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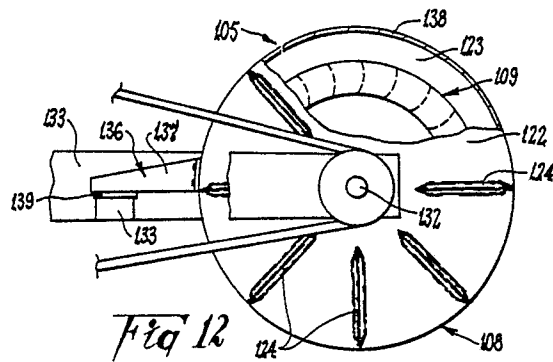
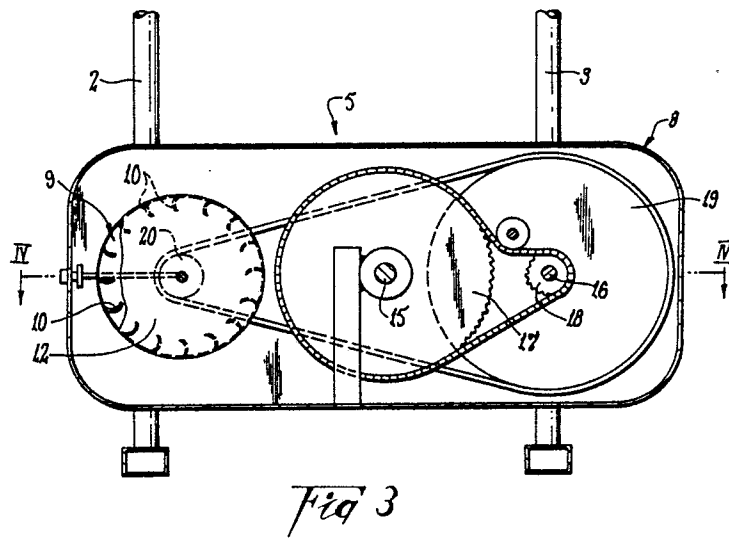
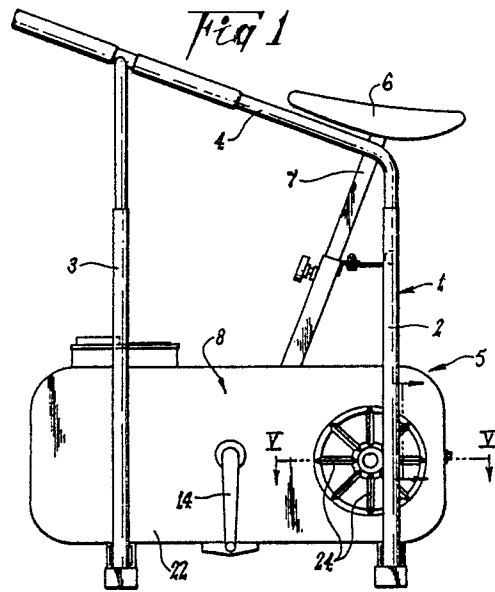
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London WC1V 7RD(GB)(54) **Energy absorbers for exercisers.**

(57) An energy absorber for use in ergometric and/or exercise apparatus. The absorber includes a centrifugal-type fan (9) which is mounted within a housing (8) so as to be rotatable relative to the housing (8) and thereby displace air, or other fluid, contained in the housing (8). The energy absorbance function is directly related to the capacity of the fan - (9) to displace air and that is optimised by providing baffle means (24,29) within the housing (8) which influences air displaced by the fan (9) to return to the fan inlet (13) for recirculation through the fan (9). The baffle means (24,29) may take the form of stator blades (24) or ducting (29) within the housing (8). According to another aspect, the housing (108) is rotatably mounted on a support (133) so as to tend to turn in response to torque applied by air displaced by the relatively rotating fan (109). An arm - (137) extends between the housing (108) and the support (133) to prevent such turning movement of the housing (108) and the turning force is reacted into a load cell (139) which is connected to that arm (137) and which responds to the reacted force in a manner representative of the magnitude of that force.

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ENERGY ABSORBERS FOR EXERCISERS

This invention relates to energy absorbers as used for ergometric and/or exercise functions. By way of example, the invention is applicable to exercisers of the air absorbance type and is particularly although not exclusively concerned with such exercisers having an ergometric function. Air absorbance exercisers of the type to which the invention is applicable have a rotor which is operable to displace air and thereby provide resistance to user operation. Such absorbers can be used in various forms of exercise apparatus, but it will be convenient to hereinafter describe the invention as applied to a cycle exerciser.

An example of an air absorbance cycle exerciser forms the subject of Australian patent 462920. In that example the rotor is formed by a standard cycle wheel having blades attached to the rim. More recent exercisers of the same general type utilize an energy absorber having a relatively small diameter rotor -e.g., in the form of a centrifugal fan -which is enclosed within a housing having an inlet and an outlet for passage of air. An absorber of that kind is disclosed by Australian patent application 46523/85.

Each of the open and enclosed rotor constructions suffer a common problem which is the noise generated by the rotor as it operates to displace air. The noise is such that the exerciser is not used in some circumstances where it could be of benefit, and in circumstances where the exerciser is used the noise can be irritating to the user and/or people in the vicinity of the exerciser.

In each of the examples referred to above the energy absorber fluid is air, but the principles of the present invention are equally applicable to other fluids such as liquids and gases. It is usually preferred however, to use either water or air as a matter of convenience.

Energy absorbers of the foregoing kind also have the disadvantage that calibration for ergometric purposes is dependant upon the maintenance of stable conditions in the working fluid. In that regard, power is determined by assuming that a particular relationship exists between power and fan speed, but that relationship is affected by changes in pressure and temperature of the working fluid. The influence of such changes on the accuracy of calibration is greater in closed-fan arrangements than open-fan arrangements, but the latter suffer unacceptable noise levels when operating. It is therefore difficult to provide an energy absorber of the foregoing kind which is quiet in operation and which also provides an accurate indication of work done.

