

Jan. 22, 1963

S. S. BROWN, JR
COMPACT MACHINE

3,074,089

Filed May 12, 1961

3 Sheets-Sheet 1

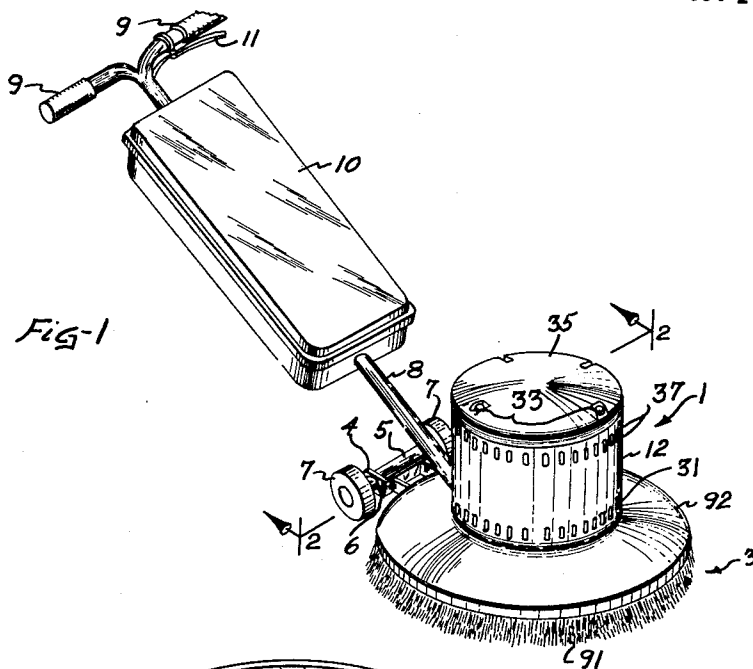
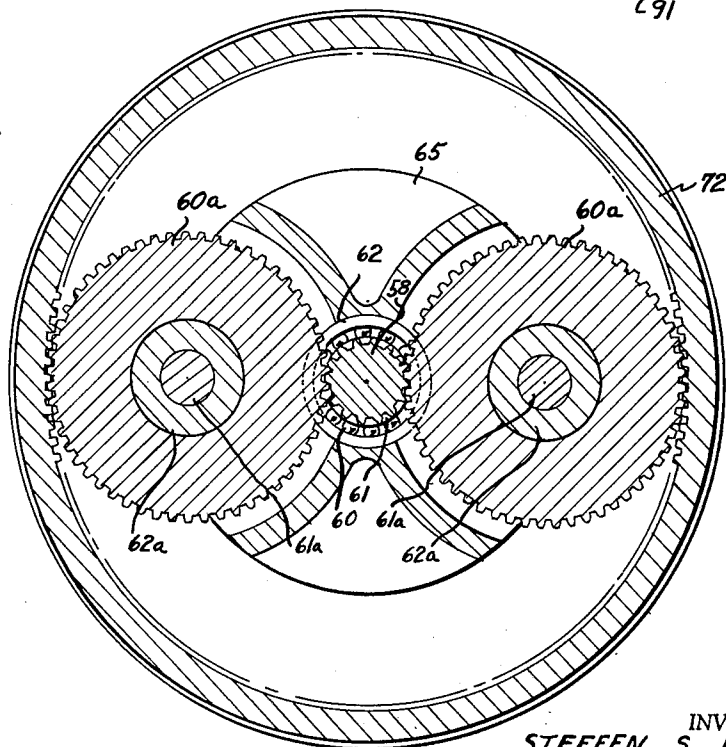


