Dec. 27, 1927. 1,654,186

M. E. NULSEN

SUCTION SWEEPER

Filed June 6, 1921 2 Sheets-Sheet 1

Fig. 1.

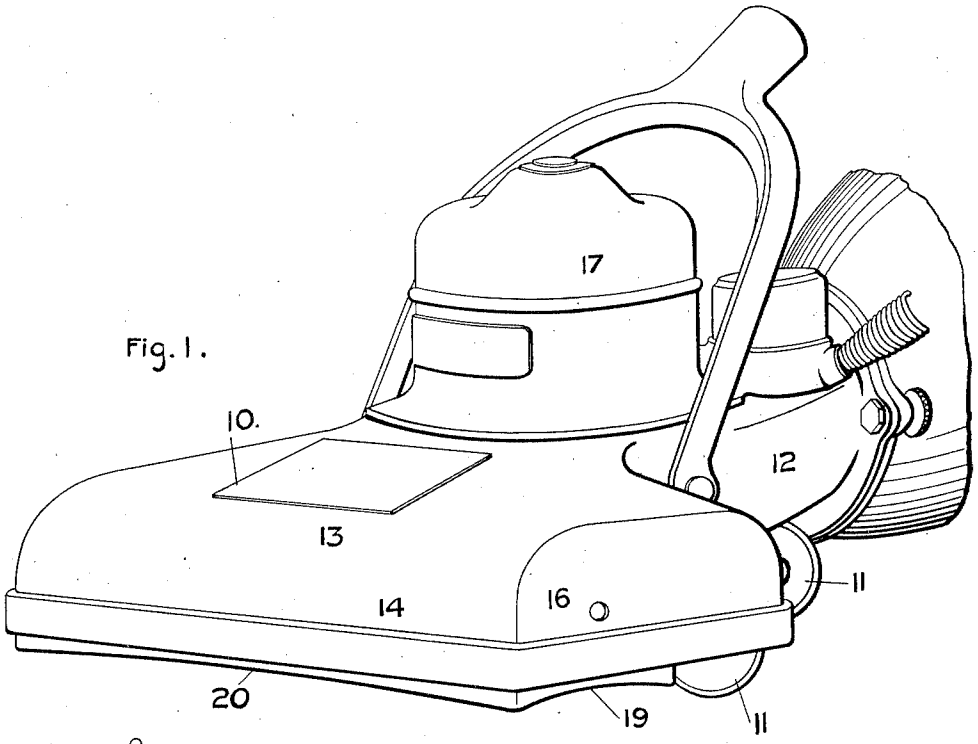


Fig. 2.

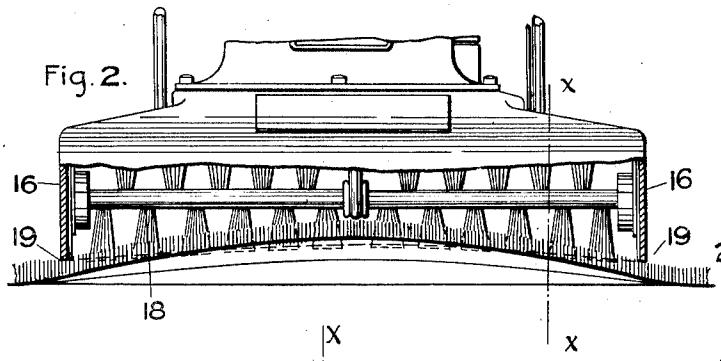


Fig. 3.

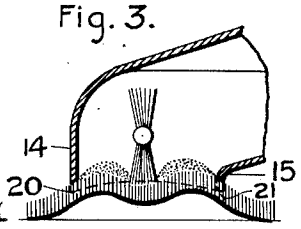
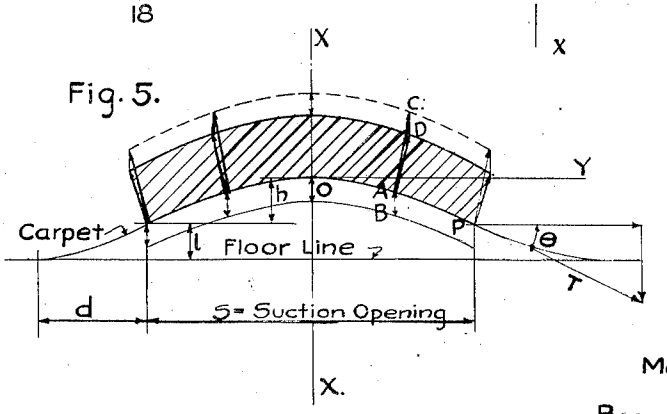


Fig. 5.



