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(54) **QUIET HAIR DRYER**

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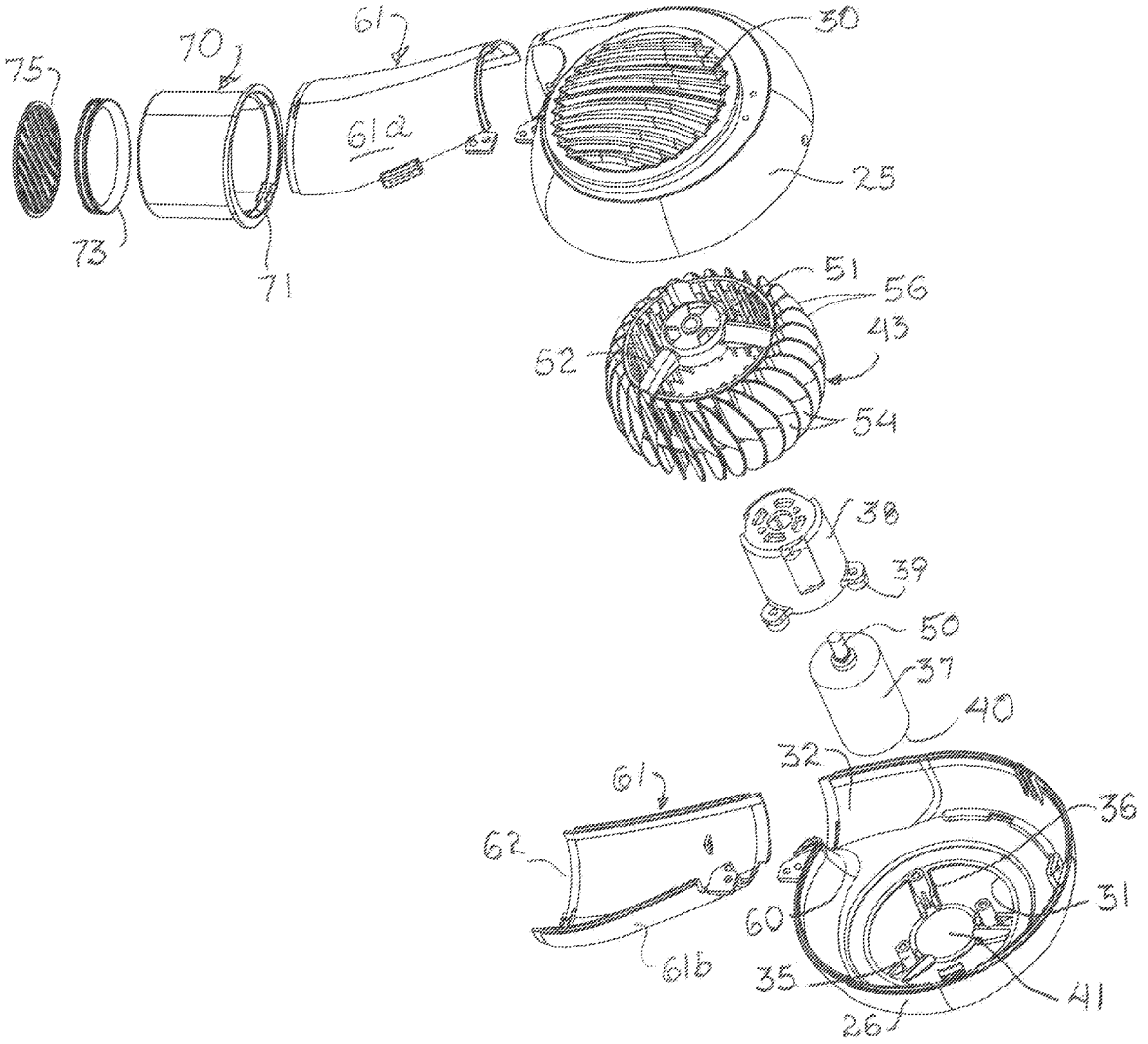
(57) **ABSTRACT**

An improved quiet (low noise) hair dryer, which includes a handle for holding the same and supporting its blower assembly having a motor driven centrifugal fan assembly, achieves a significant reduction of noise by employing balanced volume inlets above and below the fan rotor, a special fan rotor configuration having blades with airfoil shapes and a curved trailing edges and diffuser ring in its outlet that employs the Coanda effect in the air exiting the dryer.

The dryer can also include a resistive heating element to increase the temperature of the exiting air and, includes the necessary switches and cords for operation of its heating element and electric motor.



