Aug. 2, 1949. E. ANDERSON 2,477,681

ELECTROPNEUMATIC POWER UNIT

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Fig. 1

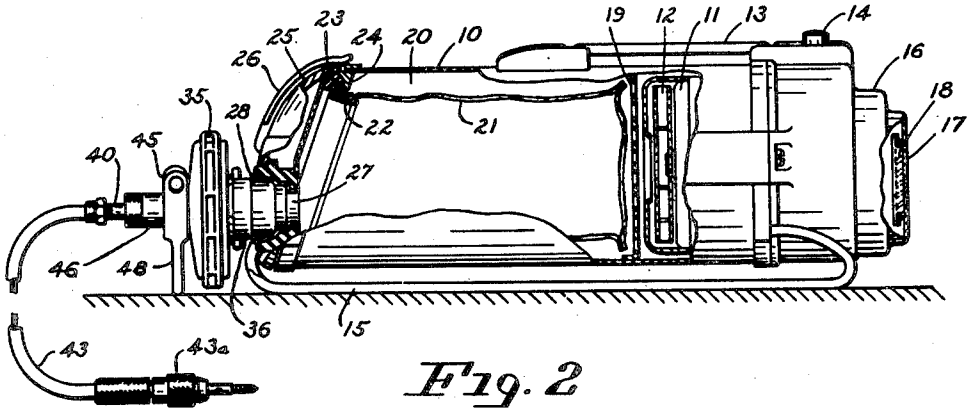


Fig. 2

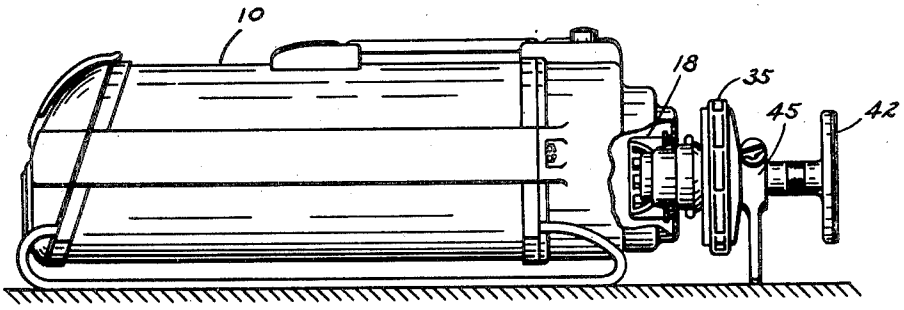


Fig. 4

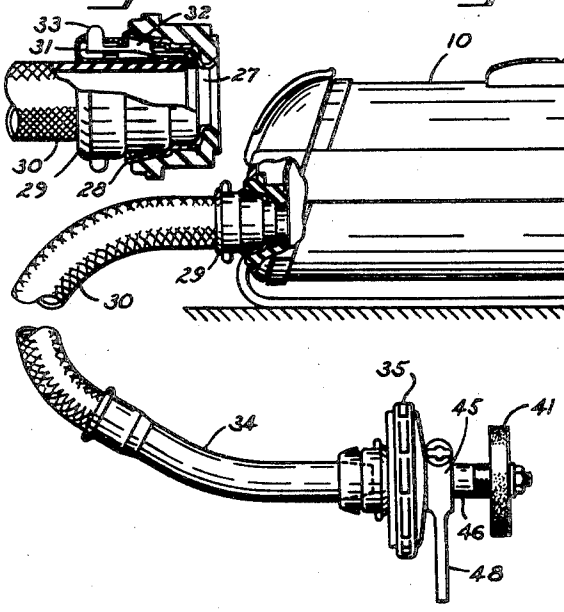


Fig. 3

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Fig. 5

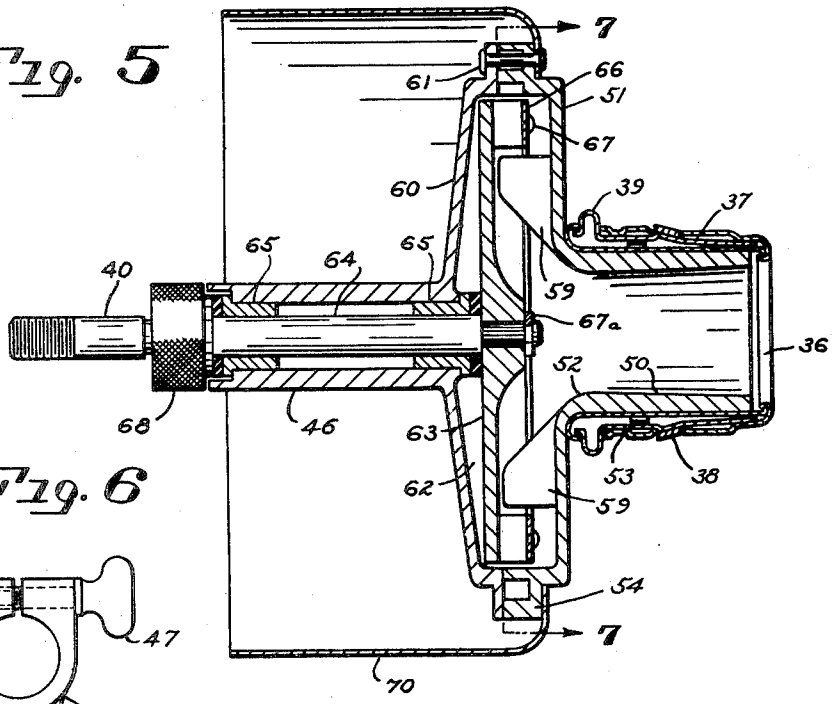


Fig. 6

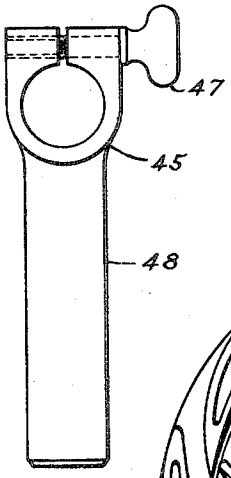
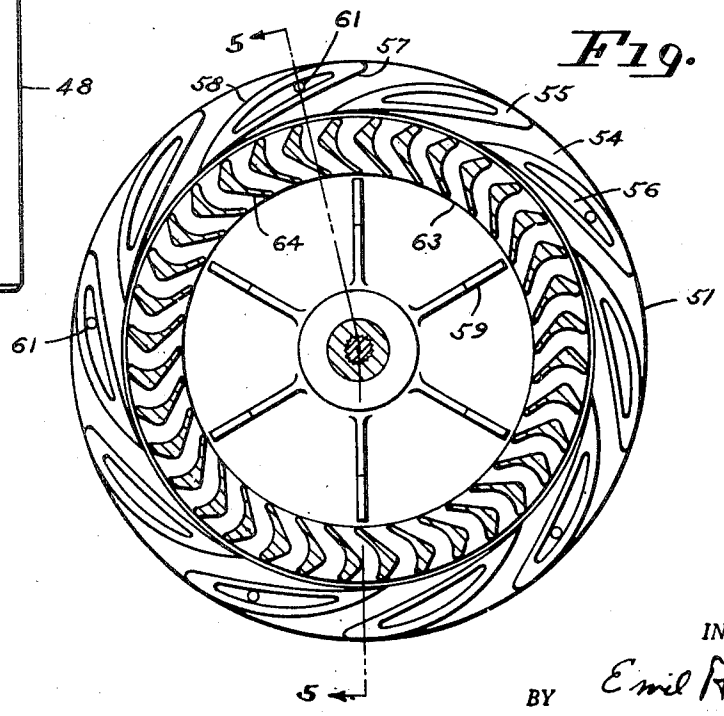


Fig. 7



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UNITED STATES PATENT OFFICE

2,477,681

ELECTROPNEUMATIC POWER UNIT

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Application August 17, 1945, Serial No. 611,124

3 Claims. (Cl. 60—60)

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This invention relates to power units and is particularly concerned with a power unit in which the flow of air is utilized as a power transmitting medium. More particularly the invention is concerned with a power unit which derives its power from a vacuum cleaner and in which an air motor in combination with the cleaner constitutes the unit. The invention is also concerned with the air motor itself and its means of uniting with the cleaner to form, in combination therewith, a single power unit.