It is an object of the present invention to provide an energy absorber which is applicable to cycle and other exercisers and in which the aforementioned noise problem is eliminated or substantially alleviated. It is a further object of the present invention to provide an energy absorber of the foregoing kind which is relatively quiet in operation and which also provides for accurate work measurement. Still another object of the invention to provide an improved exerciser incorporating an energy absorber as aforesaid.

SUMMARY OF THE INVENTION

An air absorber according to one aspect of the invention has an enclosed rotor and is characterized in that at least a substantial part of the air displaced by the rotor is recirculated within the rotor housing. That distinguishes over prior constructions in which there is no provision for returning air displaced by the rotor to the rotor inlet and consequently there is substantially no recirculation of air through the rotor.

According to the foregoing aspect of the invention, there is provided an energy absorber for exercisers including, a fluid displacement fan having an inlet side through which fluid displaced by said fan passes, means rotatably mounting said fan, a housing enclosing said fan and containing a fluid, and baffle means within said housing and arranged so that fluid displaced by said fan is directed back to said inlet side for recirculation through said fan.

The fan is preferably a substantially cylindrical fan of the centrifugal type having an inlet opening at one axial end through which air or another fluid is drawn for outward displacement by the fan. That outwardly displaced air passes between the fan blades so as to move substantially tangentially away from the fan. The baffle means may include stator blades fixed to the housing, or ducting, arranged to redirect the outwardly displaced air so that it is returned through the fan inlet for recirculation through the fan.

An energy absorber according to a further aspect of the invention includes a housing which at least substantially contains a body of working fluid, and a fan, rotor, impeller or the like (hereinafter simply called a fan) which is located within that housing and is mounted for rotation relative to the housing. The invention is characterized in that the housing is mounted in such a way that a reaction occurring between the housing and a rigid support

is representative of energy absorbed within the housing, and means is provided for determining the magnitude of that reaction and thereby providing an indication of the energy absorbed.

According to that further aspect of the invention, there is provided an energy absorber for exercisers including, a rigid support, a housing containing a fluid, means mounting said housing on said support for movement relative thereto, a fan rotatably mounted within said housing and being operable to displace said fluid and thereby impose a turning force on said housing such as to tend to cause said relative movement thereof, and reaction means interconnecting said housing and said support so as to resist said relative movement and being arranged to provide an indication of the magnitude of said turning force.

It is preferred that the housing is rotatably mounted on the support and that the respective axes of rotation of the housing and fan are substantially coincident. The fan may be of the centrifugal type referred to above in which event the housing may closely confine that fan and may include baffle means as also referred to above. In a preferred arrangement the reaction means includes a torque arm having opposite ends connected to the housing and the support respectively and a load cell or force transducer which is connected to the torque arm. A turning force applied to the housing is reacted into the torque arm and the load cell or force transducer responds to the resulting stressing of that arm in a manner which is representative of the magnitude of the turning force.

Embodiments of the invention are described in detail in the following passages of the specification which refer to the accompanying drawings. The drawings, however, are merely illustrative of how the invention might be put into effect, so that the specific form and arrangement of the various features as shown is not to be understood as limiting on the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevational view of one form of cycle exerciser incorporating an embodiment of the invention,

Figure 2 is a front elevational view of the exerciser shown in figure 1,

Figure 3 is a cross-sectional view taken along line III-III of figure 2,

Figure 4 is a cross-sectional view taken

along line IV-IV of figure 3,

Figure 5 is an enlarged cross-sectional view taken along line V-V of figure 1,

Figure 6 is a cross-sectional view taken along line VI-VI of figure 5,

Figure 7 is a cross-sectional view taken along line VII-VII of figure 1,

Figure 8 is a cross-sectional view of part only of the energy absorber shown in figure 4 but showing a further embodiment of the invention,

Figure 9 is a cross-sectional view taken along line IX-IX of figure 8,

Figure 10 is a view similar to figure 4 but showing yet another embodiment of the invention,

Figure 11 is a diagrammatic and sectioned view of an energy absorber according to still another embodiment of the invention,

Figure 12 is a side elevational view of the energy absorber shown in figure 11 with parts broken away for convenience of illustration.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1 and 2 show a cycle-type exerciser to which one form of the invention can be applied, but the invention is applicable to other types of exercisers and/or ergometric apparatus. The exerciser shown includes a main frame 1 having two uprights 2 and 3 on each of two sides and a handle bar section 4 extending forwardly and upwardly from the rearmost upright 2. An energy absorber 5 is located between the two pair of uprights 2 and 3 as best seen figure 2, and a seat 6 is supported on the upper end of a column 7 which, in the construction shown, is connected to the housing 8 of the energy absorber 5.

According to the particular construction shown in figures 3 and 4 of the drawings, the absorber 5 includes a rotor which is in the form of a cylindrical fan 9 of the centrifugal type. That is, the fan 9 includes a series of axially extending blades 10 which are arranged in circumferentially spaced relationship around the cylindrical periphery of the fan body. The blades 10 are secured to each of two end plates 11 and 12 of the fan body and the

plate 11 is annular so as to define an axial inlet opening 13 for air flow into the space 21 which is surrounded by the blades 10. Any suitable means may be adopted to mount the fan 9 for rotation within the surrounding housing 8 and that housing 8 is preferably of sufficient size to contain other components for the absorber mechanism as hereinafter described.

The aforementioned mechanism of the particular construction shown, is driven by foot operated cranks 14 (figures 1 and 2) as in prior cycle exercisers. In the construction shown, the crank spindle 15 is drivably connected to an idler spindle 16 which is in turn drivably connected to the fan 9. The drive connection between the crank spindle 15 and idler spindle 16 may be of the chain and sprocket type or it may be of the belt and pulley type. The former is preferred for the purpose of positive operation in the initial part of the drive system. It is further preferred that a belt drive is provided between the idler spindle 16 and the fan 9, particularly as that significantly reduces the noise created during operation of the air absorber 5.

