

[54] **COMPOUND MOTION RUBBING MACHINE**

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51/120, 177; 15/22 R, 49 R

[56] References Cited

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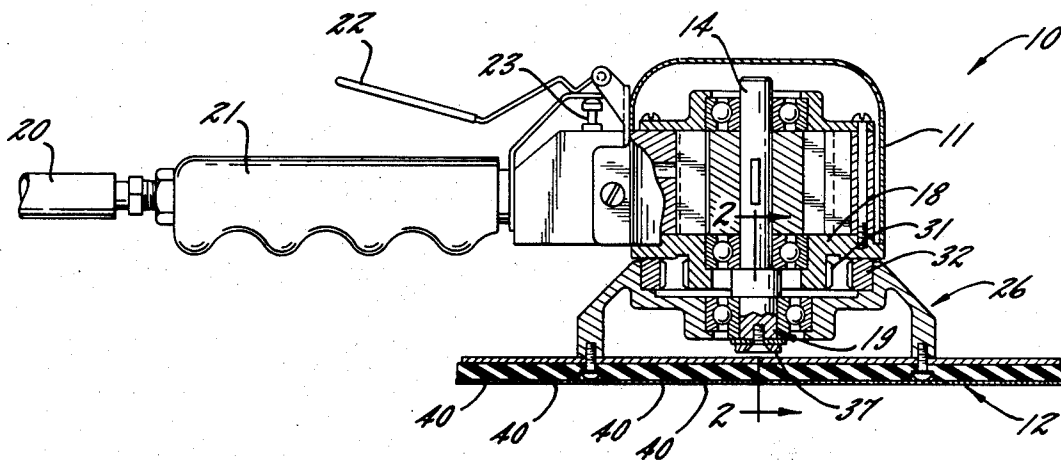
