

March 28, 1944.

G. C. SCHAUFFLER ET AL

2,345,294

METHOD OF SCRUBBING

Filed Nov. 13, 1939

3 Sheets-Sheet 1

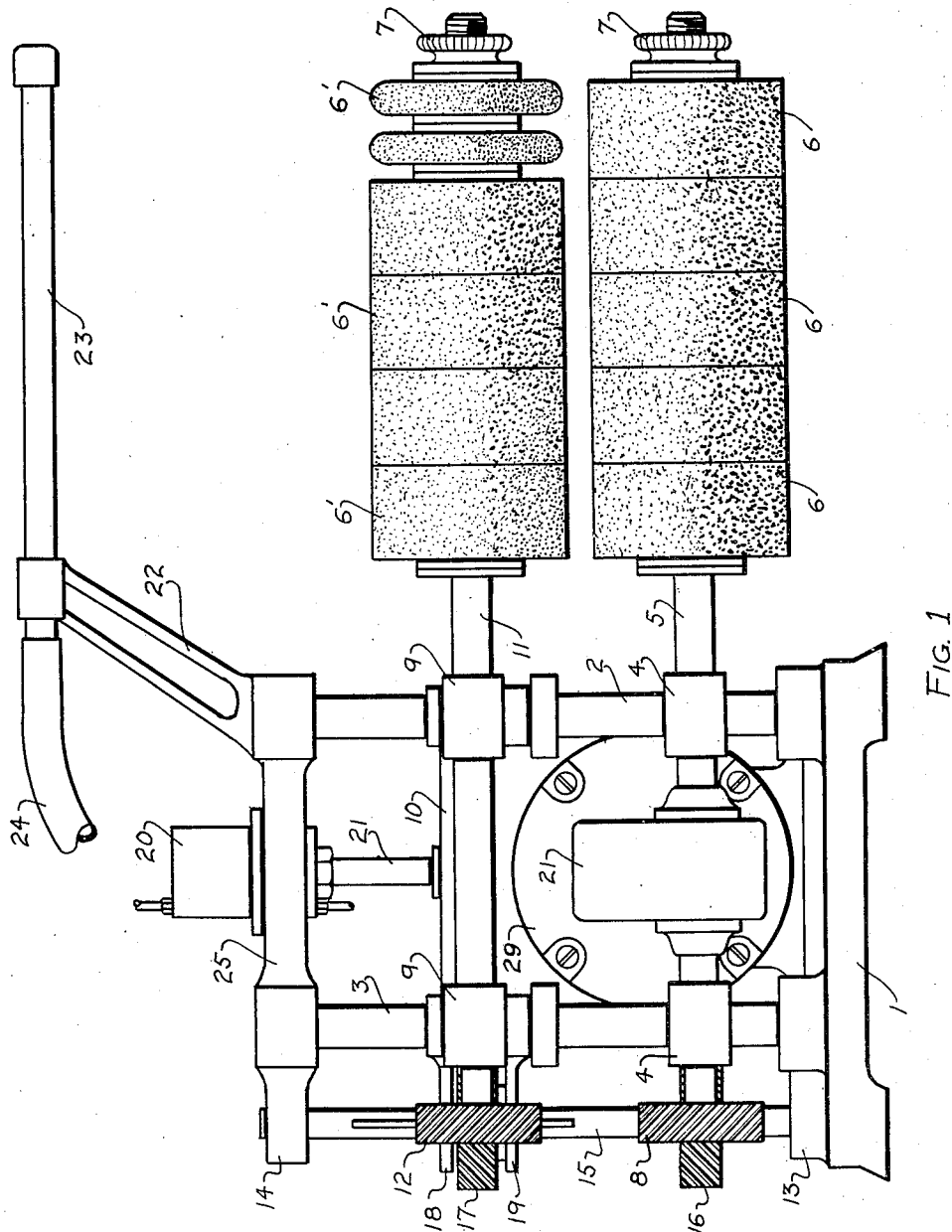


FIG. 1

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3 Sheets-Sheet 2

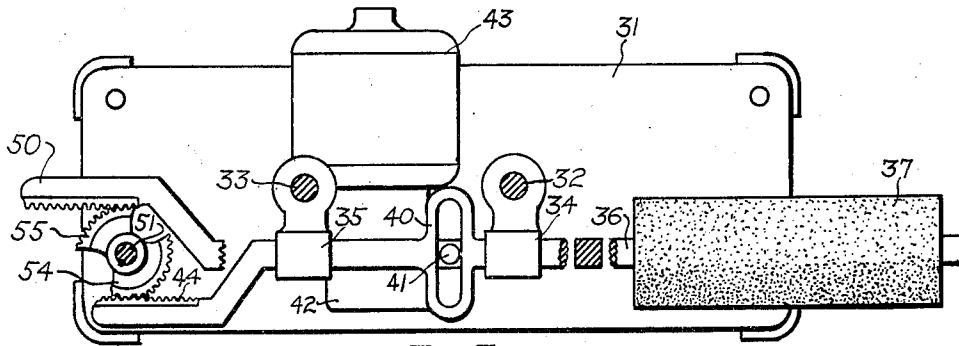


FIG. 5

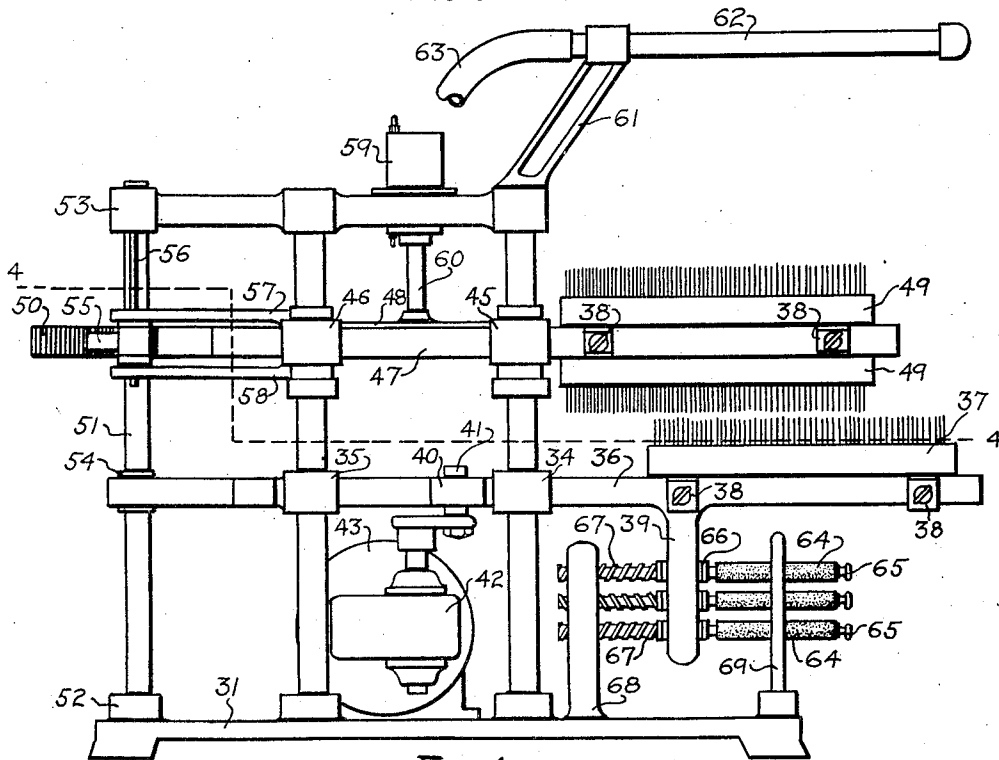


FIG. 4

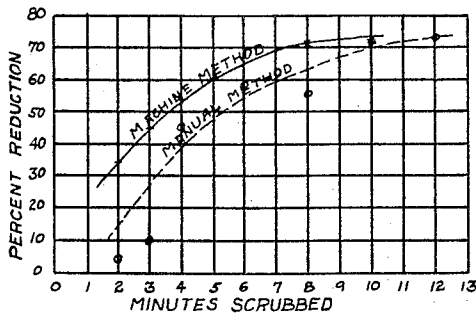


FIG. 7

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3 Sheets-Sheet 3

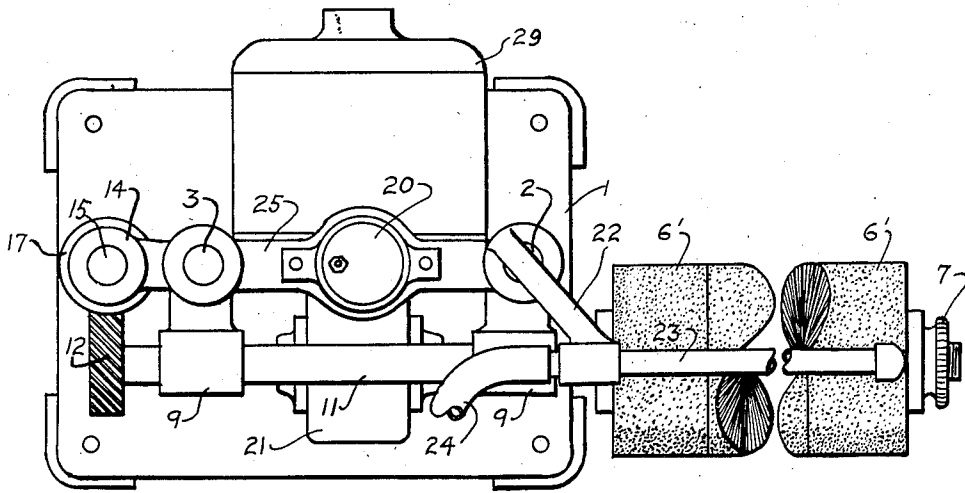


FIG. 2

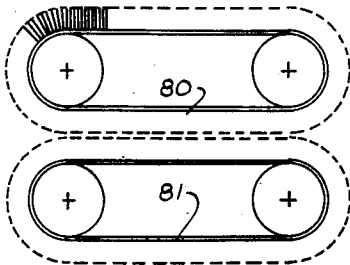


FIG. 6

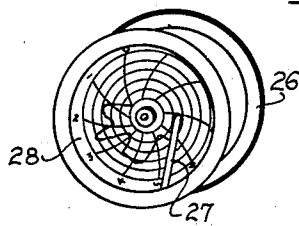
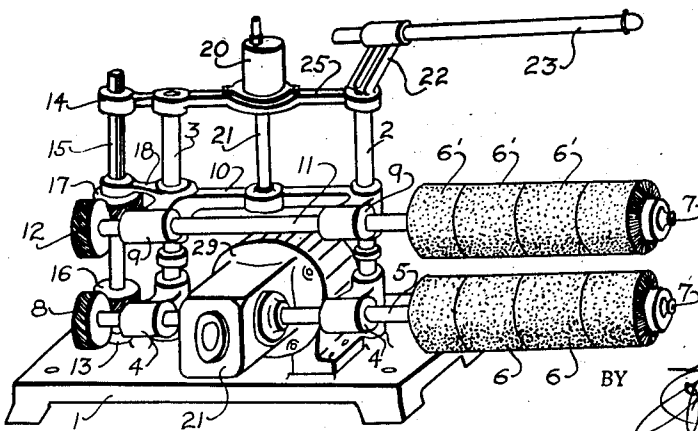


FIG. 3



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2,345,294

METHOD OF SCRUBBING

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Application November 13, 1939, Serial No. 304,034

6 Claims. (Cl. 134—6)

This invention relates to a method of cleansing or scrubbing, and has special reference to the washing of the hands and arms.

The invention is of special utility in hospital scrub rooms and bacteriological research laboratories, and has utility wherever there is a necessity to clean or sterilize the hands and arms, as in kitchens and other places where food products are handled or treated, and in machine shops and similar places where the hands and arms are particularly soiled.