Fig-3



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3 Sheets-Sheet 2

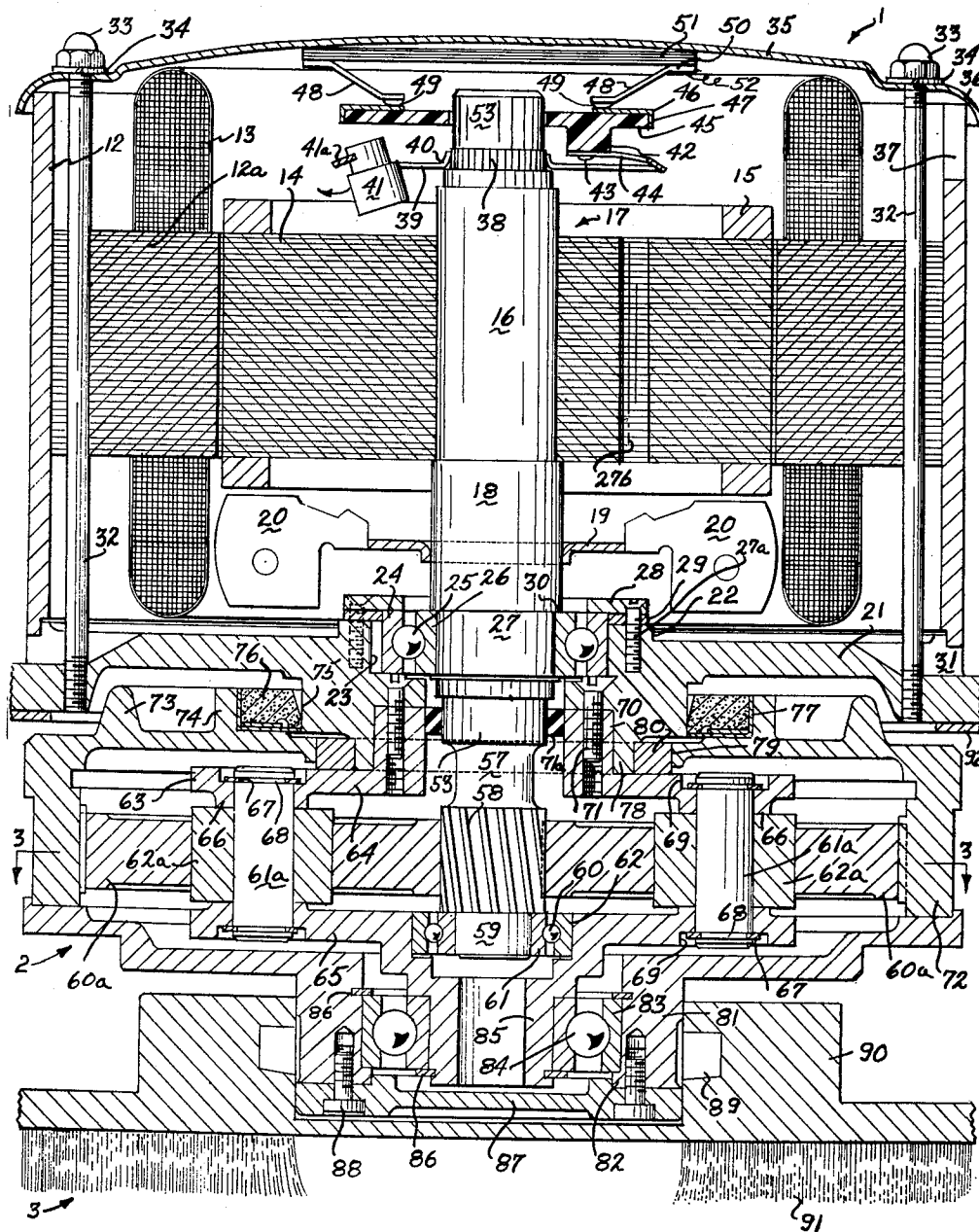


Fig-2

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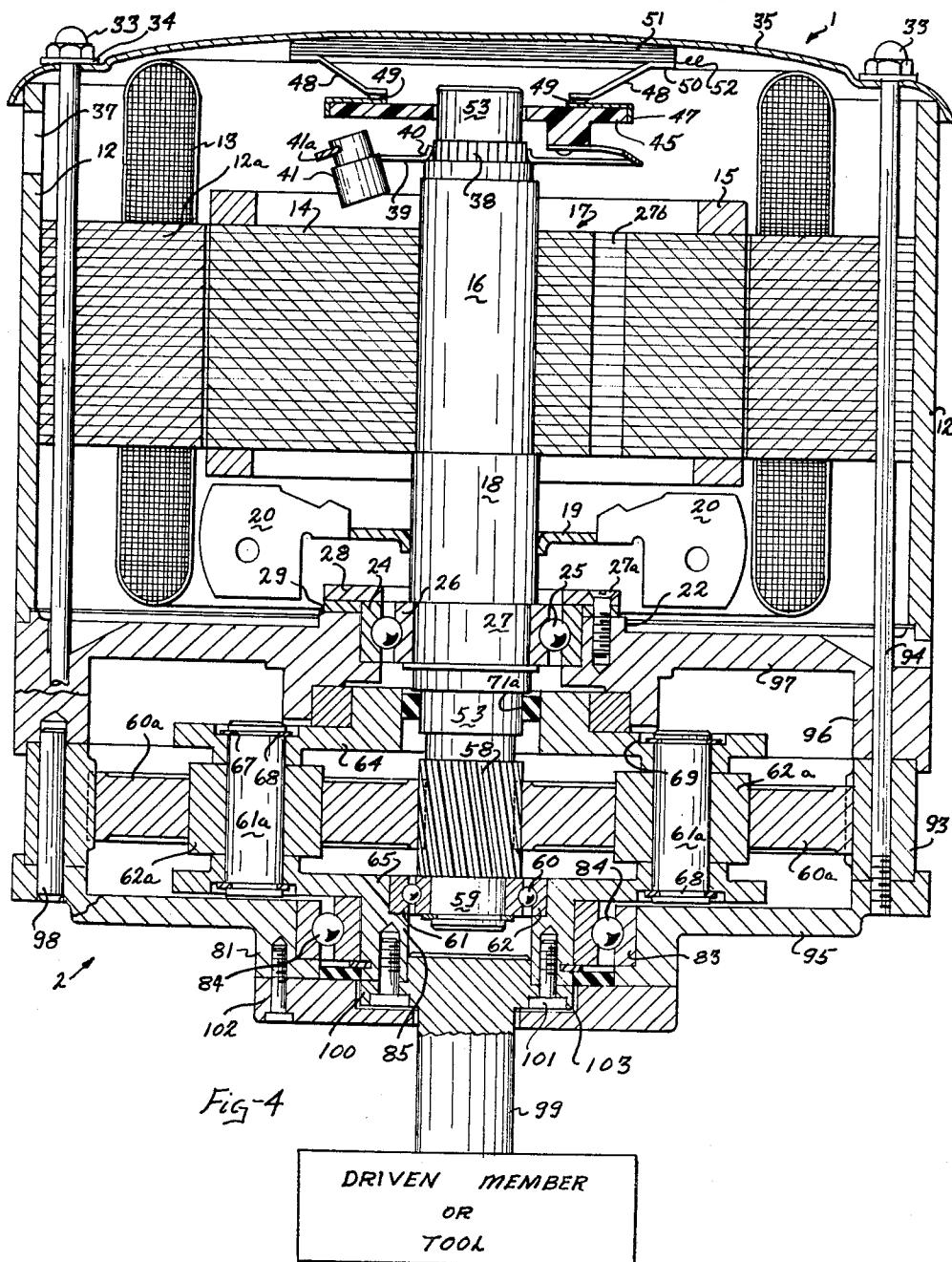
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3 Sheets-Sheet 3



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1

3,074,089

COMPACT MACHINE

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The present invention relates to machines which are designed for compactness, particularly in the vertically operable direction. Machines of this character are useful when supplied with brushes for treating floors, polishing and scrubbing, also for shampooing rugs, etc., which require minimum over-all height.

Such machines are usually powered by single-phase induction motors which require, when starting, a split-phase alternating current introduced through a capacitor which is cutout as the machine reaches a predetermined speed. The switch is sometimes placed on top of the motor casing on account of lack of space between the upper end "bell" and the motor windings, also the complications of removing the "bell" and its bearing. The switch is usually of the centrifugal type so that an extension of the motor shaft through the end "bell" has to be provided. Moreover, a protective casing usually surrounds the switch, which causes a still further increase in the height of the machine.

Machines of the prior type normally employ not less than four bearings for the main shaft, two on the motor and two for the gear mechanism. It will be understood that the manufacturer who supplies the motor usually provides a complete electrical unit, i.e., with two bearings, and another manufacturer may supply a complete gear unit, which normally has two sets of ball bearings. All of these bearings are applied either to the main shaft which extends through the entire machine or else to individual shafts which are mechanically coupled together. These ball bearings are not only expensive, but, in accordance with the principles of the present invention, some of them have been found to be unnecessary when certain structural changes have been made in the machine. Moreover, it has been noted that the bearing at the top of the motor shaft is apt to become noisy due to the fact that all the remaining bearings either operate in the lubricant supplied to the gear mechanism or have access thereto. However, the uppermost bearing is not supplied with oil on account of the difficulty of maintaining an oil seal on a vertical shaft.