According to the example shown, the crank spindle 15 carries a sprocket 17 of relatively large diameter and that may be roughly five times larger than the sprocket 18 on the idler spindle 16 to which it is connected. A belt drive pulley 19 is also provided on the idler spindle 16 and may be roughly six times larger than the pulley 20 on the fan 9 to which it is connected. The crank spindle 15 is preferably located between the fan 9 and the idler spindle 16, although in an alternative and more compact arrangement the crank spindle 15 could be coaxial with the fan 9. It is further preferred that the three rotational axes are located in substantially the same horizontal plane as that minimizes the overall height of the housing 8 necessary to contain the drive system. The overall length of the housing 8 may be minimized by overlapping the large pulley 19 and the large sprocket 17.

In the preferred construction shown, the housing 8 for the fan 9 and associated drive system is substantially rectangular in side elevation, having a height and front to back length such as to closely contain the internal components. The housing 8 will also have a rectangular shape in end elevation and the height will usually be significantly greater than the transverse width. Even so, the height need not be great in relation to the total height of apparatus with which the absorber 5 is used.

The width of the housing 8 is preferably such that a person can conveniently straddle the housing 8 while operating the foot cranks 14. It is further preferred that the foot cranks 14 are the only components of the drive system which project outwards from the side walls 22 and 23 of the housing 8.

In the final assembly as shown the fan 9 extends between the side walls 22 and 23 of the housing 8 and has each end located quite close to a respective one of those walls 22 and 23. It is not necessary to provide a specific inlet for air through any one of the housing walls since the aim is to recirculate air within the housing rather than continually replace part of the contained body of air as in prior constructions. Nevertheless, the housing 8 is preferably not hermetically sealed so that air can enter or escape from the housing 8 through the crank bearings for example and other mountings and or joints.

Baffle means is provided within the housing 8 to encourage recirculation of air through the fan 9. In one form as shown in figures 1 to 7, that means comprises a plurality of stator blades 24 attached to or formed integral with the housing side wall 22 adjacent the inlet opening 13 of the fan 9. Each blade 24 preferably extends substantially radially of the fan axis and may have its inner and outer ends located inwardly and outwardly respectively relative to the rotor blades 10. That is, the inner end 25 of each stator blade 24 is located radially inwardly relative to the inside diameter of the rotor blades 10 and the outer end 26 is located radially outwards relative to the outside diameter of the rotor blades 10. Part of each blade 24 is thereby located in opposed relationship to the fan opening 13. According to the arrangement shown, there are eight stator blades 24 arranged in equally spaced circumferential relationship, but a greater or lesser number of blades 24 could be selected.

If desired, the stator blades 24 could be partially contained within an annular depression 27 formed in the inside surface of the housing side wall 22 and which is substantially coaxial with the fan 9. For example, approximately one half the depth of each blade 24 may be contained in the depression 27 and that depression 27 may have a radial width substantially equal to the length of the stator blades 24. Each stator blade 24 may be flat or contoured as required.

In the construction according to figures 1 to 7, the stator blades 24 are formed integral with the side wall 22. They may be formed by stamping or pressing the material of that wall 22 between appropriate dies. It will be appreciated that those blades 24 could be separately formed and secured by welding, for example, to the wall 22.

Figures 8 and 9 show a slightly different version in which the blades 24 are not contained in a depression 27 as provided in the arrangement of figures 1 to 7.

When the fan 9 is turned through operation of the drive system, it operates in a known manner to draw air in through inlet opening 13 and then expel that air through the spaces between adjacent blades 10 of the fan 9. Air expelled by the turning fan 9 is confined by the surrounding housing 8 and the surrounding static body of air, and at least part of the moving body of air will come under the influence of the stator blades 24. Those blades 24 serve to deflect the moving air into a path extending towards the fan axis and thereby redirect air into the inlet opening 13 of the fan 9. As a consequence, movement of air into and out of the fan 9 is maintained so that the absorbance capacity of the fan 9 remains substantially as in prior constructions in which air is moved into and out of the fan housing.

Since the fan housing 8 is without air inlets and outlets of the normal kind, movement of air generated by the fan 9 is substantially confined to the interior of the housing 8 with the result that the level of noise is reduced significantly. The described arrangement therefore retains the functional advantage of conventional air absorbers without generation of significant noise. The housing 8 may be provided with an opening for ventilation purposes, but that opening will not cause a substantial increase in the noise level particularly if it is kept relatively small and is located remote from the fan 9.

Alternative to deflecting air flow within the housing 8 as described above, the fan out flow may be ducted into an arrangement which functions to redirect that flow back to the fan inlet 13. For example, an outlet duct may direct the out flow to a compartment or space within the housing 8 which is remote from the fan 9, and a further duct may direct air from that compartment or space to the fan inlet 13.

Figure 10 shows an arrangement of the last described kind in which the housing 8 is provided with an internal wall 28 which is located between the side wall 22 and the adjacent end of the fan 9. The walls 28 and 22 are spaced to form a duct 29 and that duct 29 communicates with the interior of

the fan 9 through an opening 30 in the wall 28 which is close to and aligned with the fan opening 13. The wall 28 does not extend the full length of the housing 8 so that air expelled by the fan 9 can enter the duct 29 from the space 31 within the housing 8 and be thereby redirected back to the fan inlet 13.

Another embodiment of the invention is shown by figures 11 and 12. Components of that embodiment which correspond to components of the previously described embodiments will be given like reference numerals except that they are in the number series 100 to 199.

In the particular construction shown by figures 11 and 12, the fan 109 is rotatably contained in a circular absorber housing 108 and is substantially concentric with that housing 108. A drive spindle 137 for the fan 109 preferably extends from opposite sides of the fan 109 to pass through two spaced side walls 122 and 123 of the housing 108 and has its opposite end portions rotatably mounted on a suitable support frame 133. Any suitable means can be adopted to rotate the spindle 132 and thereby drive the fan 109.

The working fluid within the housing 108 is preferably air, but water or another suitable fluid could be used. Assuming air is the working fluid, the housing 108 need not be completely air tight although it is preferred that it is substantially sealed so as to minimize noise levels during operation. Also in the case of air, it is preferred that the fan 109 is of the centrifugal type as previously described and that it is located closer to the side wall 123 of the housing 108 than the other side wall 122. An inlet opening 113 through which air is inducted into the fan 109 is preferably located at one end only of the fan 109 and that end is the end adjacent the side wall 122 of the housing 108.

