Sonic Skin Cleaner

This invention provides a device and a method for skin cleaning using sonic energy coupled to the skin with a liquid filled cleaning chamber. Rather than immersing the skin in the chamber, the cleaning chamber has an opening therein which fits against the skin. A cleaning liquid, such as water or a solution of water and cleaning agents, fills and circulates through the cleaning chamber. A sonic transducer is vibrationally coupled with liquid in the cleaning chamber to transfer sonic vibrations to being cleaning liquid therein. The opening in the cleaning chamber is preferably lined with a seal, such as a rubber or elastomeric seal, to keep the cleaning liquid in the chamber. Alternatively, the cleaning chamber can be made of a resilient material. The sonic transducer operates at a frequency between 200 and 1,000,000 Hz. In a preferred embodiment, the frequency of the transducer is substantially resonant with the frequency of the liquid filled chamber.
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SONIC SKIN CLEANER

FIELD OF THE INVENTION

This invention relates to apparatus and method for skin cleaning using a cleaning reservoir filled with a cleaning liquid and having a sonic transducer therein, the reservoir having an inlet and an outlet for cleaning liquid whereby the cleaning liquid circulates through the reservoir.

BACKGROUND OF THE INVENTION

Skin cleansing is of primary importance in the prevention and treatment of acne. It is also an element of personal hygiene, especially for the removal of cosmetics. Skin cleansing is also required for first aid and treatment of medical conditions such as cuts, scrapes and infections. A number of skin cleaning devices have been described employing a suction cup placed against the skin (U.S. Patent Nos 2,631,583 and 5,295,982). The suction can be supplemented by alternately spraying water or a cleaning solution on the skin (U.S.P.N.s 2,612,892 and 4,900,316), by the application of steam (U.S.P.N. 4,292,971) or with a brush (U.S.P.N.s 4,378,804 and 5,484,427). Although a number of these devices employ a cup placed against the skin, the cup is used for vacuum suction or as a splash guard, and in none of these devices is the cup filled with a cleaning liquid.

Ultrasonic cleaning is widely used for cleaning objects ranging from engine parts to jewelry to wounds. Generally an ultrasonic transducer is mounted on a fluid container and the object to be clean is immersed in the fluid. For cleaning skin, an ultrasonic transducer has been mounted on a bathtub (U.S.P.N. 5,339,804). Since this requires immersion in the tub, it can be inconvenient for cleaning, especially routine facial cleaning.

In lieu of immersion, ultrasonic vibrations can be transferred to an object by direct contact between the object and a vibrator such as a toothbrush (U.S.P.N.s 5,189,751 and 5,378,153) or surgical probe (U.S.P.N. 4,609,368). A liquid stream can be used to couple ultrasonic energy between the object to be cleaned and the vibrator (U.S.P.N. 4,982,730). This can be a messy process as there is no integral provision for removal of spent cleaning liquid.

Additionally, this cannot exploit cavity resonance for amplification of the ultrasonic energy. Ultrasonic energy has been used to administer a drug to the skin (U.S.P.N. 5,582,586). The drug is contained in a container adhered to the skin, but not in a circulating solution.
None of these devices provides convenient and effective skin cleaning using a chamber filled with circulating liquid both to couple ultrasonic energy to the skin and to assist in the cleaning.

SUMMARY OF THE INVENTION

This invention provides a device and a method for skin cleaning using sonic energy coupled to the skin with a liquid filled cleaning chamber. Rather than immersing the skin in the chamber, the cleaning chamber has an opening therein which fits against the skin. A cleaning liquid, such as water or a solution of water and cleaning agents, fills and circulates through the cleaning chamber. A sonic transducer is vibrationally coupled with liquid in the cleaning chamber to transfer sonic vibrations to be cleaning liquid therein.

The opening in the cleaning chamber is preferably lined with a seal, such as a rubber or elastomeric seal, to keep the cleaning liquid in the chamber. Alternatively, the cleaning chamber can be made of a resilient material. Preferably the cleaning liquid inlet is toward the bottom of the cleaning chamber and the outlet is toward the top to facilitate filling the chamber with liquid during operation. The liquid outlet can be equipped with an antisiphon device to prevent draining of the cleaning chamber during operation.

The sonic transducer operates at a frequency between 200 and 1,000,000 Hz. More preferably it operates between 300 and 20,000 Hz. The transducer can be, for example, a piezoelectric or electromagnetic transducer. The transducer is preferably separated from liquid in the cleaning chamber by a diaphragm. In a preferred embodiment, the frequency of the transducer is substantially resonant with the frequency of the liquid filled chamber.

In a preferred embodiment the device consists of two parts, a base unit and a hand unit. The hand unit comprises the cleaning chamber, the sonic transducer, a cleaning liquid inlet and a cleaning liquid outlet. The base unit comprises a tank for holding a cleaning solution, a metering pump for delivering the cleaning liquid at a controlled rate and electronics for energizing the transducer.
BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an ultrasonic cleaning device.