The primary object of the invention is to provide a machine, including a motor, gearing and working tool, all of a character as will individually and collectively take up the smallest space in at least one critical dimension.

Another object is to provide a machine of the character described in which the bearing elements of the machine as a whole are improved.

Still another object is to provide a machine, particularly of the floor-working or treating type, in which the number of bearings in the machine as a whole is reduced, without reducing the efficiency or life of the machine.

A further object is to provide a machine of the character mentioned in which not only the number of bearings is reduced, but the bearings that are retained are in a lubricated region, which renders them substantially noiseless.

Another object is to provide a floor-working machine with an electrical motor of the single-phase type in which ready access to the starting switch is afforded in order that repairs may be made at the place of use.

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A further object is to provide a floor-working machine in which the operating elements are compacted into minimum height by the use of a capacitor-start motor of improved design and an improved planetary gear mechanism for transmitting the power from the motor to the floor-working tool.

The above objects are attained in brief by providing a single-phase capacitor-start motor with a concealed but readily accessible starting switch, a planetary gear mechanism for conveying the power of the motor to the floor-working tool, the motor and gear mechanism having a shaft in common which is supported solely on two bearings. In carrying out these objects I also replace the usual upper-end bell of the motor by a removable dust cover of flattened contour, entirely separate from the shaft and then position the starting switch in a space provided between the cover and the rotor of the motor where it is readily accessible after the cover has been removed.

Other objects and features will be apparent as the specification is perused in connection with the accompanying drawings in which:

FIGURE 1 represents a perspective view of the improved floor-treating and scrubbing machine;

FIGURE 2 depicts on an enlarged scale a vertical sectional view taken through the combined motor, gear and brush assembly and looking in the direction of the arrows 2—2 in FIGURE 1;

FIGURE 3 represents a horizontal sectional view of the planetary gear train looking in the direction of the arrows 3—3 in FIGURE 2 but on a slightly smaller scale;

FIGURE 4 illustrates, on the approximate same scale as FIGURE 2, a vertical sectional view taken through a modified form of the combined motor and gear assembly together with an output shaft of broad general use.

Referring to FIGURE 1, reference character 1 generally designates an electrical motor, preferably of the single-phase induction type which is mounted in a vertical position. Reference character 2 generally designates a rotary gear casing to which a brush element generally indicated at 3 is detachably connected. Attached to the motor casing is a pair of bearing brackets 4, spaced apart by a sleeve 5, through which a shaft 6 extends. The end of the shaft carries a pair of rollers 7. This shaft 6 extends loosely through the sleeve so that as the handle shaft 8 is pressed downwardly at the handle bars 9, the entire machine carried on the sleeve 5 and the brackets 4 is then rotated about the shaft 6 and in that way the brush 3 is held elevated above the floor when transporting the machine as a whole from place to place on the rollers 7. In the event that it is desired to employ the machine for shampooing a rug, the shaft 8 may comprise a pipe which leads at the bottom to a position just above the brush element and at the other end communicates with a long and fairly deep pan 10 containing shampoo material. The handle bars 9 can be taken out of the top of the pan 10 so that the latter constitutes an integral part of the guiding member of the machine. A lever member 11 is located on the handle bars so as to open and close a valve (not shown) in the pan 10 in order to control the downward flow of the shampoo material into the brush attachment.

As stated hereinbefore, the machine as a whole employs three primary parts, the gear casing, the motor, and the brush or other floor-treating member which is detachably secured to the gear casing. These elements are structurally and integrally related by reason of the fact that a single shaft is employed to carry the elements and, furthermore, only two bearings are relied upon to give adequate support to the various members.

The Motor

The motor 1 is contained within a cylindrical casing 12 of metal to which is bolted (not shown) or otherwise secured an annular stack of laminations 12a through which stator windings 13 are threaded in the usual manner. There is a rotor indicated at 14 formed of soft iron laminations with transversely extending conductor bars (not shown) short-circuited by conductor ring members 15. Stator and rotor windings are well known in the art and the rotor is what is commonly called a "squirrel cage." The rotor 14 is mounted on the shoulder portion 16 of the main shaft designated generally at 17.