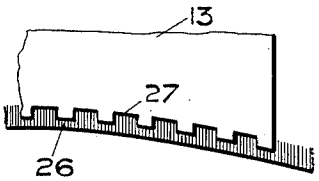


Fig. 4.

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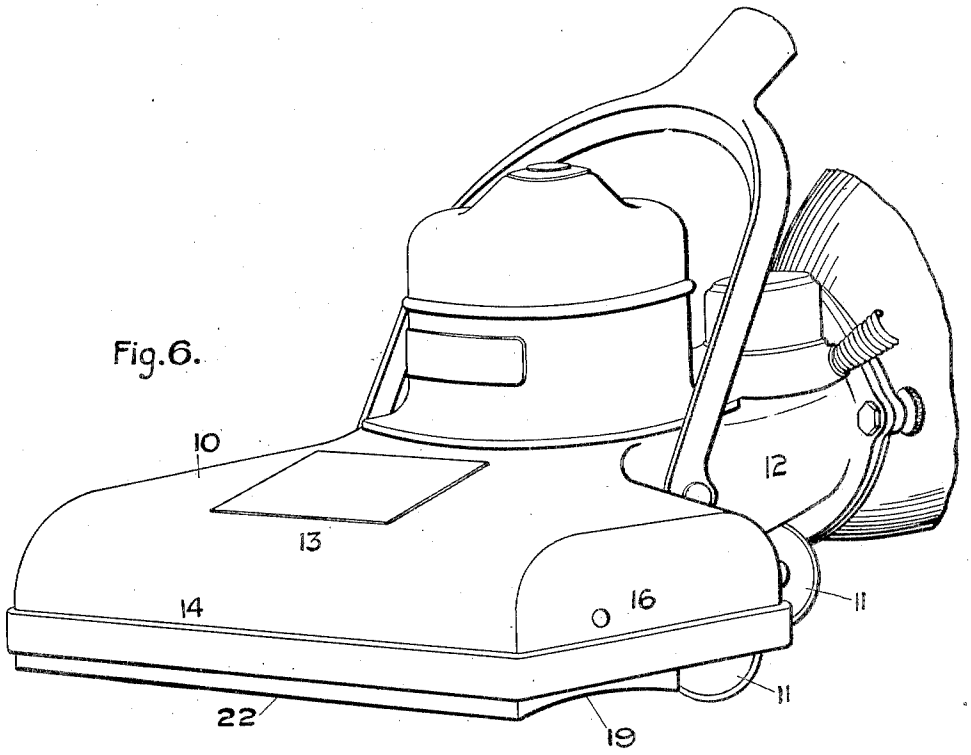
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M. E. NULSEN

SUCTION SWEEPER

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Fig.6.



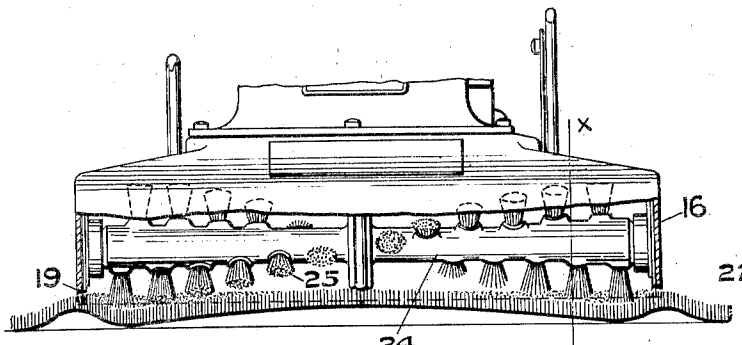


Fig.7.

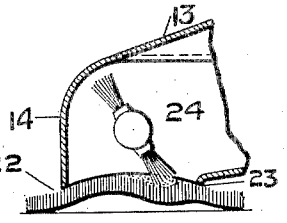


Fig.8.

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Patented Dec. 27, 1927. 1,654,186

UNITED STATES PATENT OFFICE.

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SUCTION SWEEPER.

Application filed June 6, 1921. Serial No. 475,183.

This invention relates in general to suction-cleaners and in particular, although not necessarily, to that type of cleaner illustrated and disclosed in the Letters Patent No. 1,147,307 granted to F. M. Case, reissued as No. 14,383, October 23, 1917.

In suction-cleaners, and particularly in the type mentioned above, where the suction-nozzle is situated at a substantial distance from the floor, the floor covering is raised to the nozzle and held thereagainst by atmospheric pressure, the pressure within the nozzle being reduced by any suitable means, for example, a centrifugal pump. Floor covering under such conditions assumes a wave-like formation beneath the cleaner nozzle and this wave travels along the floor covering with the cleaner as it is moved about.

