direction as required to position the head 20 so as to effect proper engagement of the element 26 with the surface of the work 44.

According to the present invention, oscillatory movement of the head 20 about the axes of pivots 28 is damped by a device 46 and oscillatory movement of the yoke 32 about the axis of pivot 34 is similarly damped by a corresponding device 48. The devices 46 and 48 are identical in construction and a detailed description of one only therefore is given. In this connection, attention is directed to Fig. 2 which shows in detail the construction and illustrates the operation of the damping device 48.

The device here shown comprises an elongated cylinder 50 arranged transversely and above the bore 36 and fastened securely to a flange 52 on support 38 by cap screws 54. A semi-cylindrical housing 56 formed integrally and extending downwardly from the cylinder 50 communicates with the interior of the cylinder and with the bore 36. The terminal portion of shaft 36 extends into housing 56 and the portion of the shaft within the housing carries a pinion 58 that meshes with a rack 60 on a piston 62 supported for reciprocation in the cylinder 50 by a sleeve 64. Thus, oscillation of yoke 32 causes pivot 34 to rock back and forth, and rocking movement of the pivot acts through pinion 58 and rack 60 to reciprocate piston 62.

In order to damp oscillations of the yoke 32, hollow caps 66 and 68 are attached to the ends of cylinder 50. The particular caps 66 and 68 here shown are cylindrical in form and they are attached to the cylinder 50 by cap screws 70 which extend through flanges 72 at the attached ends of the caps and into threaded holes provided in the ends of the cylinder 50. As shown in the drawings, the internal diameter of the caps 66 and 68 is less than the internal diameter of the cylinder 50 so that the caps also provide internal abutments which retain the sleeve 64. Preferably, however, the ends of the sleeve 64 are spaced slightly from the ends of the caps and suitable seals such as O rings 74 are interposed therebetween. Since the O rings 64 fit snugly between the ends of sleeve 64 and the ends of caps 66 and 68, they assist in retaining the sleeve and also seal the joints between the sleeve, cylinder and caps.

The caps 66 and 68 normally are filled with oil or other suitable hydraulic liquid which is introduced therein through openings in the tops of the caps, which openings normally are closed by removable plugs 76. In order to permit reciprocation of the piston 62, it is provided with a passage 78 which extends axially entirely therethrough. Thus hydraulic liquid in the caps 66 and 68 is displaced through the passage 78 upon reciprocation of the piston, and the reciprocatory travel of the piston is of course restricted by the size of the passage 78. In this manner the piston is permitted to reciprocate at a controlled rate and by controlling reciprocation of the piston oscillatory movements of the yoke 32 in both directions are effectively damped.

In order to selectively control the damping effect of the device 48, the piston 62 is provided with a needle valve 80 which projects into and controls flow through the passage 78 in the usual way. The needle valve 80 is held in a selected adjusted position by a lock nut 82. Access is had to the needle valve for adjustment through an opening 84 in the cylinder 50 and sleeve 64, and the opening normally is closed by a cover 86 removably attached to the cylinder by cap screws 88.

As perhaps best shown in Fig. 6, the damping device 46 is attached to one arm of the yoke 32 by cap screws 90, and the pivot 28 associated with the mentioned arm is longer than the other pivot 28 so that it extends into the housing 56 and carries a driving pinion 58 to operate the damping device in the same manner as pivot 34. It is contemplated that the damping device 46 be attached to either of the pivots 28, the pivot selected depending upon the exigencies of the particular situation.

In the particular form of the invention here shown by way of illustration the workpiece 44 has an inclined leading edge 92 and a flat top surface 94. Thus the buffing head 20 must assume the position shown in broken lines in Fig. 1 preparatory to engaging the workpiece; and as the workpiece moves under the head, the buffing and polishing element 26 rides upwardly onto the flat top surface 94. As element 26 moves onto the top surface 94, it assumes the full-line, horizontal position illustrated in Fig. 1, and the carrier 38 pivots to accommodate upward movement of the head. If it is assumed that the horizontal top surface 94 extends to the rearward end of workpiece 44 it will be apparent that the head 20 will be positioned horizontally when the workpiece moves out from under it. The weight of head 20 will then cause the support 38 to pivot downwardly for proper initial engagement with a succeeding workpiece. In order to pivot the head 20 from a horizontal to the inclined, initial position shown in broken lines in Fig. 1, a rod 96 is provided on the housing 22 at one side thereof, which rod carries a weight 98. As perhaps best shown in Fig. 6 the weight 98 is disposed substantially in front of the pivotal axis of head 20 so that it acts at all times to urge the head to the broken-line position. Preferably, the weight 98 is adjustable on rod 96 and it is held in a selected adjusted position in any suitable manner as by a set screw 100. Tilting of the head 20 under the influence of weight 98 is limited by an adjusting screw 102 carried by and extending downwardly from an inwardly projecting lug 104 on the yoke 32 (Fig. 6).