A primary object of the invention is to provide a power unit including in combination a motor driven fan and an air driven rotor by which air is used as a driving medium thus constituting a flexible drive so as to give a safety factor not found in units driven directly by mechanical means such as direct drive from electric motors. By transfer of power in the present device through the medium of air, the output shaft may be loaded to the stalling point without danger of injury to the electric motor and such flexibility of drive also renders the device less hazardous to the user.

A further and important object of the invention is to provide a power unit of the type set forth to which may be applied a wide variety of instrumentalities, as for instance grinding, polishing, and buffing wheels as well as sanders and tool chucks to which may be attached various types of cutting and drilling tools or which may be provided with work holding chucks to impart rotary movement to a work piece while cutting, dressing, or finishing implements are applied thereto or which may further actuate a tool indirectly by means of a flexible shaft.

More specifically it is among the objects of the present invention to provide a power unit formed by the combination of a vacuum cleaner and an air rotor whereby air currents set up through the operation of the normal fan unit of the cleaner will actuate the air motor.

A further object of the present invention is to provide a simple, effective, and efficient air driven motor which may be operated by the air flow caused by a vacuum cleaner fan through attachment either directly to a stationary cleaner or by attachment to a manually manipulatable hose of a cleaner.

A further and more specific object of the invention is to provide an air motor so constructed and arranged as to provide for an air flow therethrough in such manner as to act as an exhaust fan for dirt, dust, and fumes which may be engendered by the operation of a tool actuated by the motor.

Numerous other objects and features of the present inventive concept will be apparent from a consideration of the following specification

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taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a side elevation partly in section of the power unit with the air motor applied to the suction end of the cleaner and operating a flexible shaft with a tool applied to its opposite end;

Fig. 2 is a similar view of the power unit with the air motor applied to the exhaust end of the cleaner and operating a sanding disk;

Fig. 3 is a view of the power unit showing the conventional flexible hose applied between the body of the cleaner and the air motor and the motor operating a grinding wheel;

Fig. 4 is a detailed view of the hose coupling as applied to either the inlet or outlet of the cleaner body;

Fig. 5 is a detailed longitudinal section through a preferred form of power unit, taken on line 5—5 of Fig. 7;

Fig. 6 is a detailed view of a preferred handle and brace for attachment for the unit shown in Figs. 5 and 7, and

Fig. 7 is a section taken on the line 7—7 of Fig. 5.

Throughout the present specification the expression "power unit" has been employed, and by such expression is meant the combination of fan and air motor by which electrically derived air flow is used to create mechanical motion which motion is available for the drive of various instrumentalities, primarily tools. In the preferred embodiment of the invention the "power unit" comprises the combination of a vacuum cleaner with an air motor. The term "air motor" is used to define the means for converting the energy of the air flow to mechanical motion and is intended to distinguish from air driven tools in which the tool itself, although actuated by air flow, is in fact a tool as such, the means of converting power being an integral part of the tool construction. In such devices the power means is a built-in element of the tool usually modified in the light of the tool structure and such devices are therefore not "air motors" as here used which provide a universally applicable source of power which may be used in a great many different ways.

For purposes of illustrating the present inventive concept, the vacuum cleaner portion of the combination is disclosed as a tank type domestic cleaner which is characterized by a housing enclosing an electric motor-fan unit and a removable dust collecting receptacle. It is characteristic of the particular type of cleaner here selected for illustrative purposes that both the front cover and the rear cover are provided with hose receptacles of similar construction so that the hose may be applied to the front cover when suction cleaning operations are to be carried out but permitting application of the hose to the exhaust end of the device when it is to be used as a

blower. It will, of course, be understood that the present inventive concept is not limited to the use of this particular type of vacuum cleaner as a part of the present combination and numerous other types of cleaners to which the air motor may be applied, either directly and/or to the hose thereof, can be utilized without departing from the present invention.

