

March 15, 1938.

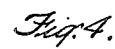
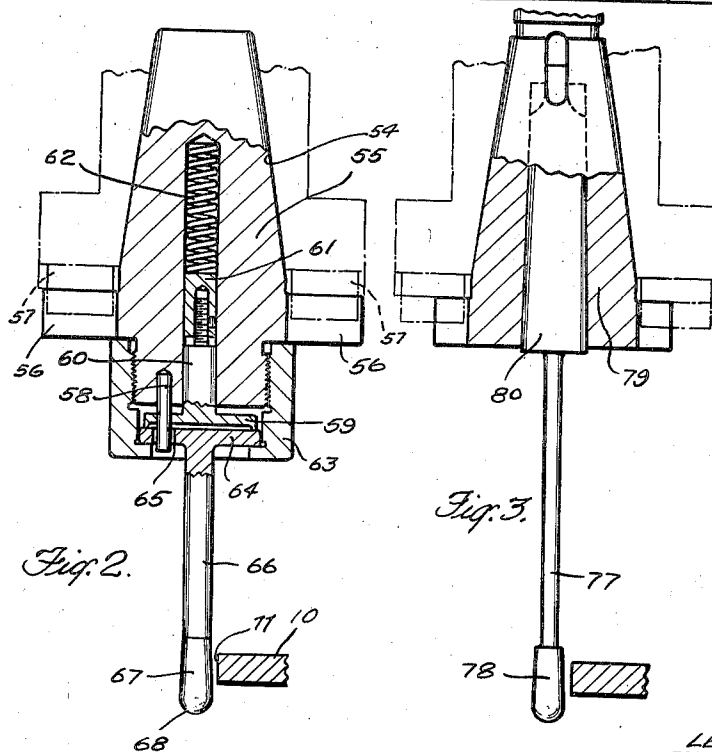
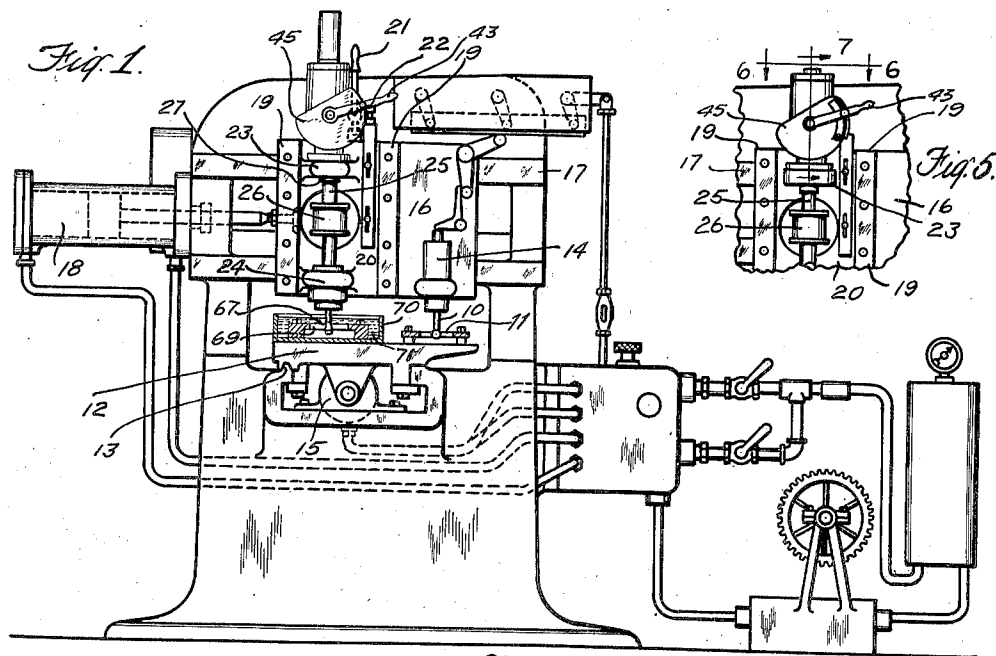
L. F. NENNINGER