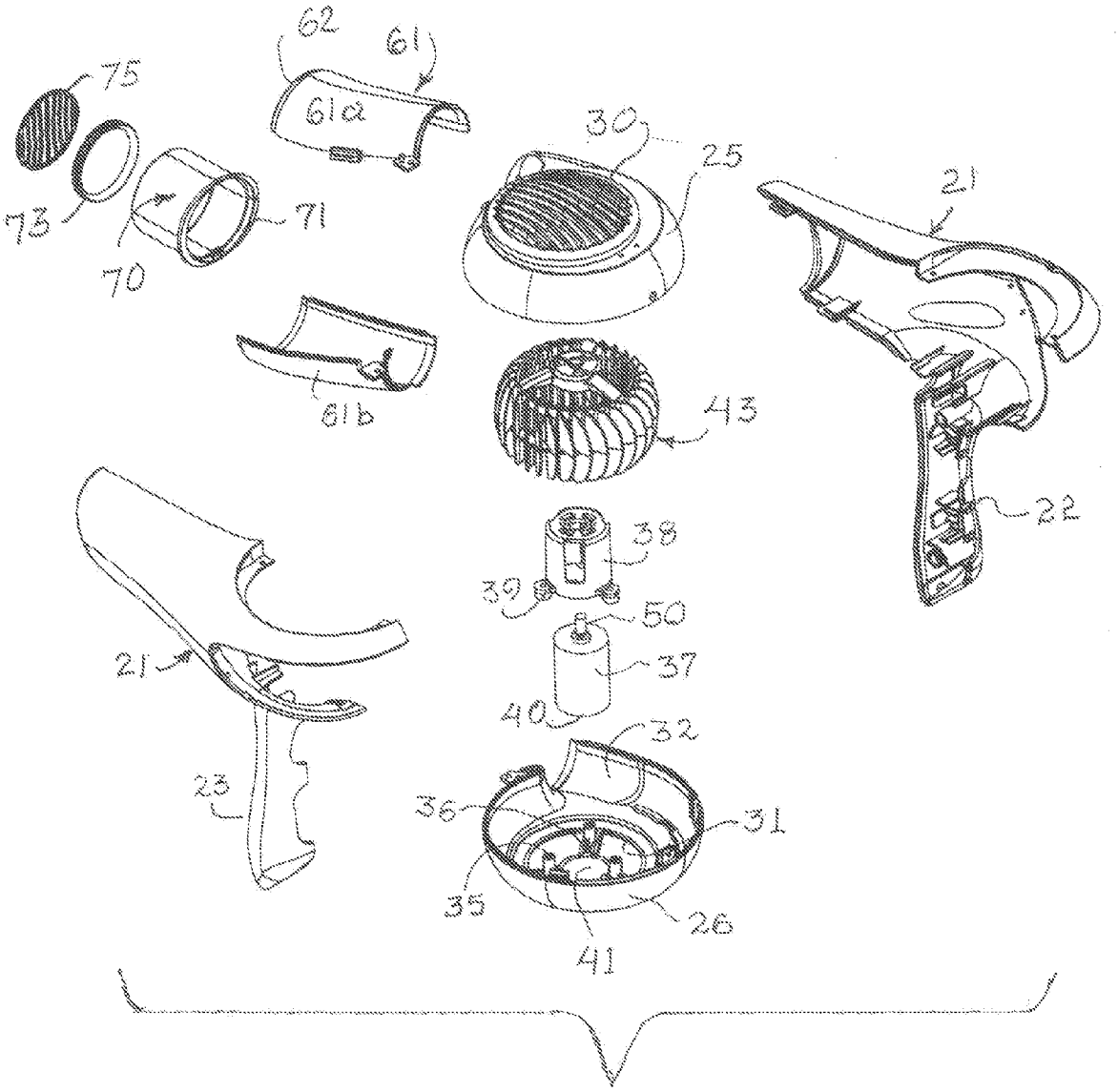

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Fig. 1

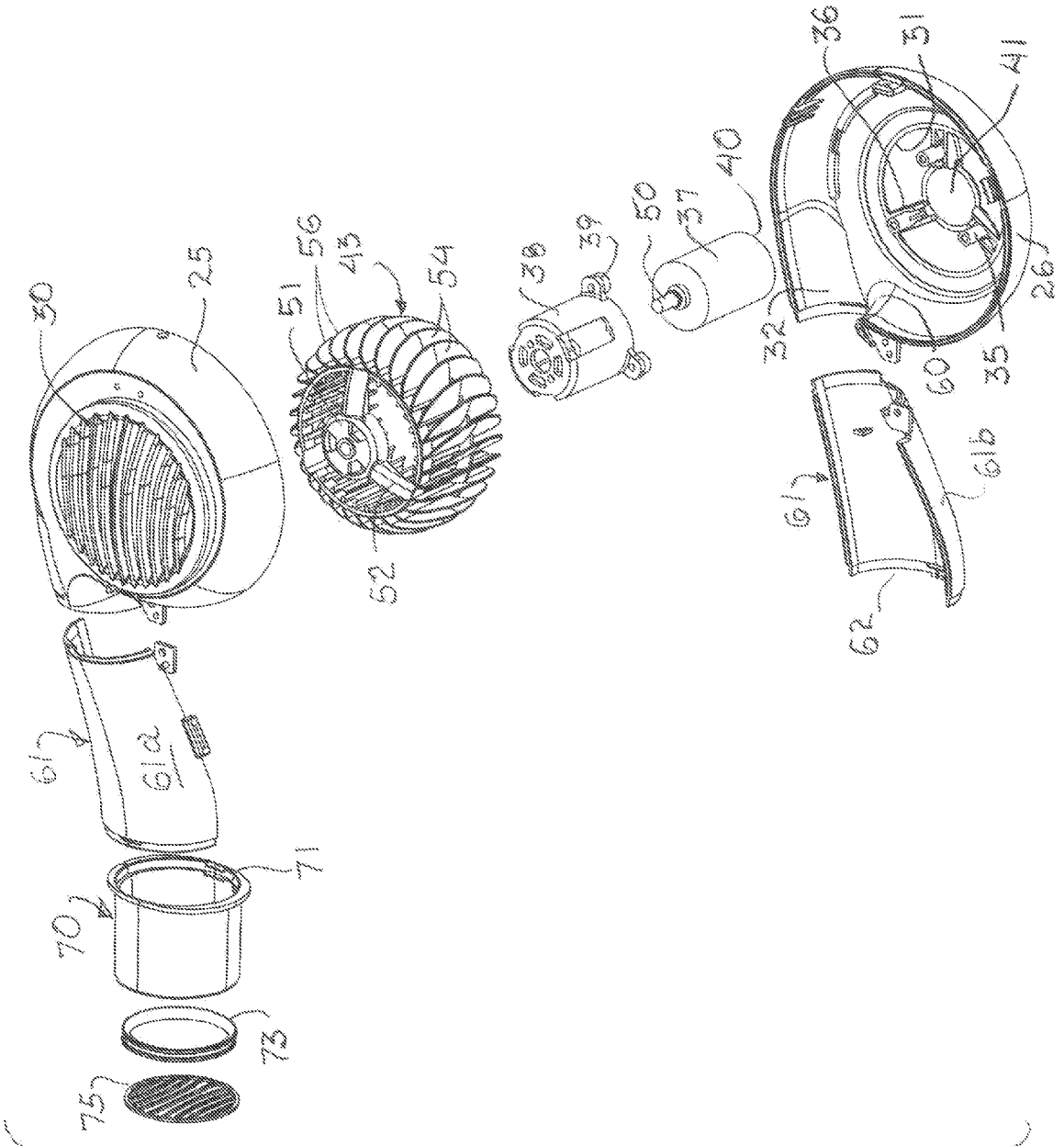
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Fig. 2