FIG. 2 is the hand unit of an ultrasonic cleaning device.

FIG. 3 is a cross section of a hand unit of an ultrasonic cleaning device in use.

DETAILED DESCRIPTION OF THE INVENTION

The cleaning device of this invention is illustrated in FIG. 1. It comprises a hand unit and a base unit. The hand unit comprises cleaning chamber 10 and cleaning head 11 mounted on handle 15. Cleaning liquid from reservoir 38 flows to metering pump 36 which delivers it to the cleaning chamber via conduit 30. The spent liquid drains through conduit 32. A sonic transducer (not shown) is vibrationally coupled to liquid in the cleaning chamber. Transducer electronics 25 power the transducer via cable 24. Switch 23 on the handle can be used to circulate the cleaning solution and to activate the transducer. Electronics 26 operate the transducer electronics and the metering pump.

To facilitate cleaning and storage, the hand unit is preferably separable from the base unit. The hand unit separated from the base unit is shown in FIG. 2. Liquid conduit connectors 31 and 33 mate with conduits 30 and 32, respectively. The spent solution conduit and connectors are designed for easy cleaning to prevent clogging and bacterial growth therein. Electrical connector 27 mates with cable 24.

Figure 3 shows a cross-section of cleaning head 11 in use on human face 1 having facial pores 2. The opening of cleaning chamber 10 fits against the skin. The cleaning chamber is filled with cleaning liquid during use, which provides optimal cleaning efficiency. To prevent leakage of the cleaning liquid, the cleaning chamber can be made of a resilient material such as rubber or an elastomer. Alternatively, a seal (not shown) can be positioned on the rim of the opening of the cleaning chamber. The size of the cleaning chamber is designed to fit the application. For cleaning human facial skin, it is small enough to be moved around facial contours without losing cleaning liquid. Optional antisiphon device 35
can be used to prevent draining of the cleaning liquid from the cleaning chamber. The antisiphon device can be, for example, a spring loaded valve venting to air.

Sonic transducer 20 is vibrationally coupled to the cleaning chamber. Although the transducer is described as coupled to the cleaning chamber, for operation the transducer is coupled to cleaning liquid in the cleaning chamber. The coupling to the chamber is accomplished via the link between the transducer and the liquid. The electrical connection to the transducer is not shown. Air pocket 22 allows the transducer to vibrate freely and prevents coupling of vibrations to the rest of the cleaning head. Diaphragm 21 separates the transducer from the cleaning liquid. In a preferred embodiment, in order to amplify cleaning energy, the frequency of the transducer is resonant with the natural frequency of the cleaning chamber. The natural frequency of the cleaning chamber is a function of the chamber size and geometry, the properties of the cleaning liquid and the properties of the diaphragm. The diaphragm can be selected to tune the natural frequency of the liquid filled chamber to substantially match the transducer frequency. The criterion for substantially matching the frequencies of the transducer and the cleaning chamber is that resonant enhancement of the transducer vibration be achieved. The operating frequency of the sonic transducer is preferably between 200 and 1,000,000 Hz, and more preferably between 300 and 20,000 Hz. Optional vibration isolation device 34 prevents propagation of sonic energy back to the metering pump.

To operate this device for facial cleaning, the user first fills the cleaning liquid tank with a cleaning liquid and picks up the hand unit and holds it vertical. The user turns on the switch to circulate the cleaning liquid until the cleaning liquid reaches the cleaning chamber. Thereupon, the user presses the cleaning chamber against his or her face and continues to circulate the cleaning liquid until the cleaning chamber fills with cleaning liquid. Once the chamber is filled with cleaning liquid, the user switches on the transducer to energized the cleaning liquid. The user moves the hand unit around the skin to clean all desired portions of the face. Energized cleaning liquid cleans facial debris, including oily residue, makeup, dust, or sebum from the surface of the skin as well as from within the facial pores. The sequence of operation can vary. For example, the cleaning chamber can be pressed against the face
before activating the pump. The cleaning liquid pump and the transducer can be simultaneously activated.

A partial embodiment of the cleaning device was constructed and tested. A vibrating toothbrush was used as a 300 Hz sonic transducer. The head of the toothbrush was inserted into a plastic container and the junction of the container and toothbrush handle was sealed. The container was filled with water. Unlike the full embodiment of the invention, the water was not circulated. To test the cleaning ability of the device, white paper was coated with lamp black. The filled container was placed upside down on the paper and the transducer was energized. The water turned black and the paper was markedly cleaner.