In order for such a machine to perform most efficiently it is necessary that a substantially-complete seal at all points along the lips of the nozzle and the floor covering be secured. It has been noted where the suction nozzle lips are parallel to the floor that the floor covering at times it not drawn up against the ends of the nozzle, a condition which permits an undesirable rush of air into the nozzle that lowers the difference in pressure between the interior of the machine and the outside. Furthermore, where a rotating brush is mounted in the suction nozzle, the ends of the brush are prevented from functioning by being kept out of contact with the carpet.

An object of this invention is to overcome such difficulties by providing a suction cleaner nozzle with lips so shaped as to more or less conform with the shape assumed by the floor covering under working conditions and to insure a uniform contact pressure between the floor covering and the nozzle lips.

Another object is to provide a rotating beating and sweeping brush capable of cooperating with a suction nozzle in an efficient manner.

With these and other objects in mind, which will appear from a study of the following detailed description and in particular from the claims appended thereto, I have shown and embodied my invention in the constructions illustrated in the attached drawings, in which—

Figure 1 is a perspective view of a suction-cleaner provided with a nozzle formed according to my invention;

Figure 2 is a front elevation of the same partly in section;

Figure 3 is a cross-sectional view taken on line x—x of Figure 2;

Figure 4 is a detail view showing a modified form of nozzle lip;

Figure 5 is a force diagram illustrating the derivation of the lip curvature;

Figure 6 is a perspective view of a suction cleaner illustrating a modified embodiment of my invention;

Figure 7 is a front elevation shown partly in section; and

Figure 8 is a cross-sectional view taken on line x—x of Figure 7.

In order to present my invention, I have embodied it in a suction-cleaner comprising a casing 10 supported by floor-wheels 11. In the casing are formed a fan-chamber 12 and a suction nozzle 13 having front and rear walls 14 and 15 respectively and end walls 16. Mounted on the casing is a motor 17 adapted to drive a centrifugal fan enclosed in the fan casing and also a rotatable brush 18 mounted in the end walls of the suction-nozzle. The centrifugal fan is not illustrated, as it forms no part of my invention.

The edges of the nozzle walls which contact with the floor carpeting or other covering, I have termed "lips", and, in order to overcome the undesirable features mentioned above, I have, in the embodiment of my invention illustrated in Figures 1, 2, and 3, curved each of the four lips of the suction-nozzle in such manner as to conform to the natural curvature of the carpet when lifted from the floor by suction. In order to more

clearly show this condition, I have illustrated it in Figure 2 in an exaggerated form. In practice, the curvature will be very much less and will depend directly upon the height of the carpet lift at the corners of the nozzle mouth.

In order to present a surface parallel to the pile surface of the carpet, the surfaces of the nozzle lips have been beveled off as shown in Figures 2 and 3, that is, the surfaces of the end lips 19 are curved transversely so that they form a continuation of the longitudinal curvature of the front and rear lips 20 and 21 respectively, and in a similar manner, the surfaces of the front and rear lips are curved transversely to form a continuation of the curvature of the end lips. This transverse curvature of the lips prevents the edges from digging down into the pile of the carpet which would tend to cut off the transverse flow of air through and around the pile threads as well as have a destructive effect on the same. The curvature of the suction lips described in the foregoing is comparatively small, and, therefore, the force required to bend the carpet into the curve is quite small compared to the tension in the carpet. The direction and relative magnitudes of the forces acting on the carpet are indicated in the diagram designated as Figure 5 of the drawings, in which—

Vector A B = weight of a unit area of carpet.

Vector A C = unbalanced air pressure (suction) acting on a unit area of carpet.

Vector C D = Vector A B.

Vector A D = resultant of suction and weight per unit area.

Then for zero contact pressure between lip and carpet pile, the shaded area, of which A D is an element, represents the force which is balanced by the tension T in the carpet, and for a positive contact pressure between lip and carpet pile, vectors A D and the height of the shaded area will be shortened, and h, l, d, Θ, and T will be lessened. But the shortened (in height) shaded area will still represent the force which is balanced by the decreased T, and the decrease in shaded area will represent the contact pressure between lip and carpet. It is thus seen that the carpet curve is in effect practically that of a suspended cable of uniform weight; the decreased (in height) shaded area represents the uniform cable weight, and the decreased T represents the cable tension. The curve taken by a suspended cable is the catenary, and for the flat arcs under discussion, the catenary closely resembles the parabola.