The conventional practice in washing the hands, where the operation is to be done thoroughly, is to scrub them alternately, using one hand to scrub the other. In the case of surgeons it is generally necessary to cleanse the hands thoroughly by scrubbing at least once every day and, on occasion, many times a day. Accepted practice demands that this scrub be not less than seven nor more than ten minutes in duration, which process is time consuming, fatiguing, nerve wracking and often damaging to the hands. It is the custom to hold a brush in one hand and scrub as much of the surface of the back of the other hand as can be contacted at one time. Eventually the entire area of the back of the hand is covered. The hand is then turned and the palm scrubbed in the same manner. Interstices between the fingers are thereupon carefully scrubbed individually, then the under surface of each nail is carefully scrubbed. The wrists and each surface of the forearm are then scrubbed, a small portion at a time. When one hand and arm have thus been completely cleansed by scrubbing, the brush is shifted to the clean hand and the process is repeated on the other hand and arm.

No attempt is made to allot given time intervals to particular surface areas, and each operator carries out the procedure according to his own concept of effectiveness. For example, surgeons of long experience, as well as relatively inexperienced interns, scrub their hands without any definite or accepted standard of effectiveness. A muscular, nervous, high strung individual tends to scrub at high speed under great tension, moving rapidly, covering large surfaces with each stroke of the brush and using high pressure. Languid, lethargic individuals daub small areas of either hand with a disinterested and ineffective touch. As a result of this lack of uniform procedure, a uniform standard of cleanliness, or freedom from bacteria, is not ordinarily attained, and in many cases the amount of bacteria re-

maining on the hands is shocking when revealed by test.

The necessity of prolonged scrubbing by the conventional method just described is not established upon a scientific basis, although considerable fairly well controlled scientific research indicates that the ten minute period leaves some margin of safety for everyone. How much less than ten minutes might safely be used for scrubbing by the conventional method has not previously been established. A study of the lack of uniformity, and the many uncontrolled variable factors in the conventional method indicate why there is little or no dependable background of scientific research. The reason is that the lack of standardization of variables in the present scrubbing practice is so manifest that its use to establish scientific results is grossly unsatisfactory and unreliable. In other words, present methods are so unreliable that bacteriological studies based upon them must be considered unsound.