Preferred embodiments of the cleaning device and the method of use are illustrated herein. Numerous variations will be readily apparent to those skilled in the art. For example, the separation of the elements between the hand unit and the base unit can vary. The switch can be located in the basic unit or transducer electronics can be located in the hand unit. If the cleaning liquid is water, a cleaning liquid reservoir and pump are not necessary. The cleaning liquid input conduit can be connected directly to the water tap. In this embodiment, the entire cleaning device can be contained in the hand unit, and a base unit is not required. The device has been illustrated with a metering pump, but any means for conducting a cleaning liquid into the cleaning chamber can be used. For example, it can be a non-metering pump, the liquid can be injected into the chamber with a syringe, or the reservoir can be elevated and gravity feed can be employed. A pump can be a located on the drain line in lieu of the supply line to draw the cleaning liquid through the cleaning chamber. Any means can be used for conducting cleaning liquid out of the cleaning chamber, for example a pump, gravity or the force of the input liquid.

The sonic transducer can be separated from the cleaning chamber by a diaphragm, as illustrated, or it can be in direct contact with the cleaning liquid. As with the toothbrush, the transducer can be external to the cleaning chamber and can be attached to a vibrating element within the cleaning chamber. It can be positioned anywhere on the cleaning head as long as it is vibrationally coupled to liquid in the cleaning chamber. More than one transducer can be employed. The cleaning device can also include a heater located either on the cleaning
chamber itself or coupled with the cleaning liquid (and thereby the cleaning liquid inlet) to enhance cleaning. The cleaning device can also include a fixed or agitating brush for contacting the skin. In another embodiment, sonic cleaning with a liquid filled chamber and suction with an empty chamber can be alternatively applied. Suction can be applied with a suction pump, for example, a mechanical pump or an aspiration pump.

The cleaning chamber has been illustrated with a round cup shape. It can alternatively be contoured to fit a specific surface, for example to fit over the bridge of the nose. The hand unit can have interchangeable cleaning chambers to fit a variety of surfaces. The cleaning device can have more than one hand units connected to a single base unit. The cleaning device can be used on surfaces other than skin, especially slightly porous surfaces such as leather or stone.

These and other variations fall within the spirit and scope of this invention, as defined by the following claims.
CLAIMS

I claim:

1. A cleaning device comprising:

   a cleaning chamber having an opening shaped to fit against the surface of an object to be cleaned;

   a cleaning liquid inlet connected to said cleaning chamber;

   a spent liquid outlet connected to said cleaning chamber; and

   a sonic transducer vibrationally coupled to said cleaning chamber.

2. The cleaning device of claim 1 further including a seal positioned on said opening of said cleaning chamber.

3. The cleaning device of claim 2 wherein said seal is rubber or elastomeric.

4. The cleaning device of claim 1 wherein said cleaning chamber is made of a resilient material.

5. The cleaning device of claim 1 further comprising a handle connected to said cleaning chamber for hand holding said cleaning device.

6. The cleaning device of claim 5 further comprising a base unit fluidically and electrically connected to said cleaning chamber, said base unit comprising a cleaning liquid reservoir and a cleaning liquid pump in fluidic connection with said cleaning liquid inlet.

7. The cleaning device of claim 6 wherein said pump is a metering pump.
8. The cleaning device of claim 6 wherein said base unit further comprises transducer electronics electrically connected to said transducer.

9. The cleaning device of claim 1 wherein said cleaning chamber comprises a diaphragm and wherein said transducer abuts said diaphragm.

10. The cleaning device of claim 1 wherein said transducer is selected from the group consisting of piezoelectric and electromagnetic transducers.

11. The cleaning device of claim 1 wherein said transducer operates at a frequency between 200 and 1,000,000 Hz.

12. The cleaning device of claim 11 wherein said transducer operates at a frequency between 300 and 20,000 Hz.

13. The cleaning device of claim 1 wherein said cleaning chamber has a natural frequency when filled with cleaning liquid and wherein said transducer operates at a frequency substantially equal to said natural frequency.

14. The cleaning device of claim 1 further including an antisiphon device in fluid connection with said spent liquid outlet.

15. The cleaning device of claim 1 further comprising a heater thermally coupled with said cleaning chamber.

16. The cleaning device of claim 1 further comprising a heater thermally coupled with said cleaning liquid inlet.

17. The cleaning device of claim 1 further comprising a suction pump coupled with said cleaning chamber.
18. A method of skin cleaning using the cleaning device of claim 1, comprising the steps of:

   placing said cleaning chamber against the skin to be cleaned;

   filling said cleaning chamber with a cleaning liquid; and

   energizing said transducer.

19. The method of claim 18 further comprising the step of moving said cleaning chamber, while filled, across the skin.

20. A device for cleaning a surface comprising:

   a cleaning chamber;

   a means for conducting a cleaning liquid into said cleaning chamber;

   a means for simultaneously conducting cleaning liquid out of said cleaning chamber; and

   a means for sonically agitating cleaning liquid in said cleaning chamber.
FIG. 2