The shaft has a larger portion 18 to which is secured in any suitable manner a fan 19 having blades 20. The bottom of the casing 12 is closed by a bottom plate 21 having a hub 22 provided with a counter-sunk portion 23. The latter is adapted to receive the outer race 24 of a ball bearing 25 of which the inner race is indicated at 26. The latter surrounds a shoulder portion 27 of the shaft. In order to retain the outer race in place a flat ring 28 is provided and the latter is screwed as indicated at 27a to the bottom plate 21. For convenience of assembly, holes 27b may be provided in the rotor to permit the insertion of a screw driver onto the screws 27a.

A shim ring 29 may also be employed to support the outer edge of the ring 28. The inner race 26 fits tightly about the shaft portion 27 and is pressed against the shoulder 30 of the shaft. Ventilating openings 31 are provided peripherally about the casing 12 and the bottom plate is secured in position by means of long stay bolts 32 which are threaded at the bottom into the plate 21. The bolts are provided at the top with acorn nuts 33 and washers 34 which bear against a cover 35. This cover is of flattened configuration and has an overhanging flange portion 36 which presses against the upper edge of the casing 12 when the nuts 33 are tightened. Slots 37 (shown in FIGURE 1) may be provided at the upper end of the casing 12 and together with the lower slots 31 provide the ventilation forced by fan 20.

The motor is preferably of the alternating-current type, single-phase, and in order to start it is necessary that the phase be split during the starting period. This is done by the use of a capacitor (not shown) connected to a starting winding in the stator, as is well known in the art. In order to effect connection to the capacitor, any practical form of centrifugal actuator may be employed. The type illustrated in FIGURE 2 should be considered as merely typical.

As shown, the shaft 17 is provided with a knurled shoulder portion 38 on which is tightly pressed a spring-like disc 39 having an upstanding lip 40 for securing purposes. The disc is provided with an even number of counterweights 41 at the periphery and held to the disc by fingers 41a or any other suitable manner. There are openings (not shown) in the disc through which heavy lugs 42 may move downwardly as the disc is flexed, and these lugs are riveted, as indicated at 43, to a pair of oppositely disposed strips 44. The latter are secured at suitable places on the periphery of the disc 39. The lugs 42 form an integral part of a disc of insulating material 45 which carries a metal plate 46 along its upper surface and down along the periphery as indicated at 47.

There is a pair of oppositely disposed spring members 48 having rounded contacts 49. The upper ends of the springs terminate in a flat ring 50 which may be secured to an insulating member 51, typified as a number of individual sheets of insulating material. The insulating member 51 is secured in any suitable manner to the inside surface of the cover member 35. A wire 52 is taken from the ring 50 for grounding the free terminal of the capacitor, as is well known in the art.

As current is applied to the motor through conductors (not shown) connected to the wound stator, the starting position of the contacts 49 is against the plate 46. The capacitor is permanently connected at one end to the

stator winding and at the other end is normally connected to ground through the contact between the points 49 and the metal plate 46. Thus the capacitor is connected in circuit to give a split-phase effect to the starting current whereupon the motor begins to turn.

As the rotor 14 attains a predetermined speed, the counterweights 41 swing outwardly which causes the disc 39 to flex downwardly at the outer edge, i.e., concave fashion, which, in turn, causes the lugs 42 to move the plate 46 downwardly and thus break contact at the points 49. It will be understood that the plate 45 can slide easily along the end shaft portion 53. As long as the counterweights remain in their twisted position due to the normal speed of the rotor 41 the contacts will remain broken at the ring 46 and the capacitor will remain disconnected from ground and, therefore, inoperative. The reverse operation takes place if the rotor drops to less than predetermined speed, in fact, down to zero, at which time the capacitor is again cut-in in the manner stated.

It will be noted that the capacitor control switch is contained between the upper surface of the rotor 14 and the cover 35 so that it adds nothing to the height of the motor as a whole. Furthermore, it is completely protected from dust, etc., by the cover 35.

After continuous use there is a tendency for the contact points 49 to oxidize and perhaps fail to make an electrical connection with the ring 46. It becomes an easy matter to remove the cover 35 by unscrewing the acorn nuts 33, scraping the contact surface, and finally mounting the cover and screwing the same in place. Thus, the centrifugal switch of the type disclosed or any other type mounted on the shaft could readily be serviced from the top of the motor without requiring an extensive repair bill.