Recirculation of air through the fan 109 may be encouraged in any suitable way, but in the arrangement shown, that is achieved by way of a plurality of stators 124 at the inside surface of the housing side wall 122. As shown, each stator 124 may be in the form of a bar or blade-like member which projects inwardly from the aforementioned inside surface and extends generally radially of the housing 108. Such stators 124 could be formed integral with or attached to the side wall 122 and any suitable number may be selected. Preferably, the stators 124 are circumferentially spaced in substantially regular fashion as shown.

The housing 108 is located between the two rotatable mountings 134 for the drive spindle 132 and is in turn rotatably mounted on that spindle 132. That is, a suitable bearing 135 may be provided between each of the side walls 122 and 123

of the housing 108 and the spindle 132 so that the spindle 132 is capable of rotating freely relative to the housing 108. The fan 109 is secured to the spindle 132 against relative rotation. The arrangement is such that when the spindle 132 rotates relative to the housing 108, the resulting displacement of air within the housing 108 tends to cause the housing 108 to turn with the spindle 132, and consequently some form of restraint is required to hold the housing 108 against such turning movement.

Reaction means 136 serves to hold the housing 108 against rotation with the spindle 132 and preferably includes a torque arm 137 which is connected at its opposite ends to the housing 108 and the support frame 133 respectively. As shown, the torque arm 137 may extend substantially radially outwards from the cylindrical outer wall 138 of the housing 108 and is preferably of such a form as to have substantial resistance to bending in the circumferential direction of the housing 108. It is further preferred, but not essential, that the arm 137 has minimal resistance to bending in the axial direction of the housing 108.

Force measurement means 139 is preferably provided in the connection between the arm 137 and the support frame 133 so that any torsional force acting on the housing 108 in at least one direction is reacted into the support frame 133 through the force measurement means 139. That means 139 may be a load cell or transducer of suitable form which responds to an applied force in a manner representative of the magnitude of that force.

As shown diagrammatically in figure 11, appropriate electronic means 140 may be connected to the load cell 139 so as to provide a signal representative of the applied torque reaction. Further electronic means 141 such as a micro processor may be operable to relate that signal to another signal which is representative of fan speed and thereby generate an output which is indicative of the magnitude of the work being done at any instant in the operation of the energy absorber 105.

It will be appreciated from the foregoing description that rotation of the fan 109 within the housing 108 generates torque in the housing 108 which attempts to turn that housing 108 in the same direction of rotation as the fan 109. The magnitude of that torque will increase with increased fan speed because of the well known cube law relationship between speed and power. Since the torque arm 137 provides the sole resistance to rotation of the housing 108, the generated torque will be reacted into that arm 137 and thus into the load cell 139. The load cell 139 response at any

time is therefore an accurate indication of the torque being applied to the housing 108 at that time and consequently the amount of work being expended in rotating the fan 109.

Temperature and pressure conditions may change within the housing 108, but such changes will not seriously disturb the accuracy of the work done measurement because that measurement is directly related to the torque to which the housing 108 is subjected. If the density of the working fluid (air) changes because of a pressure/temperature change, the torque to which the housing 108 is subjected will also change if the fan speed is kept constant. A change in fan speed may avoid a change in torque, but since both speed and torque are factors which determine the work done measurement, the accuracy of that measurement will remain substantially undisturbed.

It will be appreciated that the concept of the invention can be embodied in an arrangement in which the housing 108 is not rotatably mounted as described above. Satisfactory results can be achieved so long as the housing 108 is mounted in such a way as to enable reaction between that housing and a support in such a way as to provide a signal which is representative of the work being done within the housing at the relevant time.

An energy absorber 105 as described is a substantial improvement over prior energy absorbers of the same general kind in that it incorporates the advantages of quietness in operation and accuracy in terms of ergometric measurement. Such an energy absorber 105 can be used in various environments including purely ergometric applications and exercisers having an ergometric function and which can be of any form such as cycling, rowing, kayaking, hand-cranked, or swimming exercisers, by way of example only.

Any one of the absorber mechanisms described in the preceding passages of this specification can be arranged as required in an exerciser assembly.

Various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention as defined by the appended claims.

Claims

1. An energy absorber for exercisers including, a fluid displacement fan (9) having an inlet side through which fluid displaced by said fan (9) passes, means rotatably mounting said fan (9), and a housing (8) enclosing said fan (9) and containing

a fluid; characterised in that baffle means (24,29) is provided within said housing (8) and is arranged so that fluid displaced by said fan (9) is directed back to said inlet side for recirculation through said fan (9).

2. An energy absorber according to claim 1, wherein said fluid is air.

3. An energy absorber according to claim 1 or 2, wherein said fan (9) is of the centrifugal type having a series of blades (10) which are arranged in circumferentially shaped relationship around the rotational axis of the fan (9), said inlet side is at one axial end of said fan (9), and an opening (13) at that end communicates with a space (21) within said fan (9) which is surrounded by said blades (10).

4. An energy absorber according to claim 3, wherein said baffle means (24,29) includes a plurality of stator blades (24) on a side wall (22) of said housing (8) which is located adjacent said one axial end of the fan (9), and at least part of each said stator blade (24) is in opposed relationship to said fan opening (13).

5. An energy absorber according to claim 4, wherein said stator blades (24) are arranged in circumferentially spaced relationship about the rotational axis of said fan (9), and each said blade (24) projects inwardly of said side wall (22) and extends generally radially relative to said fan axis.

6. An energy absorber according to claim 4 or 5, wherein each said stator blade (24) is at least partially located within an annular depression (27) formed in said side wall (22).

7. An energy absorber according to claim 4, 5 or 6, wherein said stator blades (24) are formed integral with said side wall (22).

8. An energy absorber according to claim 1, 2 or 3, wherein said baffle means (24,29) includes a duct (29) which is arranged to receive fluid displaced by said fan (9) and redirect that displaced fluid to said inlet side of the fan (9).

