United States Patent [19]

Mogaki et al.

[11] **3,755,972**

[45] **Sept. 4, 1973**

[54] **PORTABLE SANDER**

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[73] Assignee: **Nitto Kohki Company Limited**, Tokyo, Japan

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[21] Appl. No.: **143,139**

[30] **Foreign Application Priority Data**

May 14, 1970 Japan 45/40653
Jan. 29, 1971 Japan 46/3160

[52] **U.S. Cl.** ..... **51/170 MT**, 51/119
[51] **Int. Cl.** **B24b 23/04**
[58] **Field of Search** 51/170, 119; 74/87

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Primary Examiner—Harold D. Whitehead
Attorney—Flynn & Frishauf

[57] **ABSTRACT**

A portable sander characterized in that at least one circulating member is circulated in an air-operated circulator at a high speed to obtain a vibration which is directly transmitted to a sanding head and the handle of the sander is resiliently mounted to the air operated circulator, preferably with an air control valve in the handle.

16 Claims, 42 Drawing Figures

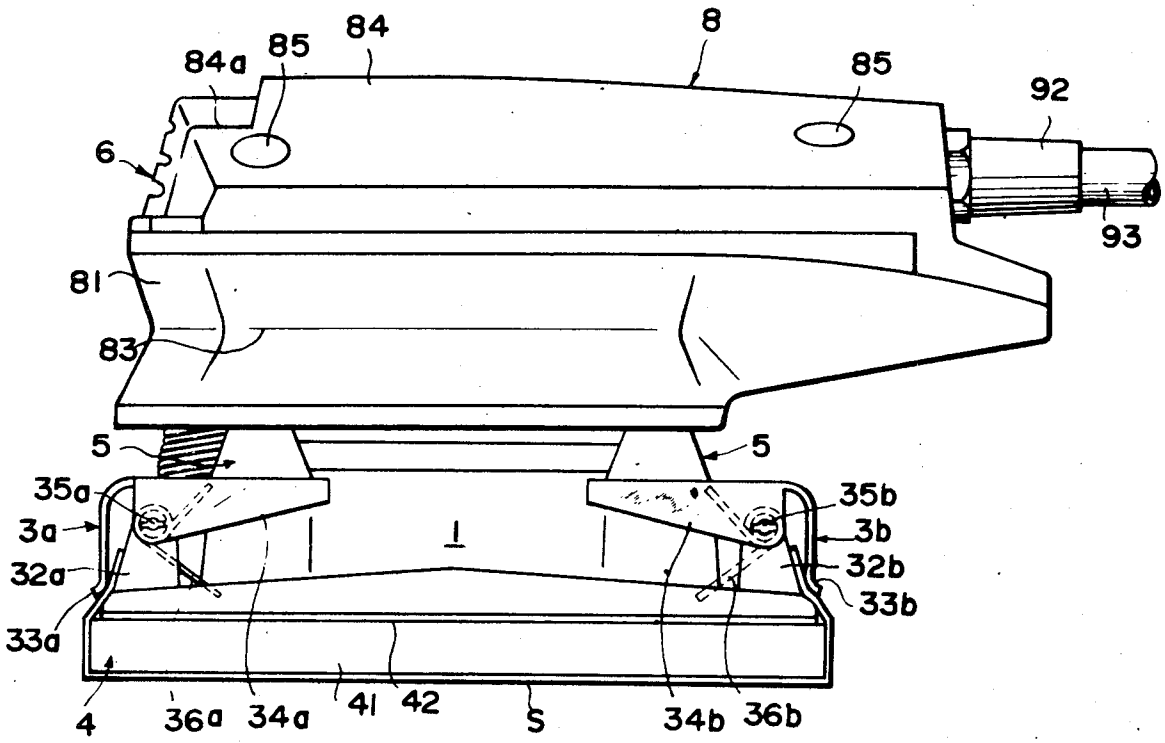


FIG. 1

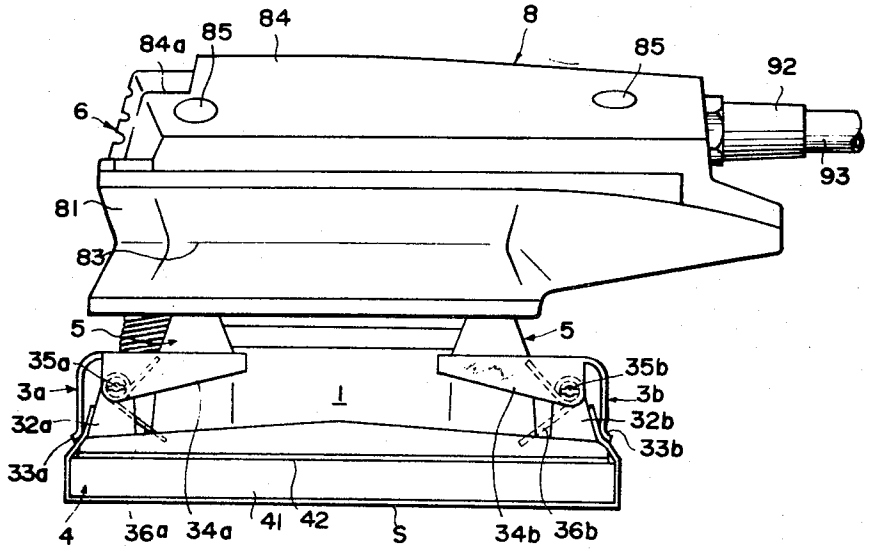

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FIG. 2

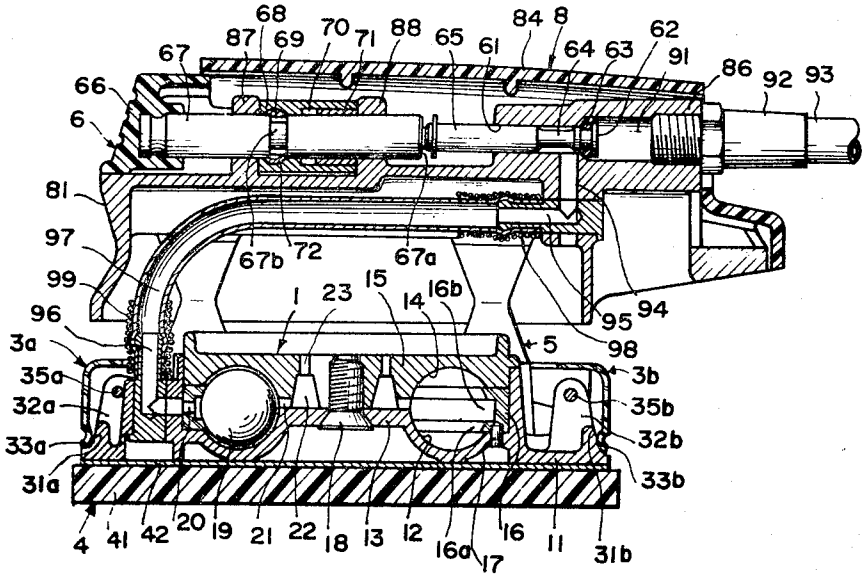

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FIG. 3

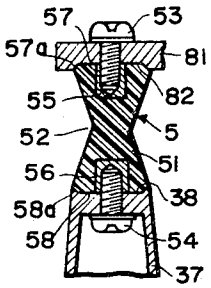


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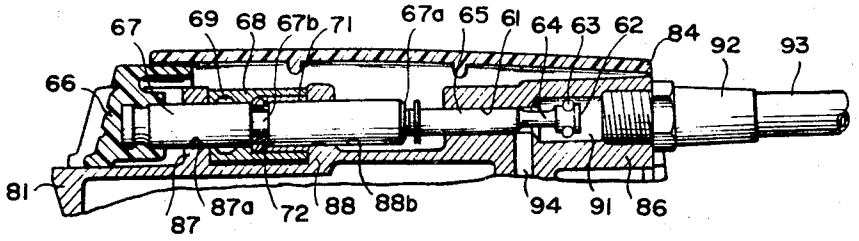