2,111,271

APPARATUS FOR LAPPING

Filed July 12, 1935

2 Sheets-Sheet 1



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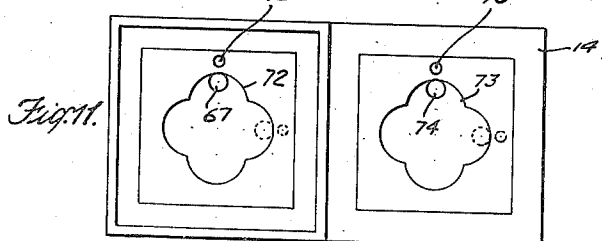
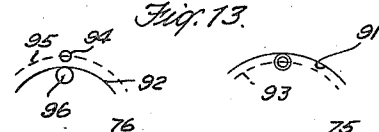
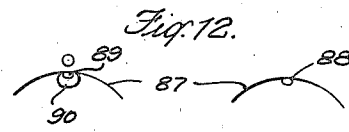
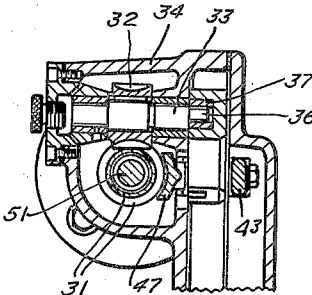
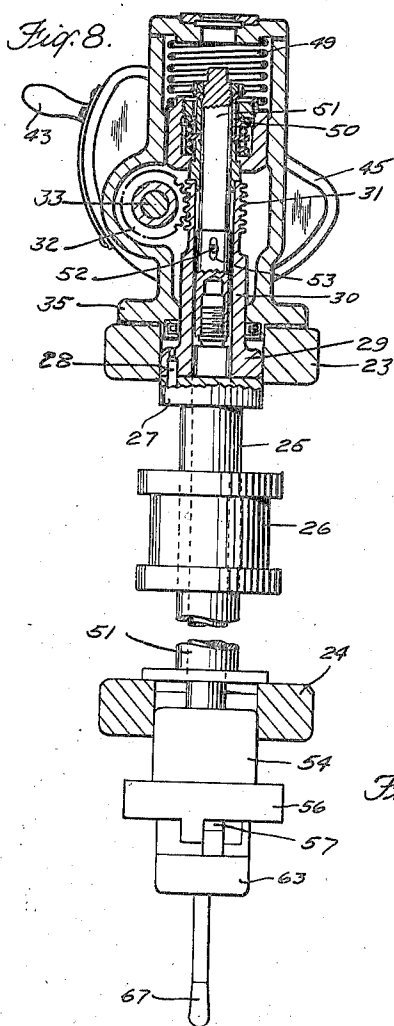
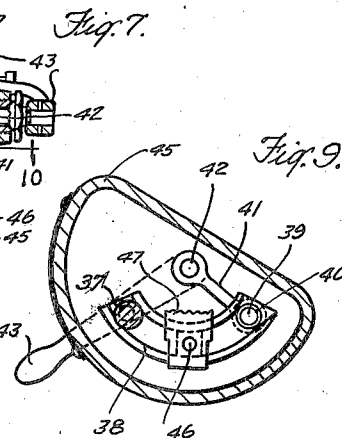
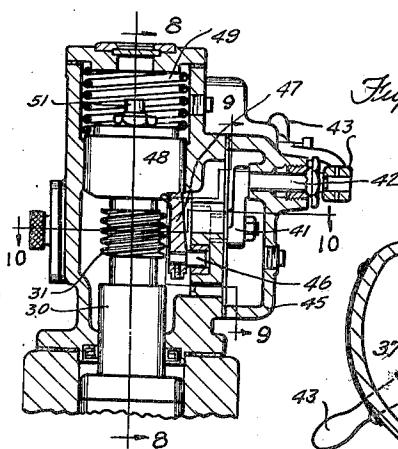
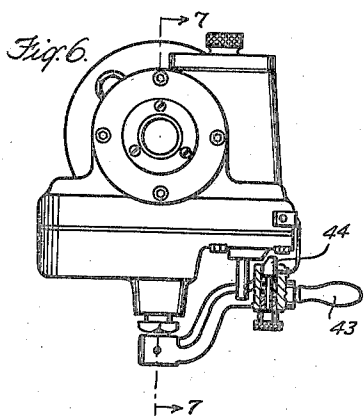
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2,111,271

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2 Sheets-Sheet 2



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2,111,271

APPARATUS FOR LAPPING

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Application July 12, 1935, Serial No. 30,995

16 Claims. (Cl. 51—100)

This invention relates to abrasion and more particularly to lapping, and its more specific features are best suited to the lapping of dies and the like.