9. An energy absorber according to claim 8 when appended to claim 3, wherein said duct (29) is formed between a side wall (22) and an internal wall (28) of the housing (8).

10. An energy absorber according to any preceding claim, including drive mechanism which is operable to cause rotation of said fan (9).

erale to cause rotation of said fan (9).

11. An energy absorber according to claim 10, wherein said drive mechanism includes a spindle (15) rotatably mounted on said housing (8) and a drive connection between that spindle (15) and the fan (9) and which is contained within said housing (8).

12. An energy absorber according to claim 11, wherein said housing (8) is of rectangular cross-sectional shape and is elongate, said fan (9) is located at one end of said housing (8) and is closely confined at least by opposed side walls (22,23) of the housing (8), and said spindle (15) is located towards the other end of the housing (8).

13. An energy absorber according to any preceding claim, further including a rigid support (133), means (132,134,135) mounting said housing (108) on said support (133) for movement relative thereto, whereby fluid displaced by rotation of said fan (109) imposes a turning force on said housing (108) such as to tend to cause said relative movement thereof, and reaction means (136) interconnecting said housing (108) and said support (133) so as to resist said relative movement and being arranged to provide an indication of the magnitude of said turning force.

14. An energy absorber for exercisers including, a rigid support (133), a housing (108) containing a fluid, and a fan (109) rotatably mounted in said housing (108); characterised in that means (132,134,135) mounts said housing (108) on said support (133) for movement relative thereto, whereby rotation of said fan (109) relative to said housing (108) is operable to displace said fluid and thereby impose a turning force on said housing (108) such as to tend to cause said relative movement thereof, and reaction means (136) interconnects said housing (108) and said support (133) so as to resist said relative movement and is arranged to provide an indication of the magnitude of said turning force.

15. An energy absorber according to claim 13 or 14, wherein said mounting means (132,134,135) rotatably mounts said housing (108) on said support (133) and the respective axes of rotation of the housing (108) and the fan (109) are substantially coincident.

16. An energy absorber according to claim 15 when appended to claim 14, wherein said mounting means (132,134,135) includes a drive spindle (132) which is rotatably mounted on said support -

(133) and which passes through said housing -
(108), said fan (109) is secured to the spindle -
(132) against relative rotation, and said housing -
(108) is rotatably mounted on said spindle (132).

17. An energy absorber according to any one of
claims 13 to 16, wherein said reaction means
(136) includes a torque arm (137) which is con-
nected at its opposite ends to the housing (108)
and the support (133) respectively and is arranged
to have substantial resistance to bending in the
direction of said turning force, and force measure-
ment means (139) connected to said torque arm -
(137) and being responsive to application of said
turning force to said torque arm (137) in a manner
which is representative of the magnitude of that

force.

18. An energy absorber according to claim 17,
wherein said torque arm (137) has minimal resis-
tance to bending in a direction transverse to the
direction of said turning force.

19. An energy absorber according to claim 17 or 18,
wherein means (140) is connected to said force
measurement means (139) and is operative to pro-
duce a signal representative of the magnitude of
the turning force, and further means (141) is pro-
vided for relating that signal to a signal which is
representative of the rotational speed of said fan -
(109) and thereby provide an output which in-
dicates the work done in rotating the fan (109).

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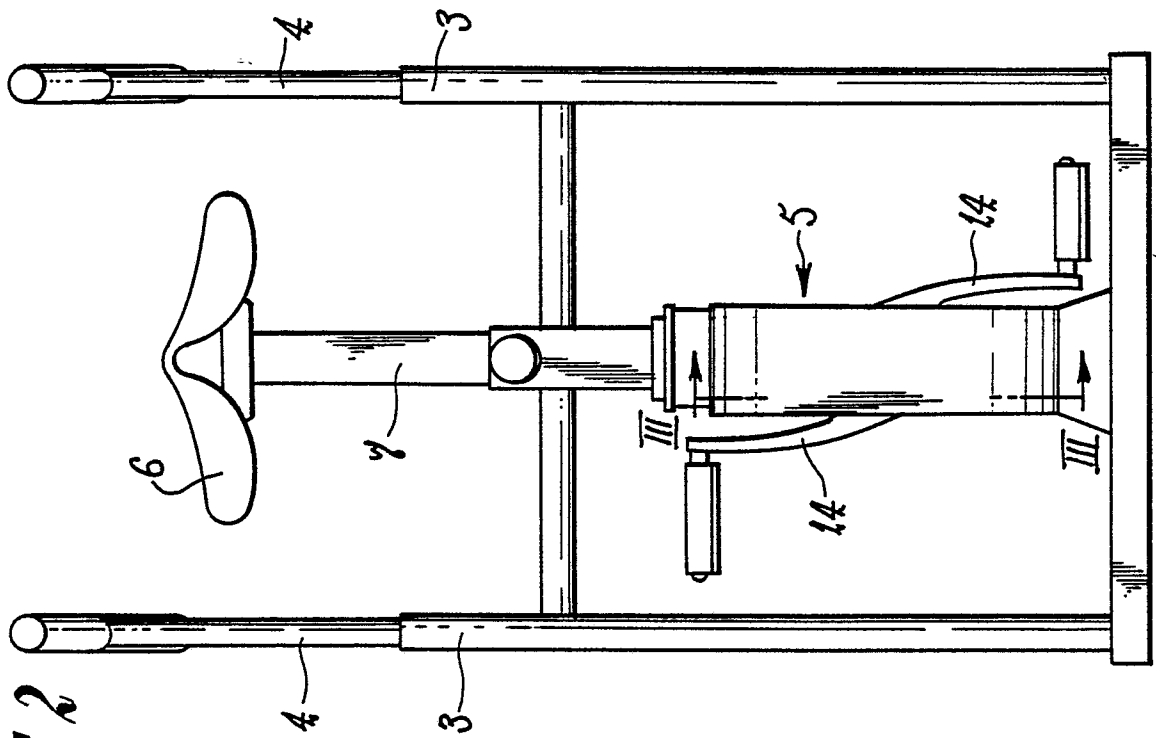