Similarly, if the surface acted upon by the head 20 slopes to one side or the other, it is necessary for the yoke to rock about the axis of pivot 34 in order to maintain the buffing and polishing element 26 flatly engaged with the work and it is necessary to position the head angularly to one side or the other, depending upon the direction of slope of the surface to be buffed and polished.

To this end the yoke 32 is provided with embossments 106 and 108 at opposite sides thereof and the embossments have threaded holes (not shown) adapted to receive a rod 110 which carries a weight 112. For reasons set forth above, the weight 112 preferably is adjustable on rod 110, and it is held in a selected position on the rod by a set screw 114. The rod 110 is here shown screwed into embossment 106.

It is, of course, not desirable for the weight 112 to pull the head 20 all the way around. Oscillatory movement of the yoke 32 therefore is limited by adjusting screws 116 and 118 carried by lugs 120 and 122 which extend rearwardly from the yoke at opposite sides of the pivot 34. Screws 116 and 118 engage stops 124 and 126 respectively on the support 38. In the arrangement here shown, the weight 112 normally tends to pivot the head 20 until adjusting screws 116 engage the stop 124, but the head can pivot freely within limits defined by screws 116 and 118.

The particular mounting for support 38 here shown permits vertical and angular bodily adjustment of the buffing head 20. More particularly, the support 38 is carried by and pivoted to a yoke 128. The yoke 128 embraces the support 38 and the latter is provided with pivots 130 which are journaled in bearings 132 mounted in bearing retainers 134 at the ends of the yoke arms. The yoke 128 in turn is mounted for angular adjustment on a shaft 136 carried by a vertically movable slide 138 and is held securely in a selected, angularly adjusted position by a nut 140 threaded on the shaft 136. The slide 138 has a dovetail groove 140 forming a way which receives a correspondingly shaped guide 142 on a vertical, platelike support 144. Guide 142 has a longitudinal groove 146 and a lug 148 which extends into the groove substantially midway between the ends of the support 144. Slide 138 has an inwardly extending lug 150 at the upper end thereof which carries an adjusting screw 152 and the screw extends through and threadedly engages the lug 148 as shown in Fig. 1. Manifestly, the slide 138 can be either raised or lowered on the support 144 depending upon the direction of rotation of the screw 152. An adjustment of the slide in this manner positions the head 22 vertically for proper initial engagement with the work 44.

The support 144 here shown is attached to and is horizontally adjustable on a transverse beam 154, and adjustment of the plate on the beam 154 moves the entire apparatus bodily transversely of the work 44 to position the buffing head 20 for proper engagement with a predetermined portion of the work. The weight of the head 20 preferably is counterbalanced so that it easily follows the contour of the work and so that the pressure exerted by the head against the work can be selectively regulated. To this end the support 38 is provided with rearwardly extending rods 156 that carry weights 158. The weights are adjustable on the rods 156 and are held in selected, adjusted positions by set screws 160. In operation, the weights 158 are adjusted so as to be overcome by the head 20 and so that the polishing element 26 exerts the desired pressure on the work 44.

In addition to the above, it is desirable to provide some means for damping downward movement of the head 20 so that it will not come down too fast or with much of a jerk. The damping means should be such, however, that very little, if any, resistance is offered to upward movement of the head 20.

The particular damping means 161 here shown comprises a cylinder 162 pivotally attached at 164 to a bracket 166 extending outwardly from the yoke 128 and provided with a piston (not shown) having a depending piston rod 168 pivotally attached at 170 to the support 38. Movement of the piston within cylinder 162 is controlled by a hydraulic circuit comprising a pipe 172 extending from the upper end of the cylinder, pipe 174 extending from the lower end of the cylinder, and a pipe 176 interconnecting pipes 172 and 174. Pipe 174 is controlled by a check valve 178 which seats downwardly as shown in Fig. 4. Also, pipe 174 is provided with a by-pass 180 around the check valve, which by-pass is controlled by a needle valve 182. A reservoir 184 having a removable cover 186 is connected to the system at the juncture of pipes 172 and 176. The cylinder 162 and connecting pipes normally are filled with hydraulic liquid, and an excess supply of liquid is provided in the reservoir 184 according to conventional practice to replenish any liquid lost from the system. Liquid in the reservoir 184 may be replenished from time to time as required.