It will also be understood that while the present inventive concept embraces a new and improved air motor whose characteristics as hereinafter set forth render it particularly suitable for efficient use in combination with the air flow set up by a cleaner of the type illustrated, numerous other types of air motors may be utilized, the characteristics of design being dictated by specific types of use to which they are to be put and the power characteristics of the cleaner to which they are to be applied.

Referring more particularly to Figs. 1 through 3 of the drawings, the tank type cleaner here selected for illustrative purposes includes a general cylindrical casing **10** within the rear end of which is mounted an electric motor-fan unit including the motor **11** and a fan **12** driven thereby. The cleaner is provided with a lifting handle **13** and the motor is controlled by a step switch **14** and suitable sleighs **15** are secured to the body to act as support therefor and to permit movement of the unit over its supporting surface when desired.

The rear end of the casing **10** is provided with a rear or exhaust cover **16** through which air impelled by the fan **12** is expelled by way of an exhaust aperture **17**. If desired a pair of louver members **18** may be pivotally mounted adjacent to aperture **17** so as to normally extend across the aperture to divert the exhausted air upwardly from the supporting surface. The casing **10** is here shown as divided by a perforated bulkhead **19** forming a forward dust receiving compartment **20**. A porous flexible dust bag **21** is mounted within compartment **20** and is supported by a ring **22** having a gasket **23** which seals against the forward end plate **24** of the casing **10**. The gasket **23** is firmly seated against the end plate **24** by application of the front cover **25** which may be suitably secured to the end plate **24** by the manipulations of the cover handle **26**. The cover **25** is provided with a central inlet aperture which is defined by a suitably secured hose receptacle **27** characterized by an inwardly directed securing flange **28** behind which depressible securing lugs **32** of a hose or power unit may be engaged to firmly secure the same within the aperture (see Fig. 4).

In normal cleaning operation, a hose of the type shown at **30** in Fig. 3 is applied to the receptacle **27**, the coupling end of the hose being provided with a coupling unit **29** which seats within the receptacle **27** (see Fig. 4). The coupling **29** is provided with a pair of spring arms **31** including lugs or detents **32** which engage behind the flange **28** to retain the hose in sealed relation within the receptacle **27** and being further provided with operating projections **33** which may be depressed by the fingers of the operator to withdraw the detents from behind the flange so as to remove the hose. The opposite end of the hose **30** is provided with a tapering metallic connector **34** which may be attached by simple frictional engagement to any one of various types of cleaning devices, as for instance floor brushes, rug cleaners, upholstery nozzles and the like. The foregoing structure is not of itself novel with respect to the present invention, various features of which are already the subject matter of numerous issued patents. Such structure, however, does constitute one preferred exemplification of structural features which do constitute some of the elements of the novel combination herein claimed.

Referring further to Figs. 1 through 3, the air motor of the present invention, which may preferably be of the turbine type as shown specifically in Figs. 5 and 7 and hereinafter discussed, is indicated generally by the numeral **35** and is provided with a coupling unit **36** similar to the coupling unit **29** of the hose **30** including similar spring arms **37**, detents **38**, and operating projections **39** (see Fig. 5). The internal bore of the connector **36** of the air motor **35** as more particularly shown in Fig. 5 is characterized by a slight tapering inner surface **50** which is adapted to be frictionally engaged by the terminal tapering end of the hose member **34** as shown in Fig. 3. The arrangement is such that the unit may be applied universally by insertion in the intake or exhaust end of the cleaner or by having inserted therein the tapering end of the hose **30**.

The output shaft of the air motor is indicated by the numeral **40** and may have applied thereto any one of a very wide variety of tools or chucks, a grinding wheel **41** for instance being indicated in Fig. 3 while a flat and preferably somewhat flexible sanding disc is indicated at **42** as applied to the shaft **40** in Fig. 2. In Fig. 1 the shaft **40** is indicated as being provided with a flexible shaft **43** having a chuck **43a** within which may be secured boring or cutting tools of various types. It will be understood, of course, that the invention is in no way limited to the specific air motor here shown nor to the tools which are applied to the power shaft and various polishing and buffing wheels, wire brushes or other types of instrumentalities may be affixed to the shaft **40** which may also be arranged to rotate a work piece to which a manually directed tool may be applied.