Fig 2

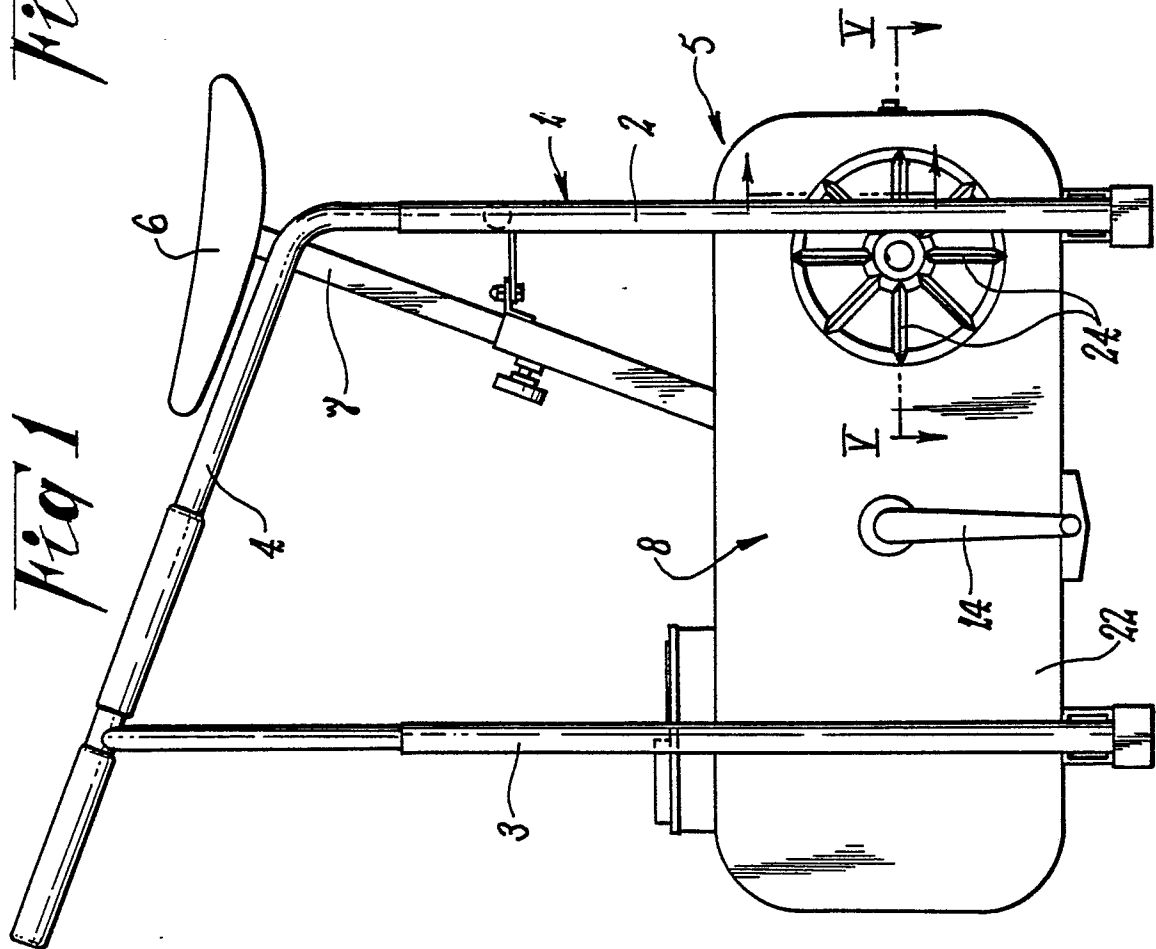
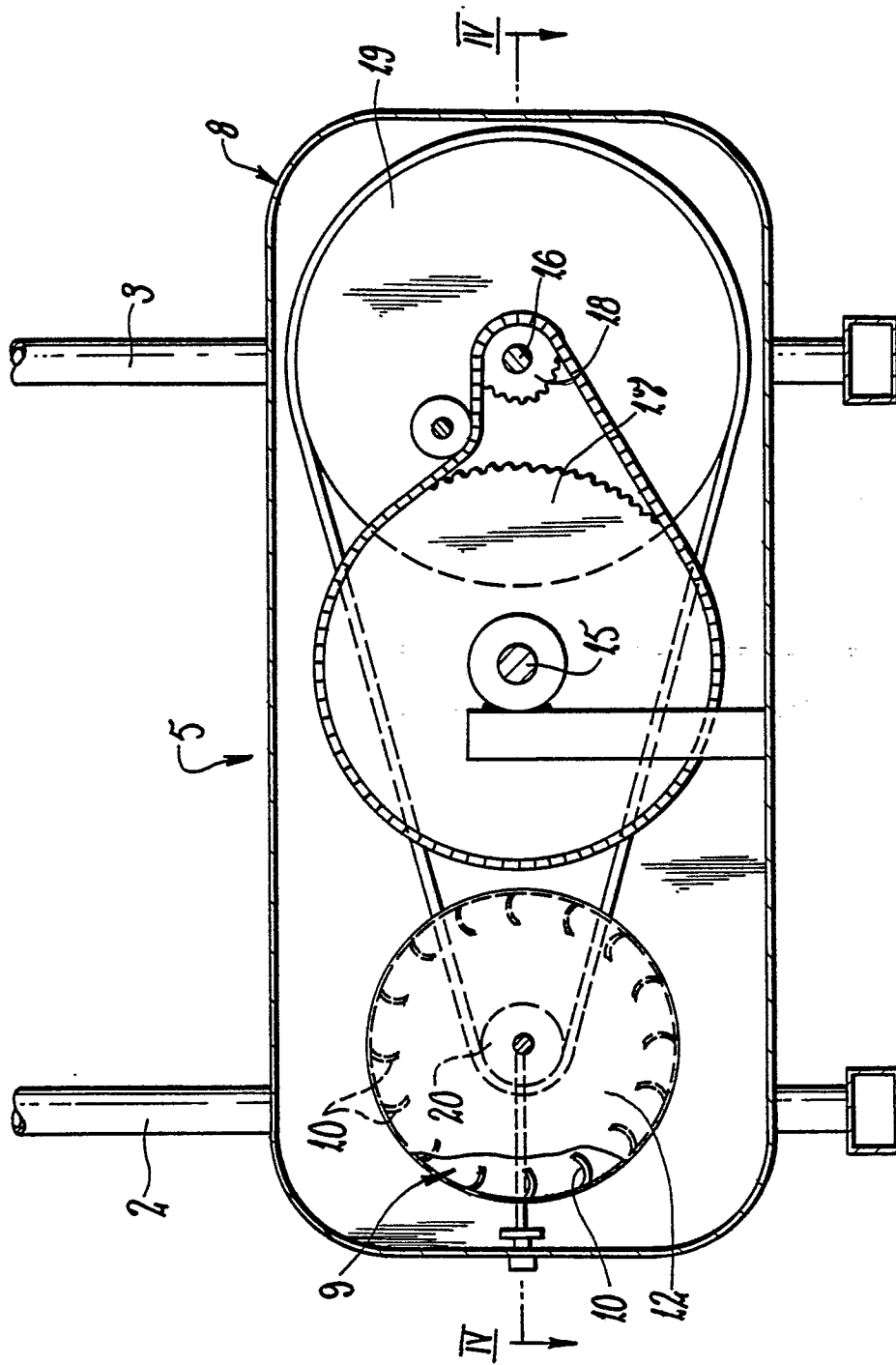


