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PLASTIC FAN FOR SUCTION CLEANERS

Filed Sept. 7, 1946

2 Sheets-Sheet 1

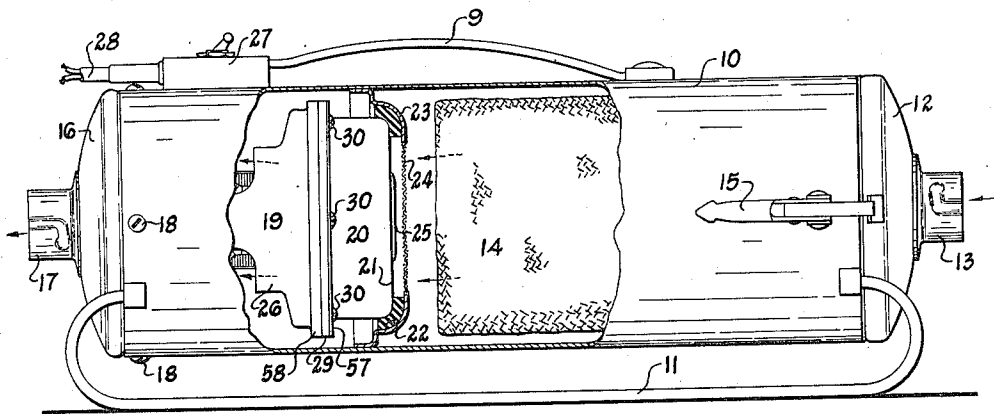


Fig. 1

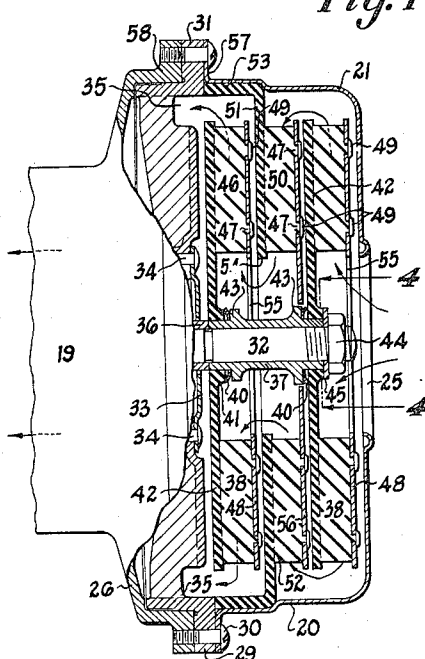


Fig. 2

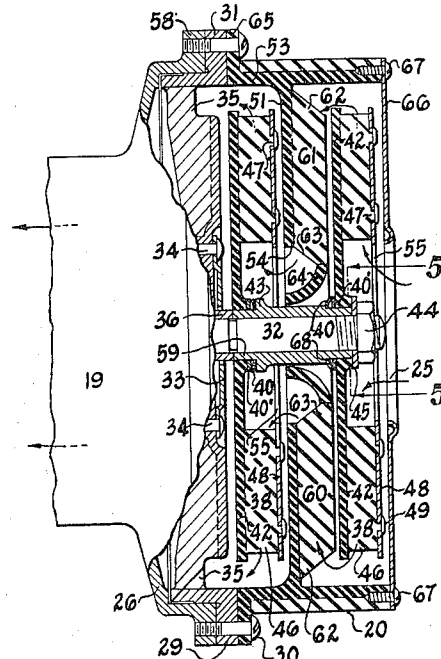


Fig. 3

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2 Sheets-Sheet 2

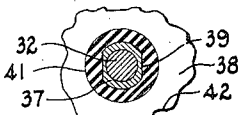


Fig. 4

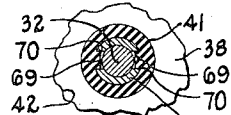


Fig. 5

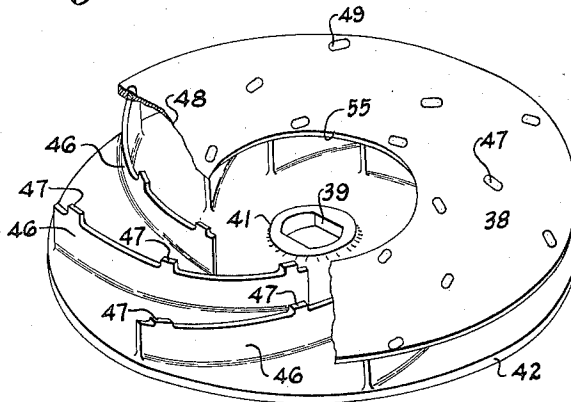


Fig. 6

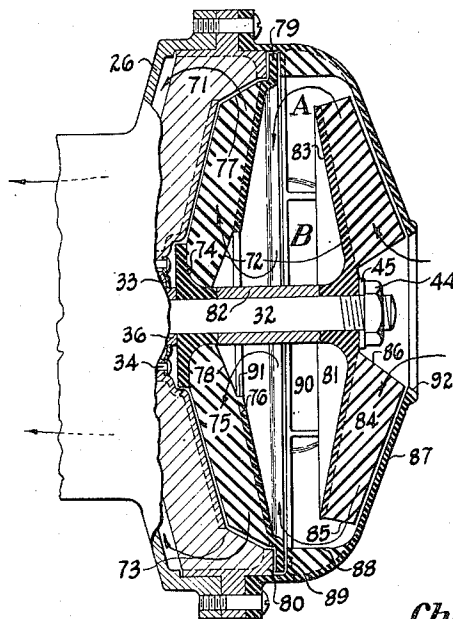


Fig. 7

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PLASTIC FAN FOR SUCTION CLEANERS

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9 Claims. (Cl. 230—117)

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The present invention relates to suction cleaners and more particularly to improvements in multi-stage suction-producing fans for suction cleaners.

More particularly, the present invention comprises the provision of a fan construction in which the fan may be fabricated solely from polymeric organic compounds which are thermoplastic and readily moldable or with parts thereof fabricated from sheet metal and a suitable thermoplastic material.

Another object is to provide a fan formed of a thermoplastic polymeric organic compound in which the molding powder used has very little, if any, plasticizer added. The thermoplastic material should have high tensile and flexural strength and should have dimensional stability under the high stresses to which high speed fans of this type are subjected.

Another object is to provide a fan which may be economically and easily manufactured. Other objects of the invention are to provide fans of this type having increased efficiency due to better air flow characteristics by the reduction of sharp edges, etc., and, furthermore, to provide fans of this type which are quieter and free of objectionable resonant noises.

Further objects and advantages of this invention will become apparent as the following description proceeds, and the features of novelty which characterize this invention will be pointed out with particularity in the claims connected to and forming a part of the following specification and upon considering in connection therewith the attached drawings to which they relate wherein:

Figure 1 is a side view of a suction cleaner of the canister type partly in section showing a fan of this invention embodied therein;