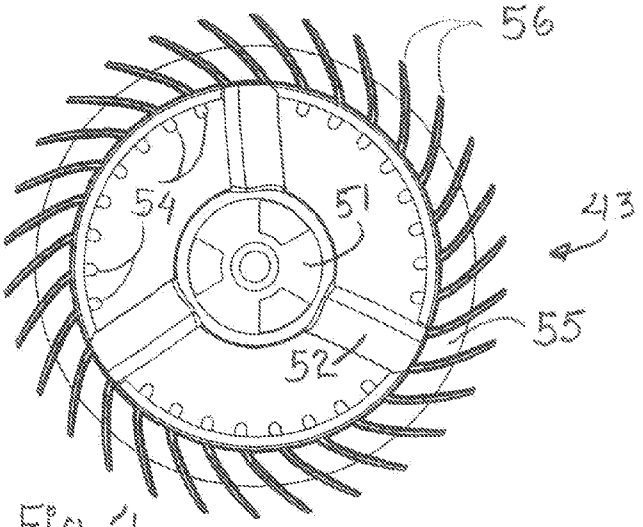

Fig. 4

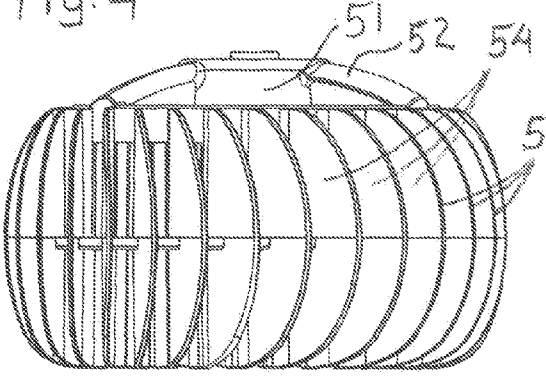

Fig. 5

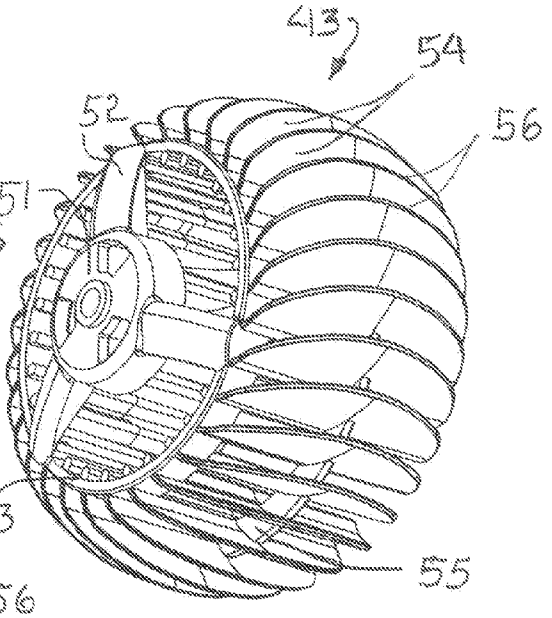

Fig. 3

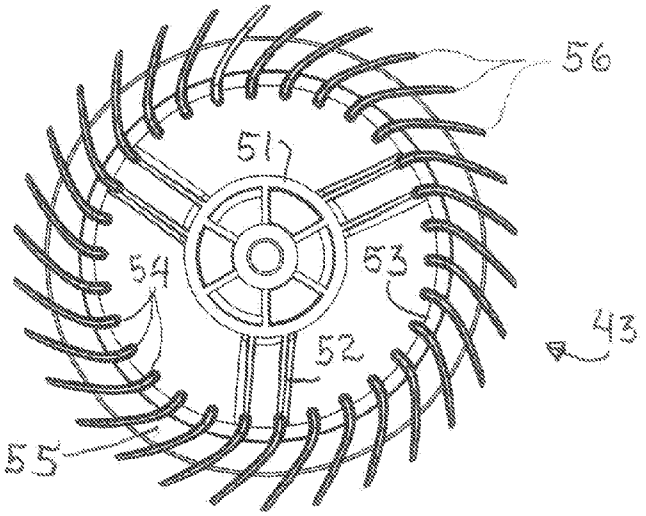

Fig. 6

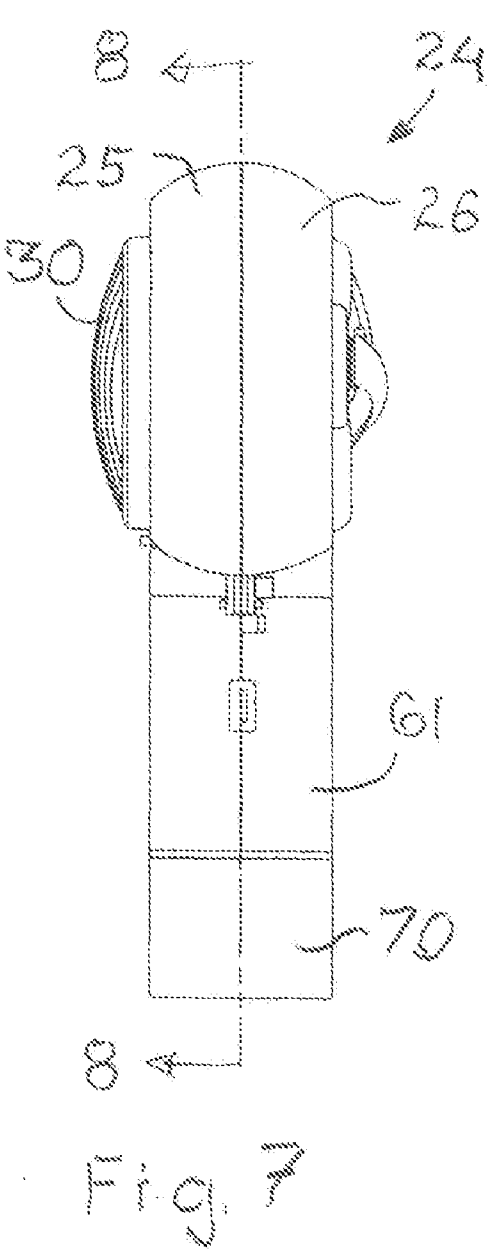

Fig. 7