Fig 1



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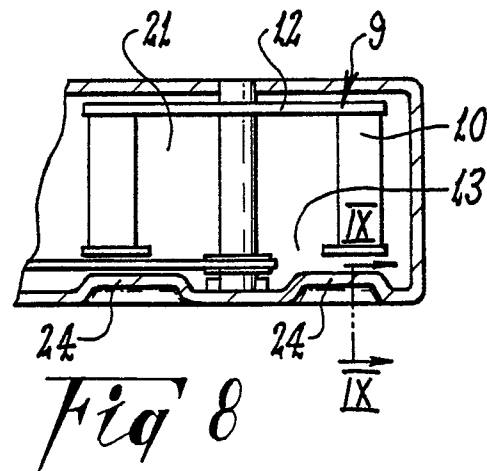
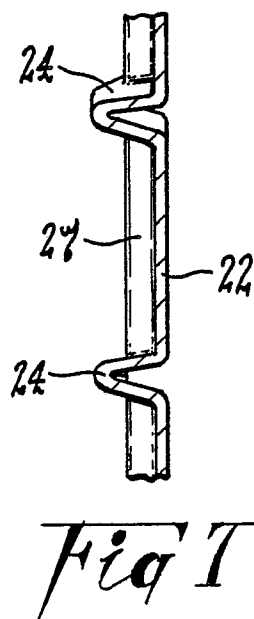
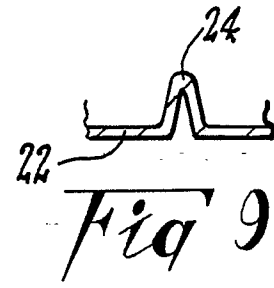
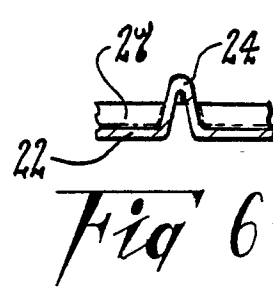
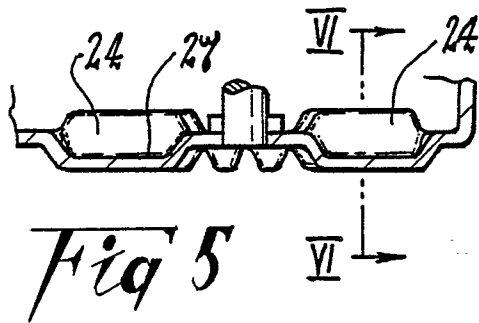
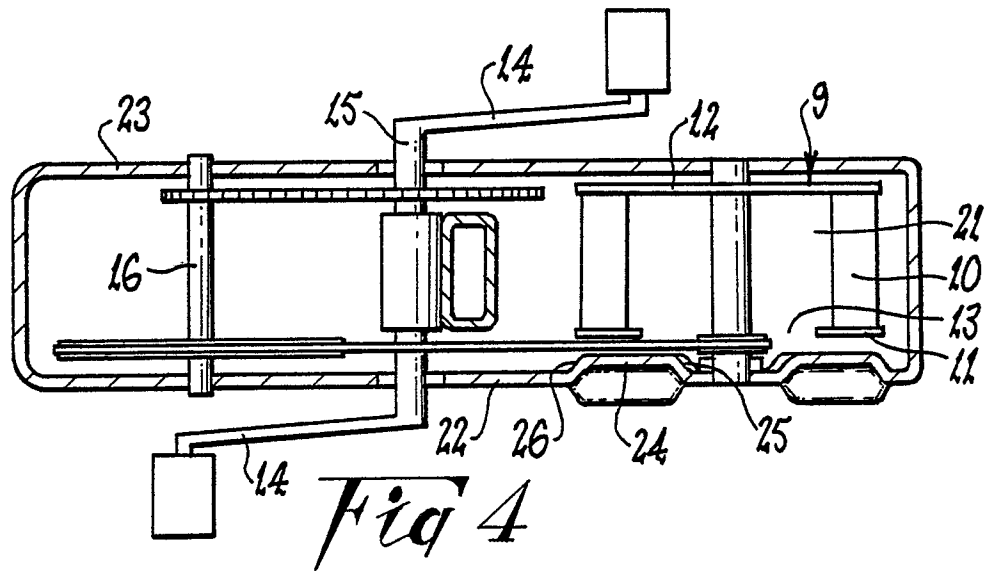