Figure 2 is a vertical view partly in section of an embodiment of a multi-stage plastic fan system including a plastic inter-stage for a tank cleaner fan system of Figure 1;

Figure 3 is a vertical view partly in section of another embodiment of a multi-stage plastic fan system including a plastic inter-stage for the tank cleaner fan system of Figure 1;

Figure 4 is a section taken on line 4—4 of Figure 2 in the direction of the arrows illustrating a method of keying the plastic fan to a spacing sleeve;

Figure 5 is a similar view to that of Figure 4 taken along line 5—5 of Figure 3 illustrating an alternate method of keying fans to a spacing sleeve;

Figure 6 is a perspective view broken away and

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partly in section illustrating a fan impeller constructed in accordance with this invention; and

Figure 7 is a vertical view in section of another embodiment of the invention of a multi-stage fan system constructed in accordance with this invention.

Like parts are indicated by like reference characters throughout the specification and drawings.

Referring to Figure 1, a suction cleaner is shown comprising a housing 10 mounted for transport on runners 11. Removably attached at one end of the housing 10 is an end cap 12. The end cap 12 is provided with a suction inlet connection 13 for the connection of conventional dusting tools and the end cap 12 may be removably attached and detached from the housing 10 for the removal of a filter 14 and inspection thereof by manipulation of latches 15.

An end cap 16 at the opposite end of the cleaner is provided with a blower outlet connection 17 for the connection of conventional dusting tools and is secured in place by suitable securing means 18. The end cap 16 may therefore be readily removed for the inspection and repair of the motor and fan assemblies 19 and 20, respectively, the reference character 19 indicating the motor assembly and the reference character 20 indicating the fan assembly of this invention. The motor-fan unit 19 and 20 is supported at one end by a fan housing 21 supported by an annular rubber ring 22 to prevent vibrations from being transmitted to a bulkhead 23. The bulkhead 23 is provided with an additional filter 24 in the form of a fine mesh circular screen contiguous to an inlet 25 of the multi-stage fan 20.