To provide a combined manipulating handle and support for the power unit there is provided as shown in the detailed Fig. 6, a handle and support element indicated by the numeral **45**, this element being provided with a split collar which is adapted to be drawn together to embrace a shaft housing **46** by means of a readily manipulated wing screw **47** and is provided with a combined leg and handle **48**. When the device is mounted for rigid combination with the cleaner body as in Figs. 1 and 2 the leg will engage the supporting surface to brace the air motor and will act to prevent inadvertent turning of the air motor housing with respect to the cleaner. When the device is applied to the hose as shown in Fig. 3 this portion acts as a handle to provide a convenient manipulating means for the unit.

From a consideration of the structure so far set forth and without regard for the particular characteristics of the preferred type of air motor shown in Figs. 5 and 7, it will be seen that this invention provides a universally applicable "power unit" employing a vacuum cleaner as an element of the combination and which forms in combination with the air motor a novel and improved relationship, one important feature of which is the fact that power is transmitted from the motor **11** to the turbine wheel of the air motor **35** by air flow generated by the fan **12**. Thus, a flexible and resilient type of drive is permitted such that upon complete stalling by the application of undue resistance to rotation of the shaft **40** no injury will result to the motor **11** which will be free to

rotate and thus there will be no danger of burning out the motor upon the application of such intense resistance. It will also be noted that such flexible drive provides for a safety factor with respect to the operator. While the speed of rotation of the turbine and the torque induced thereby is ample to operate a very wide variety of small tools, the drive is a fluid drive and is thus more yielding to strong resistance than would be a direct and positive drive from the motor shaft and thus the arrangement incorporates an important safety factor.

It is also an important feature of the present arrangement that while the power unit is applicable to the flexible hose 30 as shown in Fig. 3, it is equally applicable to either the intake or exhaust end of the cleaner and when so applied constitutes a single solid and unitary arrangement. Air motor and cleaner constitutes equally important elements of this single combination which combination may be characterized as a power unit compressing an electric motor and an output shaft with compressible fluid drive between the motor and the shaft and in such combination the device constitutes a bench unit which may be secured in position and to which the work may be applied by manual presentation to selected tools applied to the power shaft.

Referring more particularly to Figs. 5 and 7, there is disclosed a preferred embodiment of an air motor which is particularly designed for operation through attachment to the suction side of a cleaner casing or to a hose applied to the suction side of the casing. This preferred structural embodiment is characterized by the provision of two main body pieces which may preferably be formed by a die-casting and which jointly combine to form the entire turbine housing. The connector 36 is formed as an extension of an inner body piece 51 and is provided with the securing elements 37, 38, and 39 hereinbefore discussed. It will be noted that the detents 39 are formed by spot welding or otherwise securing detent pieces to the lever springs 37 while a flexible ring 53 surrounds the body of the connector internally of the springs and between the detents and the operating projections.

The piece 51 is dish-shaped and is provided with a peripherial flange 54 from which extend air inlet guide fins 55 which for the purpose of economy in manufacture and lightness in structure are hollow as indicated by the recesses 56. Each is characterized by curved concave and convex surfaces 57 and 58, respectively, the result of this construction being to provide a maximum of entering air space at the periphery of the member and a similar maximum of space for the air which strikes the rotor fins. This construction also provides a minimum of turbulence with a maximum of guidance of the air as it enters the turbine so that such air has already imparted thereto a rotary motion before striking the blades of the rotor. The piece 51 is also provided with radial vanes 59 which extend within the rotor to form fixed air abutments against which the air from the cup like rotor vanes impacts to aid in its efficiency of operation.

The body of the turbine type air motor is completed by a housing piece 60 which is a companion to the piece 51 to which it is secured by equally spaced rivets or the like which preferably passes through the centers of the hollow guide fins 55 as indicated at 61. The piece 60 is also dish-shaped to cooperate with the piece 51 to form the rotor housing and extends forwardly to form the shaft housing 46.

