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SOME NEW ASEPTIC APPARATUS.

By William P. Bolles, M.D.

There are two sets of apparatus described in this paper, one a sterilizer intended for private practice, and designed to secure such asepsis as water and steam at 100° centigrade will effect, and to combine the greatest possible convenience, compactness, and portability in its construction.

The other is a pouring or irrigating flask for sterile solutions, designed for use in hospitals, where absolute theoretical purity is required, and where an apparatus that shall be practically automatic is desirable.

To take them in order, the first is a portable steam and hot-water sterilizer for instruments, dressings, and linen, in which all the necessities for ordinary operations can be arranged and packed at home or in the office, carried easily so packed to the patient's house, and sterilized on the kitchen stove while the surgeon is preparing in other ways and etherizing the patient. Incidentally, it also furnishes all the sterile pans or dishes necessary for the operation, and obviates the necessity of borrowing from the patient's pantry or carrying a set of trays.

If filled, on entering the house, with a suitable quantity of boiling water and baking soda, the water will boil again in from three to five minutes, and at the end of the half hour that generally elapses before the patient is ready, its contents are as sterile as boiling water and steam can make them, the linen thoroughly steamed and dry, the instruments, sutures, etc., boiled in alkaline water and wet.

It consists, in general, of an outside kettle, with cover, within which is an inverted box or hood, just enough smaller than the other in all directions to leave a space of,

say, one centimetre on all sides and on the top for steam and water. Within this hood lie the trays for instruments and dressings, piled one on the other. Thus there are an outer and inner chamber; the inner surrounded by the outer, excepting on the bottom, where both are bounded by the boiling water. By this means the inner chamber is entirely protected from cooling and condensation.

The process of boiling rarefies and expels the air within the inner chamber, and forces it out beneath the hood. As steam is formed it takes its place, and the excess is also forced out in the same way underneath the edge of the hood. The water inside is, of course, pressed down to the level of its escape, and rises in the outer chamber to near the top of the

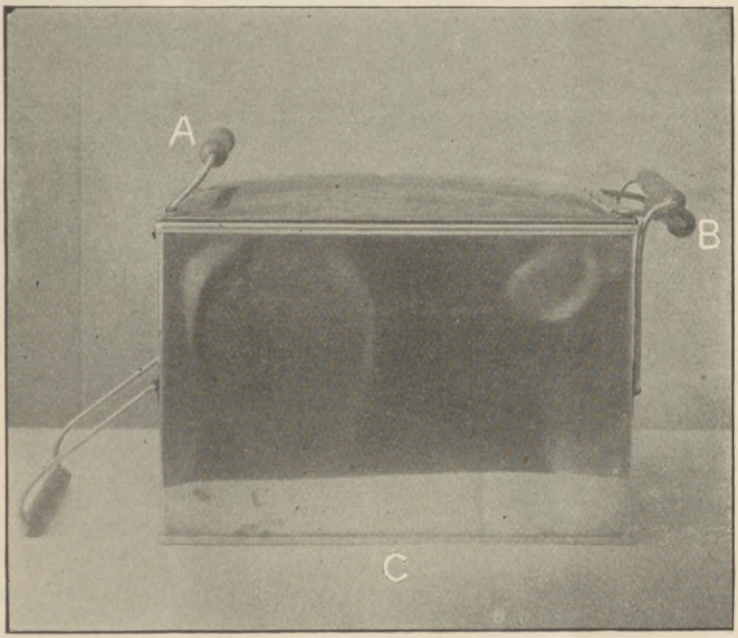

FIG. 1.

sterilizer. Thus we have a thin layer of water boiling in the inner chamber and crowding it with steam, the excess of steam carried out through the column of water at its sides, condensing until that water has attained a boiling point, and then a continual flow of fresh, live steam, permeating the

dressings, and escaping through the outer chamber, until the whole sterilizer is one mass of steam and water. The condensation that takes place on the outer surface drops back into the water, or if it falls on the top of the hood is at a boiling point and causes no condensation within.