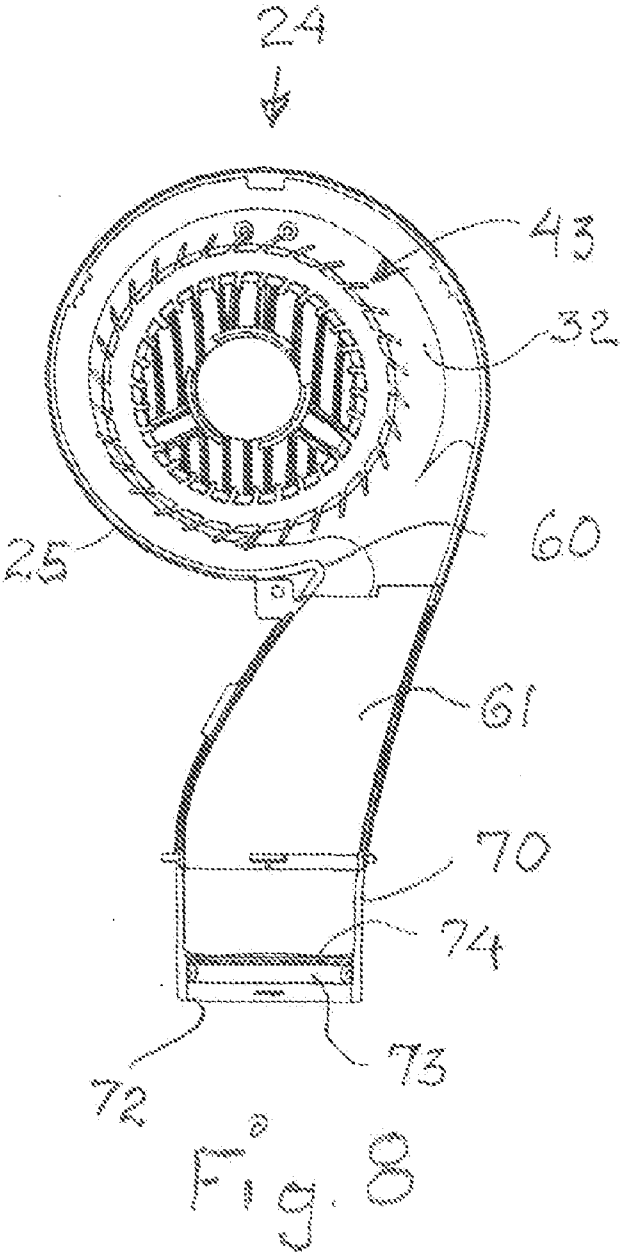

Fig. 8

QUIET HAIR DRYER

BACKGROUND OF THE INVENTION

[0001] This invention relates to hair dryers, and more specifically, it relates to such dryers with a lower noise level, i.e. "quiet" (low noise), than conventional hair dryers.

