Nov. 29, 1966 T. J. LEVEQUE 3,287,859

ROTATABLE GRINDING AND SURFACING TOOL

Filed Aug. 23, 1965 2 Sheets-Sheet 1

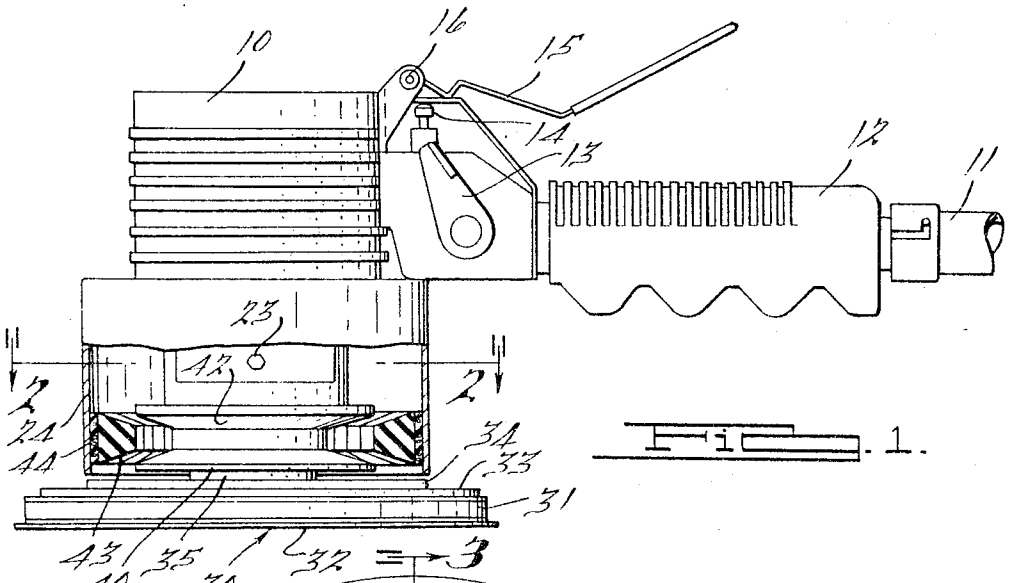


Fig. 1.

