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AIR DRIVEN ROTATING BRUSH FOR VACUUM CLEANERS

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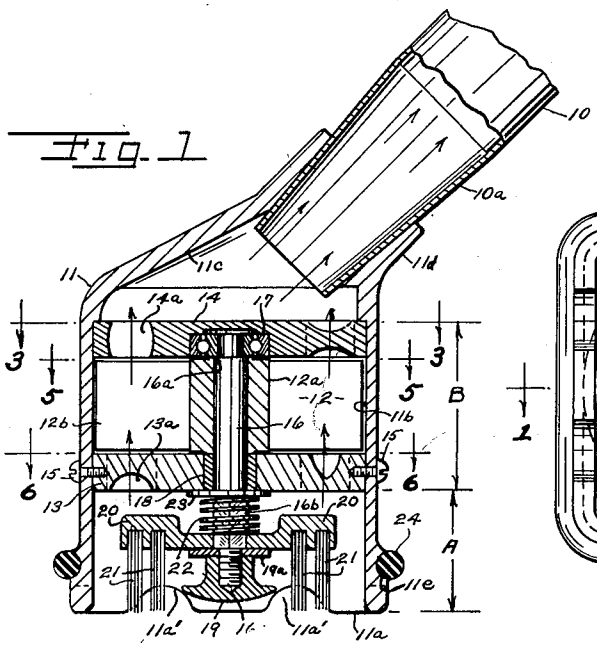

Fig. 1

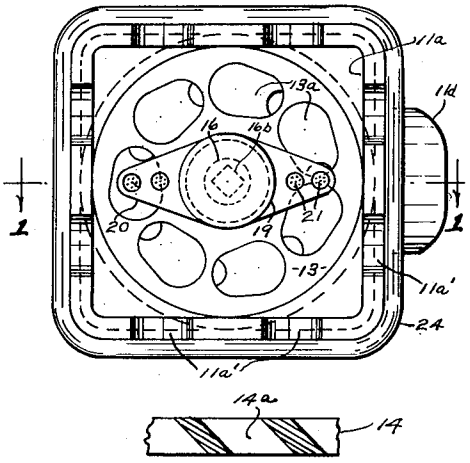

Fig. 2

Fig. 4

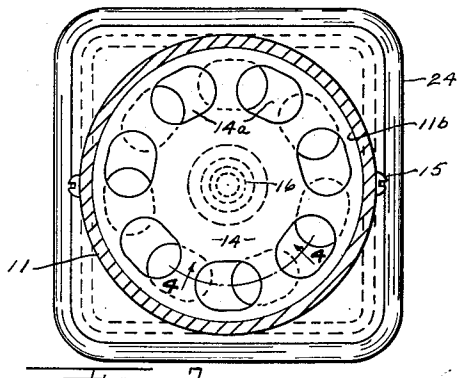

Fig. 3

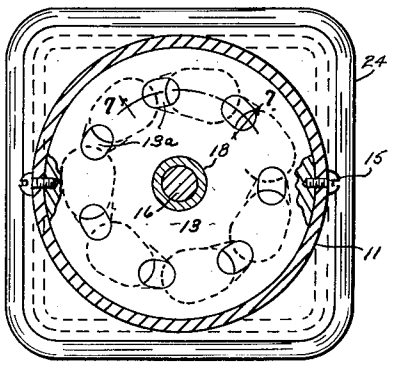

Fig. 6

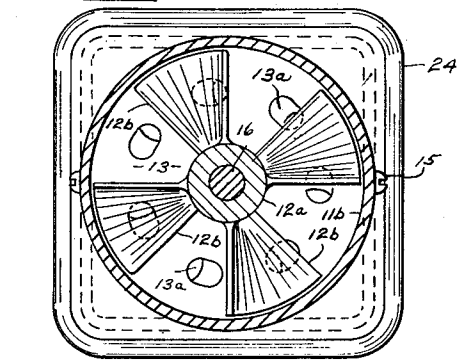

Fig. 5

Fig. 7

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AIR DRIVEN ROTATING BRUSH FOR VACUUM CLEANERS

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1 Claim. (Cl. 15—372)

This invention relates to improvements in vacuum cleaning apparatus of the tank type and more particularly to a vacuum cleaning attachment therefor.

An object of the present invention is to provide in a vacuum cleaning apparatus of the type described means for readily picking up lint, hair, etc., from stairways, auto cushions, upholstery, etc., wherein said means is driven by the suction that carries the dust and other particles to the vacuum cleaner tank.