Fig 10

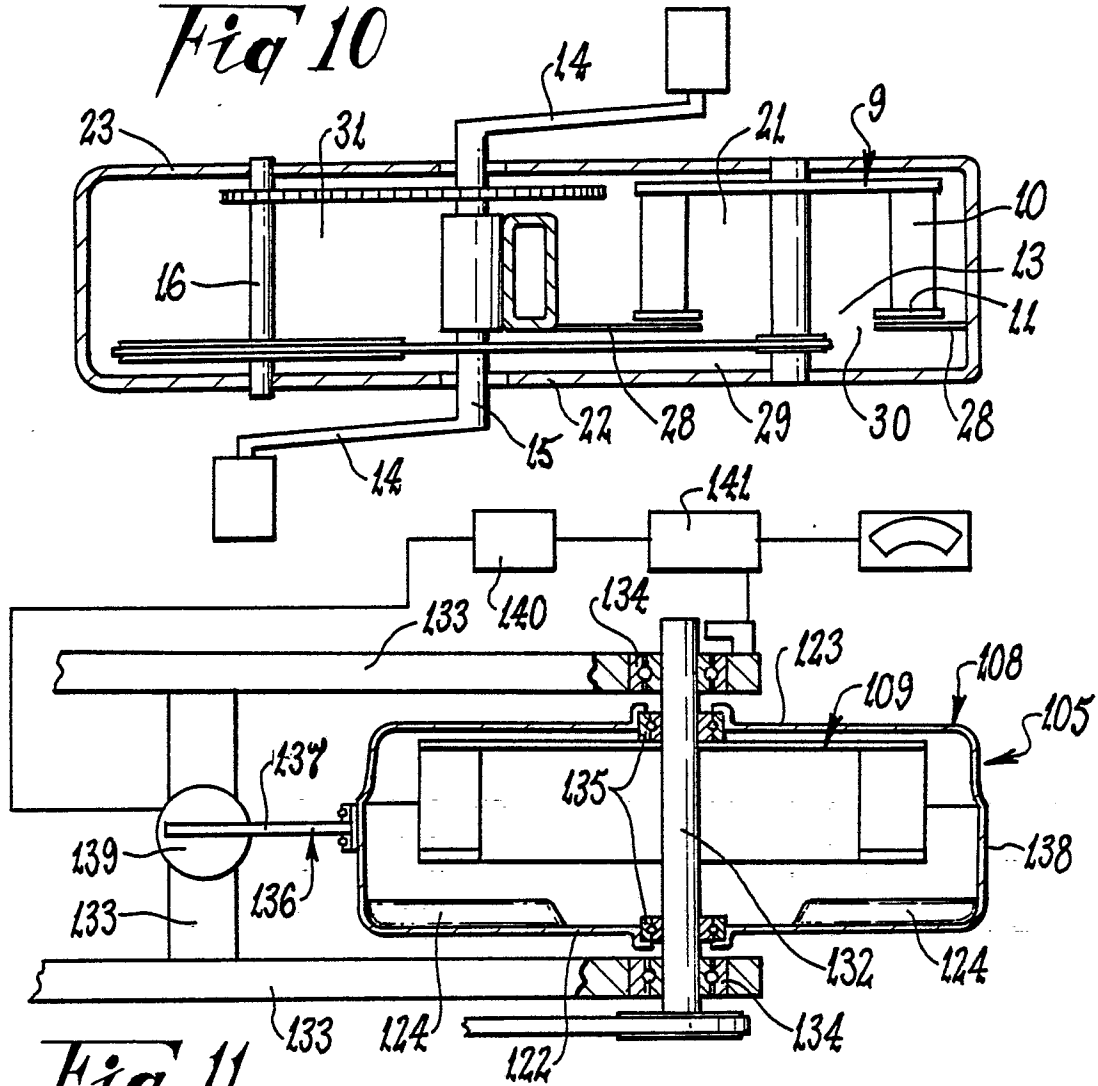


Fig 11

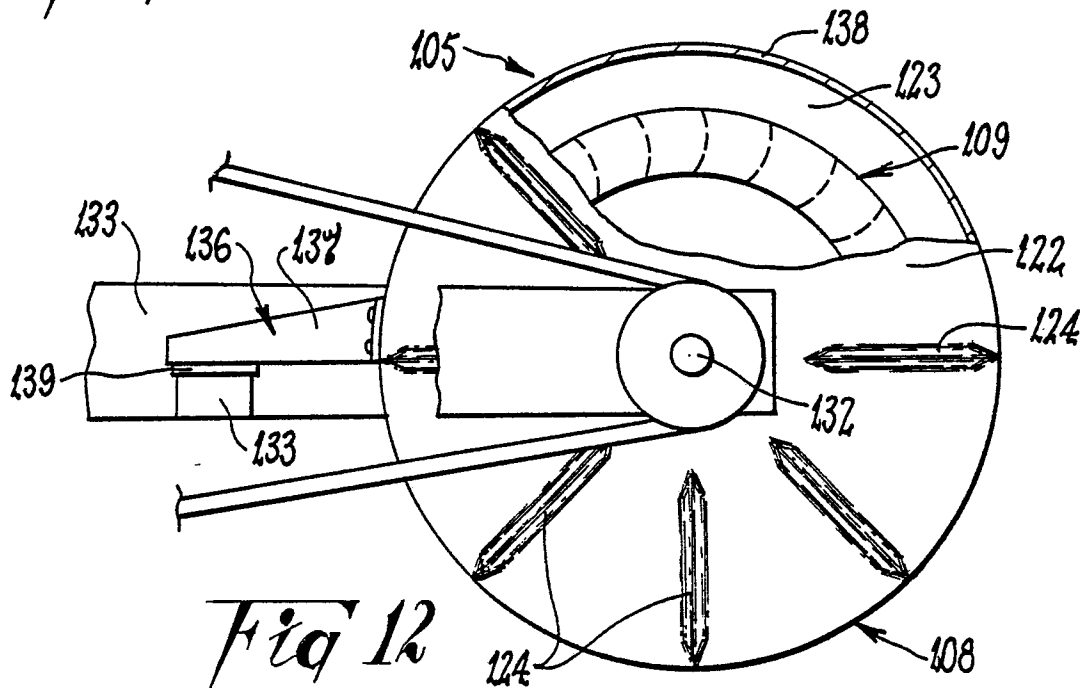


Fig 12