One of the objects thereof is to provide apparatus of the above nature of simple and practical construction. Another object is to provide apparatus of the above nature of efficient and reliable action. Other objects are to provide practical apparatus of the above nature which shall be automatic in action, capable of a high speed of production, accurate, and suitable for use by unskilled labor. Another object is to provide a practical art of the above nature which can be easily practiced with dependable results.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of one or more of the same with respect to the others, all as will be illustratively herein described and the scope of the application of which will be indicated in the claims.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several mechanical features of this invention,

Figure 1 is a front elevation of a machine, certain parts being broken away in order to show the construction more clearly;

Figure 2 is a detailed elevation of a tool holder and related parts partially cut away along an axial line;

Figure 3 is a similar view of a slightly different embodiment of these parts;

Figure 4 is a similar view showing a lapping tool coacting with a somewhat different form of work;

Figure 5 is a detailed view of the mechanism for causing an axial reciprocation of the tool spindle;

Figure 6 is a detailed plan of the parts shown in Figure 5;

Figure 7 is a sectional elevation along the line 7—7 of Figure 6;

Figure 8 is a sectional elevation along the line 8—8 of Figure 7;

Figure 9 is a sectional elevation along the line 9—9 of Figure 7;

Figure 10 is a sectional plan along the line 10—10 of Figure 7;

Figure 11 is a diagrammatic plan indicating relation of tool and tracer to the coacting parts;

Figure 12 is a diagrammatic plan showing the relation of these parts in modified form; and

Figure 13 is a similar view showing another modification of the relation of these parts.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to Figure 1 of the drawings, there is shown in general a machine such as is shown and described in United States patent to Anderson No. 1,952,230 issued March 27, 1934. The construction and action of the controlling and feeding parts of this machine is that disclosed in the said patent to Anderson, and it will suffice to note in general terms that a tracer 10 coacts with a form or master 11 mounted upon a bed 12 slidable on ways 13 in such manner that the end of the tracer will follow the surface of the master with which it contacts by an automatic control of the direction of relative movements of these parts. The tracer member 10 has a normal deflection or inclination from the axis of the mechanism 14 and any lessening or increase of this angle of deflection will correspondingly lessen or increase the components of relative movement of these parts so as to restore the normal degree of deflection. The bed 12 is hydraulically actuated as by the cylinder 15 in a direction toward and away from the vertical plane of the head 16 upon which the tracer is supported, and this head is slidably mounted for movement in a transverse direction; that is, to the right or left with respect to Figure 1, on the ways 17, being actuated by the hydraulic cylinder 18. The amount and direction of change of inclination of the tracer 10 governs the movements as well as rate and direction of movement of the table 12 and head 16, and accordingly causes the tracer to maintain its following contact with the surface of the master as above set forth.

Mounted upon head 16 and vertically adjusted thereon in the guides 19 is a slide 20. This vertical adjustment is brought about as by a hand lever 21 and is limited as by the set screw 22 in the well-known way. Slide 20 is provided with bearings 23 and 24 for a driving sleeve 25, as best shown in Figure 8 of the drawings. This sleeve is driven by the pulley 26 and provided at its upper end with a flange 27 connected as by pin 28 with a flange 29 upon an extension sleeve 30. Sleeve 30 is provided with a worm 31 coacting with a worm wheel 32 which drives a short cross-shaft 33 journaled in a frame 34 which is mounted by a suitable flange 35 upon the upper portion of bearing 23.

At the end of shaft 33, as best shown in Figure 10 of the drawings, is an eccentric pin 36 having a roller 37 mounted thereon and fitted within a curved oscillating channel 38. The pivot 39 about which the channel or grooved arc 38 oscillates is provided by a pin 40 upon the arm 41 of a rock shaft 42 best shown in Figures 7 and 9 of the drawings. This shaft is swung by the hand lever 43 the position of which is controlled by a detent or latch 44 coacting with suitable mechanism upon the casing 45 so that its position may be adjusted and held.

The shaft 42 is at the center of curvature of the grooved channel 38, and accordingly the pin 39 may be swung throughout the length of the channel and by its position determines the stationary axis about which the channel will be oscillated. Accordingly, by swinging this pin into any certain position, such as that indicated by the pin 46, the latter will be unaffected by the eccentric 36, but as the pin 39 is swung away from alignment with the pin 46, the latter will be reciprocated vertically throughout a path which is proportional in length to the remoteness of the position into which pin 39 has been moved. Accordingly, as hand lever 43 is swung, the pin 46 is either stopped or is vertically reciprocated with a stroke dependent in length upon the position into which the lever is moved.