Another object of the present invention is to provide in a vacuum cleaning apparatus of the type described a rotating cleaning brush driven by the suction of the vacuum cleaner.

Another object of the present invention is to provide in a vacuum cleaning apparatus of the type described a rotating brush driven by an air motor having inclined nozzles directing the air stream against rotor blades of said motor in response to the vacuum cleaner suction.

Another object of the present invention is to provide in a vacuum cleaning apparatus of the type described above means for preventing stalling of said motor when said brush encounters too much resistance.

Another object of the present invention is to provide in a vacuum cleaning apparatus of the type described above means for removably mounting said brush and at least a portion of the motor in an enclosing housing so that the brush and motor parts may be easily removed for cleaning.

Other features of this invention reside in the arrangement and design of the parts for carrying out their appropriate function.

Other objects and advantages of this invention will be apparent from the accompanying drawing and description and the essential features will be set forth in the appended claim.

In the drawings,

Fig. 1 is a vertical longitudinal sectional view of the vacuum cleaner attachment;

Fig. 2 is a bottom view of the attachment shown in Fig. 1;

Fig. 3 is a horizontal sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a vertical sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is a horizontal sectional view showing the rotor of the air motor and taken along the line 5—5 of Fig. 1;

Fig. 6 is a horizontal sectional view taken along the line 6—6 of Fig. 1; while

Fig. 7 is a vertical sectional view of one of the nozzles taken along the line 7—7 of Fig. 6.

Those familiar with this art will recognize that my invention may be applied in many ways, but I have chosen to illustrate the same in connection with a tank-type vacuum cleaner of known type. In general, there are two types of vacuum cleaning apparatus used for household cleaning—a tank-type vacuum cleaner and an upright-type vacuum cleaner. The upright type is the older and has a motor-driven rotating brush engaging the rug or other article being cleaned. The tank type is easier to use since only the cleaning head need be moved across the article being cleaned. However, the user of the tank-type cleaner has great difficulty in picking up lint, hair, etc., since a rotating brush does not contact the article being cleaned. The suction conduit between the cleaning head and the tank in the tank-type cleaner is flexible so that it is not practical to directly rotate a brush in the cleaning head by the same motor that supplies the vacuum in the tank. In the present invention, the suction developed by the motor in the tank is utilized to rapidly rotate a cleaning brush in the cleaning head as well as to suck lint, dust, etc., through the cleaning head and flexible conduit into the tank. The suction drives an air motor in the cleaning head to rotate the brush.

Fig. 1 discloses a flexible suction line **10** from a conventional type tank-type cleaner (not shown). This suction line **10** is connected to the cleaning head of the present invention. The cleaning head comprises a tubular housing **11** having an air inlet at one end adapted to contact the article being cleaned and an air outlet at the opposite end adapted to be attached to the suction line **10**. The inlet **11***a* shown in Figs. 1 and 2 as being substantially square in cross section and as extending for a distance equal to the dimension A in Fig. 1. Of course, it is understood that the inlet **11***a* may have any desired cross sectional shape found to be useful by the user; it need not necessarily be square. The through tubular passageway of the tubular housing **11** also has a cylindrical bore **11***b* extending substantially the distance shown by the dimension B in Fig. 1. The outlet of the housing **11** serves as a coupling for connection to the suction line **10**. Although the coupling may be of any shape or type, it is shown here as being composed of the cylindrical bore **11***d* being telescoped over the tapered end **10***a* of the suction line **10**. A converging portion **11***c* connects the cylindrical bore **11***b* and the outlet **11***d*.

A suction-driven power means for rotating the cleaning brush is provided. This means takes the form of an air motor in the present disclosure being driven by the suction created by the tank-type cleaner. The air motor has a rotor **12** having a hub **12***a* integrally formed with a plurality of outwardly and radially extending blades **12***b*. Each blade has a substantially helical surface. The rotor is mounted in the cylindrical bore **11***b*, as seen in Fig. 5, so that only a small clearance exists between the tip of the blades and the bore. This rotor is mounted for rotation in the housing **11** coaxially with the cylindrical bore **11***b*.