Analysis indicates that the important variable factors are: (a) speed of bristle movement; (b) pressure exerted upon the skin by the bristles; (c) extent of surface covered by each stroke; (d) scrubbing time. The gross irregularity of these factors in various individuals is at once obvious. Because of these many variables it is difficult to use the present method to evaluate itself to actually determine its own effectiveness.

The object in general, therefore, of the present invention is to provide a method whereby a better controlled and more uniform result than heretofore obtainable may be accomplished in washing and scrubbing the hands, through accurate control and standardization of the speed of the bristle movement, the pressure exerted upon the skin by the bristles, and the extent of the surface covered by the stroke.

Particular objects are: (1) to improve the final hand sterilization result; (2) to decrease the time and effort involved in obtaining the desired result; (3) to achieve uniformity of result in different individuals; (4) to indicate and record the amount of effort and thus the relative effectiveness of each individual scrub; (5) to establish a reliable means of studying methods of hand sterilization; and (6) to facilitate the preparation of standards whereby individuals may be catalogued as to relative contamination by dangerous hand bacteria.

The present invention not only facilitates clinical procedure, but also offers a means of standardizing methods of study and achieving accu-

rateness in the study of hand sterilization. Instead of wasting valuable nervous energy in actual scrubbing, standing and bending prior to entering the surgery, an operator using the machine of the present invention will be comfortably seated in a chair facing the scrubbing device. Above the machine is framed a simple, diagrammatic, illustrated instruction chart. On this chart the scrubber is shown successive positions of the hands and arms, and the precise amount of energy to be applied in each of those positions. Bristle pressure is registered indirectly in the form of applied energy on a recording dynamometer. A clock or special timing device, or the time indicator on the recording dynamometer, may be used to time each position. The operator accomplishes at complete ease, without any concentrated attention on this part, the following functions: Instead of one small surface of one hand, there is scrubbed simultaneously both surfaces of both hands. Instead of one interdigital space or one or two nail beds, there are scrubbed several, or all, at the same time, all being treated with a uniform bristle speed and pressure. Regardless of the operator's experience in scrubbing, and irrespective of his individual temperament, the scrubbing will be accomplished on all operators by a scientific, almost identical, process. The standard of cleanliness will be substantially the same for the experienced surgeon, the inexperienced interne, and the listless or conscienceless operator.

These and other advantages of the invention will become apparent to one skilled in the art as the disclosure proceeds in connection with the drawings, in which:

Figure 1 is an elevation view of a scrubbing machine embodying the principles of the present invention.

Figure 2 is a plan view of the machine shown in Figure 1.

Figure 3 is a perspective view of the machine of Figure 1, and includes a showing of one form of dynamometer device.

Figure 4 is an elevation view of a modified form of scrubbing machine.

Figure 5 is a sectional view taken on the line 4-4 of Figure 4.

Figure 6 illustrates a second modified form of the scrubbing members.

Figure 7 is a graph illustrating the relative effectiveness of machine and manual methods of scrubbing the hands to reduce the bacteria count thereof.

Figures 1, 2 and 3 illustrate a scrubbing machine employing revolving brushes. Upon a base 1 are supported the vertical columns 2 and 3. Fixedly secured to the lower portions of columns 2 and 3 are bearings 4, in which is journaled the lower shaft or mandrel 5. Keyed to the mandrel or shaft 5 are brushes such as illustrated at 5, 6, 6'. The brushes may be retained on the mandrel by means of a knurled nut 7. The opposite end of shaft 5 carries a spiral gear 8 keyed thereto. Slidably mounted on the vertical columns 2 and 3 above the fixed bearings 4 are bearings 9 joined by the web 10. The bearings 9 carry the upper shaft or mandrel 11, on which are mounted brushes 6', 6', 6' etc., in a manner similar to the brushes on the lower shaft. Likewise, the opposite end of shaft 11 carries spiral gear 12 keyed thereto. A bearing 13 on the base, and a bearing 14 supported and held in alignment by the columns 2 and 3 hold the shaft 15 for rotation. Fixed to the lower portion of said shaft 15, so as

to rotate therewith, is the spiral gear 16 in engagement with the spiral gear 8. Keyed to the shaft 15 and free for longitudinal movement thereon is the upper spiral gear 17 retained between fingers 18 and 19 on an extension of the web 10. An electric motor 29 secured to the base 1 furnishes the motive power, driving the shaft 5 through the reduction gear 21.

Means is provided for vertically adjusting the upper shaft 11 to vary the spacing between the opposed brushes 6 and 6'. Various means may be employed to provide this vertical adjustment, and other suitable means will occur to persons skilled in the art, but in the illustrated embodiment there is shown the cylinder 20, carried by the bridge 25, having therein a piston (not shown) and a piston rod 21 connected at its lower end to the web 10. Suitable fluid pressure means may be employed to operate the piston within the cylinder 20 in response to pedal movement or other convenient manipulating device.