Pin 46 is mounted in a depending lug 47 upon a plunger 48 urged downwardly by a spring 49 and connected as by a thrust bearing 50 with a spindle 51. This spindle is driven by the pin 52 which rests in slots 53 in opposite walls of the sleeve extension 30. In this manner the spindle 51 is rotated by the sleeve driven from pulley 26 and yet has a vertical oscillation controlled, as above set forth, by the position of the hand lever 43.

The lower end of the spindle terminates in a driving nose or socket 54 into which the tapered end 55 of the tool is thrust. This tool is provided with wings 56 on opposite sides which fit into corresponding diametrical grooves 57. From the tapered end portion 55 extends downwardly a driving pin 58 which has a sliding fit through a flange 59 upon a plunger 60, the adjustable extension 61 of which rests against a spiral compression spring 62. Threaded about the lower portion of the member 55 is a flanged cap 63 supporting by its lower flange the disk 64 formed on the tool member. This disk is loosely mounted within the cap 63 so that it may rock in any direction, and such rocking or tilting movement forces upwardly the flange 59 and adds to the compression of the spring 62. The driving pin 58, passing loosely through the opening 65, maintains the rotary drive on the tool which is here shown as comprising the shank 66 and lapping lower end 67 which is provided with a hemispherical lower surface 68.

Referring back to Figure 1, the active portion 67 of the tool is shown as coacting with the surface 69 of a blanking die secured in position on the table. There is preferably mounted or formed upon the table wall 70, constituting a tank or receptacle, in which the die is positioned, the connections being tight so that this receptacle may be filled with a suitable lapping fluid, as indicated at 71. Thus the work and active portion of the tool may be continuously subject to the fluid, whereby the action is rendered more efficient.

It is to be understood that the active surface 69 of the work corresponds closely to the guid-

ing surface of the form or master at 11, and inasmuch as both tracer and tool are mounted upon the same slide, they partake of the extent and rate of motion of this slide. The same being true of the mounting of the work and master upon the table 12, it will follow that the relative movement of tool and work is substantially identical with the relative movement of tracer and master.

The work illustratively shown is a blanking die the surface of which is to be lapped, but it will be readily understood that work of various shapes and types may be effectively handled on this machine. It is also to be understood that although the above apparatus is best suited for lapping, nevertheless certain of its advantageous features are utilized in which a more pronounced abrasive action is involved. Accordingly the term "abrasive" is used herein with a broad significance to include not only lapping but grinding; whereas, the term "lapping" is to be given its commonly accepted meaning.

In the use of this apparatus, the work and master or form are mounted upon the table 12 and secured in position, and the work preferably submerged with a suitable lapping liquid. The lapping tool at its active lower end is then brought into engagement with the surface to be lapped; whereas the tracer at the same time contacts with its normal inclination the corresponding portion of the surface of the form or master. The machine then being in action, the deflection of the tracer will result in a corresponding deflection of the lapping tool with respect to the vertical axis of its tapered shank. This is illustrated in Figure 11 of the drawings in which the curved figures 72 and 73 indicate respectively the plan of the surface to be lapped and the corresponding guiding surface of the master. In this Figure 11 there is indicated at 74 the lower end of the tracer member; whereas, at 75 there is indicated the axis of the tracer casing 14, these parts being offset in plan due to the inclination or deflection of the tracer finger. Accordingly, if 76 indicates the axis of the shank of the tool, its active lower end would be indicated at 67, and this deflection or tilt, by reason of the additional compression of the spring 62, will cause the part 67 to press with any desired force against the surface which it contacts. As the tracer follows the master and as the tool follows the work, this pressure of the tool against the work will be maintained as indicated, for example, by the dotted circles at the right hand side of each portion of Figure 11.

Thus the tool member is rotated at any desired speed and simultaneously oscillated in a vertical direction to any desired extent and always pressed against the work with a resilient force which may be adjusted to the desired degree by a suitable adjustment of the plunger portion 61. Furthermore, this accurate control of movement and pressure is maintained throughout the most complex shapes and the lapping action is achieved automatically and accurately as well as at a high rate of speed. If a number of similar parts are to be lapped, this may be quickly brought about by simply withdrawing the table and substituting an unfinished for a finished piece of work.