[0002] Hand-held hair dryers are well-known in the prior art. Such devices are generally sold in various sizes, configurations, and with various features, though most are characterized by a housing with an outlet for an air stream and having an internal motor driven fan for air movement, a heater for heating the air passing through the unit and a handle for holding the dryer.

[0003] Typically the housing of such devices is constructed of metal or hard plastic, with the motor being directly supported in the housing or the handle. As a result of such configurations vibrations of the motor are transmitted to the housing creating a source noise.

[0004] Motor driven hair dryers employ typically employ axial fan systems or centrifugal fan systems, the latter being a more efficient system and is the system employed in this invention.

[0005] Further the fan blades create substantial aerodynamic noise in combination with the surrounding structures, part of which is transmitted through the rigid housing and part of which simply passes outward through the outlet of the dryer. In addition inlet openings of the hair dryer are also a source of aerodynamic noise.

[0006] When the air velocity in the region of the heater downstream of the fan system in the dryer is relatively high, it also creates supplemental noise in the dryer as the air stream passes through the resistive elements employed to heat the air stream. Thus, most commercially available hand held hair dryers, while varying somewhat from design to design, all generate very substantial noise within the audible region of the human ear, typically on the order of 70 db or higher at a test point of 18 inches from the hair dryer.

[0007] While the noise signatures of various hair dryers vary, most tend to emit substantial noise which may resonate with the fan blade passing speed (motor speed times the number of fan blades) and harmonics thereof, along with other noise. Professional hair dryers used in salons have superior construction, but still emit undesirable high noise levels.

[0008] High noise levels of prior art hand held hair dryers is undesirable in that it drowns out other sounds, normally making it impossible to carry on a conversation with others, to listen to a radio or TV, to hear the doorbell or telephone ring, etc. when these dryers are in use. In salons the operator cannot talk to the customer and operators being subject to the noise levels of conventional hair dryers for extended periods may suffer health problems.

[0009] Noise levels of hair dryers have been of concern for some time and been addressed in the prior art. For example see U.S. Pat. No. 4,795,319 issued to Popovich, et al, for "Quiet Hair Dryer" and U.S. Pat. No. 4,596,921 issued to Hersh et al for "Low Noise Hand Held Hair Dryer" noting that maintaining high volume air flow in such dryers, along with lower noise levels, is a difficult parameter to achieve. Popovich, et al, uses an open cell foam rotor (fan) to reduce the noise level and Hersh et al uses sound absorbing materials (mufflers) inside the dryer to reduce the noise levels. Both of these patents use a muffling effect obtained with sound absorbing materials. U.S. Pat. No. 3,418,452 issued to Garbner employs a sleeve thermal insulation inside the dryer and between the mounting brackets of the motor to dampen mechanical vibrations from the motor to the housing. In U.S. Pat. No. 3,261,107 issued to Ponczek et al "dampening" rings around the motor casing are used to reduce the transmission of its vibrations to the housing of the dryer, but the motor is rigidly coupled to the shroud by the use of metal vanes and a metal motor bracket, allowing motor's vibrations to be directly transmitted to the housing. Because the spacing between the shroud and outer shell halves is quite small the rotating vanes will create a vortex with increased upstream airborne noise from the resulting turbulence.

[0010] Thus, the conventional, prior art handheld hair dryers, which employ motor driven fans, are so noisy, they are disturbing to users and or customers alike even when employing the forgoing techniques to quite them. Further other patents have located the motor driving the fan remote from the fan rotor itself in both centrifugal fan assemblies and axial fan assemblies in hair dryers, see for example U.S. Pat. No. 5,875,562 issued to Forgerty which has the motor buried in the handle remote from the fan rotor.

[0011] An object of the current invention is to provide a handheld hair dryer which has reduced noise levels, by a specially designed fan or blower system.

[0012] Another object of the novel unit is to reduce operational noise of a hair dryer without sacrificing performance.

[0013] It is also an object to suppress the noise arising from air turbulence by using a diffuser ring in the outlet of the novel hair dryer.

[0014] Still other objects and advantages will be noted in the description of and drawings for this novel hair dryer.

SUMMARY OF INVENTION

[0015] The above objects and others are accomplished by quiet handheld hair dryer having a handle means for holding the dryer, a hollow blower assembly with top and bottom inlet bezel means mounted on the top of the handle, with the top and bottom bezel means each having equal open diameters for balanced air inflow into said blower assembly with the blower assembly having an internal a torus shaped chamber designed for housing a centrifugal fan, a squirrel cage fan rotor having a plurality of blades mounted in the torus shaped chamber, each of said blades of said fan rotor having an air foil configuration, an electric motor means mounted inside of the squirrel cage fan rotor with its armature connected in driving relationship with said fan rotor to rotate it, the electric motor means having its base supported through one of said bezel means so that the fan rotor is adjacent to both of said inlet bezel means, a tubular throat means connected to the outlet of said blower assembly having an outlet for the air flow exiting the blower assembly, and control means connected to the motor means with switch means operable to control the power to the electrical motor means when connected to a source of power.