Extending upwardly from the bridge 25 is the bracket 22 carrying a spray pipe 23 for dispensing water, soap solution, or other liquid conveyed by the tube 24. The pipe 23 may be provided with orifices in any suitable arrangement above the brushes 6 and 6'. Hot and cold water and a soap solution may be fed selectively into the single tube 24 under the control of foot or knee operated valves (not shown), or separate tubes may be provided. The water valves should provide an increased flow for rinsing the hands and brushes.

In the machine illustrated in Figure 1, the drive is such as to produce counter-clockwise rotation of both sets of brushes, 6 and 6', when viewed from the right hand ends of the shafts 5 and 11. It has been found desirable to make both sets of brushes revolve in the same direction so that the frictional forces tending to pull the hand or arm further into the brushes balance the other frictional forces, tending to thrust the hand or arm out from between the brushes. With the brushes rotating in the direction described, the upper brushes 6' will tend to pull the hand inwardly while the lower brushes 6 will tend to thrust the hand outwardly, thus relieving the operator of effort in holding his hand in the desired position, or of moving it from one position to another. In addition to having both sets of brushes rotate in the same direction, it is desirable that the upper brush rotate away from the operator on its under side. If the upper brush rotated toward the operator on its under side, the rotating bristles would snap water droplets onto the operator in an objectionable manner. With counterclockwise rotation the revolving bristles on the lower brushes will snap water droplets in the direction of the operator, but a shield may conveniently be arranged to protect the operator from water coming from the lower brush. Suitable means should be provided beneath the brushes to catch or carry away excess soap and water.

It may be found convenient to provide brushes of various shapes and contours for cleaning different parts of the hands and arms, as for instance, small, stiff brushes for cleaning around the finger nails, thin brushes for cleaning between the fingers, and perhaps specially grooved brushes to allow complete insertion of the hand and forearm. However, the arm may be inserted between the cylindrical brushes illustrated by appropriately raising the upper brush.

The speed of rotation should be sufficient to

keep the brushes saturated with water entirely around their peripheries, but insufficient to spin the water off by centrifugal force. Experimentation shows that at speeds above a certain minimum, the liquid will distribute itself annularly in a substantially uniform layer near the ends of the revolving bristles, and will not tend to collect at the bottom side of the brush, nor to drip therefrom. When the brush is revolving at the proper speed, the water and soap will be carried around with the brush until it contacts some foreign object such as the hand or arm to be washed. A portion of the liquid will thereupon be transferred from the revolving brush to the hand, or arm, and the water flow from spray pipe 23 should be adjusted to supply only the rate of flow desired for washing. When the hand or arm is not in contact with the revolving brush, the water will remain therein, unless the flow from pipe 23 is allowed to continue, causing an excess over the capacity of the brush. It is intended that a foot valve or the like be allowed to close, stopping the water flow from pipe 23, when the hands are removed from the brushes.

When the brushes are idling at the proper speed, the water will be retained as described, and if the rotational speed should be reduced, or the brushes stopped entirely, it will be noted that a considerable quantity of water will flow from the under sides thereof. Also, if the brush speed be increased, centrifugal force will overcome capillary attraction, and the water will spin off tangentially in all directions. Neither of these last mentioned conditions is desired for performing a satisfactory washing or scrubbing operation.

Proper control of speed prevents wasting of the soap, in that the brushes can be kept continuously saturated with soap and water by adding through the spray bar only the quantity required for use on the hands. The actual optimum speed for a given installation depends upon the above-discussed considerations, and it is held within the scope of this invention to vary the diameter of the brushes as desired, as well as to vary their form, in order to best satisfy the requirements of various scrubbing conditions.

In using the machine of Figure 1 the hands may be inserted flatwise between the brushes and the relative spacing of brushes 6 and 6' adjusted by means of fluid pressure in the cylinder 20 to give the desired scrubbing effect. As the hands or arms are progressively subjected to scrubbing action and the thicker parts of the forearms are inserted between brushes 6 and 6', greater spacing will be required to develop the same scrubbing action without undue abrasion to the skin. Cleansing of the finger nails and the adjacent surfaces of the fingers can be accomplished by appropriate technique with the particular kinds of brushes employed, the pressure against the brushes being controlled by the operator either by applying the fingers directly to one of the brushes alone, or by means of the cylinder 20, if the hands are between the two brushes 6 and 6', so as to obtain a satisfactory scrubbing operation.