The Gear Mechanism

As shown in FIGURE 2, the gear mechanism 2 is positioned directly under the motor and employs a single shaft common to the motor. This shaft is provided at its upper end with a shoulder portion 53, and nearer the bottom of the shaft there is provided a neck portion 57, also a shoulder portion 58 which constitutes a spiral gear. The lowermost tip of the shaft is indicated at 59 and rotates in a ball bearing 60 of which the inner race is indicated at 61 and the outer race at 62. It will be noted that the motor shaft 17 and its gear shaft extension are supported solely by two bearings indicated at 25 and 60 respectively, of which the upper bearing is at a position slightly lower than the mid-position of the combined shaft and the lower bearing is positioned at the lowermost end of the shaft. It has been found, in operation, that these two bearings are capable of supporting the entire rotary mechanism even when the gap between the rotor 14 and the laminations 12a of the stator is fairly small. The reason for this is that, in the first place, the shaft is mounted in a vertical position, although not limited thereto, and in the second place, the support distance between the ball bearings 25 and 60 is considerable to give a long leverage effect.

Meshing with the spiral gear 58 and in planar relation thereto, there is a pair of gears 60a, preferably of steel, oppositely positioned from one another and mounted on fixed bearing shafts 61a. Bushings 62a carry the gears and are adapted to rotate about the bearings 61a. The latter are mounted vertically by being supported on a carrier 63 made of cast iron and comprise two oppositely disposed flat plates 64 and 65 separated from one another at the bosses 66 which serve as surface bearings for the bushings 62a. Spring washers 67 which are adapted to fit in grooves 68 in the bearings 61a may be employed to hold the latter in their proper vertical positions. These washers are contained in recesses 69 formed in the plates 64 and 65 of the carrier. The latter is provided with an upstanding boss 70 at the center which fits into a circular recess extending upwardly from the bottom plate member 21. Screws 71 may be provided for hold-

ing the boss 70 to the bottom plate. An oil seal 71a of suitable material may be inserted between the boss 70 and the shaft portion 53.

The gears 60a are caused to mesh with the teeth formed on the inner surface of an outer casing 72. The casing is provided at the top surface with a stiffening hump 73 and also an annular boss 74. The bottom plate 21 is extended downwardly as indicated at 75 to leave a space between the inner surface of the annular boss 74 and the portion 75. This space contains an oil seal 76 of any suitable type, such as graphite. The seal is wedged into position and, if desired, secured in any suitable manner within a retaining member 77. The bottom plate 21 is also provided with an annular boss 78 to leave a space with respect to the inner edge 79 of the top portion of the casing 72. A metal bearing ring 80 may be positioned within this space.

The lower end of the casing 72 is provided with a downwardly extending collar 81 having an inwardly extending lip 82 to retain the outer race 83 of a ball bearing 84. The inner race of the bearing is contained within an annular recess formed in a downwardly extending collar 85 of the carrier member. Snap rings 86 may be employed to hold the outer and inner races in vertical position. Thus, the casing 72 is adapted to rotate at the top along the bearing surface 79, and at the bottom is carried on the outer race of the ball bearing 84.

The lower surface of the casing is closed by means of a bottom plate 87 screwed as indicated at 88 to a downwardly extending collar 81. In practice, the entire inner surface of the casing 72 and as far upwardly as the spacer rings 71a and as far downwardly as the base plate 87 is filled with a suitable lubricating oil. Thus, the planetary gears 60a, as well as the sun gear 58 rotate in oil, also the two sets of ball bearings 60 and 84. However, it should be noted that a seepage of the oil may take place through the seal at 71a and eventually the oil may reach the ball bearing element 25 so that all rotating parts below the bottom plate 21 of the motor are either contained in oil or they have access to oil, which prevents the slightest noise from these parts during operation.

Brush Attachment

The collar 81 is provided at its outer periphery with three or more outwardly extending lugs 89 (four, as shown) which are adapted to receive the attachment brush of standard design provided on the interior circular surface of a cylindrical brush 90 made of metal or wood to which bristles 91 are attached. The locking device between the lugs 89 and the slots provided in the brush member 90 is such that they will tend to tighten as the brush is being rotated. It is simply necessary to rotate by hand the brush in the opposite direction slightly to release the brush from the portion 81 of the rotary casing.