When the head 20 pivots downwardly after disengaging the work 44 it pulls the piston downwardly in cylinder 162. Fluid trapped below the piston is displaced to the cylinder above the piston through by-pass pipes 172, 174, and 176. However, by reason of the fact that check valve 178 seats downwardly, fluid traversing the pipes in the manner described tends to seat the valve so that the fluid is forced to by-pass through the needle valve 182. The needle valve 182 is adjusted so that the fluid is displaced at a control rate and thus regulates lowering of the head 20. On the other hand, when the head is raised, little, if any, resistance is offered to fluid traversing pipes 172, 174, and 176 caused by the piston rising in cylinder 162. When the hydraulic liquid is displaced from the top to the bottom of the cylinder it exerts a pressure against check valve 178 tending to open the latter, thus by-passing the needle valve 182. The check valve 178 is adjusted to offer very little resistance to flow of the liquid so that the damping mechanism offers little resistance to upward movement of the head 20.

Operation of the apparatus will be apparent from the above. The head 20 is positioned properly vertically and angularly for engagement with the work 44 by adjusting the slide 138 and yoke 128. Once this adjustment has been made, no further adjustments are required as long as the workpiece remains the same. As the workpieces pass successively under the head 20 the latter rides on and intimately contacts the surface of the work so as to buff and polish that portion engaged by the element 26. A substantially uniform pressure is exerted on the work at all times to assure uniform processing of the surface. Of particular significance as far as the present invention is concerned is the fact that the buffing element 26 is prevented from wobbling when changing its position on the head by damping oscillatory movement in both directions of the universal mounting which supports the head. When the apparatus is constructed as shown in the drawings, the element 26 flatly engages the work at all times even though the surface traversed thereby is irregular in shape and even though there may be abrupt changes in the height, inclination, or altitude of the surface.

Attention is now directed to Figs. 7–12 which show a modified form of the invention. The modification utilizes a buffing head 20 identical to the one described in connection with the first form of the invention, and the motor housing 22 is bolted or otherwise secured to a plate 27 having pivots 28. A rectangular frame 200 is provided around the motor housing 22, and the pivots 28 are journaled in bearings 202 provided at diametrically opposite sides of the frame. The frame 200 in turn is disposed between and pivotally attached to the ends of an inverted U-shaped frame 204. Specifically the rectangular frame 200 is provided with pivots 206 (Fig. 9) disposed at diametrically opposite sides thereof and arranged at right-angular relation with respect to pivots 28, and the pivots 206 are received in bearings 208 at the ends of frame 204. Manifestly, the two sets of pivots 28 and 206 collectively provide a universal mounting for the buffing and polishing head 22.

The assembly described above is supported by upper and lower pairs of parallel links 212 and 214. The upper pair of links 212 are pivoted at one end to the depending arms of the frame 204 substantially midway between the ends of the arms, and the lower links 214 carry bearings 216 which receive the pivots 206 as shown in Fig. 9. Links 212 and 214 also are pivoted to a vertical plate 218 which is attached to a vertically movable slide 220. The slide 220 is equipped at the upper end thereof with an eyebolt 222 to which a hoist or the like can be attached for assembling or maneuvering the apparatus. The slide 220 travels on a vertical guide 224 and vertical adjustment of the slide is accomplished by an adjusting screw 226. As perhaps best shown in Fig. 7, the screw 226 is carried by a lug 228 on the guide and it extends through and threadedly engages a lug 230 on the slide 220.

The guide 224, in turn, is journaled on a trunnion 232 carried by and projecting forwardly of a vertical supporting plate 234. Rotative adjustment of the guide 224 is accomplished by means of an adjusting screw 236 carried by a lug 238 (Fig. 7 and Fig. 11) on the support 234 and extending through and threaded to a lug 240 at the upper edge of the guide 224. The guide 224 is held in a selected, rotatably adjusted position by nuts 342 on studs 344 carried by the support 234 and extending through arcuate slots 346 in the guide 224.

The support 234, in turn, is mounted on a horizontal beam 348. In order to move the entire apparatus bodily in a horizontal direction, the support 234 is adjustable along the beam 348 and it is held in a selected, adjusted position by clamping bars 350 and bolts 352. From the foregoing it will be apparent that the head **20** can be initially positioned horizontally, vertically, and angularly for proper engagement with the workpiece.