The air motor is provided with spaced transverse walls, each substantially disc-shaped, fitting into the cylindrical bore **11***b*. These walls are shown in Fig. 1 as the upstream or lower wall **13** and the downstream or upper wall **14**. Means is provided for detachably securing these walls in the cylindrical bore. Although this means may take various forms, in the present disclosure it takes the form of screws **15** inserted into holes in the housing **11** and screwed into the upstream wall **13**. It should be noted that the hub **12***a* of the rotor in Fig. 1 is longer in the axial dimension than the blades **12***b*. Hence, the screws **15** detachably secure the plate **13** against the lower edge of the hub **12***a* which in turn substantially contacts the bottom of the downstream plate **14**. This latter plate is prevented from moving upwardly by the shoulder existing between the cylindrical bore **11***b* and the converging portion **11***c* of the housing. The axial length of the hub **12***a* also provides a small clearance on the upper and lower side of each blade. This clearance and the clearance between the blades and the bore **11***b* are not large enough to permit substantial air leakage past the outer ends of the rotor blades but permit the rotor to rotate freely between the spaced transverse walls.

Each of the transverse walls has a plurality of nozzles adapted to direct the incoming air so as to rotate the air motor rotor **12**. The lower or upstream plate has a plurality of nozzle apertures, as shown in Figs. 2, 5, 6 and 7. These nozzles are equally spaced and are equidistant from the central longitudinal axis of the rotor in the cylindrical bore **11***b*. The axis of each nozzle is inclined toward the direction of rotor rotation (Figs. 5 and 7) so that it directs a stream at a tangent. This air stream strikes directly against the blades of the revolving rotor in a manner to exert the most effective torque. Fig. 5 discloses that there are four blades **12***b* on the rotor while there are seven nozzles **13***a* in the upstream plate. A greater number of nozzles are provided than blades so that the air motor will provide smooth power, and there will be no possibility that the blade **12***b* will get over a

dead-center position wherein the nozzles are directing the air stream between the rotor blades. As shown in Fig. 7, each nozzle reduces in flow cross sectional area in the downstream direction (upwardly in Figs. 1 and 7). Therefore, the air moving through the nozzles will increase in speed in accordance with Bernoulli's Theorem. The greater speed of the air jet will have a higher kinetic energy and will therefore rotate the blades of the rotor **12** very rapidly in response to the suction exerted by the motor in the vacuum cleaner tank. It has been found in practice that the nozzle shape shown in Figs. 2, 5, 6 and 7 has been very satisfactory. This shape is substantially the frustrum of a cone. The downstream plate **14** has a plurality of exhaust nozzles or apertures **14***a*, as shown in Figs. 3 and 4. Each of these nozzles is fairly large and is of uniform cross sectional areas. Each is inclined toward the direction of air flow from the blades of the rotor **12** so that they provide very little resistance to the air flow. Then, the greatest portion of the pressure drop caused by the suction of the vacuum cleaner is across the nozzles **13***a* where it should be so that the air jets strike the rotor blades with high velocity and high kinetic energy.

Means is provided for rotatably mounting the rotor **12** in the housing **11** coaxial with the cylindrical bore **11***b* of the air passageway. In the present disclosure, this means takes the form of a shaft **16** fixed to the rotor **12** and rotatably mounted in bearings **17** and **18** in walls **14** and **13** respectively. Bearing **17** is of the ball bearing type and is telescoped over a reduced diameter on the upper end of the shaft **16** until it contacts shoulder **16***a* on the shaft and is telescoped into the central, blind bore in downstream plate **14**. Bearing **18** is of the sleeve type and is mounted in a central hole in the upstream wall **13** coaxial with the bore **11***b*. Of course, this latter bearing may be of the ball, needle, or any other type desired which gives satisfactory results in service. It should be noted that this structure prevents the axial movement of shaft **16** in the housing **11**. The downstream wall **14** in housing **11**, the bearing **17**, and the shaft **16** with the shoulder **16***a* are each prevented from moving in the upward direction in Fig. 1 by the shoulder engagement shown therein. They cannot move downwardly since rotor **12** is secured to the shaft **16** and the rotor hub **12***a* is supported by the upstream plate **13** held in the casing **11** by the removable screws **15**.

A brush is mounted on the lower end of the shaft **16** opposite to the rotor **12**. Means is provided for mounting the brush for limited relative axial movement along the shaft but for preventing relative rotation between the brush and the shaft. The lower end of the shaft has a non-circular cross section for keying the brush to the shaft to prevent relative rotation therebetween. In the present disclosure, this non-circular cross section is shown square in form at **16***b*. The cleaning brush has radially extending arms **20** joined to a central hub having a bore therethrough square in cross section adapted to fit loosely in a telescopic manner over the square end **16***b* of the shaft. The brush has downwardly extending bristles **21** arranged in groups and secured to the underside of the arms **20**. The brush is loosely fitted on the square end **16***b* of the shaft so that the brush will have a floating action and will conform more readily to the surface of the article being cleaned. The lower end of the shaft has a threaded end **16***c* on which a stop nut **19** is removably screwed.