If desired, a simpler form of tool may be employed as indicated in Figure 3. In this case the shank 77 is of spring metal tending to maintain the tool portion 78 in alignment with the axis of the tapered upper end 79, and the de-

flection caused by the above described action of the tracer finger will bring about the desired pressure against the work in the same manner as is done by the tilting head and spring mechanism of the arrangement shown in Figure 2. There are, however, certain advantages in the former construction.

In this Figure 3 construction, the part 79 is preferably arranged as an adaptor with an inner conical recess into which is fitted an inner conical shank 80 of the tool member, thus facilitating a change in type of tool employed.

Another form of tool is shown in Figure 4 of the drawings in which the active portion of the tool is of spherical shape, as indicated at 81, and thus will be adapted to work not only with its sides but with its end, as it would be called upon to do with work such as that indicated at 82. Although the hemispherical lower end 83 of the device shown in Figure 2 of the drawings would permit this action and its upward thrust be resisted by the spring 62, nevertheless the form of Figure 4 is somewhat simpler in which the resilient shank 83 terminates in a simpler plunger 84 compressing a spring 85 and having its downward movement limited by the threaded nipple 86.

It is to be understood that if desired the lapping tool may be controlled by a tracer which coacts with the master so as to give an automatic control in a vertical as well as lateral directions. This would, with a suitable vertical slide, give a corresponding movement of the lapping tool, but if desired the direct compression of the spring of the lapping tool, as in Figures 2 and 4, may be relied upon to give a suitable downward pressure so as to lap with the end of the tool even though the vertical movement is uncontrolled.

With a type of machine in which the tracer finger has its normal position in alignment with the axis of the tracer mechanism, instead of deflected as in that hereinbefore described, there may be employed an arrangement such as is shown in Figure 12 of the drawings. In this case, assuming that the curves 87 indicate the surface to be lapped and the guiding surface of the master, then the active end of the tracer would be indicated at 88 in line with the axis of the tracing mechanism. With this arrangement, there would be indicated at 89 the axis of the tapered upper end or shank of the tool device, but the active portion of the tool at 90 would be of considerably greater diameter than the diameter of the tracer finger. This excess of diameter would, in itself, cause a deflection of the lapping tool with respect to the axis of its upper portion and give a corresponding pressure against the work.

In Figure 13 is shown another way of accomplishing the result with apparatus in which the tracer finger is undeflected. In this case there is used a master whose active surface 91 is of a substantially larger radius of curvature than the active surface 92 to be lapped, assuming that it is an inner surface which is to be exposed to this action. If, on the other hand, it were an outer surface or male die, then the guiding surface of the master would be of less radius of curvature than that of the surface to be lapped. In this manner, while the tracer finger is maintained undeflected, as indicated at the right hand portion of Figure 13 and follows the dotted line 93, the axis of the upper portion of the tool at 94 will follow the line 95 identical with the line 93.

The active portion of the tool, indicated at 96, will accordingly be out of vertical alignment with the axis 94, and this deflection of the lower portion of the tool will give the desired pressure against the work.

In each of these forms the guidance of direction and maintenance of pressure are attained, and hence the broad idea of the invention will obviously be applicable to apparatus in which the tracer finger is normally in alignment with the axis of the tracer mechanism.

It will thus be seen that there is provided apparatus in which the several objects of this invention are achieved and in which the various advantageous features hereinbefore set forth are attained.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In apparatus of the general nature of that herein described, in combination, a deflectable lapping tool, means adapted to impart universal movement to said lapping tool, and resilient means adapted to cushion displacement of said tool with respect to its axis during its movement.

2. Apparatus of the general nature of that herein described comprising, in combination, a master and a corresponding work piece engaged respectively by a tracer and a lapping tool, means forming an operative connection between said tracer and said tool, both the tracer and the tool being deflectable from a normal position and the deflection of the tool being dependent upon the deflection of the tracer, the deflection of the tracer in turn being dependent upon the force with which it bears against the master, and means operatively connecting said tracer and said work piece whereby the pressure of the tool against the work is maintained at a substantially constant value.

3. Apparatus of the general nature of that herein described comprising, in combination, a work support reciprocable in one plane, a tool support reciprocable in another plane, a tool mounted on said tool support and reciprocable axially and adapted during its reciprocation to engage and operate upon a surface of a work piece mounted on said work support, and means associated with said tool support and said work support for automatically co-relating all of said reciprocations to maintain the engagement of said tool on said surface at a substantially constant pressure regardless of the configuration of said surface.