[0016] The throat means has an increasing internal diameter from its connection to the blower assembly to its outlet to decrease the pressure of the air exiting the blower assembly. Further the throat means can be connected to the diffuser tube having a diffuser ring therein to increase the velocity of the air flow passing through the diffuser tube.

[0017] These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following specification and drawings.

DRAWING DESCRIPTION

[0018] FIG. **1** is an exploded perspective of the novel hair dryer illustrating its major components;

[0019] FIG. **2** is an exploded perspective of the blower assembly of the novel hair dryer;

[0020] FIG. **3** is a perspective of the fan rotor of the novel hair dryer;

[0021] FIG. **4** is a top view of the fan rotor of the novel hair dryer illustrated in FIG. **3**;

[0022] FIG. **5**. is an edge elevation of the fan rotor of the novel hair dryer illustrated in FIG. **3**;

[0023] FIG. **6** is bottom view of the fan rotor of the novel hair dryer illustrated in FIG. **3**;

[0024] FIG. **7** is an elevation of the blower assembly, throat and diffuser tube of the novel hair dryer; and

[0025] FIG. **8** is a cross section of the blower assembly along lines **8-8** of FIG. **7**.

DESCRIPTION OF AN EMBODIMENT

[0026] In FIG. **1**, the major components of the quiet hair dryer **20**, according this invention, are illustrated. A majority of its parts can be constructed of plastic or pressed metal. It has a handle assembly **21** consisting of a left shell **22** and a right shell **23** that inter lock to create a pistol like cradle for the blower (fan) assembly **24**, shown in FIG. **2**. This handle also includes recesses for the electrical switches and the electrical cord attachment (the switches and cord are not shown). The handle is designed so as not to impede balanced air flow into the blower assembly from both its top unit **25** and bottom unit **26**, as discussed herein. It is important that the inflow of air to the blower assembly be balance from the top and from the bottom of the fan to eliminate aerodynamic noise which would, other wise, be generated from discordant air flows entering the blower assembly.

[0027] More particularly, the blower assembly **24** (refer to FIG. **2**) is composed of the cupped top unit **25** and cupped bottom unit **26** that form two halves of the clam shell enclosure for this assembly. Both units have an air in flow bezel, bezel **30** in the top unit and bezel **31** in the bottom unit. The diameter of the opening in each bezel is approximately 60 mm and the open area of each is approximately 2825 sq. mm for a total opening of 5650 sq. mm in the two bezels. These openings of the bezels are designed to have essentially equal cross sectional open areas for balanced air inflow into the blower assembly. As indicated above the pistol like handle is designed so as not to impede the air flow into the bezel **31** of the bottom unit when the blower assembly **24** is assembled therewith. Moreover the top and bottom units, when assembled, create a standard involute chamber **32** for a centrifugal fan rotor.

[0028] Referring to the cupped bottom unit **26**, it has extending tubular pillars **35** on the internal spokes **36** of its bezel for supporting the electric motor **37** of the fan assembly **24**. The motor is retained in a sleeve **38** that encases the motor and has feet **39** that engage the tops of pillars, which feet are affixed to the tops of the pillars with screws of the like. Between the motor and the sleeve is an elastomer layer (not shown), continuous or discontinuous, which isolates vibrations of the motor from its sleeve. Also an elastomer layer or pad (not shown) is placed between the base **40** of the motor where is rests on center button **41** of the bezel **31** to which the spokes **36** connect. So encased, the motor is securely retained in the bottom unit and only limited vibrations of the motor, and its fan rotor, are transmitted to the blower assembly as a whole. With balanced inflow of air and the isolation of the motor on elastomer buffers (layers), the design reduces noises that would otherwise be generated in its blower assembly.

[0029] Mounted on the armature **50** of motor **37** is the centrifugal fan rotor **43** which is designed to compromise aerodynamic noises when operating. The fan rotor itself, is best shown in FIGS. **3**, **4**, **5**, and **6**, has a squirrel cage design. It is formed with a spindle **51** that has radially extending spokes **52** connecting it to an assembly ring **53**. The spindle mounts on armature **50** and is rotated by the motor. Typically the motor will be a 5300 rpm motor at high speed and, at low speed, turns at 3800 rpm; however, other rotational speed motors are available in off the shelf AC induction motors. Further multi-speed motors can be employed with the appropriate switch assemblies.

[0030] The assembly ring **53** provides the mounting member for the blades **54** of the fan rotor. The structure is unique in that the blades are notched so they slide onto the assembly ring (or formed integrally with the ring such as by injection molding) but have no other attachment to the spindle. A central washer ring **55**, received in central notches midpoint in the individual blades, to stabilize the blades in this fan rotor which has a minimum physical structure associated with the blades to limit noise when in operation. In addition the blades themselves have an airfoil cross section to take advantage of the Coanda effect (see the blade edge profile in FIG. **4**). Coanda effect is the result of a gas flowing over a convex airfoil type (surface), wherein the gas is drawn down to adhere to the airfoil by a combination of the greater pressure above the gas flow and the lower pressure below the flow caused by an evacuating effect of the flow itself resulting an increase in gas velocity. By keeping the surface of the airfoil blades relatively clean (devoid of structure), as is accomplished by the novel structure of the fan rotor, less turbulence occurs about the blades, with an accompanying reduced noise level.