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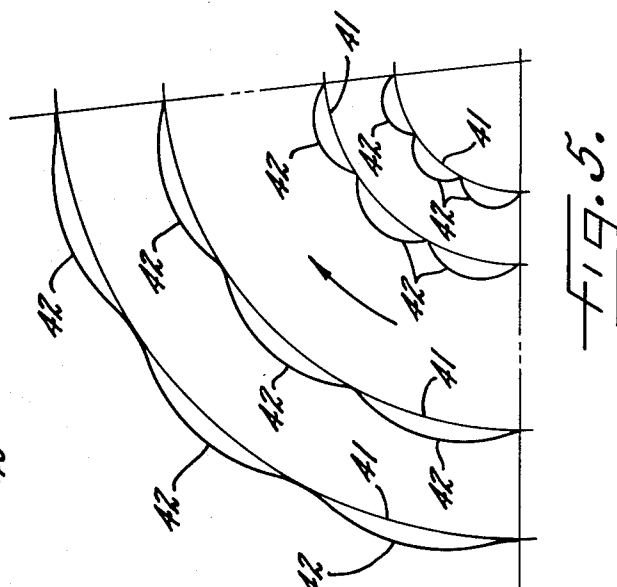
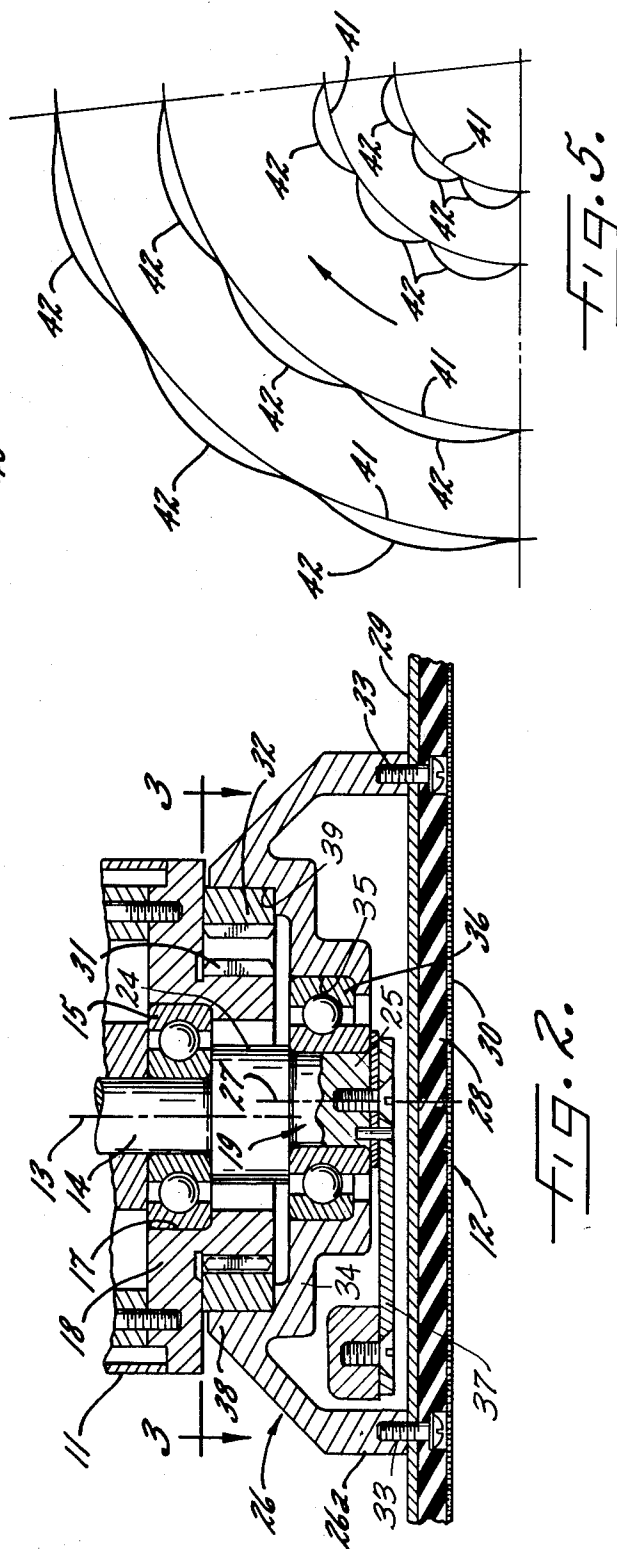
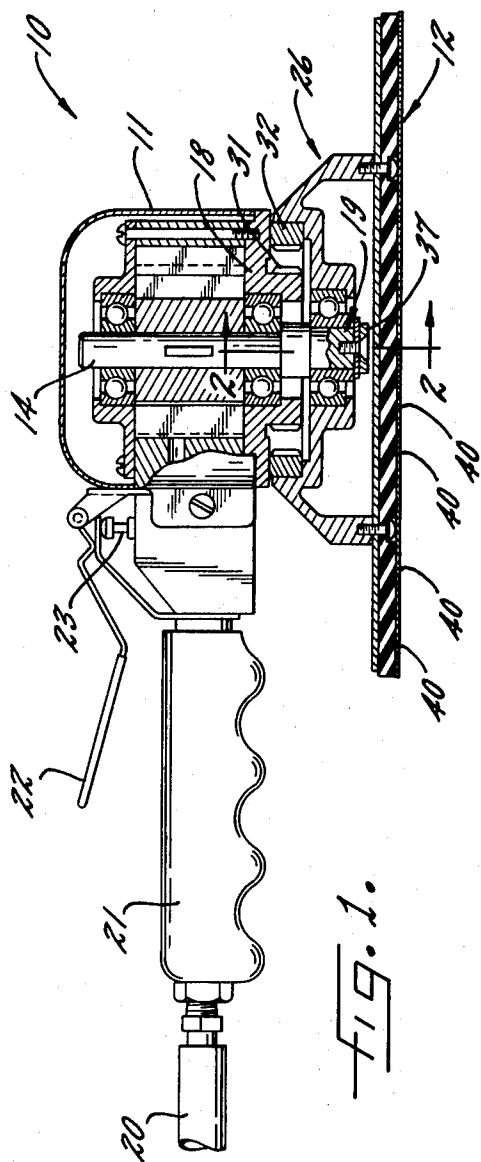
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[57] **ABSTRACT**