To describe the sterilizer more in detail, using a particular pattern (Fig. 1) : The kettle and cover have separate

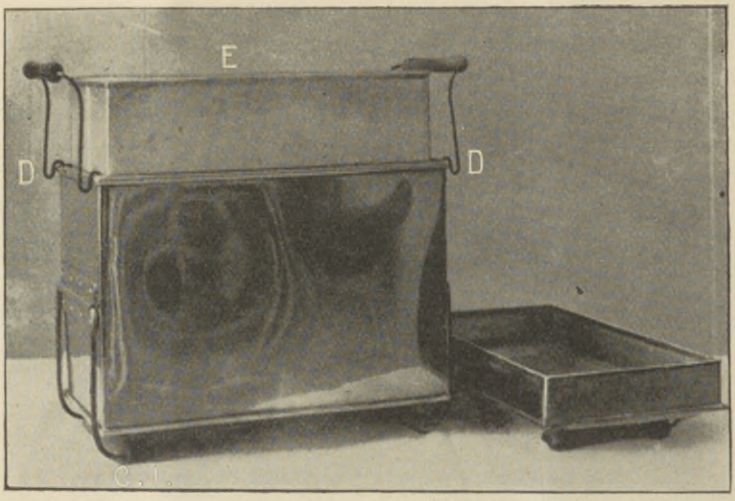

Fig. 2.

handles, as seen at A and B, interlocking in such a way as to form a convenient united handle for carrying, and at the same time to fasten the cover securely down ; or, when open, the handles of the cover can be turned back in such a way that when the cover is inverted and laid on the table, they form steadying feet to prevent its rocking and keep it from the table (Fig. 2). The kettle handles, too, can be carried downwards under the bottom of the kettle, as at Fig. 2, C.1, and so form feet which shall raise the kettle and its boiling contents, when set upon the table, so far from the surface as not to scald or damage the table top. The cover is fitted with a deep inside lip, and when taken off and inverted upon the table makes a convenient sterile dish, the very edges of which are

also clean. This exposes to view the inner inverted box, or hood, with two handles connecting with loose peculiarly bent wire loops reaching around the bottom of the whole contents of the outer kettle in such a manner that everything can be lifted bodily out of it and placed in a convenient place. The handles of these loops are of wood, are sterile, can be handled by the surgeon's sterile hands, and no others need touch the apparatus after the cover is off in the course of arranging the trays. In the middle of these handles, as will be seen, is a peculiar bend or hook, by means of which the contents of the kettle can be rested half-lifted out to drip

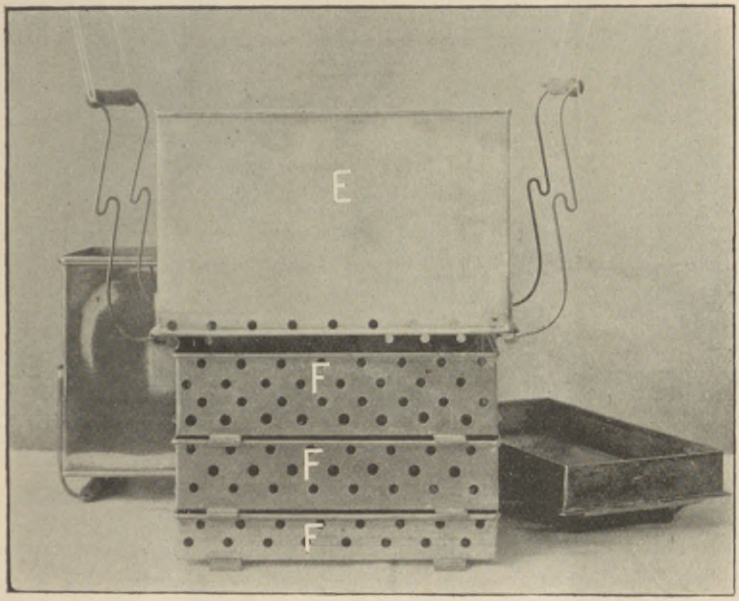

FIG. 3.