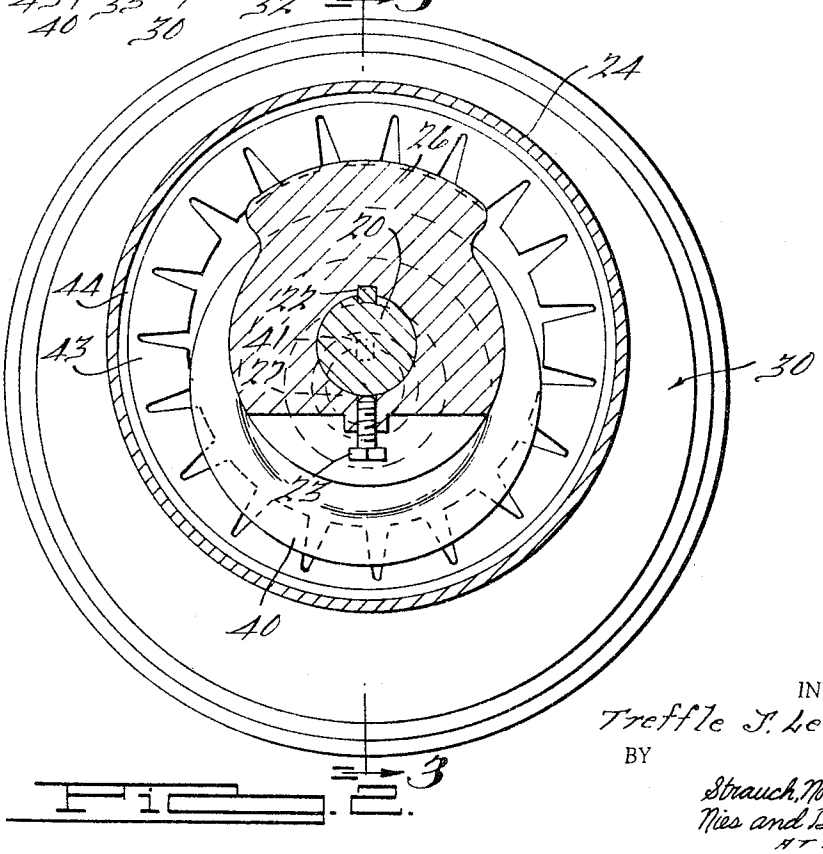


Fig. 2.

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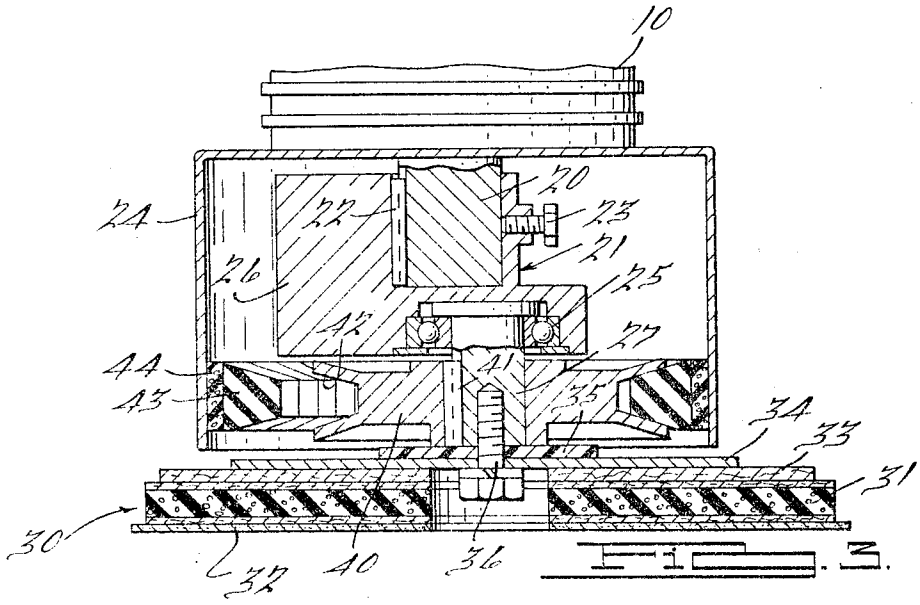


Fig. 3.