A portable sander having an air motor with an output shaft driving an eccentric, parallel shaft on which an inverted cup-shaped casing is journaled for eccentric motion about the driving shaft. A pinion gear is fast on the motor housing around the motor shaft and meshes with a larger ring gear fast in the upper end of the casing to rotate the casing about an eccentric axis as it moves about the axis of the driving shaft. The casing carries a rubbing shoe to which a sheet of sandpaper is attached for contact with a work surface.

9 Claims, 5 Drawing Figures





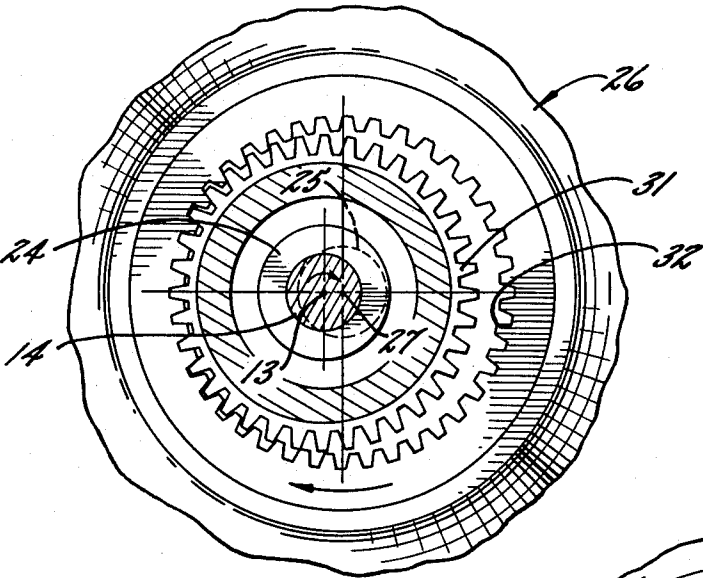


Fig. 3.

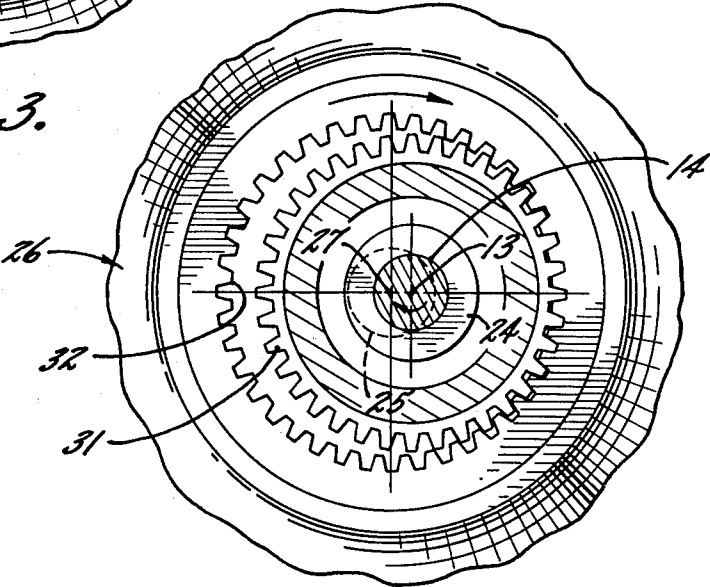


Fig. 4.

COMPOUND MOTION RUBBING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to compound motion rubbing machines such as portable sanders in which a rubbing shoe is driven eccentrically and simultaneously rotated to produce a compound wobbling and rolling motion of abrasive particles on the shoe. The invention relates more particularly to a sander in which a pinion gear is disposed within and meshes with a ring gear to produce the rolling motion during eccentric movement of the shoe. A prior machine of this general type is disclosed in U.S. Pat. No. 3,205,622 wherein it will be seen that the ring member is fixed to the motor housing or frame and the pinion or wheel rolls around the interior of the ring.

SUMMARY OF THE PRESENT INVENTION

The primary object of the present invention is to improve the performance of machines of the foregoing character by a basic structural change making possible the more effective utilization of available power and providing an improved and more effective compound motion of abrasive particles on the shoe relative to a work surface. More specifically, the invention utilizes the motion produced by moving the ring member around a stationary wheel member to obtain epicycloidal motion of the abrasive particles, and this is believed to be responsible for the more effective rubbing action.