To determine and measure the amount of work being done in the scrubbing operation, a dynamometer is provided. The dynamometer will indicate when the scrubbing is being conducted sufficiently vigorously and will also give readings which may be compared with a standard of satisfactory operation. The dynamometer may be of any type known in the art, and may be either an

electrical or a mechanical type. In conducting experimental work, the dynamometer, in addition to indicating continuously the work being done in the scrubbing operation, should also preferably make a graph or record of such work or energy output. These records would be especially valuable in bacteriological research in establishing definite basis of comparison of the cleanliness, or freedom from bacteria, of the hands, as a fundamental starting point for experiments.

In the preferred embodiment, an electrical dynamometer 26 of the recording type is connected into the electrical supply for the motor 20. The movable arm 27 responds to the power input for the motor 20, tracing a power curve on the graph 28, which revolves at a speed such that divisions thereon may be calibrated in minutes. Power may be indicated in any suitable units. The units of work expended in any scrubbing operation will then be represented by the area under the power curve, a datum line being established to represent the amount of power required to run the machine when no scrubbing is taking place.

The embodiment shown in Figures 4 and 5 employs reciprocating brushes and brushes having a spiral scrubbing movement, instead of rotary brushes. In Figures 4 and 5 the base 31 supports the two upright columns 32 and 33. The said columns carry thereon fixed bearings 34 and 35. Bar 36 is slidably supported in the bearings 34 and 35 for limited horizontal movement. Bar 36 carries on one extremity the removable brush 37 attached by wing nut or other suitable clamping means, as indicated at 38. Depending from the bar 36 is the projection 39 for purposes presently to be described. Between the bearings 34 and 35 the rod 36 is provided with an eye or Scotch yoke 40 to receive a crank 41 extending upwardly from the gear reduction box 42 on the motor 43. Motor 43 may conveniently be bolted to the base 31. Bar 36 carries at its other extremity the rack 44 offset in the manner shown.

The upright columns 32 and 33 also carry the slidable bearing blocks 45 and 46. Bar 47 is mounted for limited horizontal sliding movement in the bearing blocks 45 and 46, said bearing blocks being held in alignment by the integral web 48. Bar 47 carries a brush 49 at one extremity thereof detachably secured in any suitable manner, as is the lower brush just described. The upper brush 49 may be provided with bristles on both faces as illustrated, if desired, or may consist of two brushes, back to back. The contour of the bristles on either or both faces of the brush 49, as well as the bristles on the brush 37, may be either flat or curved as best suits the requirements of the objects to be scrubbed thereby. It is also within the scope of this invention to substitute for each of the brushes 37 and 49 a plurality of small brushes of a size readily obtainable at small cost, and the brush holding means should be adapted to receive either the small or the large brushes. Bar 47 terminates at the end opposite the brush in a rack 50 similar to the rack 44, but offset in the opposite direction.

A vertical shaft 51 is carried by lower and upper bearings 52 and 53, respectively, and carries the gear sector 54 fixed thereto. Gear sector 54 engages the rack 44 so that reciprocation of the bar 36 will oscillate the shaft 51. Slidably keyed on the upper part of the shaft 51, as by the key or spline 56, is the gear sector 55 retained between the fingers 57 and 58 extending from web 48. The fingers 57 and 58 are omitted from Figure 5.

for clearness. Gear sector 55 rotates with gear sector 54 to impart a reciprocating motion to bar 47 simultaneously with and in a direction opposite to the reciprocating motion of bar 36. To adjust the spacing between the brushes 37 and 49 the fluid cylinder 59 is provided, having a piston rod 60 operatively controlling the height of web 48 as described in the species shown in Figure 1.

A bracket 61 extends above the machine to support one or more pipes 62 which may be drilled to supply liquid from the hose 63 as in Figure 1.

In the embodiment shown in Figures 4 and 5 an additional set of brushes is provided having a spiral movement, these being particularly advantageous in scrubbing between the fingers. The spiral scrubbing brushes are shown at 64 and may be removable from their mandrels as were the brushes described in Figure 1. Knurled nuts 65 are illustrative of one means for retaining the brushes fixed on their respective mandrels. Brushes 64 are rotatably carried by bearings 66 in the depending projection 39 in such a manner that there is no axial or lengthwise movement of the brushes with respect to member 39. The shafts or mandrels for the brushes 64 extend through and beyond the bearings 66 and are provided on said extensions with spiral threads or grooves 67. An upstanding member 68 is rigidly secured to the base 31 and contains a threaded opening to cooperate with each threaded spiral 67. In this manner, reciprocation of the projection 39 on the bar 36 will impart a lengthwise reciprocating movement to the brushes 64 and at the same time cause them to oscillate so as to produce a spiral scrubbing or brushing motion. A removable guard 69 may be provided to steady the hand of the operator.