[0031] In addition the trailing edges **56** of the blades **54** have a curved periphery. This is important because a broadband noise source in centrifugal fans is generated by air separation from the blade's trailing edge which is partially controlled by curved trailing edge of each blade of the instant invention. In general the leading edge of each blade of this rotor begins straight (extending radially from the center of the spindle) and curves to "lean" 65 degrees relative to its radial beginning, see edge view of the blades in FIGS. **4** and **6**. As to the curved tailing edges **56** of the blades, if the diameter of the fan unit is about 83 mm the trailing edge of each blade is defined by a circle with a radius of approximately 40 mm. In such a fan rotor, the width is approximately 42 mm with 30 blades. Typically these relationships or similar ratios should be maintained in the fan rotor. As these curved trailing edges of the blades pass the cut off location there is less of an impulse generated and less broadband noise generated.

[0032] The over all design of the fan rotor contributes to the significant aerodynamic noise reduction in the unit.

[0033] The torus shaped involute chamber **32** of the blower assembly **24** is of a conventional (the axial clearance increases directly in proportion to the angle traversed) design and to accommodate the size of the fan rotor.

[0034] Typically this chamber design does not increase air velocity at any stage, or across a part of the cross-section of the chamber, as velocity increases in the flow here brings an overall increase aerodynamic noise generation. The cutoff clearance is critical (the minimum space between the fan rotor **43** and chamber **32**) at opening **60** (is 970 sq. mm see FIGS. **8** and **9**) of the torus. In general, the smaller the clearance, the greater the rotational noise that is generated at the cutoff

location by the blades of the rotor. A clearance of 5 to 10 percent of the fan rotor's diameter is generally considered to be the optimum spacing; a lesser clearance increases the rotational noise while a larger clearance decreases the aerodynamic efficiency. This clearance should be, in the case of a fan rotor with a diameter of 83 mm, approximately 4 to 9 mm.

[0035] The outlet of the chamber **32**, has an inner diameter of approximate 32 mm (oval in configuration with an area of 970 sq. mm) and connects to a tubular throat **61** of the novel dryer which is formed of two, elongated semicircular parts, **61***a* and **61***b*, shown in FIG. **2**. From its connection to the outlet of chamber **32** the internal diameter of the throat gradually increases to a diameter of 44 mm (1517 sq. mm) at its outlet **62**. Because of this construction the pressure of the air out put of the blower assembly **24** entering the throat decreases and its velocity increases with an accompanying decrease in noise.

[0036] Connected to the outlet **62** of the throat **61** is a diffuser tube **70** which is circular tube of a short length with an inlet **71** and an outlet **72**. Its inlet is connected to the outlet **62** of the throat. Within the outlet of the diffuser tube, having an internal diameter of 44 mm, a ring **73**, having a circular cross section, is mounted. The outer diameter of the ring approximates the inner diameter of the diffuser tube so that it seals around its contact with the diffuser tube. The ring's inner diameter is approximately 39 mm and, because of the curved outer surface or the ring, it also employs the Coanda effect to increase velocity of the air exiting the dryer with an accompanying decrease in noise, similar to a diffuser used in air conditioners. The cross section diameter of the ring is about 5 mm.

[0037] Also mounted in the outlet **72** of the diffuser tube **70** is a circular disk guard **74**, which is perforated to allow for exiting air, but prevents individuals from inserting their fingers, or other objects, into diffuser tube and throat of the dryer **20**. The guard mounted in the outlet prior to the attachment of the ring **73** in the outlet.

[0038] In FIG. **7**, the blower assembly of the novel hair dryer **20** is shown in elevation, with its handle broken away, from which it can be appreciated that the handle **21** cradles the bower assembly **24**, which blower assembly feeds pressured air to the throat **61** and that connects to the diffuser tube **70** that includes the outlet for the dryer. Further the relationship of the parts can be seen in the section illustrated in FIG. **8**.

[0039] When dryers tests were conducted having the forgoing features, the following data were collected. Average results of 8 tests (by different people):

Air speed in MPH	Exit Noise in dB A	Intake Noise in dB B
24.1	62.35	62.89

[0040] The air stream was measured in MPH at the exit at the same time the noise levels were tested in dB at A, the outlet, and in dB at B, the inlet of the hair dryer.

[0041] Comparative hair dryers were also tested and the sound levels recorded.