FIG. 5

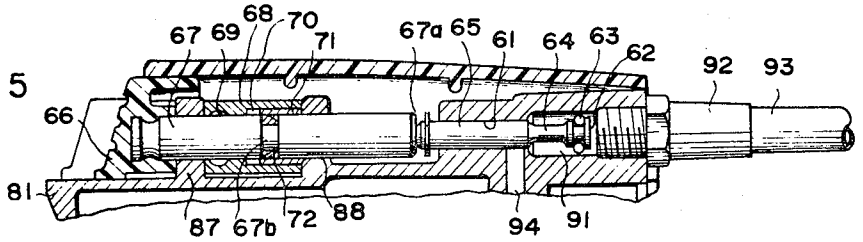


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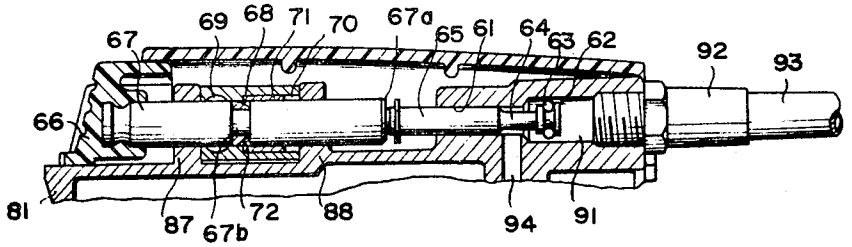


FIG. 7

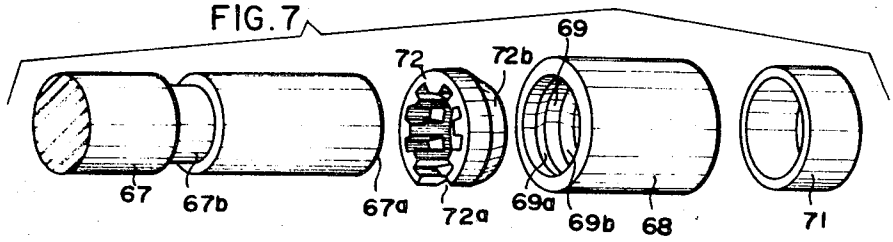


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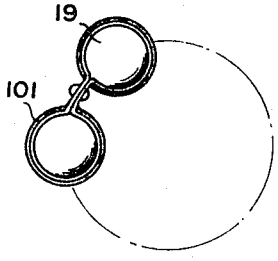


FIG. 8

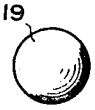
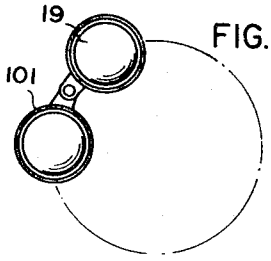


FIG. 10



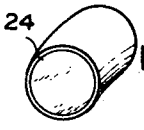


FIG. 11

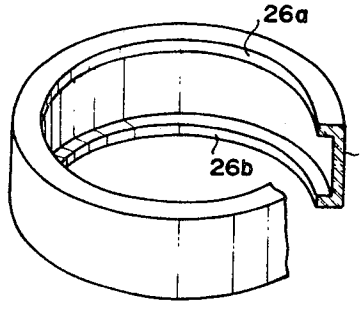


FIG. 13

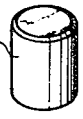


FIG. 12

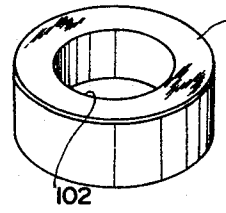


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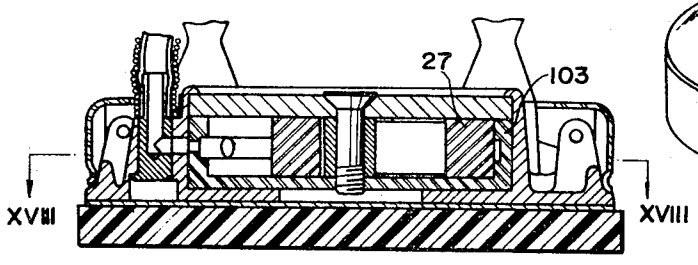


FIG. 14

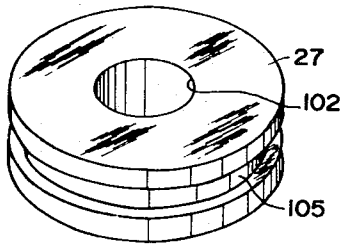


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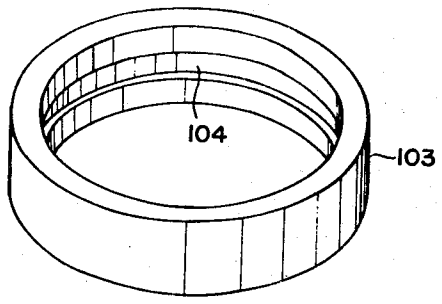


FIG. 17

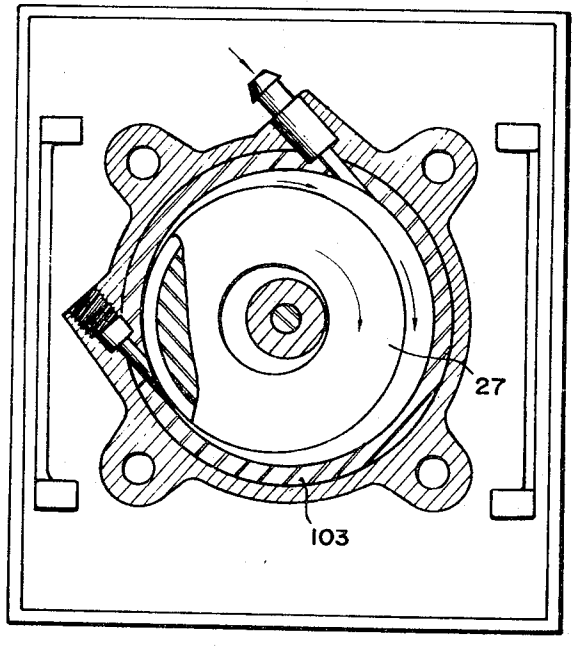


FIG. 18

FIG. 19

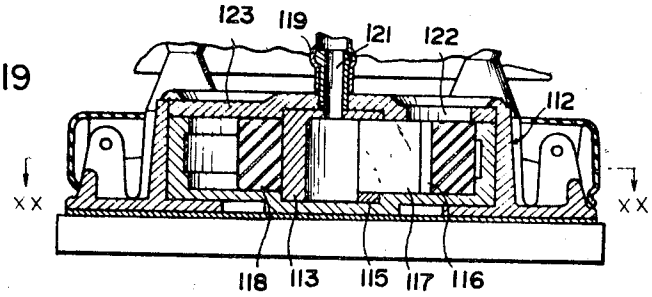


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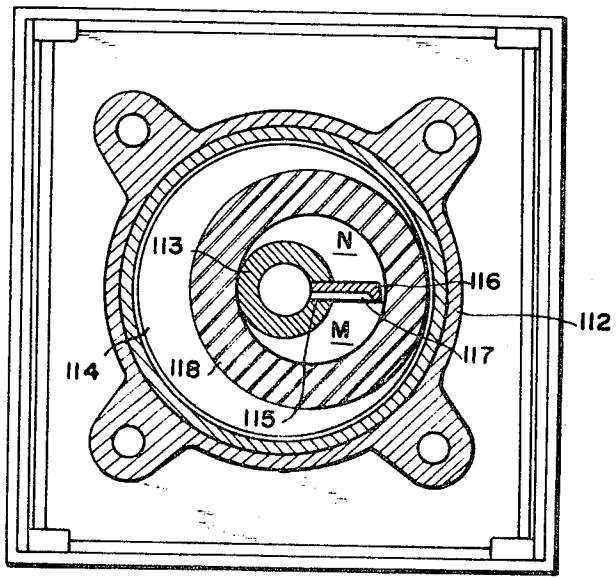
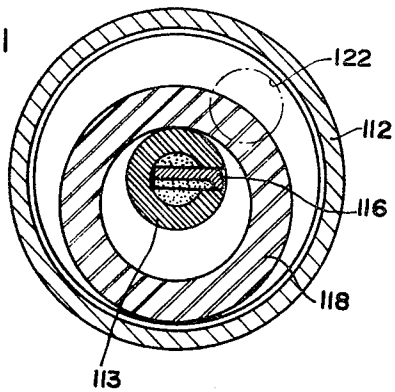


FIG. 21



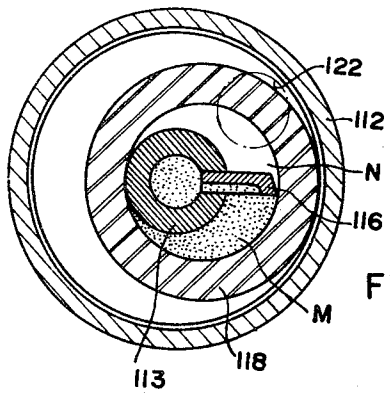
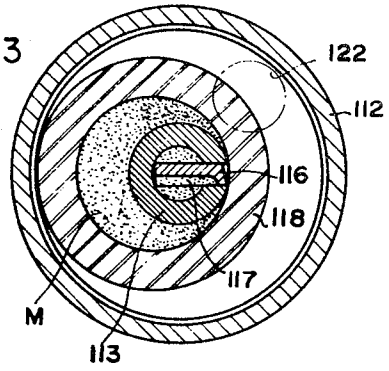