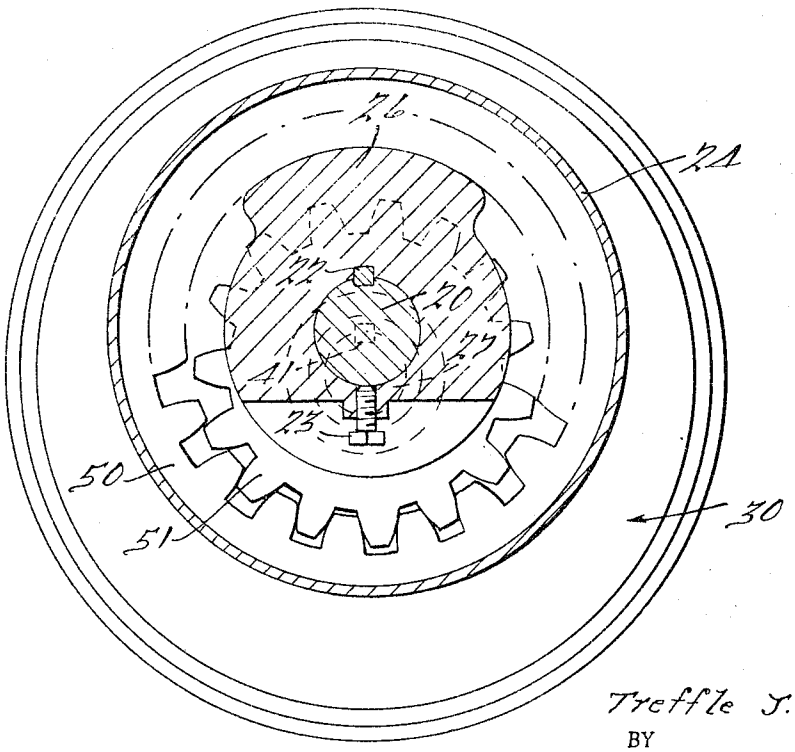


Fig. 4.

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ROTATABLE GRINDING AND SURFACING TOOL

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15 Claims. (Cl. 51—120)

This application is a continuation-in-part of my co-pending application Serial No. 260,482 filed February 25, 1963, for Rotatable Grinding and Sunfacing Tool now Patent No. 3,205,622, issued September 14, 1965.

This invention relates to a rotatable grinding and surfacting tool or the like and, more particularly, to improvements in devices of this type wherein the sanding pad thereof has a compound orbital and rotary movement imparted thereto.

The invention has as one of its objects to provide a tool of this type in which the sanding pad is moved in an orbital path and wherein this orbital movement causes the sanding pad to be simultaneously rotated about its axis.

Another object of the invention is to provide simple but expedient means for rotating the sanding pad whereby this action of the sanding pad may be accomplished in a positive manner and without the addition of costly and complicated mechanism for the purpose.

Another important object of the invention is to provide a device of this type which is so reduced in the number and character of its component parts as to approach the ultimate in structural simplicity thereby creating an economy in its manufacture, assembly and maintenance.

In attaining the objects and advantages of the invention, means such as an eccentric shaft, is provided for moving the sanding pad in an orbital path. Drive means, such as a V-pulley or a gear wheel, is carried by the eccentric shaft for orbital movement thereby. This drive means, during its orbital movement, engages a stationary complementary ring member carried by the housing of the device. If a V-pulley is employed as the drive means, the stationary ring member comprises a V-belt. If a gear wheel is used as the drive means, the stationary ring member comprises a ring gear. The V-pulley or gear wheel is connected to the sanding pad and, as the V-pulley or gear wheel is orbited relative to its complementary ring member, the V-pulley or gear wheel is rotated, thus rotating the sanding pad. Thus, simple but effective means is provided for accomplishing the purposes of the invention.

Further objects of this invention will appear as the description proceeds in connection with the appended claims and annexed drawings wherein:

FIGURE 1 is a sectional elevational view of a device constructed in accordance with this invention;

FIGURE 2 is an enlarged horizontal sectional view taken substantially on the plane indicated by line 2—2 in FIGURE 1;

FIGURE 3 is a vertical sectional view taken substantially on the plane indicated by line 3—3 in FIGURE 2; and

FIGURE 4 is a view similar to FIGURE 2 showing a modified form of construction.

In the embodiments of the invention herein illustrated there is shown a motor **10**, which in the present instance is an air motor which is supplied with air under pressure through an air conduit **11** which extends through a handle **12** to the motor. The volume of air supplied to the motor **10** may be controlled by a valve (not shown) actuated by a lever **13**. The reference character **14** indicates a button-type control for an on-and-off valve (not shown), the button being actuated by depressing a hand lever **15** pivoted to the motor as at **16**.

Extending from the motor **10** is a drive shaft **20**. Sleeved on the shaft **20** is a connecting or coupling member **21** which is keyed to the shaft **20** as at **22** and is secured against longitudinal displacement thereon by means of a set screw **23** or the like. The shaft **20** is concentric with a stationary part of the device, here shown as a housing **24** which is secured to the motor **10**.