[0042] The tests were made with commercial available hair dryers by comparing the fan size and the outlet diameter of these units. Dryer Q is the one constructed according to this invention. (next page)

	Front HI dB	Front LOW dB	Rear HI dB	Rear LOW dB
Dryer A	81.5	72	82.5	73
Dryer B	76	69	77	71
Dryer C	77	66.5	74	67.5
Dryer E	78	71.5	79	72
Dryer F	81	73	83	75.5
Dryer G	77.5	72	79.5	76
Dryer H	81	72	79.5	71
Dryer Q*	71	63	70	63
Average	78.9	70.9	79.2	72.3
Delta Avg	−7.9	−7.9	−9.2	−9.3
Median	78	72	79.5	72
Delta Median	−7	−9	−9.5	−9
Max	81.5	73	83	76
Delta Max	−10.5	−10	−13	−13
Min	76	66.5	74	67.5
Delta Min	−5	−3.5	−4	−4.5

	Configuration	Fan dia mm	Outlet dia mm
Dryer A	turbo	65.0	46.20
Dryer B	horizontal pistol	66.5	45.70
Dryer C	turbo	60.0	38.20
Dryer E	turbo	60.8	36.90
Dryer F	turbo	66.0	42.20
Dryer G	turbo	66.0	41.40
Dryer H	AC turbo	60.0	36.77
Dryer Q	horizontal pistol	70.0	38.90

*Hair dryer constructed according to the teachings of this invention.

[0043] Using these data it is useful to understand how changes in dB relate to the loudness perceived by individuals. In this regard the effect of dB changes in perceived loudness are:

[0044] 3 dB Just noticeable

[0045] 5 dB Clearly noticeable

[0046] 10 dB Twice (or half) as loud

[0047] With the novel dryer the empirical data show a −10 dB decrease in the level of loudness of the noise when compared to other hair dryers tested.

[0048] The hair dryer **20** in its throat **61** will included internal resistive elements (not shown), typical wire coils, which heat when an electric current is applied. Further it has an electric cord (not shown) for connecting the dryer to an outlet. Both these elements are within the competency of those skill in the art and need not be described, along with the switches that control the dryer motor **37** (On-Off—or selected speeds) and the resistive elements (On-Off—or low or high).

[0049] Also the novel hair dryer can include filters and ornamental features which enhance its appeal but which do not contribute to the decrease in noise levels.

Having described the invention, I/we claim:

1. A quiet handheld hair dryer comprising:

handle means for holding the dryer;

a hollow blower assembly with top and bottom inlet bezel means mounted on said handle, said top and bottom bezel means each having equal open diameters for balanced air inflow into said blower assembly and said blower assembly having an internal a torus shaped chamber for housing a centrifugal fan;

a squirrel cage fan rotor having a plurality of blades mounted in such torus shaped chamber, each of said blades of said fan rotor having an air foil configuration;

an electric motor means mounted inside of said squirrel cage fan rotor with its armature connected in driving relationship with said fan rotor operable to rotate it, said electric motor means having its base supported through one of said bezel means so that said fan rotor is adjacent to both of said inlet bezel means; and

tubular throat means connected to the outlet of said blower assembly having an outlet for the air flow generated by said blower assembly; and

control means connected said motor means and having means to connect to a source of electricity and switch means operable to control electricity to said electrical motor means.

2. The novel hair dryer defined in claim **1** wherein a diffusing ring is placed proximate to the outlet of the tubular throat means to reduce the turbulence in the exiting air stream when said dryer is operated.

3. The novel hair dryer defined in claim **1** wherein the throat means contains internal electrical resistive heating coils and the control means is operable to control electricity to said resistive heating coils.

4. A quiet handheld hair dryer comprising:

handle means for holding the novel dryer;

a hollow blower assembly with top inlet bezel means and bottom inlet bezel means mounted on said handle, said bezel means each having equal open diameters for balanced air inflow into said blower assembly and said blower assembly having an internal a torus shaped chamber designed for housing a centrifugal fan;

a squirrel cage fan rotor sized to fit into said blower assembly having a plurality of blades and mounted in such torus shaped chamber, each of said blades of said fan rotor having an air foil configuration;

electric motor means mounted inside of said squirrel cage rotor with its armature connected in driving relationship with said fan rotor operable to rotate it, said electric motor means having its base supported through one of said bezel means so that said fan rotor is adjacent to both of said inlet bezel means;

tubular throat means connected to the outlet of said blower assembly and having an outlet for the air flow generated by said blower assembly passing there through; and

control means connected to said motor means having means to connect it to a source of electricity and switch means operable to control the flow of electricity to said electrical motor means.

5. The novel hair dryer defined in claim **4** wherein the fan rotor is formed with a spindle having radially extending spokes connected to an assembly ring on which the individual blades are mounted in equal spacing.

6. The novel hair dryer defined in claim **5** wherein the trailing edges of the individual blades on the fan rotor have a semicircular profile operable to decrease the aerodynamic noise as each blade as it passes the cut off location.

7. The novel hair dryer defined in claim **4** wherein the tubular throat means has an increasing internal diameter from its connection to the blower assembly to its outlet operable to decreases the pressure of the air flow existing from said blower assembly and to increase its velocity.

8. The novel hair dryer defined in claim **7** wherein the outlet of the throat means connects to a diffuser tube means, said tube means having a diffuser ring mounted in its outlet operable to increase the velocity of air flow flowing through such aperture.

9. The novel hair dryer defined in claim **7** wherein the diffuser tube means has a constant internal diameter.

10. The novel hair dryer defined in claim **8** wherein the cross sectional diameter of the diffuser ring from is 4 to 6 mm.

11. The novel hair dryer defined in claim **6** wherein the throat has resistive heating means disposed therein operable to heat the air flow passing through said throat means.

12. The novel hair dryer defined in claim **11** wherein the control means has connections to the resistive heating means and is operable to control the electric current supplied to said resistive heating means.

* * * * *