FIG. 22

FIG. 23



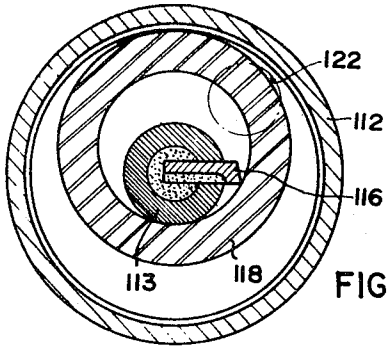


FIG. 24

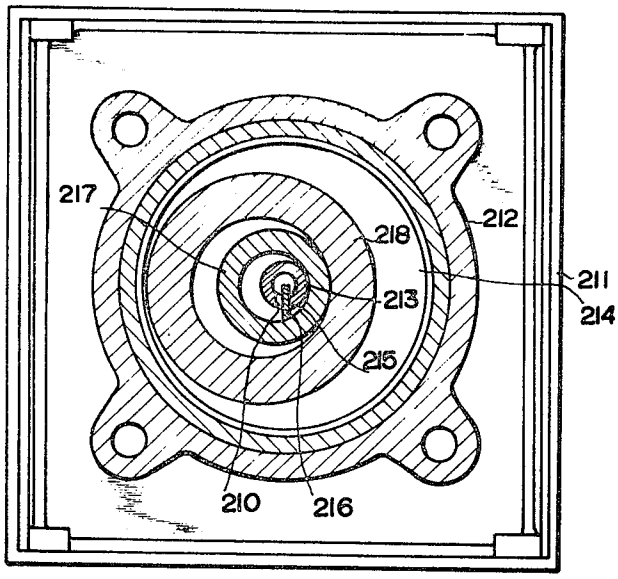
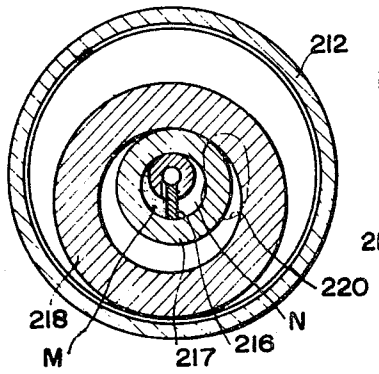


FIG. 25

FIG. 26



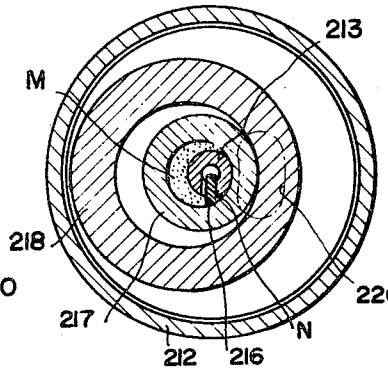
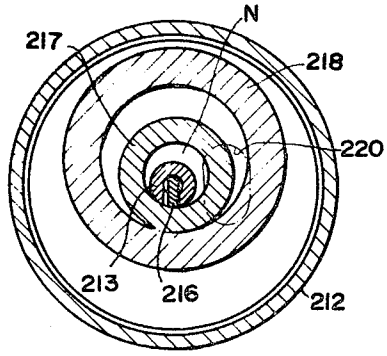


FIG. 27

FIG. 28



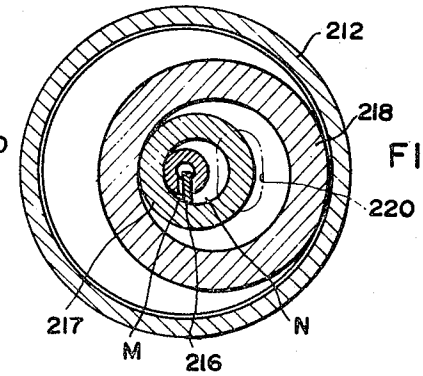
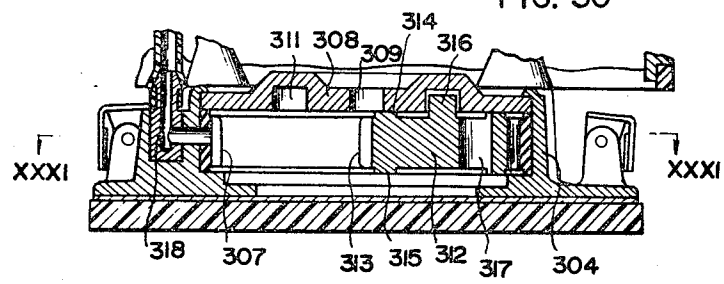