Arranged in the connecting or coupling member **21** is a bearing **25**. The bearing **25** is arranged eccentrically of the axis of the drive shaft **20** so that when the coupling member **21** is rotated by the drive shaft, the bearing member **25** will travel in an orbital path. The coupling member **21** is provided with a counter weight **26** diametrically opposite the eccentric position of the bearing **25** to compensate for the eccentricity of the bearing member **25** and the driven shaft carried thereby.

Rotatably mounted in the bearing **25** is a driven shaft **27** which thus is arranged eccentric to the drive shaft **20** and is moved in an orbital path by the bearing **25**.

Secured to the end of the driven shaft **27** is a work performing member indicated generally by the reference character **30**. This work performing member may consist of a pad **31** to which is secured a sheet **32** of sand paper or the like. The pad **31** is reinforced by metal top plates **33** and **34** and a spacing washer **35** is interposed between the plate **34** and the end of the driven shaft **27**. The work performing element **30** is non-rotatably secured to the driven shaft **27** by means, for instance, of a machine screw **36** or the like. Thus, the work performing element **30** is moved in an orbital path by the orbital bearing **25** and the driven shaft **27**.

The invention contemplates drive means for also rotating the work performing element **30** about its axis and this means, in the embodiment of FIGURES 1–3, comprises a V-belt pulley **40** keyed to the driven shaft **27** as at **41**. The V-shaped periphery **42** of this V-pulley is adapted to engage a V-belt **43** secured to the stationary housnig **24**. The V-belt **43** preferably has a peripheral layer **44** of relatively soft material, such as foam or sponge rubber, or the like so that the V-belt member may be seated within the housing **24** and fixed thereto against relative rotation. As the orbiting V-belt pulley **40** travels in its orbital path, it engages the V-belt **43** and, because of the frictional contact between these parts, will rotate the V-belt pulley **40** and also the driven shaft **27** about the axis of the latter so as to rotate the work performing element **30**.

Thus, while the work performing element or member **30** is moving in its orbital path, it is also positively rotated about its axis so that the area of engagement of, for instance, the sand paper **32** with the work piece is constantly changed. Thus, the effectiveness of the tool is enhanced and it may be used as a grinder and as a surfacing machine.

From the drawings it is clear that the ratio of the inside radius of V-belt **43** to the radius of pulley **40** is less than two to one and further that the diameter of work performing element **30** is greater than the diameter of V-belt **43**. For example, V-belt **43** may have inside and outside diameters of 2$\frac{3}{16}$ inches and 3$\frac{1}{8}$ inches respectively, pulley **40** may have an inside groove diameter of 1$\frac{5}{8}$ inches and an outside wheel diameter of 2$\frac{3}{16}$ inches, and work performing element may have a diameter of 4$\frac{1}{4}$ inches.

In the embodiment illustrated in FIGURE 4, the complementary gear means consists of a ring gear **50** secured to the housing **24** and a gear wheel **51** secured to the driven shaft **27**. Thus, during the oribtal movement of the driven shaft **27**, the gear wheel **51** will engage the ring gear **50** to rotate the driven shaft **27**, as in the previously described construction. Thus, the work performing element **30** will be positively rotated about its axis

during its orbital movement so as to thus provide the desired compound movement to the work performing element.

In producing the compound movement, it will be noted from FIGURE 4, that the gear wheel **51** has 15 teeth and the ring gear **50** has approximately 20 teeth. As a result of this small difference in the number of teeth on the gear elements, the gear wheel will lag 5 teeth each rotation from the prior position on the ring gear. That is to say, a tooth on the gear wheel **51** will back up one-third of the periphery of the ring gear each rotation of the gear wheel. This produces a hypocycloidal movement to each particle on the sanding disk **32**. This movement accelerates a particle from a stop position in the first half of an arcuate path and decelerates the particle to a stop position in the last half of the arcuate path. This occurs once for each rotation of the gear wheel and the length of the arcuate path depends upon the difference in the number of teeth between the gear elements.