Other objects are to facilitate optimum counterbalancing of the moving parts, to provide a substantial working mass for ruggedness of construction and performance of the machine and to provide a rugged and comparatively large mounting for the rubbing shoe.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a portable sander embodying the novel features of the present invention, certain parts of the sander being broken away and shown in section.

FIG. 2 is an enlarged fragmentary cross-sectional view taken substantially along the line 2—2 of FIG. 1.

FIG. 3 is a fragmentary cross-sectional view taken along the line 3—3 of FIG. 2.

FIG. 4 is a view similar to FIG. 3 with the parts in moved positions.

FIG. 5 is an enlarged view schematically illustrating the paths followed by particles on the rubbing shoe during operation of the sander.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the invention is embodied in a portable sander 10 powered by a motor in a hollow frame or housing 11 beneath which a rubbing shoe 12 is supported for gyratory motion about the axis 13 of the depending motor shaft 14. The lower end portion of the motor shaft projects through and is journaled in an anti-friction bearing 15 (FIG. 2) fitted in a plate 18 forming the bottom wall of the motor housing. The rubbing shoe is car-

ried by an eccentric indicated generally at 19 on the lower end of the drive shaft.

In the present instance, the sander 10 is powered by a rotary air motor which receives air under pressure through a flexible hose 20 connected to the free end of a handle 21 on the housing 11 and communicating with the motor through an air passage in the handle. The flow of air to the motor is controlled by a lever 22 extending outwardly from the casing along the top of the handle and movable toward and away from the latter to open and close a valve 23 interposed between the air passage and the motor. The construction and operation of the motor and the control valve are well known to those skilled in the art and thus are not described in detail herein.

As shown in FIG. 2, the eccentric 19 comprises a crank disk 24 secured to the lower end of the drive shaft 14 beneath the bearing 15 with a second shaft 25 projecting downwardly from the disk in radially offset parallel relation with the drive shaft. The rubbing shoe 12 is supported on a carrier 26 journaled on the eccentric shaft 25 to turn about the axis 27 of such shaft and to wobble eccentrically about the axis 13 of the drive shaft. Herein, the shoe comprises a pad 28 of resiliently yieldable material secured to the underside of a flat circular backing plate 29 fastened to the carrier in a plane perpendicular to the axes of the shafts 14 and 25. A sheet 30 of abrasive material such as sandpaper is fastened to the underside of the pad for rubbing engagement with a work surface.

With the foregoing general arrangement, rotation of the motor shaft 14 at high speed, for example, at 4,000–6,000 r.p.m., swings the carrier 26 about the axis 13 of the motor shaft to impart a gyratory or wobbling motion to the rubbing shoe 12 and to the abrasive particles on the sheet 30 of abrasive material fastened to the shoe. The amount of eccentricity of the shaft 25 determines the amount of lateral motion or "throw" of the rubbing shoe during each revolution of the drive shaft. For example, the eccentricity may be one-eighth of an inch. It will be understood by those skilled in the art, however, that the representative figure given above is not critical and will vary according to the size of the machine and the type of the rubbing action desired.

In order to improve the abrasive action obtained with gyratory motion machines of this type, a secondary turning or rolling motion is imparted to the shoe 12 to rotate the latter about the axis 27 of the eccentric shaft 25 as the shoe gyrates about the drive shaft 14. This secondary motion prevents the formation of circular grooves in the work surface by the abrasive particles on the shoe by moving the particles along non-circular paths. In addition, the compound motion of the shoe assists in the automatic removal of the foreign material that tends to accumulate between and around the abrasive particles and thus "unloads" the abrasive sheet in service use.

In accordance with the present invention, an improved and more effective compound motion of the shoe 12 is produced by a positive drive comprising a circular gear wheel or pinion 31 stationarily mounted on the machine frame 11 and drivingly engaging a ring gear 32 movable with the carrier 26, the ring gear being larger than and encircling the stationary pinion gear. During gyration of the carrier and the shoe, the ring gear rolls continuously around the periphery of the stationary gear to impart a wobbling rotary motion to the

carrier and the shoe and produce an abrasive action which has been found to be superior to the action of comparable known machines.