FIG. 29

FIG. 30



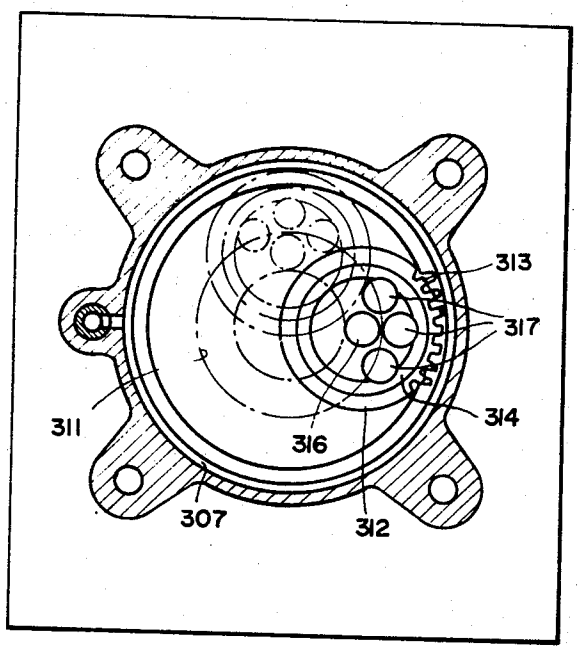


FIG. 31

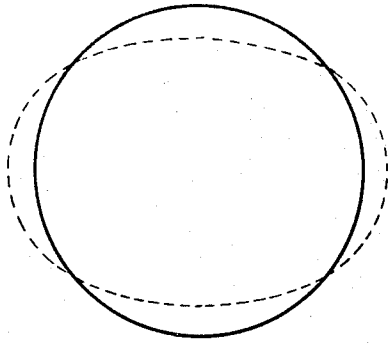


FIG. 32

FIG. 33

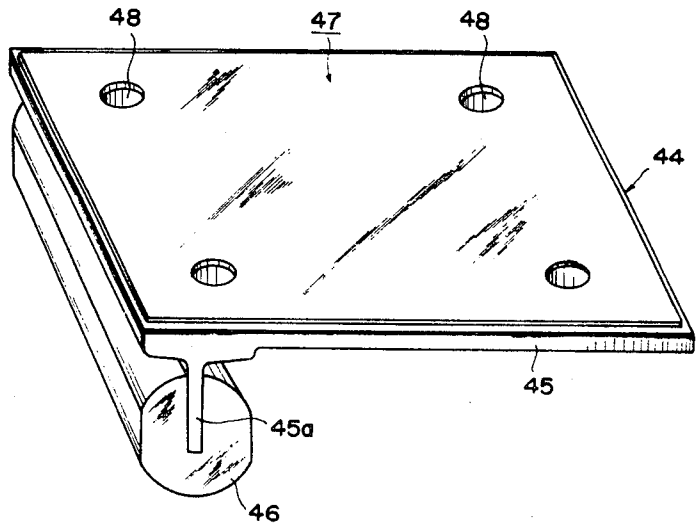


FIG. 34

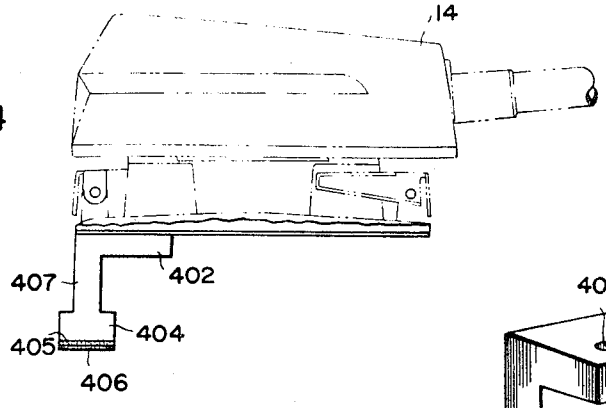


FIG. 35

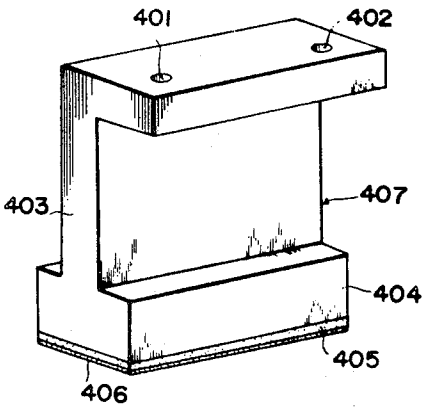
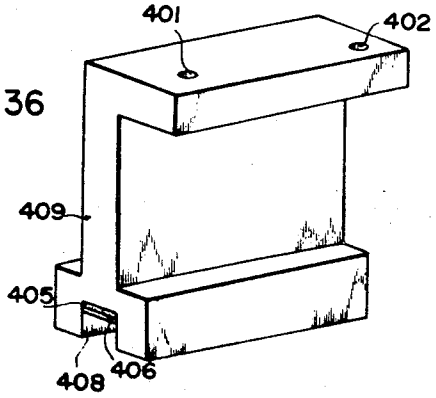


FIG. 36



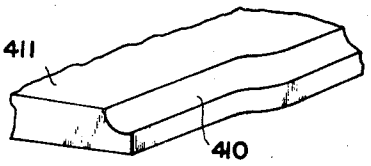


FIG. 37

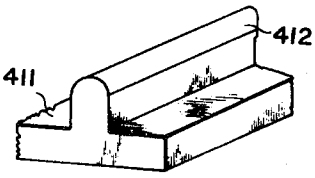


FIG. 38

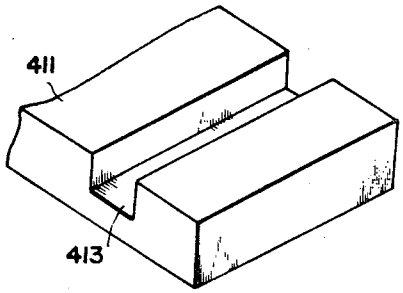


FIG. 39

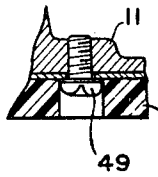


FIG. 40

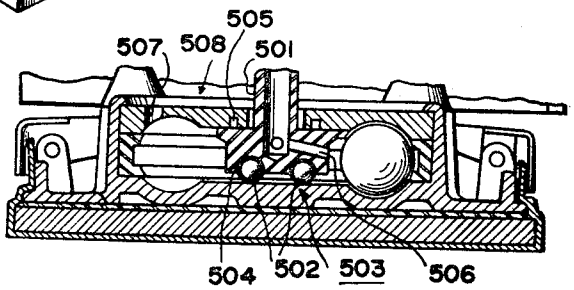


FIG. 41

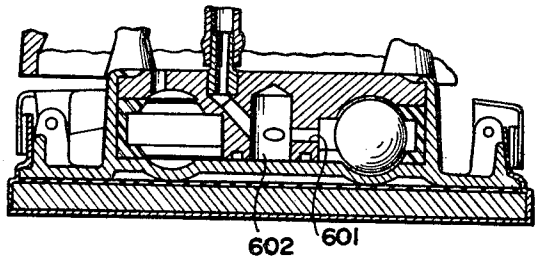


FIG. 42

PORTABLE SANDER

BACKGROUND OF THE INVENTION

Several kinds of motor operated sanders are known, such as disk sanders and bolt sanders, which are used for relatively rough sanding. However, no sander suitable for fine sanding has been proposed up to now. A sander suitable for finishing, for example, high class automobile bodies, high quality furniture, musical instruments, artistic work and the like is not readily available.

In particular, in the painting of automobile bodies, furniture and the like, several undercoats of paint are applied prior to applying the finishing coat. The undercoats must then be manually sanded by abrasive paper or cloth or wet-ground prior to applying the finishing coat, thereby diminishing the efficiency of the painting operation.

Surface finishing has been regarded as the least mechanised process in mass production lines, so that the development of powered sanding tools to take the place of a manual finishing operation is desirable.

SUMMARY OF THE INVENTION

The present invention relates to a sander for conducting a sanding operation using a continuous rotational vibration. More particularly, the present invention relates to a portable sander for operation by compressed air wherein a rolling member is circulated in a circulator at a high speed, this forming a motor generating a continuous rotational vibration by means of the centrifugal force of the rolling member, and comprising a sanding table to which may be suitable attached an abrasive material such as sand paper or cloth, the table being driven by said motor, thereby enabling a sanding operation to be affected by the continuous rotational vibration of the abrasive material transmitted from said motor.

The invention provides a portable sander which has a simple construction, is light and relatively small and enables a sanding operation to be carried out while a handle thereof is held in the hand.

The invention also provides a portable sander which is easy to handle and is equipped with a valve controlling mechanism of the so-called two-knock type, different from the conventional starting and stopping mechanism by a lever or a circulating ring, wherein a starting or stopping operation can be performed only by lightly pressing the movable member at one end of the handle of the sander held in a hand of an operator.

There is also provided a portable sander equipped with a vibration-absorbent structure and which does not fatigue the operator even during hours of use because the vibration is not transmitted to his hands or arms during the operation while he holds the handle of the sander.

The sanding table may easily be interchanged to permit the finishing operations on intricate parts such as the inside of an elongate groove, decorative frames, arabesque designs on furniture and the like, as well as on simple, plane or curved surfaces.

The present invention will be more clearly understood from the following description of some embodiments thereof, by way of example, with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side-elevation of a sander, being one embodiment in accordance with the present invention;

FIG. 2 is a longitudinal sectional view thereof;

FIG. 3 is a longitudinal sectional view showing the structure of the supporting leg;

FIGS. 4 to 6 are longitudinal sectional views showing the activating state of the valve body and the valve controlling mechanism;

FIG. 7 is a perspective view of the components of said valve controlling mechanism;

FIGS. 8 to 13 are views of parts of a vibration generating means;

FIGS. 14 to 18 are explanatory views of a further form of vibration generating means, FIG. 18 being a cross-sectional view taken along line XVIII — XVIII in FIG. 14;

FIGS. 19 to 29 are explanatory views of the embodiments showing the combination of a circulating member of annular shape and the vane plate;

FIGS. 30 and 31 show another form of vibration generating means;

FIG. 32 is an explanatory view of the path of the rolling member;

FIG. 33 is a perspective view of a sanding table;

FIG. 34 is a partial sectional view showing how the sanding table may be secured;

FIGS. 35 and 36 are perspective views showing another type of sanding table;

FIGS. 37 to 39 are partial perspective views showing the shapes of surfaces to be sanded;

FIG. 40 is a partially enlarged sectional view of a fixing part of the sanding table; and

FIGS. 41 and 42 are longitudinal sectional views of a motor showing supply and exhaust passages for compressed air.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sander shown in FIGS. 1 and 2, comprises a motor 1 supplied with compressed air and generating rotational vibration by circulation of a rolling member of a suitable shape in a circulator at a high speed. A sanding table 4 to which an abrasive material such as sand paper or cloth may be attached is fixed to the lower portion of said motor and the handle 8 enclosing the valve controlling mechanism 6 is located above said motor on a supporting leg 5 of vibration-absorbent structure.

In the motor 1 of FIG. 2, the orbital path of the circulator 16 is channel shaped in section and has two individual bearing faces 16*a* formed respectively on a lower frame 13 having a concave circulating groove 12 therein and formed integral with the base table 11, and on an upper frame 15 having a concave circulating groove 14 therein opposed to the above-mentioned groove 12, these two frames being held together and located by means of pin 17 and bolt 18. The circulator space formed by the concave grooves 12 and 14 in the orbital path of the circulator 16, along which a spherical body 19 moves on the slanting bearing faces 16*a*. When compressed air is supplied from the opening 20 at one end of the orbital path of the circulator 16, the air flows along the circumferential wall face 16*a* of said orbital path of the circulator, and thus the rolling mem-

ber (the spherical body) **19** is circulated at a high speed.