From the foregoing, it will be seen that there is provided a rotatable grinding and surfacing tool in which the work performing element or sanding pad is moved in an orbital path and at the same time rotated about its axis. This compound movement is accomplished by a construction which is so reduced in the number and character of its component parts as to approach the ultimate in structural simplicity, thereby creating an economy in its manufacture, assembly and maintenance.

By providing gear wheel **51** with 15 teeth in comparison with the twenty teeth on ring gear **50**, it is clear that the ratio of the internal radius of ring gear **50** to the radius of gear wheel **51** is appreciably less than two to one as shown in FIGURE 4. Thus, in both embodiments described herein the ratio of the radius of the fixed ring member to the radius of the driven wheel member which is rotated by driving engagement with the fixed ring member is less than two to one. Because of this ratio, the radii of pulley **40** and gear wheel **51** are appreciably greater than their magnitudes of eccentricity or, more particularly, the shortest linear distance between the rotational axis of the work performing member **30** and the axis of drive shaft **20**. It is apparent, therefore, that the driving torque applied to rotate the work performing element **30** will be increased by reducing the ratio of the radius of the fixed ring member to the radius of the driven wheel member. Increasing the ratio of the radius of the ring member to the radius of the driven wheel member, on the other hand, increases the angular velocity of the work performing member at the sacrifice of torque.

The amount of torque available to rotate the work performing member **30** will determine its maximum diametrical size since the resistive torque resulting from frictional forces applied at the periphery of the work performing member increases as the diameter of the work performing member increases. For a tool in which the ratio of the radius of the driving ring member to the radius of the driven wheel member is high such as a ratio which is greater than two-to-one, it is evident that if a work performing element is provided with any substantial diameter, relatively small resistive frictional forces applied at its periphery will cause the driving motor to stall. To avoid this objectionable condition a larger drive motor would have to be used or a work performing element having a smaller diameter would have to be employed. Use of larger motors is particularly objectionable from the standpoint that the unavoidable increased bulk and weight of such motors would render the tool impractical for use by hand manipulation. Reducing the diameter of the work performing element in the alternative also is objectionable since a work performing element having a working surface of substantial diameter is needed for assuring the rapid removal of surface material and for obtaining a "feather edge" or quality finish desired of such a hand tool.

By providing a ratio of the radius of the driving ring member to the radius of the driven wheel member which is less than two to one in accordance with this invention it will thus be appreciated that the torque output of a small motor having relatively low horse power, such as ¼ horsepower or less, is sufficient to drive a work performing element having a substantial diameter which may be appreciably larger than the diameter of either ring gear **50** or belt **43** as shown in the drawings. Accordingly the tool of this invention is light and small to render it practical for portable, hand manipulation in addition to providing the necessary driving torque for enabling large diametered work performing members to be used in obtaining a quality finish on a work piece surface.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. A drive mechanism for a hand tool for surface finishing workpieces comprising a motor having a drive shaft providing a protruding end; a housing rigidly secured to said motor into which said shaft end extends; a coupling member fixed to said drive shaft end for rotation therewith; a driven member mounted for rotation on said coupling member about an axis eccentric to the axis of said drive shaft, said driven member being adapted to fixedly mount a work performing member; ring means fixed to said housing in position to drivingly engage said driven member and to effect rotational movement of said driven member about its axis during orbital movement of said drive member about the axis of said drive shaft, the ratio of the radius of said ring means to the radius of said driven member being less than two to one.

2. A hand tool for surface finishing workpieces comprising a motor having a drive shaft providing a protruding end; a housing rigidly secured to said motor, said drive shaft end extending into said housing; a coupling member fixed to said drive shaft end for rotation therewith; driven means mounted for rotation on and with respect to said coupling member about an axis eccentric to the axis of said drive shaft; ring means fixed to said housing in position to drivingly engage said driven means and to effect rotational movement of said driven means about its axis during orbital movement of said driven means about the axis of said drive shaft, the ratio of the radius of said ring means to the radius of said driven means being less than two to one; and a rotational work performing member secured for rotation and orbital movement with said driven means.