Within the space 62 formed by the pieces 51 and 60, there is mounted the rotor of the air motor which consists of a plate 63 on the outer periphery of which is formed the blades 64. While the particular configuration of the blades and their angular relationship with respect to the fins 55 is not critical, it has been found that the present arrangement gives exceedingly good efficiency particularly when the motor is applied to the suction end of the cleaner or cleaner hose. Different characteristics are indicated for use of the motor exclusively on the pressure side of the cleaner. The structure here shown has been found to give a speed of 6,000 R. P. M. with one inch pound torque using a vacuum cleaner which produces a one pound pressure. Obviously, the invention is not confined to the specific structure and angularities here depicted.

The rotor 63 is mounted upon a rotor shaft 64 which in turn is supported by bearings 65 mounted within the shaft housing 46. An annular cover plate 66 is provided over the blades, being secured thereto as by rivets 67 while the shaft 64 is secured to the plate 63 by a readily removable split washer or snap ring 67a and the assembly is completed by a knurled nut 68 which secures the parts in assembled relation and from which extends the shaft 40 to which the working tools may be applied.

As shown in Fig. 5, it may be desirable in some instances to provide an air guide or hood 70 which will have the effect of drawing air through the turbine from the immediate vicinity of the working operations so as to combine in the assembly an exhaust system by which dust and dirt engendered by the working operations will be drawn into the cleaner and removed by the bag 21 thereof.

From the foregoing, it will be seen that the present invention provides a unique and novel power unit involving an electric motor and fan which induces a flow by air by which the air motor is operated and the combination provides for the use of a standard vacuum cleaner as the motor-fan unit to which the air motor may be selectively applied for completing the combination. It will, of course, be understood that numerous changes and modifications and the full use of equivalents may be resorted to without departure from the spirit or scope of the invention as outlined in the appended claims.

What I claim is:

1. In combination, a hollow casing having an inlet opening and an outlet opening, means for supporting said casing on a horizontal surface so that said openings are disposed in vertical planes and spaced above said surface, an air impeller in said casing for moving air therethrough, a motor in said casing for driving said impeller, an air motor including a housing and a turbine rotor rotatably mounted therein, a hollow coupling member fixed to said housing, means in one of said openings for detachable and rotatable engagement with said coupling member for removably securing said housing to said casing and for establishing communication between said housing and said casing for causing all of the air moved by said impeller to flow through said housing, means for detachably connecting a tool to said rotor to be driven thereby, and a member secured to and extending from said housing for contacting said surface to restrain rotation of said housing relative to said surface and to said casing.

2. In combination, a hollow casing having an inlet opening and an outlet opening, an air impeller in said casing for moving air therethrough, a motor in said casing for driving said impeller, an air motor including a housing member and a turbine rotor rotatably mounted therein, a hollow coupling fixed to said housing member, a flexible air hose member, a hollow coupling secured to one end of said hose member, a rigid tube secured to the other end of said hose member, means in one of said openings for detachable engagement with the exterior of each of said couplings for optionally connecting each of said members to said casing for causing all of the air moved by said impeller to flow through the member thus connected to the casing, said rigid tube being detachably engageable with the interior of the coupling fixed to said housing member for causing all of the air flowing through said hose member to pass through said housing member, and means for detachably connecting a tool to said rotor to be driven thereby.

3. A combination, a hollow casing having an inlet opening and an outlet opening, an air impeller in said casing for moving air therethrough, a motor in said casing for driving said impeller, a flexible hose, a first coupling member on one end of said hose having exterior means removably engageable within one of said openings, a second coupling member on the opposite end of said hose, an air motor including a housing and

a turbine rotor rotatably mounted therein, and a hollow coupling member fixed to said housing and having exterior means removably engageable within said one of said openings and having interior means removably engageable with the exterior of the second coupling on said hose, whereby said air motor may be selectively coupled directly to said one opening or connected thereto with said hose interposed therebetween.

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