In this instance, the pinion 31 is integral with the underside of the plate 18, the pinion and the plate being formed by conventional powdered metal techniques. The carrier 26 is an inverted cup-shaped casing having a cylindrical body 26a abutting against and secured by screws 33 to the backing plate 29. The top wall 34 of the cup is disposed immediately beneath the crank disk 24 and is formed with a central circular opening 35 in which an antifriction bearing 36 is fitted. The eccentric shaft 25 extends downwardly through this bearing, there being a counterweight 37 fastened to and projecting radially from the lower end portion of the shaft beneath the cup wall 34. Thus, the bearing 36 mounts the cup 26 and the shoe 12 rotatably on the eccentric shaft 25 in coaxial relation therewith.

Extending upwardly from the cup body 26a in loosely telescoping relation with the pinion 31 is an annular rim 38 in which the ring gear 32 is fixed, both the ring gear and the internal surface 39 of the rim being coaxial with the eccentric shaft 25 and the carrier body 26a. The ring gear is sized to mesh with the pinion on one side and to roll around the latter as the carrier gyrates around the axis 13 of the drive shaft thereby utilizing the gyratory motion of the carrier to produce the rotary motion as well. FIGS. 3 and 4 show two extreme positions of the ring gear and the carrier relative to the pinion and the drive shaft and the corresponding position of the eccentric shaft 25.

As shown most clearly in FIGS. 3 and 4, the pinion 31 has fewer teeth than the ring gear 32. The amount of eccentricity of the shaft 25 is a factor in determining the tooth differential and also in determining the proper size differential between the ring gear and the pinion, the gear sizes being correlated with the eccentricity to insure that the ring gear remains in meshing engagement with the pinion during gyration of the carrier 26. The specific numbers of teeth determine the ratio of the gearing and are a matter of sound design choice. Herein, the ring gear is shown as having 39 teeth while the stationary gear has 36 teeth.

The superior abrasive action obtained with this construction is believed to be the result of several unique effects of the drive arrangement. First, the rolling motion of the carrier 26 and the shoe 12 is forward, that is, in the same direction as the rotation of the drive shaft 14 and the gyration of the carrier, as indicated by the arrows in FIG. 5. Moreover, the illustrative sander, with 36 teeth on the pinion and 39 teeth on the ring gear, has a lower gear ratio than a similar sander with a counter-rotating shoe. The increased power thus available at the shoe makes it possible to operate the sander effectively with greater rubbing pressures.

In FIG. 5, the general paths followed by four radially spaced abrasive particles 40 on the shoe during three successive drive shaft revolutions are shown to illustrate another advantageous effect of the novel drive arrangement. Each particle travels generally along an epicycloidal path, that is, a path of the type generated by a point on an imaginary circle rolling on the outside of a larger base circle 41. Such a path comprises a plurality of arcs 42 curving outwardly from a point on the base circle and then back to an angularly spaced point where the next arc of the path begins. It is believed that such epicycloidal paths produce the optimum amount

of particle travel and abrasive contact with the work per revolution of the drive shaft 13 and thus result in optimum rubbing efficiency.

While the gears 31 and 32 located adjacent the upper end of the carrier 26, there is ample room within the carrier for the counterweight 37 which is advantageously positioned directly adjacent the top of the shoe 12. The addition of the carrier to the gyrating mass not only increases the mass but also raises the center of gravity of the mass into a horizontal plane well above the plane of the shoe. By virtue of the gear location and the hollow carrier, it is possible to locate the center of gravity of the counterweight in the same horizontal plane as the center of gravity of the gyrating mass thereby to provide optimum counterbalancing of the shoe for smooth and vibration-free operation. Moreover, the carrier is of relatively large diameter as a result of being fixed to the ring gear and thus provides a large, rugged and stable support upon which to mount the shoe 12.