The exhaust air is passed out through the exhaust port **23** to the outside of the device via the discharge groove **21** and the channel **22** provided in the upper frame **15.**

As the spherical body **19,** which may be of steel, having a predetermined volume, is circulated at a high speed by the supplied compressed air, a rotational vibration is generated by the centrifugal action of said spherical body.

The orbital path of the circulator **16** receiving the spherical body **19** requires to select the material having an abrasion resistance due to the high speed circulation of said spherical body. However, it is not definitely necessary to compose said orbital path of the circulator and the lower frame separately as far as the material of the lower frame **13** satisfies the above-going property.

As illustrated in FIGS. **8** to **12,** the circulating member may be a sliding type **24** (FIG. **11**) in the shape of a sector of a toroid or may be a cylinder **25** (FIG. **12**) apart from the aforementioned spherical body **19** (FIG. **8**) provided it generates a vibration when circulated in the circulator at a high speed.

The aforementioned centrifugal force depends on the relationship between the size and the rate of circulation of the circulating member. In tools of this type a large centrifugal force is generally required and accordingly a circulating member of great size and volume is proposed. However, a circulating member of large size forces the circulator to be large in proportion, thereby causing such drawbacks as a great waste of the compressed air, an increase in abrasion resistance, a decrease in the rate of circulation and a reduction of the centrifugal force. For this reason, it is proposed that a number of rolling members of a ball shape be arranged in series, allowing free circulation of the respective rolling members by using a holder **101** (FIGS. **9** and **10**). The maximum number of rolling members to be arranged in series should not be more than would occupy half of the inside length of the circulator and the minimum number thereof is two. FIGS. **9** and **10** show the embodiments wherein two rolling members of a ball type are arranged in series. The holder **101** for the rolling members is advantageously made of light metal or synthetic resin and is easily insertable and fixable to the inside of the ring.

As shown in FIG. **13,** when the circulating member is of the cylinder shape **25** mentioned above, the shape of the orbital path of the circulator **26** (FIG. **13**) corresponding thereto desirably has a structure having two lines of the receiving or bearing faces **26***a* and **26***b* contacting the circumferential face of said cylinder. That is to say, the shape of the orbital path of the circulator may be formed to correspond to the shape of the circulating member.

Further, the circulator may have an oval orbital path rather than the solid circulator orbit.

In the embodiments illustrated in FIGS. **14** to **18,** the circulating member has an annular shape **27** (FIG. **15**), which is advantageous for a strong sanding operation as the volume thereof is great and a vigourous rotational vibration is obtainable. The member **27** is provided with a large opening **102** at the central portion thereof and is enclosed in the circulator **103** (see FIGS. **14** and **18**). In this case, a concave groove **104** (FIG. **17**) and supply and exhaust ports therein may be provided on the inner circumference of the circulator in order to obtain efficient circulation of the compressed air and high speed circulation of the circulating member. Further, a concave groove **105** may be provided on the outer circumference of the circulating member (FIG. **16**).

An embodiment wherein a circulating member of annular shape is used will now be explained in more detail, reference being made to FIGS. **19** to **29.** In this embodiment, a vane plate is used in conjunction with the circulating member and said vane plate is provided to the column as shown in FIGS. **19** and **20** (FIG. **20** is a cross-sectional view taken along line XX — XX in FIG. **19**).

In this embodiment, the circulating member enclosed in the circulator of the motor is circulated in an occontric motion by the compressed air, a vibration being generated by the motor **112** by virtue of the centrifugal force caused by the above operation, thereby providing suitable power for the sanding operation.

Reference numeral **113** denotes a column fixed at the central portion of the motor chamber **114** provided in the motor. A vane plate **116** is located in a slot **115** formed at one side of said column so as to be able to move freely radially therein. An air supplying groove **117** is formed at one side of said vane plate **116.** Reference numeral **118** denotes an annular body which is the circulating member and is enclosed between outer circumference of said column **113** and the wall of the chamber **114.** A chamber created between the inner surface of said body **118** and the outer circumference of the column **113** is divided into an air suction chamber M and an air exhaust chamber N by means of the vane plate **116.** Reference numeral **119** is a connecting pipe connecting a connecting opening (not shown in the drawings) branched off from the valve port to an inlet opening **121** connected to the column **113.** Reference numeral **122** is an air exhaust port provided in the upper cover of the motor **112.**

The compressed air from the compressor (not shown) is fed under pressure to the column **113** via the connecting pipe **119.** The vane plate **116** is driven outwardly radially by the air so that the tip of said vane plate **116** is in contact with the inner surface of the body **118,** whereby the compressed air enters the suction chamber M under pressure via the air supplying groove **117** of the vane plate **116,** and said annular body **118** is swung and circulated in the clockwise direction while successively varying the contact point of the inner surface of said circulator body **118** and the outer circumferential face thereof. When said body **118** is swung through the maximum volume position for the pressure chamber M (as shown in FIG. **23**), the chamber M overlaps with the air exhaust port **122** (as shown in FIG. **24**) and then becomes the air exhaust chamber N, but a new chamber M is created into which the compressed air from the air supplying groove **117** of the vane plate **116** enters to drive said body **118** for a further cycle, and so on.

As mentioned hereinabove, in the embodiment wherein the combination of a circulating member of an annular shape and a vane plate is used, as the circulating body, having a large volume, is swung about and circulated in an eccentric motion, a strong centrifugal force is generated and an energetic but low amplitude vibration is generated by the motor **112** at the same time, the compressed air being fed under pressure not

to the chamber 114 but to the suction chamber M having a small volume provided to the inner side of the circular body 118, thereby resulting in only a relatively small amount of compressed air being used, and giving a remarkably efficient sanding operation.

FIGS. 25 to 29 illustrate an embodiment wherein two circulating members are used and FIG. 25 illustrates a modified embodiment of FIG. 20.

Reference numeral 212 denotes a motor provided with a sanding pad 211 made of a resilient material at the lower portion thereof. A cut-out 215 is provided at one side of a column 213 supported at the central portion of a motor chamber 214 provided in said motor 212, a suitable number of air suction ports 210 being arranged at one side of said cut-out 215, and a vane plate 216 being located in said cut-out 215 so as to be movable radially. A first annular body 217 having an inner diameter greater than the outer diameter of said column loosely encircles said column 213, and a second annular body 218 having an inner diameter greater than the outer diameter of said body 217 loosely encircles the same. Said first and second bodies 217 and 218 circulate in the action chamber 214 at a high speed with an eccentric motion, driven by compressed air and generating a centrifugal force. The vane plate 216 is constantly pressed outwardly radially by the air fed under pressure to column 213, and the air is expelled out of column 213 via the air port 210 provided at one side of the cut-out of said column 213. The air passed driven out from the air port 210 enters under pressure into the chamber M of the two chambers M and N formed by the column 213 and the first body 217 and the vane plate 216. In this manner, the volume of the chamber M increases due to the entry of the compressed air. Thus, the first body 217 circulates in the clockwise direction while making an eccentric motion, thereby similarly swinging the second body 218 positioned outside said first body 217. In this way, as shown in FIG. 27, after the chamber M reaches its maximum volume, the first body 217 is circulated further in the clockwise direction, while making its eccentric motion, under the influence of the swinging second body 218. When said chamber M overlaps with the air exhaust port 220 as shown in FIG. 28, the chamber M becomes the chamber N, and the air therein is exhausted through the air exhaust port 220. Then, the compressed air enters under pressure the new chamber M from the air suction port 210, and the first body 217 is circulated again in the same manner through another cycle. As the second body 218 having a great volume is swung about by the circulation of said first body 217, the centrifugal force is substantial, thereby obtaining an energetic vibration in spite of the small amount of air used.

In the embodiment hereinafter described with reference to FIGS. 30 to 32, the circulating member is of circular shape having external teeth engaging with teeth in the inner wall of the chamber of the motor, and low amplitude oval vibrations are generated by pressing the outer circumference of the circulating member into a suitable shape engaging with said teeth. In this case, the centre of gravity of the circulating member is made eccentric and a column composing a supply passage for compressed air is not required.

A toothed portion 307 is formed in the inner wall face of the housing 304 of the motor, the upper cover 308 being fixed to the upper portion of said housing, an air exhaust port 309 being provided in the central portion of said upper cover to form a motor chamber 310, and a groove 311 being provided concentric with said air exhaust port between said air exhaust port and the circumferential wall of the motor chamber. Reference numeral 312 denotes a circulating member freely rotatable enclosed in the chamber 310, said member 312 having a diameter which is substantially half that of the chamber 310, teeth 313 being provided at the outer circumference thereof. Projections 314 and 315 of a circular shape are formed near the circumference of the upper and lower surfaces of said member 312, and a central projecting part 316 on the upper surface of said member 312 is in engagement with the aforementioned groove 311. A number of openings 317 are provided displaced to one side of said member 312 so as to make its centre of gravity eccentric.