and cool as much as necessary (Fig. 2). After this, by means of the same handles, the contents are taken out and laid upon the table, and we have the outer kettle containing a quart or three pints of boiling water, which may be used for rinsing instruments in the course of the operation. The wire loops or handles marked D also serve several other purposes. They have already lifted the hood and the three trays *en masse* out of the kettle, and previously, by means of the

hooks in the middle, have held it half out to drain. Now their further usefulness is shown: The steam hood E has at its four corners four crooked legs, so bent that the wire loops can be slipped into them to the very extreme of the length of the hood by simply carrying the handles apart, and thus disengage the trays within, which they have so far been holding, so that the hood may be lifted completely off (Fig. 3), and at the same time, by a little trick of handling,

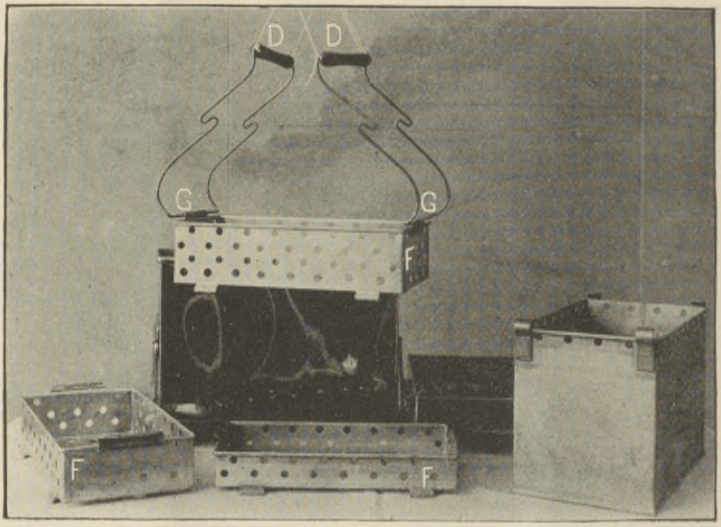

FIG. 4.

inverted and placed in a convenient portion of the table as the third sterile receptacle. This exposes the three trays FFF, resting one upon another, and separated from each other by their feet, which also serve as guides to keep them in position. They are perforated on the sides and bottom, so as to admit of the free circulation of the steam, and they have at the end handles of peculiar construction, so fitted as to prevent end motion, and with the feet, to prevent side motion, they keep them in a straight and even pile, securely locked. The handles also turn out in such a way, as shown at G, Fig. 4, that the loops will lock in and hold them, and enable the surgeon to lift them off from each other and place them in position for the operation. The bottom

tray contains the instruments folded in a towel, which has only to be unfolded to show them laid out in order for the operation. A perforated plate H, Fig. 5, may be laid on the towel enclosing the instruments to prevent water being carried into the tray above by the folds of the towel. The other two trays are above the water line, and contain the dressings, which come out steaming hot, but which, as soon as they are cooled or shaken out, are absolutely dry. A thermometer placed in a central part of the uppermost tray will mark 100 to 100.5 degrees centigrade, showing that the extreme temperature of boiling water has been attained in the thirty minutes that the

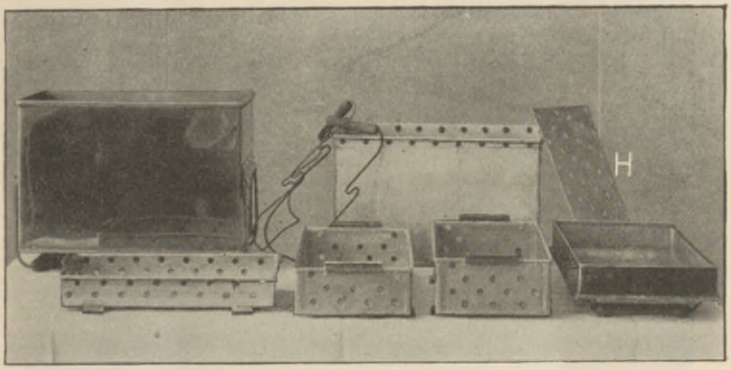

FIG. 5.

apparatus has been on the stove. This temperature, as those who are familiar with the results of bacteriological tests know, does not give absolute certainty of freedom from spores, but as a matter of practical experience it does kill most pathogenic organisms, and those whose persistent vitality enables them to withstand it are comparatively rare, and as a rule easily avoided by a surgeon in private practice, whose instruments and dressings are kept and stored clean and in good condition. On the other hand, it does do what no other sterilizer of its kind achieves so easily. It does reach in all its parts the maximum temperature of boiling water rapidly; it is wholly free from the annoying moisture of dressings, which is caused by the condensation of water on the roofs and sides of sterilizers that are not made with