A simple way to determine the equation of this curve is to measure experimentally the angle Θ which is the angle made with the horizontal by the tangent at the point of contact with the lip. Then, taking the equation of the parabola when the origin is at the vertex, we have—

$$y^2 = 2ax \qquad (1)$$
$$y = \sqrt{2a}x^{\frac{1}{2}}$$

The slope at any point =

$$\tan \phi = \frac{dy}{dx} = \sqrt{2a}\,\frac{1}{2\sqrt{x}}$$

The slope at point P, where $x = h$, is

$$\tan \phi_p = \cot \Theta = \sqrt{2a}\,\frac{1}{2\sqrt{h}},$$

solving for $2a$.

$$2a = 4h \cot^2 \Theta \qquad (2)$$

but

$$\tan \Theta = \frac{2h}{1/2S} = \frac{4h}{S},$$

whence

$$4h = S \tan \Theta \qquad (3)$$

Substitute in (2) the value of $4h$ (3)

$$\therefore 2a = S \tan \Theta \cot^2 \Theta = S \cot \Theta \qquad (4)$$

Substituting in (1) the value of $2a$ (4)

$$y^2 = (S \cot \Theta)\, x \text{ or}$$

$$x = \frac{Y^2}{S \cot \Theta} = y^2 \frac{\tan \Theta}{S} \qquad (5)$$

The measured value of Θ and S for the particular suction opening in question, should be inserted in equation (5). Then the exact contour of the suction opening can easily be laid off with the aid of the resulting equation.

Under a suction nozzle of this construction a wave in the carpet is formed having a crest with its greatest height situated in the diametrical center of the nozzle. In order to properly beat and sweep a carpet under a nozzle of this sort, i. e., one having all four lips of the nozzle curved, it is desirable that the brush or beating device used have a conformation following that of the longitudinal curvature of the front and rear lips of the nozzle. Such a brush is illustrated in Figure 2.

In another embodiment of my invention, as illustrated by Figures 6, 7, and 8 of the drawings, I have shown a suction nozzle with the front and rear lips 22 and 23 respectively formed substantially straight and in which the end lips 19 are curved to conform to the wave formed in the carpet by the suction. In this modification, the front and rear lips would be curved transversely as shown in Fig. 8 with the same curvature as the end lips and no longitudinal curvature would be given to the front and rear lips. Under a suction nozzle of this construction a wave in the carpet is formed having a crest of substantially uniform height along its length within the confines of the nozzle. To co-operate with such a nozzle I,

therefore, prefer a beating and sweeping brush 24, such as is shown in Figure 7, in which all of the bristle bunches 25 are of uniform length.

In Figure 4 a modified form of nozzle lip is shown in which the surface of the lip 26 is provided with a series of indentations 27 cut in the surface thereof and substantially equally spaced from each other. By providing the nozzle lips with an interrupted surface of this sort in lieu of the uninterrupted surfaces as shown in the other figures, the majority of the pile on the carpet is not crushed down as the lips pass over the same. Furthermore, this construction provides a passageway for the blast of air created by the suction device which is transverse to the pile threads, a condition conducive to efficient cleaning.

I claim:

1. In a suction-cleaner, a suction-nozzle having the lips thereof curved arcuately in relation to a horizontal plane, and a rug contacting cleaning element operable within said nozzle and having a longitudinal peripheral curvature substantially corresponding with that of said lips.

2. In a suction-cleaner, a suction-nozzle having the lips thereof curved arcuately in relation to a horizontal plane, and a rotary-brush journaled within said nozzle and having a longitudinal peripheral curvature substantially corresponding with that of said lips.

3. In a suction-cleaner, a suction-nozzle having arcuately-curved lips, and a rotary cleaning element located within said nozzle and having a longitudinal peripheral curvature approximating that of said lips.

4. In a suction-cleaner, a suction-nozzle having the lips thereof formed with their opposite end portions upwardly and inwardly inclined to form a seal with the suction-elevated portion or bulge of an underlying floor-covering, and a sweeping element operable within said nozzle and shaped to conform throughout to the nozzle-sealing portion of the bulge of said floor-covering.

5. In a suction sweeper having a suction producing means and a downwardly opening inlet nozzle, side and end walls having lips defining the nozzle opening, means sustaining the nozzle opening in spaced relation to a material to be cleaned, the sustaining means positioned to allow the material to be freely raised to the nozzle opening, the end nozzle defining lips being upwardly curved from their ends toward their centers.

6. In a suction sweeper having suction producing means and a downwardly opening inlet nozzle, side and end walls having lips defining the nozzle opening, means sustaining the nozzle opening in spaced relation to a material to be cleaned, the sustaining means positioned to allow the material to be freely raised to the nozzle opening, the front and back nozzle defining lips being upwardly curved from their ends toward their centers.

7. A suction sweeper having suction producing means and a downwardly opening inlet nozzle, side and end walls having lips defining the nozzle opening, means sustaining the nozzle opening in spaced relation to the material to be cleaned, the sustaining means positioned to allow the material to be freely raised to the nozzle opening, each of the nozzle defining lips being upwardly curved from its ends toward its center.

Signed at North Canton, in the county of Stark and State of Ohio, this 27th day of May, A. D. 1921.

MARVIN E. NULSEN.