Operation

When electricity is applied to the wound stator and the capacitor is placed in circuit through the contact between the plate 46 and the contact points 49, the rotor will start to turn, carrying with it the shaft 17. The shaft will rotate the sun gear 58, which will cause the planetary gears to rotate about their stationary bearings 61a. These last-mentioned gears actuate the ring gear formed on the casing 72 and the latter will rotate the downwardly extending collar 81 on the ball bearings 84. The collar actuates the brush 90 and its work bristles 91.

In order to protect the user from coming into contact with the rotating casing 72, it may be desirable to provide a shield 92 of sheet metal, having a contour edge extending loosely over the casing as seen more clearly in FIGURE 1.

Assuming that the rotor has a speed of approximately 1750 r.p.m., the gear ratio between 58 and 60a will be approximately 10:1 so that the brush 90 will operate

at approximately 175 r.p.m. The brush-bristle unit can be used for scrubbing floors, polishing waxed floors and, when shampoo material is added to the compartment 10, the brush may be employed for cleaning carpets, etc.

It will be noted that the upper end of the shaft 17 is completely devoid of a bearing. I have discovered, as one of the features of my invention, that the bearings 25 and 60 are located at such a distance apart and the shaft 17 of a motor is sufficiently large to carry the load, so that there is no lateral movement of the rotating parts at the upper end of the shaft. As shown, the lower bearing 84 which carries the entire weight of the rotating parts is preferably of greater size than the other bearings. There is always the proper clearance between the adjacent surfaces of the rotor and the field laminations, even though these spaces may be quite small. I have further noted that if there is any noise in a floor machine of the conventional unimproved type, such noise usually emanates from the upper-most bearing (not illustrated) where there is no oil available or, at any rate, if oil is provided, the bearing would eventually lose the oil. Consequently, by eliminating the bearing entirely and employing otherwise the proper support of the shaft in accordance with one of the features of my invention, I have eliminated a primary source of the noise. Moreover, as explained hereinbefore, the upper end of the shaft 17 is readily accessible to the user of the machine by simply removing the acorn nuts 33 and withdrawing the cover 35. Any necessary repairs or adjustments can be made in the switch elements, including the position of the counterweights.

It will be noted that I have shown and described my improved floor machine in connection with a train of gears of the planetary type in which the gears are located in the same horizontal plane, thus allowing greater compactness of the parts in the vertical direction. This feature is highly desirable in a floor machine which, on occasion, must be pushed under low-lying furniture, tables, chair, etc. However, certain features of my invention, particularly the elimination of the conventional upper-shaft bearing by providing an improved support for the shaft, is not limited to a planetary system of gears. It may be desirable to use other forms of gear trains such as the double parallel reduction gear system or even to effect the proper reduction by the use of sprocket gears and timing belts. However, for all practical purposes, I prefer a gear train of the improved planetary type as described hereinbefore since this type lends itself more readily to a compactness of the machine as a whole in the vertical direction.

In FIGURE 4 I have illustrated the application of the invention to a mechanical load taken from a shaft coaxial with the combined motor and gear shaft. In this figure the same motor structure is employed as is shown in FIGURE 1 of the drawing so that corresponding parts are given similar reference characters.

The main shaft extends down through the planetary gear system as before, but the shafts 61a, instead of being fixed in space, are now allowed to rotate about the sun gear 58. The ring gear 93 is fixed to the casing 12 by extending the stay rods 94 to pass through the ring gear and threadedly engage the bottom plate 95 of the gear casing. The ring gear 93 abuts a peripheral flange 96 of the upper plate 97 of the gear casing. This plate also serves as the bottom plate of the motor. While the stay rods 94 would prevent the ring gear 93 from turning, it is preferable to insert a number of equidistantly spaced dowel pins 98 to pass through the lower plate 95, the ring gear 93 and the peripheral boss 96. An output shaft 99 having a peripheral flange 100 is screwed as indicated at 101 to the boss 85 of the carrier portion 63. The base plate is screwed at 102 to the boss 81 of the gear casing. This plate is provided with a circular recess 103 for receiving the flange of the output shaft.

In operation, the rotary movement of the gear 58 will

cause the gears 60a to roll around the sun gear and since the ring gear 93 is fixed, the gear carrier member 64, 65 is caused to turn at a reduced rotational speed from that of the sun gear. The rotation of the carrier is carried through the boss 85 which turns on the bearing 84 to the output shaft 99.

This output shaft can serve as a source of power for many kinds of uses such as meat grinders, vertical water pumps, tire balancing machines, milk agitating machines, and machine tools of all descriptions.