The machine illustrated in Figure 4 performs a scrubbing operation basically in the same manner as the machine in Figure 1, except that the scrubbing motion on the hands is imparted by reciprocating brushes instead of revolving brushes. The motor 43 operates through the reduction gear, crank, gear sectors and racks, illustrated and described, to move the brush 37 horizontally to the right as the brush 49 is simultaneously moved horizontally to the left, and vice versa. Freedom of access to the brushes 37 and 49 may be obtained either from the front or from the right of the machine as viewed in Figure 5. As in the case of the revolving brushes of Figure 1, the hands may be inserted between the opposed brushes, and the opposite surfaces scrubbed, thereupon advancing the hands to present the forearms on the various surfaces to the brushing action progressively. The spacing between the brushes 37 and 49 may be varied continually during the scrubbing operation by the fluid pressure cylinder 59 to maintain the desired application of pressure on the skin.

In Figure 4 the small brushes 64 are especially efficacious for cleaning between the fingers and for cleaning under the finger nails. As described, the reciprocating movement of the lower brush causes a combined reciprocating and oscillating movement of brushes 64. If the operator's hand is steadied against the guard 69 to hold the hand stationary, adjacent surfaces of the fingers inserted between the brushes will be subjected to a reversing spiral scrubbing action. While the brushes 64 are illustrated as being cylindrical, other shapes may be used if desired.

If desired, the main brushes 37 and 49 may be made to oscillate as they reciprocate, in the same manner as brushes 64, to give a spiral

scrubbing motion. Cylindrical brushes might then be used, similar to the brushes 6, 6' of Figure 1. Other types of scrubbing motions, and other types of scrubbing members may be used in carrying out the spirit of applicant's invention. For instance, the scrubbing members may be carried on juxtaposed endless belts, as illustrated at 80, 81, in Figure 6, or revolving discs, adjustably spaced so that a part of the body, such as a hand, may be scrubbed simultaneously on both sides. It is not necessary that the scrubbing members be bristle brushes as rubber projections may be substituted for animal bristles, or the scrubbing surfaces may be formed of sponge or crepe rubber, or other material suitable for producing the desired scrubbing action. In practice, the sterilization requirements will constitute a major consideration in the choice of suitable scrubbing members.

A dynamometer device may be applied to the machine of Figure 4 as described in connection with the revolving brush machine of Figure 1. It is desired to indicate and record the work performed in the brushing operation in the same manner as described in connection with the machine employing revolving brushes.

With either type of machine a routine laboratory procedure may be developed to establish a standard of cleanliness, or freedom from bacteria. This standard may be used not only as a guide for minimum scrubbing time for surgeons and interns about to enter the operating room, but is also of the greatest utility in forming a basis for statistical comparison in the performance of bacteriological research. The method of this invention will materially assist in reducing to a constant one of the annoying variables in hand sterilization for surgery.

For the purpose of obtaining a quantitative analysis, the following procedure was prescribed by and the work carried out under the direction of the University of Oregon Medical School, Department of Bacteriology.

(a) Scrub hands and forearms vigorously for one minute with sterile brush in sterile water and sterile basin using no soap.

(b) Scrub same areas immediately thereafter in prescribed method to be tested (i. e., manually for n minutes or with machine for n minutes).

(c) Repeat (a) for one minute with new sterile brush and water.

(d) Plate out samples of water from (a) and (c) in usual manner prescribed by bacteriological practice and count for organisms after forty-eight hours incubation.

(e) Using difference between count from (a) and (c) as numerator and count from (a) as denominator calculate reduction in percent. This result is referred to below as "Percent Reduction."

This quotient appears to represent the nearest possible approach to an index of scrubbing efficiency as it is not possible to actually count the bacterial flora on the hands at any given time, i. e., before or after scrubbing in accordance with the method to be tested. In this way the minimum of time required to reduce the bacteria count to a satisfactory figure may be determined, and a standard established. This procedure also serves as a basis of comparison for the various hand washing techniques of different individuals using the conventional scrubbing brush method, as a basis for comparison of the machine method versus the conventional method, and as a basis of comparison between various antiseptic solu-

tions and soaps used for hand sterilization. It is, of course, understood that the machine, including the brushes, must be sterilized before any scrubbing operation entering into a qualitative or quantitative analysis.

Under the supervision of the Department of Bacteriology of the University of Oregon Medical School 195 test hand scrubs were done in order to determine the relative efficiency of machine scrub versus hand scrub. The results have been compiled into the table given below:

Time scrubbed in minutes	Percent reduction	
	Manual method	Machine method
2.....	4	34
3.....	10	45
4.....	46	54
6.....	59	71
8.....	56	71
10.....	71	71
12.....	72	71

Whereas from a scientific point of view we do not contend that the obvious conclusions from these tests are absolute, we submit that they have been conducted in a scientific and impartial manner and that claims have been presented in a manner actually more conservative than the general indications. Considering the large number of tests conducted, it can be stated categorically that the improvement of the machine over the hand method is established. Further tests will be necessary to establish beyond question the degree of improvement.