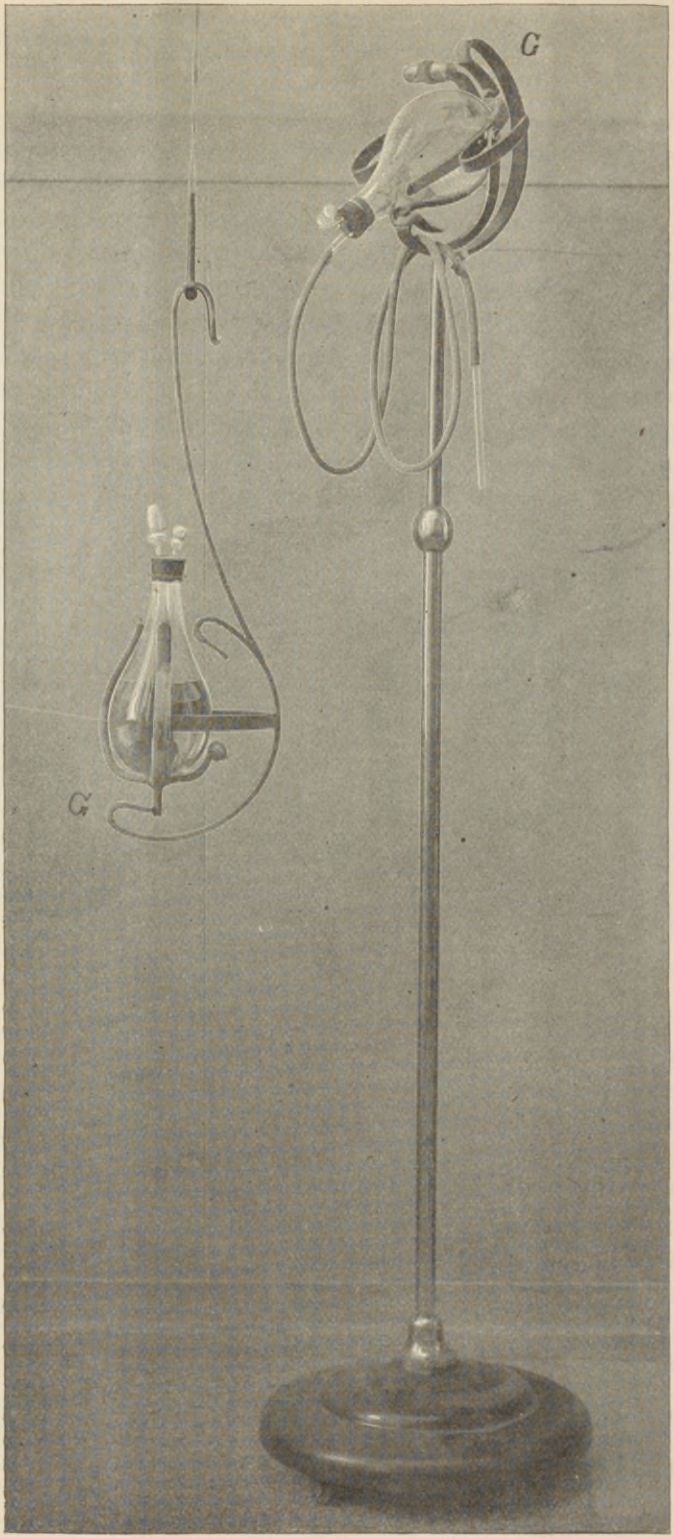

Fig. 6.

a double chamber. It furnishes to a greater extent than any other all the vessels needed in an operation. It is simple and exact in its construction; it is theoretically correct, durable, entirely practicable, and it is impossible that any essential part of it shall be forgotten and left at home. It can be kept packed, excepting for special instruments, and taken at a moment's notice. Ten or twenty grains of bicarbonate of soda should be kept in the kettle, dry.