As in the form of the invention first described, means is provided for counterbalancing the weight of the head **20** and in this form of the invention the means comprises rearward extensions **354** on the bottom links **214**. The rearward terminal portions of these extensions are bridged by a connecting plate **356** and suitable weights **358** are fastened to the supporting plate **356** by bolts **360** and nuts **362**. The weights **358** are removable and any desired number of weights may be used as required to properly counterbalance the head **22**.

In addition to the above, it will be apparent that the head **20** and its adjuncts are free to move up and down by pivotal movement of the parallel links **212** and **214** so that the head **22** remains at all times in proper engagement with the work regardless of irregularities in the surface being processed.

As perhaps best shown in Fig. 7, the head is permitted to rise substantially without restriction, and downward movement of the head is tensioned by a damping means **161** identical to the corresponding mechanism identified by the same numeral in the form of the invention first described. The damping means **161** is suspended from a mounting bracket **364** on plate **218** and the piston rod **168** is fastened to a pin **366** on one of the bottom links **214**.

Means also is provided for damping oscillatory movements of the universal mounting for the buffing head **22** in both directions; i. e., in both a clockwise and a counterclockwise direction. As in the form of the invention described first, damping of the oscillatory motion in this manner is essential in order to prevent wobbling of the buffing and polishing element **26**.

Oscillation or rocking movement of the frame **200** about pivots **206** is damped in both directions by damping means designated generally by the numeral **368**. For a detailed description of the damping device reference is had to Fig. 12 wherein the numeral **370** designates a vertical cylinder having a piston **372** mounted for reciprocation therein. The piston rod **374** extends downwardly through the lower end of the cylinder **370**, and a packing **376** is provided to seal the joint between the cylinder and the piston rod. Extending horizontally from the upper end of the cylinder is a pipe **378** provided with an upwardly opening check valve **380**. Similarly a pipe **382** extends from the lower end of cylinder **370**, and this pipe is provided with an upwardly opening check valve **384**. A vertical pipe **386** connects the outer ends of pipes **378** and **382**. The check valve **380** is by-passed by a pipe **388** and the by-pass is controlled by a needle valve **390**. Check valve **384** is similarly by-passed by a pipe **392** controlled by a needle valve **394**.

The cylinder **370** normally is filled with hydraulic liquid both above and below the piston **372**, and the system of pipes connected to the cylinder also are normally filled with the hydraulic liquid. A reservoir **396** is connected to the upper end of pipe **386** at the juncture thereof into pipe **378** to maintain the system normally filled and to replenish any liquid lost from the system. Additional liquid may be supplied to the reservoir from time to time as required through an opening **398**.

The cylinder **370** has an upstanding lug **400** which is fastened to a bracket **402** on the U-shaped frame **204** by a pivot **404**. The lower end of piston rod **374** is fastened to the rectangular frame **200** laterally of pivots **206** by a pivot **406**. When the frame **200** tends to rock or oscillate on pivots **206** the device **368** effectively damps its movement in both directions. For example, when the frame **200** attempts to oscillate in a counterclockwise direction as viewed in Fig. 7, it tends to push the piston **372** upwardly in cylinder **370**. However, piston **372** can move in cylinder **370** only if fluid is displaced from above to below the piston. Manifestly, fluid can be displaced only through the connecting pipes **378**, **382**, and **386**. These pipes, however, are controlled by valves which regulate displacement of the liquid. When the piston is rising, liquid discharging from the upper end of the cylinder tends to close check valve **380** so that it can reach pipe **386** only through the needle valve **390**. However, after traversing the needle valve **390**, the liquid flowing to the lower end of cylinder **370** tends to open check valve **384** so that the latter offers little, if any, resistance thereto. Thus, when the piston is rising in the cylinder, its rate of travel is controlled by needle valve **390**. On the other hand, when piston **372** is moving downwardly in cylinder **370**, liquid discharged from the lower end of the cylinder tends to seat check valve **384** so that it can reach the vertical pipe **386** only through needle valve **394**. In this manner, the needle valve **394** controls the rate of discharge from the cylinder **370** and thus the rate of travel of the piston **372** in the cylinder. Fluid charged to the upper end of the cylinder **370** tends to unseat check valve **380** so that little, if any, resistance is offered to the liquid.