Resilient means is provided between the upstream wall and the brush so that the brush is normally biased toward the inlet into engagement with the article being cleaned but so that the brush can move axially toward the rotor to reduce the power required from the rotor when the brush exerts a stalling torque on the rotor. Any obstruction or irregularity on the surface of the article being cleaned may cause the rotor to stall. When the brush hits this obstruction, it may move axially toward the rotor to reduce the torque required but the resilient means will always tend to push the brush away from the rotor to contact the article being cleaned so that the brush bristles **21** will have a firm contact with the article. In the present disclosure, the compression spring **22** is loosely fitted around the square shaft portion **16***b* between the top of the brush and the lower surface of the upstream wall **13**. Thrust washer **23** is loosely fitted around the cylindrical portion of the shaft **16** between the spring **22** and the upstream wall **13**. The spring is so dimensioned that it will normally urge the brush bristles **21** down into firm cleaning engagement with the article being cleaned while still permitting the brush to float or to move axially upwardly on the squared portion **16***b* of the shaft when an obstruction is encountered by the bristles which might cause the rotor **12** to stall.

The inlet of the vacuum cleaner attachment, shown at **11***a*, lies in a plane perpendicular to the axis of the rotation of shaft **16**. Air inlet or vacuum relief slots **11***a'* are provided in the housing wall **11** adjacent the inlet to permit entrance of air when the surface **11***a* is pressed tightly against the article being cleaned. These slots may take the form of indentations in the surface **11***a*, as shown in Fig. 1, or may take the form of apertures in the housing sidewall adjacent the surface **11***a*. Around the inlet on the housing is provided a peripheral groove **11***e* having a rubber O-ring **24** therein to prevent any accidental damage to furniture or other objects having finished surfaces as the cleaning head is moved across the article being cleaned.

The operation of the vacuum cleaner attachment in the present invention should now be apparent. The suction of the tank-type cleaner not only carries the dust, dirt, lint, hair, etc., through the suction line to the tank but also rotates a cleaning brush by pulling air through and driving an air motor. The inlet **11***a* on the cleaning head or attachment engages the article to be cleaned, such as stairways, auto cushions, upholstery, etc., and readily picks up the hard-to-pick-up lint, hair, etc. The air is sucked radially through the slots **11***a'* and strikes the lint, hairs, etc., to aid the rotating brush in their removal from the article being cleaned. The spring **22** resiliently urges the brush bristles **21** to cleaning engagement with the article while still permitting the brush to move axially upwardly to prevent stalling of the rotor when obstacles impede the rotation of the brush. The brush, since it has a floating mounting, tends to accommodate itself to the surface being cleaned without stalling. With the presently disclosed design, it has been found that the brush rotates at about 2500 R. P. M. with a standard tank-type vacuum cleaner having a one-half horsepower motor. This speed permits the brush to quickly pick up dust, lint, and hairs which would not normally be picked up by the standard tank-type vacuum cleaner.

The attachment may be quickly cleaned by having the operator hold the brush so that the suction pulls the air through the nozzles and rotor to carry any lint or hairs tending to plug said parts out into the tank-type cleaner. However, sometimes the dust, lint, hairs, etc., will pack up in the nozzles and between the rotor blades in such a manner that this method of cleaning is not satisfactory. This clogging by incoming material may even tend to stop the rotation of the rotor or may tend to reduce its power so that the effectiveness of the brush is materially reduced. Then, the vacuum cleaning attachment must be disassembled. The detachable securing means or screws **15** in the upstream wall **13** are removed so that the upstream wall **13**, the rotor **12**, the shaft **16** and the brush may be removed from the housing. Then, the parts may be easily cleaned. In that manner of removal, the shaft **16** has a sliding telescopic fit in the bearing **17** while the downstream wall **14** is secured in the housing **11**. However, in the present disclosure the shaft **16** has a pressed fit in the bearing **17** while downstream wall **14** has a sliding fit in the housing **11**. Then when screws **15** are removed, both walls as well as the rotor and the brush are removed as a unit for cleaning. There is no danger of losing small parts when the attachment is disassembled since all the parts are removed as a unit. Any adhering and clogging dust, lint or hairs may be easily removed before reassembly. Of course, it is quite evident that any type of detachable securing means can be substituted for the screws **15** in Fig. 1, for example, a bayonet joint.