The opposite end of the motor-fan unit 19 and 20 is resiliently mounted in any suitable manner.

Any suitable switch mechanism 27 connected to a source of power by an electrical cord 28 may be provided for energizing the motor 19, the details of which do not themselves form part of the present invention. A conventional carrying handle 9 may be provided for the transporting of the suction cleaner from place to place.

A motor end plate 29 is provided with flanges for attachment to the motor casing 26. The fan housing 21 is also attached to the casing 26 by means of screws 30 which pass through the flange of plate 29. A bearing retainer 31 is fixed to the motor end plate 29 by tubular rivets 34. The plate 29 is provided with peripherally spaced openings 35 to provide outlets for the air stream into the interior of the motor casing 26 for cooling the motor.

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A sleeve 36 serves to space the fan on the shaft 32. A collar 37 serves to space the fan impellers 38 on the shaft 32 and is utilized to rigidly mount them thereon. The impellers 38 are fixed to the opposite ends of the sleeve 37 by means of non-circular openings 39 in the hubs of the impellers interfitting with complementary non-circular ends of the collar 37 as illustrated in Figure 4. A spring washer 40 lies between the boss 41 of the plate 42 and the inner collar 43 of sleeve 37 and between an outer collar 43 and the plate 42 of the outer impeller 38. The washers 40 serve to distribute the pressure on the material of the fan hubs to prevent cold flow thereof. The collar 37 is attached to the shaft 32 by a nut 44 and lock washer 45.

Referring to Figures 2, 3, and 6, the thermoplastic impellers 38 comprise a back plate 42 and a plurality of vanes 46 molded integrally therewith. Each of the vanes 46 is provided with integrally molded tabs 47 which extend through openings in a shroud 48 and are fused over by a suitable hot forming tool to form heads 49.

It is preferred to form the plastic impellers from a polymeric organic compound which may be readily molded by conventional methods. Multi-stage fans for tank cleaners are rotated at a speed of from 13,000 to 15,000 R. P. M. It is therefore necessary that the material from which the impellers are made have tensile and bending strength such that the material will not cold flow and alter the impeller's dimensions due to the centrifugal force at the high speeds involved. Polymeric organic compounds which are thermoplastic and possess the desired physical characteristic described are polystyrenes, vinylite which may be a polymer vinyl acetate or a vinyl chloride and acrylic resins.

Referring to Figure 2, a plastic inter-stage 50 comprises a back plate 51 and fins 52 integrally molded therewith. The back plate 51 has a flange 53 engaging the flange 31 of the motor end plate 29. The back plate 51 with its flange 32 in cooperation with the motor end plate 29 forms an exhaust chamber for the rear impeller 38. The impeller 38 draws air through an opening 54 in the back plate 51 and through an opening 55 in the impeller shroud in axial alignment with the opening 54. The fins 52 are curved similarly to the impeller blades 46 to reduce the friction loss in air moving to the next stage.

A plate 56 is fixed to the deflector fins 52 in the same manner as the shroud is fixed to the impeller blades 46. The fins are provided with integral tabs 47 receivable in openings in the plate 56 and fused over by suitable hot forming tools to form heads thereon which serve to fix the plate 56 to the fins.

The fan housing 21 is provided with an air inlet opening 25 in axial alignment with the opening 55 of the first stage impeller.

The fan housing 21 is provided with a recessed portion to receive the flange 53 of the inter-stage 50 and with a flange 57 abutting flange 31 of the motor end plate 29.

In the construction of Figure 3, the impeller 38 of the second stage is mounted on a spacing sleeve 59 similar to the spacing sleeve 37, but having sufficient space for a flat metal washer 40' in addition to the spring washer 40. The flat metal washer 40' serves to distribute the pressure on the material of the fan.

The deflector back 51 of inter-stage 60 has integrally molded deflector fins 61 extended as illustrated at 62 and 63 to aid the air flow. A

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conical shaped deflector 64 is also provided to aid the air flow from the inter-stage 60 to the second stage of the fan.