Reference numeral 318 denotes a supply port fixed to the housing 304, the port opening into the chamber 310. Compressed air is supplied to the action chamber 310 through port 318. The teeth 307 on the inner wall of said action chamber are in engagement with the teeth 313 at the outer circumference of the member 312, the projection 316 being engaged with the groove 311. Thus, said member 312 is revolved around the projection 316 because of the engagement of the teeth, and at the same time circulates around the chamber 310 at a high speed guided by said groove 311. In this case, if the overall upper and lower surfaces of the member 312 contact the inner, upper and lower surfaces of the chamber 310, the friction is great. This friction is reduced by providing the projections 314 and 315 which enables the member 312 to circulate at a higher speed. Further, the centre of gravity of said rolling member is made eccentric by means of the openings 317 adjacent one side of said member, so that the centre of gravity of said rolling member 312 follows an oval locus as shown by the dotted line in FIG. 32 although the member has a circular locus as shown by the solid line in FIG. 32. For this reason, the sanding table fixed to the motor vibrates at a high speed due to the low amplitude vibration in an oval motion, thereby carrying out the sanding operation.

An embodiment as illustrated in FIGS. 1 to 8 has been constructed using the following data:

Inner diameter of the circulator	50 mm
Diameter of rolling member (steel spherical body)	14 mm
Gauge pressure of compressed air	3.5 kg/cm²
Circulation rate of the rolling member	approximately 6,500 r.p.m.
Diameter of rotational vibration	approximately 1.2 mm

However, this 1.2 mm diameter of the rotational vibration is at no load. The diameter of the rotational vibration varies within the range of 0 to 1.2 mm depending on the type and state of the surface to be sanded during the sanding operation. For instance, when the sanding table 4 is fixed to the lower surface of the motor 1 and said motor is driven in a groove having a width equal to that of said sanding table, the vibration at right angles to the groove wall is substantially absorbed and an oval rotational vibration is obtained.

On the other hand, in a prior sander shown in U.S. Pat. No. 2,367,668, the eccentricity of the supporting axis of the sanding table relative to the motor axis is constant. If that type of sander is used in a groove in the

same manner as was mentioned above, the sanding table is not driven at all and, on the contrary, the motor itself eccentrically circulates.

In FIGS. 1 and 2, the manner of securing the abrasive material, such as sand paper or cloth, is composed of the receiving peripheries 31*a* and 31*b* of the sanding tracks 32*a* and 32*b* provided integrally with the front and rear portions of the base table 11 of the motor 1, holders 3*a* and 3*b* having holding portions 33*a* and 33*b* respectively opposing the said receiving peripheries, and the hand levers 34*a* and 34*b* mounted respectively between the above pair of projecting tracks 32*a* and 32*b* on pivots 35*a* and 35*b*, and spring-loaded by means of springs 36*a* and 36*b*.

Generally, the sand paper or cloth S is gripped by the action of the springs 36*a* and 36*b* between the receiving peripheries 31*a* and 31*b* and the holding portions 33*a* and 33*b* of the holders 3*a* and 3*b*. When the levers 34*a* and 34*b* of said holder are pushed down against the elasticity of said springs, said holding portions are lifted, thereby releasing the sand paper or cloth S.

In FIGS. 1 and 2, the sanding table 4 is so composed as to rigidly adhere the plate member 42 to the upper portion of the sanding pad 41 made of a relatively thick and flexible rubber material so that the sanding table 4 may follow the surface to be sanded. Said plate member 42 is substantially as large as the base table 11 of the motor 1, and said sanding pad is slightly larger at the rear, the front and both sides thereof than said plate member. Said sanding table is secured to the base table 11 of the motor so as to be freely adherable, removable and replaceable. In the embodiment as shown in FIG. 40, the head part of the sanding table is screwed to one end of the base table 11 of the lower frame 13 of the motor 1 by means of the bolt 49 embedded in the sanding pad 41.

The sand paper or cloth S is rigidly adhered to said sanding pad, and both peripheries thereof are rigidly supported by means of the holders 3*a* and 3*b*.

When conducting the sanding operation, the sanding table 4 affixing the sand paper or cloth S thereto is lightly contacted with the surface to be sanded and the motor 1 is driven. At this moment, it is more advantageous to conduct the sanding operation while circulating the sanding table 4 slowly in the same direction as the circulating direction of the rolling member 19 of the motor 1.

The bottom surface of said sanding pad has a flat surface 43 in the embodiment illustrated in the drawings. However, it is not confined to this form, and it may, for example, have a convex surface although not so shown in the drawings.

FIG. 33 illustrates the sanding table 44 in another embodiment. Said sanding table has a structure wherein a projecting leg 45*a* is formed at one end of the lower portion of a sanding pad 45 made of relatively hard rubber material, and a sanding body 46 of a suitable shape made of a soft material rigidly adhered to said projecting leg, the plate member 47 being rigidly adhered on the upper portion of the sanding pad 45. Reference numeral 48 denotes fixing openings. When using said sanding table, the sand paper or cloth may be so adhered to the outer surface of the sanding body 46 as to be removable therefrom.

The sanding body 46 of said sanding table 44 is most suitable for the finishing of e.g. decorative edges, concave or convex surfaces, oblong grooves, projecting lines or mounted parts of furniture, and the like. The sanding body 46 in the FIG. 33 embodiment is primarily for finishing a groove. Said sanding body is provided on a projecting leg 45*a* of a hard quality of the sanding pad 45, so that when said sanding body is entered in the groove, for example a concave groove, said curve can be absorbed by the elasticity of said projecting leg. Accordingly, when the motor 1 is driven and the sander is moved along the groove, the rotational vibration of said motor is transmitted to the sanding body 46 without being absorbed, thereby performing an efficient sanding operation over the entire surface of the groove.

The sanding body 46 may take various shapes to conform with the shape of a surface to be sanded. For example, a sanding body as illustrated in FIGS. 34 to 36 may be employed in sanding a cut-out such as is shown in FIG. 37 at 410 in a surface 411, or the concave and recessed parts 412 and 413 as shown in FIGS. 37 to 39. In FIGS. 34 and 35, an opening 401 for a fixing bolt is provided in the fixing part 402 and a portion 403 with a narrow width and having elasticity projects from the lower portion thereof. A sanding segment 404 is provided to the lower end of said portion 403, sand paper 406 being attached on the bottom surface thereof with the interposition of a soft body 405 made of urethane or the like. FIG. 36 shows an attachment 409 wherein a concave groove 408 is formed at the undersurface of the sanding segment 404 and the sand paper is attached thereto in the same manner as in FIG. 35.

Particularly in FIG. 3, the supporting leg 5 should absorb the vibration and not transmit the rotational vibration of the motor 1 to the handle 8 which an operator holds directly, and the assembly thereof should never be knocked down by the vibration.

For this reason, the main body of the supporting leg 51 is advantageously made of rubber having elastic properties and has a waisted shape with a narrowed waist 52. Metal cores 55 and 56 are embedded in the upper and lower core portions to provide anchor points for the fixing bolts 53 and 54. Large area bevel faces 57*a* and 57*b* are provided at the upper and lower ends of said main body 51, the upper and lower end surfaces 57 and 58 respectively being rigidly positioned in recess 82 at one end of the skirt of the handle 8 and recess 38 in the leg receiving part 37 provided at one end of the lower frame 13 of the motor 1, the main body of the supporting leg 51 and said recesses being so composed as to be incapable of moving naturally, whereby loosening of the fixing bolts 53 and 54 because of the vibration transmitted from the motor 1 is prevented. When the handle 8 is held in the hand with the sanding table 4 contacting the surface to be sanded, the rotational vibration of the motor 1 is naturally transmitted also to the supporting leg 5. However, the waist 52 of the main body 51 of said supporting leg is so narrowed that the upper and lower portions thereof can move relative to each other, so that the vibration is being absorbed at said part and not transmitted to the hand holding the handle 8.

Referring to FIGS. 1 and 2, the handle 8 comprises a skirt 81 having a waist 83 whose both sides are indented so that one can easily place fingers round that and the upper cover 84. Said upper cover is secured to said skirt by bolts. Reference numeral 85 denotes openings for the heads of the bolts.

The upper surface of the upper cover 84 has a smooth and curving face suitable for being held in a

hand, one end of the front portion being provided with a space 84*a* and the movable body 66 of the valve controlling mechanism which will be described later being enclosed in said space.