The vacuum cleaning attachment may have all its parts made of plastic, either molded or fabricated from standard shapes. Plastic construction is inexpensive and makes a very attractive unit. Also, if transparent plastic is used, the rotation of the rotor **12** may be observed and the parts may be disassembled when lint or hairs threaten to clog the mechanism even before the effectiveness of the brush is reduced.

It is readily seen that the cylindrical bore **11***b* in the

tubular housing has certain advantages. It conforms to the outer edges of the rotor blades **12***b* so that very little clearance exists and substantially all of the air must move between and against the rotor blades to drive the brush and very little can escape around the ends of the rotor blades. Also, the cylindrical bore **11***b* provides a construction wherein the spaced transverse walls **13** and **14**, the rotor **12**, the shaft **16** and the brush may be quickly and easily disassembled from the housing for cleaning purposes.

The rotor **12** will operate without the exhaust nozzles **14***a* and the downstream wall **14**, but the downstream wall has certain advantages. The exhaust nozzles **14***a*, as seen in Fig. 4, remove the exhaust air in its normal direction of flow so therefore impede the exhaust flow very little. The spaced transverse walls **13** and **14** provide a sturdier construction since bearings are provided on both ends of the shaft on opposite sides of the rotor and the rotor hub **12***a* coacting with the transverse walls and the bearings reduces the end play of the rotor **12** to a minimum. The rotor cannot move away from the wall **13** under the driving force of the nozzles **13***a*. The spaced transverse wall construction permits all of the parts to be disassembled from the housing as a unit for cleaning purposes. The small clearance around the rotor blades and the placement of the exhaust nozzles **14***a* and the inlet nozzles **13***a* direct the incoming stream of motivating air along its most effective path so that the air motor exerts the highest power for the suction created by the tank-type vacuum cleaner.

Various changes in details and arrangement of parts can be made by one skilled in the art without departing from the spirit of this invention or the scope of the appended claim.

What I claim is:

In a vacuum cleaning apparatus, the combination of a housing having a through passageway having inlet and outlet ends, said outlet end of said passageway adapted to be attached to the suction side of a vacuum cleaner, spaced transverse walls in said passageway, a shaft rotatably mounted in a bearing in each of said walls, a rotor having a plurality of blades and being secured to said shaft between said walls, one of said walls being upstream from said rotor and the other wall being downstream from said rotor, said passageway forming a cylindrical

bore surrounding said rotor, said rotor being so dimensioned that only a small clearance exists between said rotor and the surrounding walls and passageway bore, a brush secured to said shaft for rotation therewith but for relative axial movement thereon and located between said upstream wall and inlet, said upstream wall having a plurality of nozzles for directing the motivating incoming air stream against said rotor blades in response to the suction of said vacuum cleaner, said nozzles being greater in number than said rotor blades, each of said nozzles being inclined in the direction of rotor rotation, each of said nozzles reducing in flow cross sectional area in the downstream direction, whereby the incoming air will increase in speed as it moves through said nozzles, said downstream plate having exhaust nozzles therein, means detachably securing at least said upstream wall to said housing, whereby said brush, shaft, rotor and upstream wall may be readily removed as a unit from said housing for cleaning, resilient means between said upstream wall and said brush, whereby said brush is normally biased toward said inlet and into engagement with the article being cleaned but said brush moves axially toward the rotor to reduce the power required from said rotor when said brush exerts a stalling torque on said rotor, the inlet of said housing lying in a plane perpendicular to the axis of rotation of said shaft, and said housing having air inlet slots in its wall adjacent said inlet, whereby air sucked radially through said slots aids in the removal of lint on an article engaging said inlet and cleaned by said rotating brush.

References Cited in the file of this patent

UNITED STATES PATENTS

987,820	Parker	Mar. 28, 1911
1,036,735	Sieben	Aug. 27, 1912
1,147,064	Wolf	July 20, 1915
1,167,996	Hauer	Jan. 11, 1916
2,045,980	De Nagy	June 30, 1936
2,078,634	Karlstrom	Apr. 27, 1937
2,246,036	Farrell	June 17, 1941
2,331,692	Hunt	Oct. 12, 1943

FOREIGN PATENTS

38,834	Denmark	June 4, 1928