In addition to the flange 53 the inter-stage 60 is provided with an integral flange 65 secured directly against the flange 29 of the motor end plate 21. The flange 53 is extended forwardly from the plate 51 and forms a chamber for the inter-stage 60 and the first stage impeller 38. A cover plate 66 is suitably secured to the flange extension by means 63 passing through the cover plate into the flange 53.

Referring to Figure 5, the opening in the impeller boss 41 is formed with diametrically opposed keys 69 interfitting with complementary keyways 70 formed in the spacing sleeve 59.

Referring to Figure 7, the tapered motor end plate 71 is mounted on the motor casing 26. The plate 71 is in the form of a ribbed spider to provide a series of peripheral outlets 73 for the discharge of air from the fan housing into the motor casing 26.

The impeller 74 of fan 72 is fabricated from a thermoplastic material including integrally molded vanes 75 and back plate 76. The vanes 75 are suitably curved to reduce friction losses and are shaped as illustrated at 77 and 78 to aid in the air flow. The back plate 76 is extended as at 79 into a recess between the portion 80 of the plate 71 and a ring 89 extending inwardly from the fan housing 87. The second stage impeller 74 is press fitted on the shaft 32 and is spaced from the first stage impeller 81 by a spacing sleeve 82.

The first stage impeller 81 is molded from a thermoplastic material and includes a back plate 81 integrally molded to curved and tapered vanes 84. The vanes 84 are shaped at their ends as illustrated at 85 and 86 to aid the air flow through the passages formed by the vanes 84, the back plate 83 and the molded fan housing 87. The housing 87 is conical in shape as illustrated, is press fitted over the flange 80 of the motor end plate 71 and is provided with fins 88 and an inwardly extending annular ring 89. The extension 79 of the second stage impeller is positioned between the ring 89 and the shoulder 80 of the plate 71 to provide a seal between the first and second stage impellers. The volume of the space 90 between the fans 78 and 81 is so proportioned that its axial dimension at point A is less than at point B to aid the air flow from the discharge of impeller 81 to the inlet 91 of impeller 74.

The air flow through the fan of Figure 7 is through the opening 92, the first stage impeller 81, the space 90, the opening 91 and the second stage impeller where it is discharged into the motor casing 26 as indicated by the arrows.

It is to be understood that whereas there has been described and illustrated a practical and operative device in the form of a multi-stage fan construction and modifications thereof, nevertheless many changes may be made in the size, shape, number and disposition of parts without departing from the spirit of this invention.

I claim:

1. In a motor and fan assembly for vacuum cleaners, the motor comprising a housing, a motor shaft extension and a motor end plate adapted for mounting the fan assembly thereon and provided with an outlet for the discharge of an induced air stream through the fan and the motor housing, the motor shaft extension adapted for mounting the fan assembly thereon, plastic fan impellers having integrally molded vanes, means

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mounted on the motor shaft extension and adapted at opposite ends thereof to mount a plastic fan impeller thereon, means for assembling the impellers to the aforesaid means adapted for mounting the impellers whereby the axial pressure applied to the impeller is limited to prevent excessive cold flow, a plastic inter-stage adapted to be mounted on the motor end plate and having an integrally molded plastic deflector back and fins curved similarly to the integrally molded vanes of the aforesaid fan to reduce friction loss in air going from one stage of the multi-stage fan to another stage of the multi-stage fan, a housing for the fan assembly provided with an inlet opening for the induced air forming a chamber for one stage of the aforesaid multi-stage fan and the inter-stage, and the deflector back of the inter-stage together with the motor end plate forming a chamber for the impeller of the second stage of the multi-stage fan, means for rigidly securing the plastic impellers and means for mounting the impellers to the motor shaft extension, and means for assembling the motor end plate, inter-stage and housing for the fan assembly to the motor housing.

2. In a motor and fan assembly for vacuum cleaners, the motor comprising a motor end plate and a motor shaft extension adapted for mounting the impellers of the multi-stage fan thereon, a plurality of plastic impellers adapted to be spaced from each other, means adapted for spacing the impellers and for affixing the impellers to the motor shaft extension, means for mounting the plastic fan impellers on the aforesaid means for affixing the impellers to the motor extension shaft whereby axial pressure applied to the fan impellers is limited to prevent excessive cold flow, a plastic inter-stage intermediate to the aforesaid plastic impellers and adapted to be affixed to the motor end plate, the plastic inter-stage provided with an integrally molded deflector back adapted to form a chamber for one of the impellers with the motor end plate, the motor end plate being provided with an outlet for the discharge of the air stream from the impeller through the motor housing, the plastic inter-stage provided with an annular integrally molded plastic housing adapted for mounting the fan assembly on the motor end plate, said annular housing together with the deflector back of the inter-stage adapted to provide a chamber for the fins of the inter-stage and the impeller of the first stage, means for rigidly affixing the impellers and means for mounting the impellers to the motor shaft extension, and a cover plate provided with an opening for the fan and adapted to be affixed to the annular housing of the inter-stage.