Said handle 8 is formed into a most suitable shape to hold, with the palm resting on the smooth upper surface of the upper cover 84, a thumb is engaged with the waist 83 on one side of the skirt 81 and fingers with the waist 83 on the other side.

In FIGS. 2, 4, 5 and 6, the compressed air is supplied to the inside of the valve chamber 91 from the air supply pipe 93 via the pipe joint 92 screwed to one end of the projecting part 86 at rear portion of the skirt 81. Said valve chamber 91 leads to the joint opening 94 through the valve body which will be described later, to lead the compressed air to the pipe coupling 95 fixed inside of the skirt 81.

The pipe coupling 96 leading to the motor air inlet 20 is fixed to the top of the motor 1, the pipe coupling 95 being coupled to the pipe coupling 96, by means of the flexible pipe 97. Thus, the compressed air is supplied to the circulator in the motor 1. Protective coating layers 98 and 99 are provided at least at the coupling part of the pipe couplings 95 and 96 for the purpose of preventing uncoupling of the pipe 97 by the rotational vibration of the motor 1.

The supply passage may be a passage reaching the inside of the circulator at the central portion of the motor 1. The embodiment illustrated in FIG. 41 is characterised by using the hollowed air supply stem 501. The upper portion of said air supply stem 501 is coupled to the joint opening 94 by suitable means, the lower portion thereof extending to the central portion of the circulator and being secured to the motor 1 through a suitable number of balls 502. Said balls 502 are set in a plurality of openings or grooves provided to the central portion 503 of the motor (using the openings 504 in this embodiment), the load on the air supply stem 501 (the pressure applied to the upper cover by the operator) not being transmitted to the motor, and the vibration generated by the motor not being transmitted to the upper lid. Reference numeral 505 denotes a packing seal.

The compressed air is supplied via the air supplying stem 501 to the air inlet 506 and hence to the circulator and is exhausted through the air exhaust port 507 into the space 508 (the space between the motor and the handle) after driving the circulating member. As efficient air exhaust action is obtainable by providing said air exhaust port 507 at the position opposing to the air inlet 501.

The manner of supplying the compressed air shown in FIG. 42 is characterised by making the use of the optional number of the air supplying openings 601 provided in the circulator in a radial manner. Said air supplying openings lead to the longitudinal opening 602 preliminarily provided to a part of the motor, and the compressed air is supplied to said opening 602 from the outside. Other mechanisms are substantially the same as in FIG. 41.

In FIGS. 1, 2, 4, 5, 6 and 7, the valve body 65, having a flange 62 with a relatively wide diameter and a sealing ring 63 behind it and a portion 64 with a small diameter at one end close to the central rear portion, is inserted inside the opening 61 leading to the valve chamber 91 and the joint opening 94 in the projecting part 86 at the rear end of the skirt 81, said valve body being pressed forwardly as the flange 62 is subjected to the compressed air pressure in the valve chamber 91 as shown in FIG. 2, so that the communication between the valve chamber 91 and the longitudinal opening 94 is intercepted by means of the sealing ring 63.

The control rod 67 on which is mounted a movable control knob is freely movable in and out relative to the front portion of the upper cover 84 and is so mounted as to be freely slidable in the openings 87*a* and 88*b* provided in the projecting parts 87 and 88 between which there is a predetermined spacing at the substantially central portion of the upper surface of the skirt 81. The valve body 65 is moved backwardly by means of the rear end 67*a* of said control rod 67 by pressing lightly on said control knob 66, whereby the compressed air in the valve chamber 91 is allowed to flow to the joint opening 94 leading to the motor 1 as shown in FIG. 4. Such a condition is further explained below. The control rod 67 extends through the cylinder body 68 interposed between the projecting parts 87 and 88 of the skirt 81, the engaging groove 69 whose front and rear surfaces are slanting faces 69*a* and 69*b* being peripherally provided close to the side of the inner front portion of said cylinder body, the movable cylinder body 71 being freely slidably enclosed at the side of the rear portion leaving the predetermined space 70.

On the other hand, the peripheral groove 67*a* is provided at one end of the central portion of the controlling rod 67 which pierces said cylinder body and the movable cylinder body and is suspended, the engaging ring 72 made of a material having an elastic stability such as nylon and the like whose one end 72*a* of the peripheral wall face is cut out and the rear end is the slanting face 72*b* being engaged with said peripheral groove.

When compressed air is supplied from the air supply pipe 93 to the valve chamber 91, the rear end flange 62 of the valve body 65 is subjected to the air pressure as shown in FIG. 1, the sealing ring 63 contacting the rear peripheral edge of the opening 61, the compressed air then staying in said valve chamber and not entering the joint opening 95 leading to the motor 1.

At this moment, the engaging ring 72 arranged at the peripheral groove 67*b* of the control rod 67 is engaged with the engaging groove 69 of the cylinder body 68, the control knob 66 at the front end of said control rod being positioned at the front-most portion

Then, when said control knob is so lightly pressed in towards the upper cover 84, the rear end 67*a* of the control rod 67 comes into contact with the valve body 65, said valve body being moved backwardly, and the sealing ring 63 secured to the rear end of said valve body becomes separated, from the rear peripheral edge of the opening 61, whereby the compressed air in the valve chamber 91 is admitted to the opening 61 and enters the joint opening 95 leading to the motor 1.

At this stage, the engaging ring 72 engaged with the peripheral groove 67*b* of the control rod 67 makes the diameter thereof small in proportion to the retreat of said control rod and is enclosed in the peripheral groove 67*b* by the guide of the rear slanting face 69*b* of the engaging groove 69 of the cylinder body 68. When said control rod is moved backwardly to the position corresponding to the space 70 in said cylinder body, said control rod is restored again, engaged with the space 70 as shown in FIG. 4 and succeeds the supply of the compressed air to the joint opening 95. As

described hereinabove, the control knob **66** is stationary in the situation where the engaging ring **72** is in engagement with the space **70.**

Further, whatever the position of the movable cylinder body **71** in the cylinder body **68,** the rear slanting face **72***b* of the engaging ring **72** secured to the peripheral groove **67***b* of the control rod **67** acts so as to move the movable cylinder body **71** backwardly proportionate to the retreat of said control rod, so that the predetermined space **70** is maintained and said engaging ring comes into engagement with said space.

Said valve controlling mechanism is of a so-called two-knock system wherein the motor **1** is actuated by the primary pressure on the control knob **66** and is stopped by the second pressure.

When stopping the supply of the compressed air, the diameter of the engaging ring **72** secured to the peripheral groove **67***b* of the control rod **67** is narrowed by pressing the control knob **66** repeatedly and moving the same backwardly, said engaging ring is entered into the movable cylinder body **71** as shown in FIG. **5,** the valve body **65** being thrust into the valve chamber **91** by the rear end **67***a* of said control rod, the opening **61** being once closed. The compressed air is still supplied to the valve chamber **91,** thereby acting on the rear flange **62** of said valve body and also advancing said valve body. Therefore, the control rod **67** in contact with said valve body is also advanced. At this moment, the engaging ring **72** thrust in the movable cylinder body advances together with said control rod accompanying said movable cylinder body, then said engaging ring **72** separated from said movable cylinder body as shown in FIG. **6** is restored in the cylinder body **68.** When said engaging ring **72** is engaged in the engaging groove **69** of said cylinder body as shown in FIG. **2,** said control rod stops. At this time, the sealing ring **63** of the valve body **65** is seated at the rear peripheral edge of the opening **61** and the connection of the valve chamber **91** and the joint opening **94** supplying the compressed air to the motor **1** is intercepted.

The pressing of the control knob **66** is sufficiently performed by lightly pressing with a forefinger while holding one side of the dented waist **83** of the skirt **81** with a thumb and the outer side thereof with three fingers when holding the handle **8** in a hand.

Prior sanders of the lever or knock type require pressure to be maintained with the fingers, thereby bringing about fatigue to the operator. In addition, in a sander of the circulating ring type, the valve closing or opening cannot be effected unless both hands are used.

On the contrary, the valve controlling mechanism of a sander in accordance with the present invention is of the so-called two-knock type wherein the control of opening or closing the valve body can be performed simply by pressing lightly the control knob **66** while holding the handle **8** of the sander and the start or stop operation can be easily effected at any time during the sanding operation. Further, the control knob **66** does not require maintained pressure by the fingers. Therefore, the fatigue on the operator is low and it is possible to perceive a delicate change of a surface to be sanded during the sanding operation at his hand or fingers.