From the foregoing, it will be readily apparent that as needle valve **390** controls upward movement of the piston, and as needle valve **394** controls downward movement thereof, oscillatory movement of the frame **200** is effectively damped regardless of which direction it attempts to rotate. Further, the needle valves **390** and **394** can be independently adjusted so that the oscillations of the frame **200** are independently damped according to the exigencies of the particular situation.

Similarly, oscillatory movement of the head **22** in the frame **200** is effectively damped by a device **408** (Fig. 8) which is identical in every respect to the damping device **368**. Accordingly, in order to avoid unnecessary repetition the several parts of the damping device **406** are identified by the same numerals as the corresponding parts in damping device **368**. Referring again to the device **408**, it will be observed that the upper end of cylinder **370** is provided with a bracket **410** which is fastened to the upper horizontal arm **412** of a bell crank **414** by a pivot **416**. The bight portion of the bell crank **414** is pivotally attached at **418** to a mounting bracket **420** on the U-shaped frame **204**. The depending vertical arm **422** of the bell crank **414** carries a forked plate **424**, and the arms of the fork embrace an upwardly arched rod **426** which spans the motor housing **24** and is attached at its ends to the mounting plate **27**.

By reason of the above construction, oscillatory movement of the head **20** on pivots **28** is transmitted to the damping device **408** through the rod **426** and bell crank **414**, and the device **408** operates in the same manner as the damping device **368** to damp oscillations of the head in both directions.

It will thus be apparent that I have achieved the objects of my invention. I have provided a buffing and polishing apparatus that is entirely automatic in operation and that can be adjusted vertically, horizontally, and angularly to position the buffing and polishing element for proper engagement with the work. Also I have provided an apparatus of this character wherein the buffing head is mounted for universal movement so that the polishing element is free to follow the contour of the workpiece. Perhaps most important also, however, is the discovery that wobbling of the buffing and polishing head is effectively prevented by damping oscillatory movements of the universal mounting in both directions and the provision of means for damping the movements. When oscillatory movement of the buffing head is controlled in the manner described, wobbling is absolutely prevented and the buffing and polishing element is held in flat pressed engagement with the surface of the work at all times.

Having thus described the invention, I claim:

1. In apparatus of the character described, a buffing head having a rotatably driven buffing element, a pivot

extending from the head at right angles to the rotational axis of the buffing element, a carrier receiving and rotatably supporting said pivot, a pivot extending from the carrier at right angles to said first-mentioned pivot and at right angles to the rotational axis of the buffing element, a support receiving and rotatably supporting said last-mentioned pivot, and means for damping oscillatory movement of each pivot in both directions about the pivot axis, each of said damping means comprising a cylinder-and-piston assembly disposed at right angles to its respective pivot, the cylinder being fixed relative to its pivot and having liquid-filled chambers at opposite ends of the piston and the latter being reciprocable in the cylinder and provided with a restricted passage extending longitudinally entirely therethrough, pinions on the ends of the pivots and racks on the pistons engaged by the pinions and operative to translate oscillatory movement of the pivots into reciprocatory movement of the pistons.

2. In apparatus of the character described, a buffing head having a rotatably driven buffing element, a pivot extending from the head at right angles to the rotational axis of the buffing element, a carrier receiving and rotatably supporting said pivot, a pivot extending from the carrier at right angles to said first-mentioned pivot and at right angles to the rotational axis of the buffing element, a support receiving and rotatably supporting said last-mentioned pivot, and means for damping oscillatory movement of each pivot in both directions about the pivot axis, each of said damping means comprising a cylinder-and-piston assembly disposed at right angles to its respective pivot, the cylinder being fixed relative to its pivot and having liquid-filled chambers at opposite ends of the piston and the latter being reciprocable in the cylinder and provided with a passage extending longitudinally entirely therethrough, means for controlling displacement of liquid in said chambers through said passage, pinions on the ends of the pivots and racks on the pistons engaged by the pinions and operative to translate oscillatory movement of the pivots into reciprocatory movement of the pistons.

3. In surface finishing equipment of the type in which a rotary surface finishing tool is required to contact surfaces of a series of work pieces advanced therepast in which portions of said surfaces extend at different inclinations so as to require universal angular movement of said tool to accommodate said tool to the surfaces of the work pieces, a tool supporting head including rotary mechanism of substantial mass rotatable at relatively high speed about a first axis, a carrier to which said head is pivoted for angular movement about a second axis perpendicular to said first axis, a support to which said carrier is pivoted for angular movement about a third axis perpendicular to said second axis, damping means operably connected between said head and said carrier effective to oppose relative angular movement therebetween in either direction, and damping means operably connected between said carrier and said support to oppose relative angular movement therebetween in either direction, said damping means comprising dash pots.