3. The combination of a multi-stage fan system with a motor having a conically shaped motor end plate provided with an opening for the discharge of air from a stage of the fan through a motor housing, a last stage of the multi-stage fan having a molded plastic impeller comprising a back plate and vanes therefor integrally molded and complementally formed with respect to the motor end plate, a molded plastic impeller having vanes and a back plate formed of plastic and molded integrally and spaced from the molded impeller of the second stage, means for mounting the plastic impellers and the spacer therefor on a shaft extension of the motor and rigidly secured thereto, a conically shaped molded plastic fan housing complementally formed with respect to the first stage impeller and provided

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with fins at the discharge of the first stage impeller to reduce swirling and turbulence and also complementally formed with respect to the back plate of the second stage impeller to further reduce turbulence, and the volume of the space between the impellers to be proportioned so that the axial dimension at the point at which the first stage impeller discharges into the space between the fans is less than the axial dimension at the point at which the air discharges from the space into the second stage impeller, and the height of the blades of the impellers forming the stages of the multi-stage fan at the inlet to the stages diminishes between the hub and the outer diameter of the impellers to also aid in the air flow through the fan by reducing the turbulence.

4. A combined fan inter-stage and housing for a multi-stage fan comprising, an annular heat weldable thermoplastic back plate having a central opening which forms a suction opening to a succeeding stage of said fan; arcuate vanes of the same material molded integrally to the face of said plate and facing a preceding stage of said fan, said vanes extending from adjacent the central opening of said back plate to the outer periphery thereof so as to form an exhaust chamber for the said preceding stage of said fan, an integral annular flange extending laterally from the outer periphery of said plate toward the said succeeding stage of said fan so as to surround the exhaust of said succeeding stage and form the outer housing thereof and means extending in the opposite direction from the periphery of said plate and forming a housing about said preceding stage exhaust chamber and for the preceding stage impeller.

5. A mounting for the plastic impellers of a multi-stage fan to limit axial pressure applied thereto to prevent excessive cold flow of the plastic material comprising, an elongated shaft member, a plastic fan impeller keyed to each end thereof, means for securing said impellers to said member and pressure distributing means between each impeller and said last mentioned means to prevent excessive localized pressure on said impellers and thus prevent excessive cold flow of the plastic material forming the impellers.

6. A combined fan inter-stage and housing according to claim 4 including lugs integral with and extending from the free edges of said vanes and a shroud extending from adjacent the outer ends of said vanes to a point adjacent the shaft for said fan, said shroud having openings therein for receiving said lugs and said lugs extending through said openings sufficiently to be heat welded over the edges of said openings and form retaining heads.

7. A motor-fan unit comprising, a motor housing, an end plate for said housing having openings therein for leading exhaust air from said fan into the interior of said housing, the shaft of said motor extending through said plate and to a point beyond the same, a casing secured in said plate and extending therefrom to a point slightly beyond the outer end of said shaft, said casing having a circular inlet opening adjacent to and surrounding the outer end of said shaft, a sleeve on the extending portion of said shaft and secured thereto so as to rotate therewith, a collar near each end of said sleeve, a thermoplastic fan impeller keyed to each end of said sleeve and abutting against said collars, means for securing said impellers against said collars, the periphery of said impellers being spaced inwardly of said

casing and a thermoplastic inter-stage extending inwardly from said casing between said impellers, each of said impellers and said inter-stage comprising a back plate and vanes molded integrally therewith and said vanes all facing toward said inlet opening.

8. A motor-fan unit according to claim 7 in which each of said impellers has an annular shroud secured to the free edges of said vanes, the inner diameter of said shrouds being substantially the same in diameter as said inlet opening and the outer diameter thereof being substantially the same as the diameter of said impellers.

9. A motor-fan unit according to claim 7 in which the cylindrical wall of said casing is formed of thermoplastic material integral with said inter-stage.

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