A simpler form and large size of this apparatus, consisting of a round deep kettle with hood to fit, and suitable wire basket for linen, would answer the needs of small hospitals whose surgeons did not consider steam under pressure essential. In large-sized hoods the circulation of steam could be insured by small pipes on the inside, extending from near the top to openings near the bottom, so that the steam to escape from the hood should rise first to the extreme top. By such a structure dressings could be prepared more uniformly steamed and more dry than by anything now obtainable among the non-pressure steamers.

The next piece of apparatus, as I said in the beginning, is designed especially for hospital use; namely, the production and preservation of absolutely sterile water or solution in a bottle or flask, so fitted that it can be kept indefinitely without contamination, and can be poured freely from it in any quantity, and that all the ingoing air which takes the place of the outflowing liquid shall be strained through a layer of sterile cotton, thus insuring no possibility (direct fraud excluded) of contamination between the autoclave where it is heated and the wound into which it is poured. It is made on the general principle of the chemist's wash-bottle, with currents inverted. That is, the wash-bottle is fitted with a perforated cork containing two tubes, a long one reaching to the bottom of the bottle, and a short one reaching just through the stopper. It is used for forcing out small quantities of distilled water and other liquids, and is operated by blowing air into the short tube, thus forcing the liquid out through the long one, with the flask in an upright position. These flushing or pouring flasks, Fig. 8, etc., are also fitted with two tubes, a long and a short one, but are to be inverted when used, when the water flows out in a

continuous stream through the short tube, while the air flows in equally through the long tube and through the disk of sterile cotton which has been tied on to the end of it. The principle is thus absolutely simple: the column of water passing out through the nozzle of the short tube draws in an equal column of air through the long tube. But the details have been worked out by a series of experiments to a considerable degree of refinement. The size and shape of the flask have been such as prove most convenient in handling and in furnishing a sufficient quantity of solution. The neck is large enough to make an easy grasp for the hand.

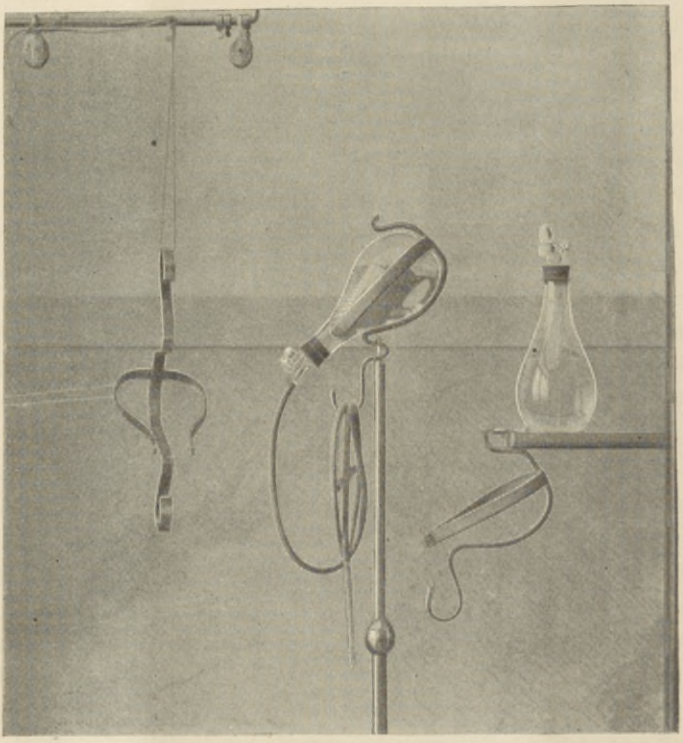

Fig. 7.

The flask is rounded in such a way that its centre of gravity is not much disturbed by its inverted position when placed

in one of the holding cages to be described further on. The glass, of course, must be moderately thin, and sufficiently well annealed to stand the high variation of temperature. The neck is flared just enough to receive the ordinary taper of the cork or rubber stopper, and allow it to fit its whole length. The two tubes must be unequal in size, at least in the inner diameter; the air-tube much smaller than the tube for pouring, otherwise drops of water will trickle down and leak untidily out from the air-tube. The air-tube should be made of what is called barometer tubing, and have an inside diameter of not more than two or three millimetres; while the inside diameter of the pouring tube should be about three times as much.