The novel sander in accordance with the present invention is so comprised and brings about effects as mentioned hereinabove.

In particular, the motor of the present invention generates the continuous rotational vibration by circulating a circulating member in the circulator at a high speed employing compressed air, the diameter being variable according to a shape of a surface to be sanded, thereby suiting best the fine finishing sanding operation. Further, the sanding table is directly fixed to the undersurface of the motor, so that the rotational vibration generated by the motor can be contrived to the finishing operation as it is. Furthermore, the sanding table is such as to be capable of replacement. Therefore, said sanding table is replaceable by tables shaped to conform with shapes of surfaces to be sanded. In the conventional sander, it is impossible to use such a sanding table as shown in FIG. **14** in view of the structure of the motor even if the abovementioned replacement is possibly done physically and mechanically.

While the rotational vibration generated by the motor is transmitted to the sanding table without fail, said vibration is not transmitted to the handle through the supporting leg. Therefore, the fatigue of the operator after using the same for long hours is remarkably low as compared with prior sanders.

The handle is shaped so as to make it easy to hold by hand as well as large enough to be held in a hand of an adult as there is no resistant feeling perceived at the time of operation, nothing being different from the sanding pad for the sand paper or cloth. There has been no sander using the so-called two-knock control system heretofore wherein the valve control is performed while holding a handle, which is easy to handle and advantageous in decreasing the labour of the operation.

The entire structure thereof is simple, light and small as the motor itself has a simple construction. The sander in accordance with the present invention is remarkably efficient and practical and has various features not present in prior sanders, such as being suitable for not only the simple finishing sanding but also wet-ground sanding operations.

What is claimed is

1. A portable sander comprising:

a motor, said motor comprising a circulator, at least one circulating member in the circulator and a compressed air inlet to the circulator to admit compressed air for circulating said at least one circulating member in the circulator at a high speed to generate continuous rotational vibration by the centrifugal force of said at least one circulating member;

a sanding table for carrying an abrasive material, said sanding table being rigidly secured to the underside of said motor, and said sanding table including an elongated leg projecting from the undersurface thereof, said leg being made of hard rubber, and a shaped sanding body for carrying an abrasive material secured to said projecting leg, vibration being transmitted to said abrasive material substantially only in the lengthwise direction of said elongated leg;

a handle; and

at least one resilient support means resiliently mounting said handle to the upper side of said motor.

2. A sander as claimed in claim **1,** wherein each said support leg includes upper and lower portions, a pair of metal cores, said metal cores being respectively embedded in said upper and lower portions of the support leg, upper and lower end surfaces of the support leg comprising large face fixing portions, and wherein a concave track is provided on the handle and a concave

track is provided on the motor, said large face fixing portions being secured to respective concave tracks by fixing bolts engaging in the metal cores.

3. A sander as claimed in claim 1, wherein the handle comprises a skirt, said skirt having two sides, said sides being indented so as to form a waist adapted for gripping by a hand, and an upper cover portion having a smooth and curved upper surface, said upper cover portion having a front portion, one end of said front portion being cut out; said sander further comprising a valve controlling mechanism for controlling the compressed air and a movable control member for the valve controlling mechanism, said valve controlling mechanism being mounted in the handle and said movable control member being accessible at the cut out portion of said handle.

4. A portable sander comprising:

a motor, said motor comprising a circulator having a compressed air supply column at the central portion thereof, at least one circulating member in the circulator, said circulating member being of annular form and encircling said air supply column, and a compressed air inlet to the circulator to admit compressed air for circulating said at least one circulating member in the circulator at a high speed to generate continuous rotational vibration by the centrifugal force of said at least one circulating member;

a sanding table for carrying an abrasive material, said sanding table being rigidly secured to the underside of said motor;

a handle; and

at least one resilient support means resiliently mounting said handle to the upper side of said motor.

5. A sander as claimed in claim 4 wherein said sanding table includes an elongated leg projecting from the undersurface thereof, said leg being made of hard rubber, and a shaped sanding body for carrying an abrasive material secured to said projecting leg, vibration being transmitted to said abrasive material substantially only in the lengthwise direction of said elongated leg.

6. A sander as claimed in claim 4, wherein a groove is formed in an outer circumferential surface of the circulating member.

7. A sander as claimed in claim 4, wherein a groove is formed in an inner circumferential surface of said circulator.

8. A sander as claimed in claim 4, wherein said compressed air supply column is hollow and forms a supply passage for compressed air, and further comprising a vane plate, said vane plate being mounted at least partly within said column, said vane plate having an air guiding formation at one side thereof and said vane plate being freely radially movable relative to said column.

9. A portable sander comprising:

a motor, said motor comprising a circulator having a compressed air supply column forming a supply passage for compressed air, a vane plate, the vane plate being mounted in a cut-out portion formed in said column, the vane plate being freely radially movable in said cutout portion, an air port formed at one side of said cutout portion, a first annular circulating member with an inner diameter greater than the outer diameter of said column, said first annular circulating member freely rotatably encircling said column, and a second annular circulating member with an inner diameter greater than the outer diameter of the first annular circulating member, said second annular circulating member freely rotatably encircling said first annular circulating member and a compressed air inlet to the circulator supply passage to admit compressed air for circulating said circulating members in the circulator at a high speed to generate continuous rotational vibration by the centrifugal force of said circulating members;

a sanding table for carrying an abrasive material, said sanding table being rigidly secured to the underside of said motor;

a handle; and

at least one resilient support means resiliently mounting said handle to the upper side of said motor.

10. A portable sander comprising:

a motor, said motor comprising a circulator, at least one circulating member in the circulator and a compressed air inlet to the circulator to admit compressed air for circulating said at least one circulating member in the circulator at a high speed to generate continuous rotational vibration by the centrifugal force of said at least one circulating member;

a sanding table for carrying an abrasive material, said sanding table being rigidly secured to the underside of said motor;

a handle having a skirt;

at least one resilient support means resiliently mounting said handle to the upper side of said motor; and

a two-knock type valve controlling mechanism including a movable valve body for selectively controlling the amount of compressed air fed to the motor; a controlling rod coupled to the movable valve body and being freely slidably suspended and enclosed in a fixed cylinder body on the upper surface of the skirt of the handle; an engaging groove peripherally provided at the front portion of the inner surface of said fixed cylinder body; a movable cylinder body being freely and axially slidably enclosed within the rear portion of said fixed cylinder body, said controlling rod being slidably mounted in said fixed cylinder body and in said movable cylinder body; and an engaging ring made of an elastic material provided in a peripheral groove at one end of said controlling rod, such that when said engaging ring is in engagement with the engaging groove of said fixed cylinder body the air supply to said motor is off, and when said engaging ring is in engagement with a space formed between the end of said movable cylinder body and said fixed cylinder body the valve body is moved to open the valve and the compressed air is fed to said motor, and when said controlling rod is actuated to move said engaging ring out of said space and interior of said movable cylinder body, said valve body is caused to move to close the valve.

11. A sander as claimed in claim 1, wherein said controlling rod is axially aligned with said movable valve body and abuts against one end thereof.

12. A sander as claimed in claim 11, wherein the compressed air fed to the sander applies a bias tending to move said movable valve body to the closed position and thereby tending to move said controlling rod forwardly to the position wherein said engaging ring engages the engaging groove of the fixed cylinder body.

13. A sander as claimed in claim 10, wherein said valve controlling mechanism includes a control knob mounted to said handle and coupled to the end of said controlling rod remote from said movable valve body, said control knob being operable with only one hand of the operator of the sander.

14. A sander as claimed in claim 1, wherein said elongated projecting leg extends along substantially the whole length of one portion of said sanding table.

15. A sander as claimed in claim 1, wherein said sanding table is non-resiliently and directly secured to the underside of said motor.

16. A portable sander comprising:

a motor, said motor comprising a circulator, at least one circulating member in the circulator and a compressed air inlet to the circulator to admit compressed air for circulating said at least one circulating member in the circulator at a high speed to generate continuous rotational vibration by the centrifugal force of said at least one circulating member;

a sanding table for carrying an abrasive material, said sanding table being rigidly secured to the underside of said motor;

a handle; and

at least one resilient waisted support leg resiliently mounting said handle to the upper side of said motor, each waisted support leg including upper and lower portions, a pair of metal cores, said metal cores being respectively embedded in said upper and lower portions of the support leg, upper and lower end surfaces of the support leg comprising large face fixing portions, and wherein a concave track is provided on the handle and a concave track is provided on the motor, said large face fixing portions being secured to respective concave tracks by fixing bolts engaging in the metal cores.

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