4. Apparatus of the general nature of that herein described comprising, in combination, a work support reciprocable in one plane, a tool support reciprocable in another plane, a rotatable tool reciprocable axially, means adapted to reciprocate said tool during its rotational engagement with a work piece mounted on said work support, means for varying at will the reciprocable stroke of said tool regardless of its operative condition, and means associated with said tool support and said work support for automatically co-relating all of said reciprocations to maintain the engagement of said tool on said surface regardless of the configuration of said surface.

5. Apparatus of the general nature of that herein described comprising, in combination, a work support reciprocable in one plane, a tool support reciprocable in another plane, a rotatable tool mounted on said tool support and adapted to engage and operate upon a surface of a work piece mounted on said work support, means including a master and a tracer associated with said work support and said tool support, said tracer being deflectable from a normal operative position, and means for relatively moving said work support and said tool support in their respective planes, said last mentioned means being responsive to deflection of said tracer whereby said tool operates upon said work piece surface at a substantially constant pressure.

6. Apparatus of the general nature of that herein described comprising, in combination, a master and a corresponding work piece engaged respectively by a tracer and a lapping tool, means forming an operative connection between said tracer and said tool, both the tracer and the tool being deflectable from a normal position and the deflection of the tool being dependent on the deflection of the tracer, the deflection of the tracer in turn being dependent on the force with which it bears against the master, means operatively connecting said tracer and said work piece whereby the pressure of the tool against the work is maintained at a substantially constant value, and means for reciprocating said tool during its engagement with said work piece.

7. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a lapping tool operatively associated with said work piece, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance with said effect, and means yieldingly urging said tool against a work piece mounted on said work support.

8. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a rotatable lapping tool operatively associated with said work support, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance with said effect, and means rendering said lapping tool deflectable from its fixed axis of rotation.

9. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a rotatable lapping tool operatively associated with said work support, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance

with said effect, and means for axially reciprocating said lapping tool as it rotates.

10. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a lapping tool operatively associated with said work support, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance with said effect, and a fluid tank disposed only about said lapping tool and said work piece, whereby the tracer and master move relative to one another outside of said fluid tank.

11. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a rotatable lapping tool operatively associated with said work support, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance with said effect, means rendering said lapping tool deflectable from its fixed axis of rotation, and means yieldingly urging said tool against said work piece.

12. Apparatus of the general nature of that herein described comprising, in combination, a work support, a master and a work piece of substantially identical configuration, said work piece being secured to said work support, a lapping tool operatively associated with said work support, a tracer operatively associated with said master, means for effecting relative universal planar movement between the master and tracer, means for transmitting the effect of said movement including means for relatively moving the work support and lapping tool in accordance with said effect, means yieldingly urging said tool against said work piece, and means axially reciprocating said tool during its engagement with said work piece.

13. In apparatus of the general nature of that herein described, in combination, means adapted to support a piece of work having a surface to be treated which is irregular in shape in a predetermined plane, a rotatable lapping device, means adapted to rotate said lapping device, means adapted to guide said lapping device along a path transverse to the axis of rotation of said lapping device and corresponding to said surface and in contact therewith, and means adapted simultaneously to reciprocate said lapping device.

14. In apparatus of the general nature of that herein described, in combination, means adapted to support a piece of work having a surface to be treated which is irregular in shape in a predetermined plane, a rotatable lapping device, means adapted to rotate said lapping device, means adapted to guide said lapping device along a path transverse to the axis of rotation of said lapping device and corresponding to said surface and in contact therewith, means adapted simultaneously to reciprocate said lapping device, and tracer control means for determining the movement of said lapping device along said path.

15. In apparatus of the general nature of that

herein described, in combination, means adapted to support a piece of work with a surface to be treated which is irregular in shape in a predetermined plane, a lapping device, means adapted to guide said lapping device along a path corresponding to said surface and in contact therewith, means adapted to rotate said lapping device, means adapted simultaneously to reciprocate the same, and means for effecting a yielding engagement between said lapping device and the work during the engagement therebetween.

16. Apparatus of the general nature of that herein described comprising, in combination, a master and a corresponding work piece engaged

respectively by a tracer and a lapping tool, the master and work piece being substantially identical in shape in a predetermined plane but being of different size, and means forming an operative connection between said tracer and said tool, said tool being deflectable from a normal position, the degree of deflection of the tool being proportionate to the difference in size between the master and work piece when the tracer and lapping tool are in operative engagement respectively with corresponding portions of the master and work piece.

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