It will be seen from the tabulation above, and from the curves in Figure 7, that the machine method of removing bacteria from the hands is consistently superior to the manual method, within the time limits tested. The advantage is of diminishing magnitude as the time increases, and would probably vanish at about twelve or thirteen minutes. The advantage of the machine method is very marked when the scrubbing time is brief, and would appear even more striking if the manual method curve had been made to pass through the two minute and three minute points. The flattening out of both curves as the time increases indicates that in ten or twelve minutes the greater part of the bacteria that can be removed have been removed. Therefore, if time is not considered, it cannot be contended that the machine does a more thorough job, but it is evident that in any given reasonable time the machine will do a better job, or, will attain a given result in less time.

The saving in time appears to average 33% of the manual time, varying from 42% at 30% reduction in bacteria count, to 28% at 70% reduction in bacteria count. This is demonstrated by the following tabulation prepared by taking values from the smooth curves of Figure 7:

Percent reduction	Minutes scrubbed			Percent of manual time saved
	Manual	Machine	Difference	
30.....	3.1	1.8	1.3	42
40.....	4.0	2.6	1.4	35
50.....	5.2	3.7	1.5	29
60.....	7.2	5.1	2.1	29
70.....	10.5	7.6	2.9	28
Average.....				33

An important conclusion to be drawn from Fig-

ure 7 is that the present machine method described herein appears to produce more uniform results than the conventional manual method. This is evident from the fact that a smooth curve is easily drawn through, or very near, all the points plotting machine results, whereas the curve for manual results is a compromise throughout most of its range. It is assumed that both curves should be smooth lines by the nature of the experiment, and that a curve that attempted to include all the points of the manual results would not be as near the truth as the curve drawn.

The advantages of this invention have been pointed out with particular reference to the requirements of surgeons and laboratory technicians, but they are present in varying degrees to other classes of persons who are required to vigorously and efficiently scrub their hands at frequent intervals, and it is to be understood that this invention is not limited to use in the surgery or laboratory, but that it may be used wherever a scrubbing operation is to be performed.

Having now described the principles and method of our invention and in what manner the same be used, what we claim as new and desire to protect by Letters Patent is:

1. The standardized method of cleansing a part of the human body which comprises applying a scrubbing action to said part and applying pressure to said part by said scrubbing action, continuously measuring the energy applied during said scrubbing action, varying said pressure to obtain a predetermined application of energy in said scrubbing action and continuing said action until said measurement indicates the expenditure of energy of a predetermined value.

2. The standardized method of cleansing a part of the human body which comprises subjecting said part to a scrubbing action, measuring the rate of expenditure of energy in said scrubbing action, continuing said action until said measurement indicates the expenditure of energy of a predetermined value, and simultaneously making a graphic record of said rate of expenditure of energy and also of the amount of work done in said scrubbing action.

3. The standardized method of cleansing a part of the body which comprises simultaneously applying a scrubbing action with pressure against opposite sides of said part, continuously measuring the total energy applied to said scrubbing action, varying said pressure to obtain a predetermined application of energy and continuing said action until said measurement indicates the expenditure of energy of a predetermined value.

4. The method of cleansing the hands and forearms which comprises subjecting said parts to the scrubbing action of complementary scrubbing means, pressing the said parts between said scrubbing means until the rate of energy expenditure due to frictional resistance between said means and said parts reaches a predetermined value, measuring the amount of energy expended in the scrubbing action, and continuing said action until said measurement indicates the expenditure of energy of a predetermined value.

5. The method of cleansing the hands and forearms which comprises providing a pair of complementary scrubbing elements, supplying cleansing material to said elements, inserting said parts between said elements, adjusting the pressure of said elements against said parts until the

rate of energy expenditure due to frictional resistance therebetween reaches a predetermined value, measuring the amount of energy expended in the scrubbing action, and continuing said action until said measurement indicates the expenditure of energy of a predetermined value.

6. The method of cleansing the hands and forearms which comprises providing a pair of rotatable brushes, supplying cleansing liquid to said brushes, rotating said brushes at a speed sufficient to keep the brushes saturated entirely around their peripheries but insufficient to spin the liquid

therefrom by centrifugal force, inserting the hands and forearms between said brushes, adjusting the pressure of said brushes against the hands and forearms until the rate of energy expenditure due to frictional resistance therebetween reaches a predetermined value, measuring the amount of energy expended in the scrubbing action, and continuing said action until said measurement indicates the expenditure of energy of a predetermined value.

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