I claim as my invention:

1. In a compound motion rubbing machine, the combination of, a frame, a drive shaft journaled on said frame with one end portion projecting downwardly therefrom, an eccentric shaft mounted on the projecting end portion of said drive shaft in radially offset parallel relation therewith, an inverted cup-shaped casing disposed around said eccentric shaft and rotatably mounted thereon for gyratory motion about the axis of said drive shaft as the latter rotates, a pinion gear stationarily mounted on the underside of said frame in coaxial relation with said drive shaft, said casing having a coaxial annular rim loosely encircling said pinion gear, a ring gear larger than said pinion gear fast in said rim and disposed around the pinion gear in meshing engagement with one side of the latter, and a rubbing shoe mounted on the lower end of said casing for movement therewith in rubbing engagement with a work surface, the amount of eccentricity of said eccentric shaft and the sizes of said gears being correlated to produce simultaneous gyrating and rotating motion of said casing during rotation of said drive shaft and generally epicycloidal motion of abrasive particles on said shoe relative to a work surface.

2. The combination defined in claim 1 further including a counterweight mounted on said eccentric shaft above said shoe and within said casing below said gears, the centers of gravity of said counterweight and the gyrating mass including said casing and said shoe being disposed generally in a common plane perpendicular to said eccentric shaft.

3. In a compound motion rubbing machine, the combination of, a frame, a drive shaft journaled on said frame with one end portion projecting downwardly therefrom, an eccentric on the projecting end portion of said drive shaft, a hollow carrier disposed around said eccentric and rotatably mounted thereon for eccentric motion with the eccentric about the axis of said drive shaft, a pinion gear stationarily mounted on the underside of said frame in coaxial relation with said drive shaft, said carrier having an annular rim projecting upwardly beyond said eccentric in loosely telescoping relation with said pinion gear, a ring gear larger than said pinion gear mounted inside said rim and meshing with the pinion gear to roll around the latter during eccentric motion of said carrier and thereby rotate the carrier about said eccentric, and a rubbing

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shoe fast on the lower end of said carrier for compound motion in rubbing engagement with a work surface.

4. In a compound motion rubbing machine, the combination of, a frame, a drive shaft journaled on said frame, a second shaft eccentrically carried by said drive shaft for eccentric motion about the axis thereof during rotation of the drive shaft, a cup-shaped casing rotatably mounted on said second shaft for eccentric motion therewith about said axis and simultaneous rotation about the axis of said second shaft, a pinion gear stationarily mounted on said frame in coaxial relation with said drive shaft, a ring gear internally larger than the exterior of said pinion gear mounted on said casing and disposed around the pinion gear for continuous rolling engagement therewith to rotate said casing about said second shaft during eccentric motion of the casing about said drive shaft, and a rubbing shoe carried by said casing for movement therewith in rubbing engagement with a work surface.

5. In a compound motion rubbing machine, the combination of, a frame, a drive shaft journaled on said frame, a second shaft eccentrically carried by said drive shaft for eccentric motion about the axis thereof during rotation of the drive shaft, a gear wheel stationarily mounted on said frame in coaxial relation with said drive shaft, a ring gear internally larger than the exterior of said gear wheel rotatably mounted on said second shaft in coaxial relation therewith for eccentric motion about said axis, said ring gear being disposed around said gear wheel and in rolling engagement therewith to be turned by the gear wheel during said eccentric motion, and a rubbing shoe carried by said ring

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gear for simultaneous eccentric and turning movement relative to said frame whereby points on said shoe move along generally epicycloidal paths.

6. The combination defined in claim 5 in which said ring gear is mounted on a hollow casing having one end portion carrying said ring gear and its opposite end portion connected to said shoe, said casing being journaled on said second shaft.

7. The combination defined in claim 6 in which the center of gravity of the mass including said casing, said ring gear and said shoe is in a plane between said shoe and said ring gear, and further including a counterweight mounted on said second shaft within said casing and below said ring gear and having a center of gravity substantially in said plane.

8. The combination defined in claim 6 in which the end of said casing connected to said shoe is larger in diameter than said ring gear.

9. In a compound motion rubbing machine, the combination of, a frame, a drive shaft journaled on said frame, an eccentric on said drive shaft, a carrier rotatably mounted on said eccentric for eccentric motion about the axis of said drive shaft during rotation of the latter, a wheel stationarily mounted on said frame in coaxial relation with said drive shaft, a ring internally larger than the exterior of said wheel disposed around the latter in continuous rolling engagement therewith, said ring being mounted on said carrier to rotate the latter as it moves eccentrically around said axis, and a rubbing shoe mounted on said carrier for movement therewith in rubbing engagement with a work surface.

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