In finishing the lower end of the air-tube the glass-blower should be very careful not to contract it, while the upper or outer end should be expanded to a sort of funnel, in order to give a considerable surface for the air to enter through the sterile gauze. At its lower end the air-tube should be gently curved toward that side of the flask which is uppermost when the flask is inverted for pouring. By this means it most readily gets above the surface of the water, and the inflowing air is less interrupted. The pouring tube and nozzle is made with a little shoulder at the top of the cork, to prevent its being pushed too far within, and also another shoulder near the end, to assist in retaining the cotton cap when it is put on. This end is tapered to fit a rubber tube, or to be used itself as an irrigating nozzle.

For use these bottles are filled with water or salt solution to be sterilized, the corks, with their tubes in, properly inserted, and a little layer of sterile cotton or gauze is folded over the end of each tube and fastened there with an elastic band, as shown in Figs. 6–10. This is then put into the autoclave and sterilized by heating to a proper degree of temperature and for a suitable length of time. It is cooled slowly, the pressure reduced slowly, to prevent too much ebulition, and then is ready for immediate use, or for laying aside until needed. The cotton plugs, of course, are not to be touched until the instant of use. When the solution is wanted, the plug covering the short pouring-tube is removed, the flask inverted, and the solution begins to flow

out. This carries the air in through the other tube, and the circulation thus begun is kept steadily up until the flask is emptied or is returned to a vertical position. The gauze or cotton on the air-tube is not to be removed, but the air allowed to strain through it.

These flasks can be made with various nozzles, or connected with long abdominal irrigating tubes, or with the usual rubber tubing, as in ordinary irrigation. They can also be sterilized with a hood or "cosey," as the housewives used to call it when placed over their tea-kettle, fastened over them, in which case, the outside of the flask being sterile, it can be handled by the surgeon himself in adjusting the irrigation exactly as he wishes to.

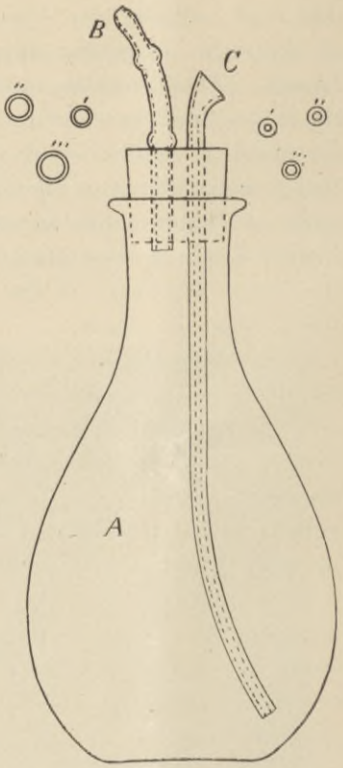

FIG. 8. — Irrigation flask complete, less than one-third linear size. A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. "', "', "', "', "': Sections showing the proper relative sizes of the pouring and air tubes inside.

In a majority of cases, pouring-flasks of this kind will be used directly on the patient; either the water poured in a stream from the flask, or by means of the long nozzle, mentioned above, inserted into the wound, but with the usual rubber irrigating tube they can be used exactly as the rubber bags, or irrigators, have heretofore been.

Occasionally, in operations and in ward dressings, it will be desirable to use the irrigation a little at a time and from a considerable height, and here, as it might be inconvenient for the orderly or nurse to always hold the bottle at a sufficient height and steadiness, and for