3. The hand tool of claim **2** wherein the diameter of said rotational work performing member is greater than the diameter of the ring gear means.

4. The drive mechanism defined in claim **2** wherein said driven member comprises a pulley and wherein said ring means comprises an endless belt drivingly engaging said pulley.

5. The drive mechanism defined in claim **2** wherein said driven member comprises a V-belt pulley and wherein said ring means comprises an endless V-belt drivingly engaging said pulley.

6. The drive mechanism defined in claim **4** wherein said belt is provided with a facing comprising an annulus of resilient material peripherally surrounding said belt.

7. The hand tool of claim **3** wherein the rotational work performing member comprises an abrading disk the abrading elements of which undergo a hypocyclical movement to enhance the abrading action on the workpiece.

8. The hand tool of claim **3** wherein the rotational work performing member comprises a spacer washer disposed

to abut the eccentric shaft end, a centrally apertured backing plate disposed to abut the spacer washer, a ring pad fixed to said backing plate, a ring of sand paper fixed to said ring pad, and a machine screw and lock washer assembly having a threaded shank freely passing through the central aperture of said backing plate and threaded into said eccentric shaft and an enlarged head overlying said lock washer to clampingly secure said rotational work performing member to the end of said eccentric shaft.

9. A hand tool for surface finishing workpieces comprising a motor having a drive shaft providing a protruding end, a housing rigidly secured to said motor, said drive shaft end extending into said housing, a pulley, means mounting said pulley on said shaft end for rotation relative to said shaft and about an axis eccentric to the axis of said drive shaft to impart orbital movement to said pulley, an endless belt having a larger diameter than said pulley, said belt being peripherally fixed to said housing in position to drivingly engage said pulley to effect rotational movement of said pulley about its axis during orbital movement of said pulley about the axis of said drive shaft, and a rotational work performing member secured for rotation and orbital movement with said pulley.

10. The hand tool defined in claim **9** wherein the ratio of the radius of said belt to the radius of said pulley is less than two to one.

11. The hand tool defined in claim **9** wherein said belt is a V-belt.

12. The hand tool defined in claim **9** wherein said housing is provided with an internal peripheral surface of uniform diameter for mounting said belt.

13. A hand tool for surface finishing workpieces comprising a motor having a rotatable drive shaft, a work performing member, and means including a V-belt transmission cooperating with said shaft to impart simultaneous rotation and orbital movement to said work performing member.

14. A hand tool for surface finishing comprising a motor having a rotatable drive shaft, a work performing member, means operatively coupling said drive shaft to said work performing member to effect orbital movement of said work performing member in a path eccentric to the shaft rotational axis, and relatively stationary V-belt transmission means forming a part of said coupling means for rotating said work performing member relative to said drive shaft as the former is orbited about the rotational axis of the latter.

15. A hand tool for surface finishing workpieces comprising a motor having a drive shaft providing a protruding end, a hollow housing fixed to said motor and having an open end facing axially away from said motor, said protruding end extending into said housing, a coupling member fixed to said protruding end within said housing, a driven shaft mounted on said coupling member for rotation about an axis that is parallel and eccentric to the rotational axis of said drive shaft, said driven shaft extending from said coupling member towards the open end of said housing, a pulley fixed on said driven shaft within said housing, an endless, V-belt having a larger diameter than said pulley, said V-belt being peripherally fixed along the interior of said housing in position to drivingly engage said pulley to effect rotational movement of said pulley about the driven shaft axis during orbital movement of said pulley about the axis of said drive shaft, and a disc shaped, rotational work performing member coaxially fixed to said driven shaft and being spaced axially beyond the open end of said housing facing away from said motor, the ratio of the radius of said belt to the radius of said pulley being less than two to one.

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