4. Structure as defined in claim 3 in which said dash pots include cylinders, pistons movable in said cylinders, restrictive passages through said pistons, and means for adjusting the restrictions of said passages.

5. In surface finishing equipment of the type in which a rotary surface finishing tool is required to contact surfaces of a series of work pieces advanced therepast in which portions of said surfaces extend at different inclinations so as to require universal angular movement of said tool to accommodate said tool to the surfaces of the work pieces, a tool supporting head including rotary mechanism of substantial mass rotatable at relatively high speed about a first axis, a carrier to which said head is pivoted for angular movement about a second axis perpendicular to said first axis and intersecting said first axis within said head, a support to which said carrier is pivoted for angular movement about a third axis perpendicular to said second axis and intersecting said second axis within said head, damping means operably connected between said head and said carrier effective to oppose relative angular movement therebetween in either direction, damping means operably connected between said carrier and said support to oppose relative angular movement therebetween in either direction, and mounting means mounting said support for swinging movement about a fourth axis perpendicular to said first axis and remote from said head.

6. Structure as defined in claim 5 which comprises means for angularly adjusting said mounting means about a fifth axis perpendicular to said fourth axis.

7. Structure as defined in claim 6 which comprises means for adjusting said mounting means toward and away from the path of advance of the series of work pieces.

8. In apparatus of the character described, a power operated buffing head including a rotary member of substantial mass rotatable at high speed about an axis of rotation and movable laterally of its axis of rotation over an irregular surface of a work piece, first support means mounting said head for pivotal movement about a first swivel axis perpendicular to the axis of rotation, second support means mounting said head for pivotal movement about a second swivel axis perpendicular to the axis of rotation and to said first swivel axis, said head being movable about both of said swivel axes during a buffing operation to allow said member to conform itself to irregular surfaces of a work piece, and separate energy absorbing damping means respectively operatively connected to said first and second support means to resist movement of said head about both of said swivel axes, said damping means each comprising means containing a hydraulic fluid, means causing a flow of fluid in accordance with movement of said head about its related swivel axis, and means for restricting the flow of fluid resulting from movement of said head about its related swivel axis to oppose a resistance to such flow.

9. Structure as defined in claim 8 in which the means for restricting the flow of fluid resulting from movement of said head about one of said swivel axes comprises separately adjustable means for restricting flow resulting from movement of said head in opposite directions about said one swivel axis.

10. In surface finishing equipment of the type in which a rotary surface finishing tool is required to contact surfaces of a series of work pieces advanced therepast in which portions of said surfaces extend at different inclinations so as to require universal angular movement of said tool to accommodate said tool to the surfaces of the work pieces, a tool supporting head including rotary mechanism of substantial mass rotatable at relatively high speed about a first axis, a carrier to which said head is pivoted for angular movement about a second axis perpendicular to said first axis, a support to which said carrier is pivoted for angular movement about a third axis perpendicular to said second axis, damping means operably connected between said head and said carrier effective to oppose relative angular movement therebetween in either direction, and damping means operably connected between said carrier and said support to oppose relative angular movement therebetween in either direction, said damping means comprising means for forcing fluid to flow through a closed system, and separately adjustable restrictive ports in each damping means effective to control flow of fluid in both directions in said system.

11. In surface finishing equipment of the type in which a rotary surface finishing tool is required to contact surfaces of a series of work pieces advanced therepast in which portions of said surfaces extend at different in-

clinations so as to require universal angular movement of said tool to accommodate said tool to the surfaces of the work pieces, a tool supporting head including rotary mechanism of substantial mass rotatable at relatively high speed about a first axis, a carrier to which said head is pivoted for angular movement about a second axis perpendicular to said first axis, a support to which said carrier is pivoted for angular movement about a third axis perpendicular to said second axis, damping means operably connected between said head and said carrier effective to oppose relative angular movement therebetween in either direction, and damping means operably connected between said carrier and said support to oppose relative angular movement therebetween in either direction, each of said damping means comprising a hydraulic system including a piston and cylinder movable in said piston in a direction dependent upon the direction of relative angular movement between the head and carrier or carrier and support to which the particular piston and cylinder is operably connected, a separately adjustable restrictive orifice effective to control flow of fluid out of either end of said cylinder, and valve means

in said system operable to selectively by-pass said orifices in accordance with the direction of relative movement of the piston and cylinder.

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