As in the case of the machine shown in FIGURE 1, the ball bearings 25, 60 and 84 are so positioned as to hold the main shaft rigidly in an upright direction with such a close tolerance that even with the smallest air gap dimension at the motor, the rotor is able freely to turn even without the presence of a bearing at the upper end of the machine. I have found the support of the shaft and gearing is so rigid, i.e., having no lateral movement whatsoever, even at the uppermost end of the shaft, that the machine as a whole can operate in a horizontal position, instead of vertical, without the slightest interference at the air gap. Obviously, the machine may be positioned at any desired angle between the vertical and horizontal positions.

While I have indicated the presence of a starting switch at the top end of the shaft for making and breaking a split-phase circuit connection, it will be understood that the motor could be of the repulsion start-induction run type in which the starting switch would make and break connection to a starting winding of suitable character. Certain of the advantages which attend my invention would also be present in case the motor is of the poly-phase type which would not require a starting switch. Even in this case, the absence of a bearing at the end of the motor opposite from the gearing would still permit the over-all length of the machine to be materially shortened without any sacrifice of operating efficiency.

It will be understood that various modifications and arrangements in structure could be made without departing from the spirit of my invention and accordingly, I desire to comprehend all such modifications and substitutions of equivalents as may be considered to come within the scope of the appended claims.

What is claimed is:

1. In a floor machine, the combination of a single-phase alternating current motor positioned on a gear mechanism for actuating the same, a rotatable casing provided with gear teeth and driven by said gear mechanism, a floor-working tool detachably secured to said casing, the shaft of said motor passing through said gear mechanism for driving said tool through the casing, a device for phase-splitting the current supplied to the motor at the start, and means responsive to the speed of said shaft for operating the phase-splitting device, a removable cover for the upper end of the motor, said last-mentioned means being positioned between the motor and said cover.

2. In a floor machine, the combination of an electric motor positioned on a gear mechanism for actuating the same, a rotatable casing surrounding and driven by said mechanism, and a floor-working tool detachably secured to said casing, the shaft of said motor passing through the gear mechanism for driving said mechanism, only two bearings for said shaft, one of said bearings being

positioned between the motor and the gear mechanism and the other of said bearings being positioned at the lower end of the shaft, the upper end of the shaft being devoid of a bearing, a centrifugally operating switch for starting said motor secured to the upper end of the shaft, which is devoid of a bearing.

3. In a floor machine, the combination of an electric motor positioned on a gear mechanism for actuating the same, a rotatable casing surrounding and driven by said mechanism, and a floor-working tool detachably secured to said casing, the shaft of said motor passing through the gear mechanism for driving said mechanism, only two bearings for said shaft, one of said bearings being positioned between the motor and the gear mechanism and the other of said bearings being positioned at the lower end of the shaft, the upper end of the shaft being devoid of a bearing, a centrifugally operating switch for starting said motor secured to the upper end of the shaft, which is devoid of a bearing, and a removable dust-proof cover extending over the upper end of the motor, said cover being provided with contacts which operate with said starting switch.

4. In a floor machine, the combination of an electric motor and gear mechanism, an actuating shaft passing through said motor and gear mechanism, a centrally disposed gear mounted on said shaft having a pair of oppositely disposed gears meshing with said central gear, said pair of gears being mounted on fixed bearing shafts supported on a stationary carrier member, a casing surrounding said mechanism and having a ring gear portion which meshes with said pair of gears, a brush adapted to be detachably secured to said casing, said shaft having only two bearings, one of which is positioned between the motor and the gear mechanism and the other positioned at the extreme end of the shaft immediately adjacent said gear mechanism, and a bearing between said carrier member and said casing.

5. In a floor machine, the combination of an electric motor and gear mechanism, an actuating shaft passing through said motor and gear mechanism, a centrally disposed gear mounted on said shaft having a pair of oppositely disposed gears meshing with said central gear, said pair of gears being mounted on fixed bearing shafts supported on a stationary carrier member, a casing surrounding said mechanism and having a ring gear portion which meshes with said pair of gears, a brush adapted to be detachably secured to said casing, said shaft having only two bearings, one of which is positioned between the motor and gear mechanism and the other positioned at the extreme end of the shaft immediately adjacent said gear mechanism, and a bearing between said carrier member and said casing, the end of the shaft remote from the bearinged end being devoid of a bearing and having a starting switch attached thereto.

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