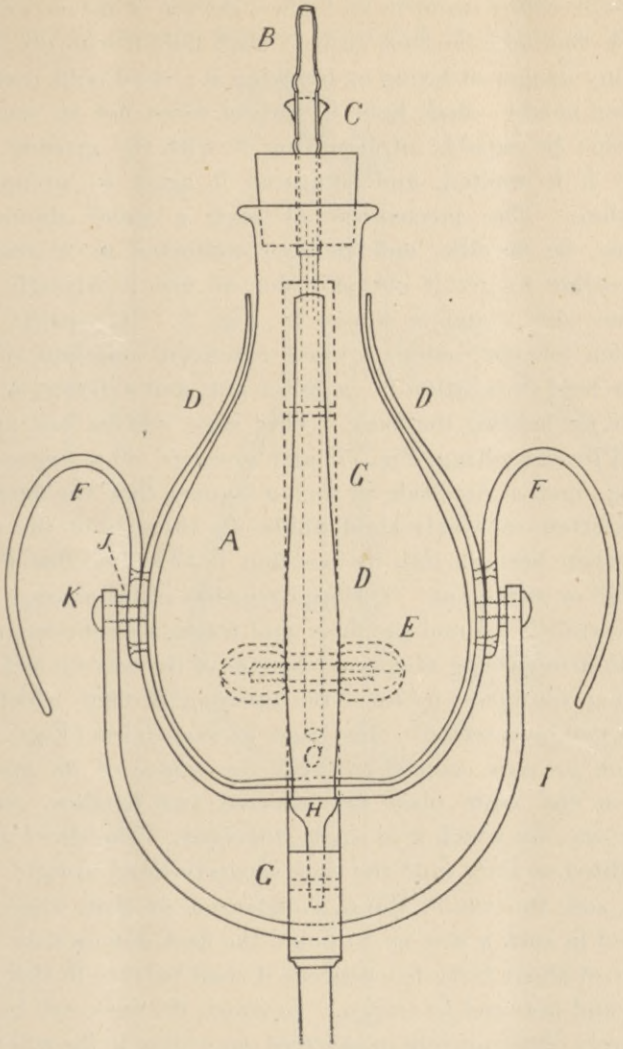

FIG. 9. — Front elevation of the holder. A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. D: The arms of the cage or basket holding the flask. E: Counterpoise. F: Handles. G: Semi-circular stop limiting the rotation of the cage and flask. H: Striker on the cage bringing up against the stop. The neck of the flask and the front arm of the cage are also limited in rotation by the stop dividing the shock and preventing breakage. I: Crutch on which the cage and flask rotate. K: Bolt forming the axis of rotation screwing into handles and cage, and tightened by clamping nut and washer.

a sufficient length of time, some sort of a stand is desirable. There are presented here several patterns. The require-

ments of such a stand in its highest degree of perfection are, that it shall take the flask easily; shall hold it securely, without any danger of losing or breaking it; shall hold it at any desired height; shall hold it upright when not in immediate use; be capable of inverting it with the greatest ease when it is wanted, and returning it again to an upright position. The mechanism of such a stand should be simple, be durable, and be so constructed as to make it impossible to get it out of order or use it wrongly.

One such stand is shown in Fig. 6. It consists of a wooden foot on casters, a brass extension standard of two tubes held in position by a taper nut, and a frame or cage above for holding the flask. This cage will be best understood by consulting Fig. 7, and consists of a four-armed frame, open at one side in such a manner that the flask can be inserted at nearly right angles to the axis of the cage, and when brought into its position is locked so that it cannot fall or shake out. This cage consists of three arms passing vertically around the flask and fitting its contour, and a fourth arm passing about one-quarter of the way up and then turning outwards to form the opening through which the flask can be inserted. The cage is suspended (Figs. 6–9–10) on its axis somewhere near the centre of its gravity, and at the same place are inserted two handles, one on each side, by which it is easily inverted. The short arm is weighted so as to hold the cage securely in an upright position, and the whole thing is balanced so that when it is tipped in such a way as to point the flask downwards to an angle of about forty-five degrees it shall balance in that position and not tend to return. In short, the flask will be held securely either upright or inverted, according to the will of the operator. This whole cage is balanced on two crutches rising from a pin in the top of the standard, and it is checked in its motion by a semi-circle, to which the crutches are welded, and whose infolded ends strike the pin projecting downward from the base of the cage, while the loop formed by their inversion offers a rest for the neck of the flask. Thus in each position there are two stops, one at the neck of the bottle and the other at the bottom of the cage, both of which act at the same time, and thereby prevent any undue

wrench or strain upon the cage or flask. These arms, and all points of contact, are so made that they can be easily

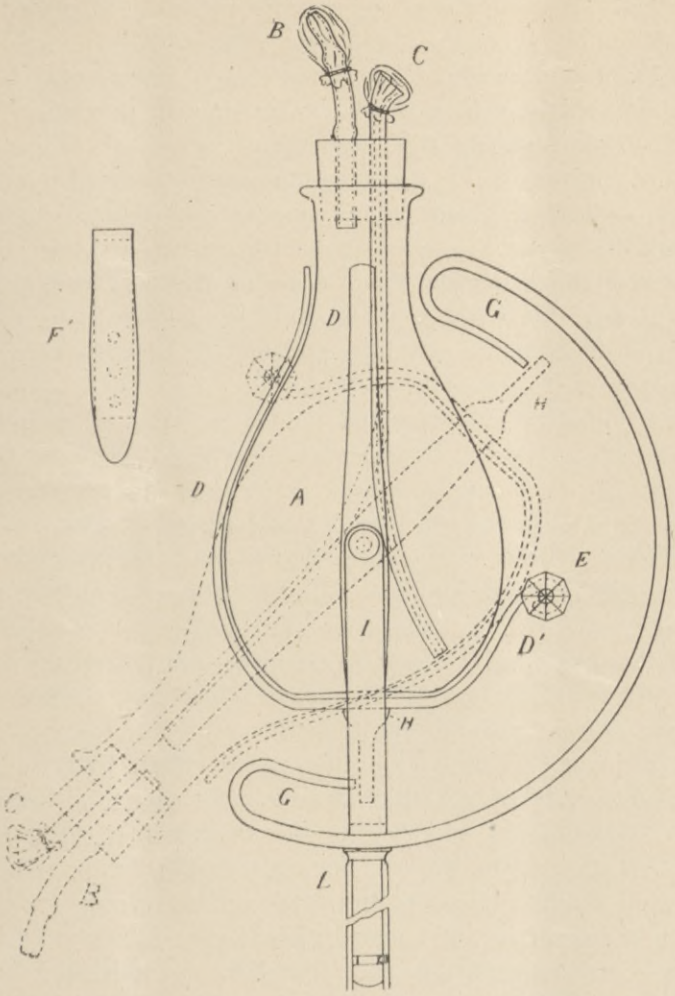

FIG. 10. — Side elevation of the holder with the handles removed for the sake of clearness. F', A: Flask holding about one and a half litres, fitted with twice-bored stopper (of rubber or cork). B: Pouring-tube with two shoulders and suitable nozzle. C: Air-tube of small internal diameter. D: The arms of the cage or basket holding the flask. D': Short arm of the cage allowing placing the bottle and also holding the counterpoise. E: Counterpoise. G: Semi-circular stop limiting the rotation of the cage and flask. H: Striker on the cage bringing up against the stop. The neck of the flask and the front arm of the cage are also limited in rotation by the stop dividing the shock and preventing breakage. I: Crutch on which the cage and flask rotate. L: Standard on which the entire structure rotates.

protected by slipping rubber tubing of suitable size over them. Thus we get in this stand an ability to place the flask

either inverted or upright, and to have it rest there in perfect security, and so joined that the whole thing can be turned in any direction, and a telescoping tube, on which the whole is supported, and by means of which it can be held at any elevation. The lower loop of the semi-circle can be used for coiling the rubber tube on, if desired.

Instead of placing this cage upon a standard, as in this figure, it may have a suspending arm attached to it, by means of which it can be fastened to any chain or cord or hook projecting downwards from the ceiling, and thus used without impairing the floor space of the operating room (Fig. 6). Or the same thing could have other fixtures, by means of which it could be attached to hospital beds for ward use, if desired.

A simpler form of stand, which answers all practical necessities pretty well, is shown in Fig. 7. The cage immediately enclosing the flask is essentially the same as that in Fig. 6, but the handles and revolving portion are omitted. Three forms are shown, one standing on the top of a pedestal, and one hanging from the ceiling, and another adjusted to hang from the head of a hospital bed, all three holding the flask in essentially the same position of inversion ready to pour, and each having a hook on its lower extremity for coiling the rubber tube, if desired.

In using this apparatus, the nurse, when irrigation is called for, takes the flask and adjusts the tube herself, inverts the flask; and begins the irrigation. After that is well started, the flask is then set in the frame and the stream regulated by the stop-cock on the rubber tube.

For the purpose of keeping these flasks of solution warm while in the operating room, a nest of four cylindrical cells or pails fitted into a water-bath answers very well.