impracticable to disinfect an occupied apartment" (Prelim. Rep. of Com. on Disinfectants). The most reliable gaseous disinfectants are formaldehyd gas, sulphur dioxid, and chlorine.

"The object of disinfection in the sick-room is, mainly, the destruction of infectious material attached to surfaces or deposited as dust upon window ledges, in crevices, etc. If the room has been properly cleansed and ventilated while still occupied by the sick person, and especially if it was stripped of carpets and unnecessary furniture at the outset of his attack, the difficulties of disinfection will be greatly reduced" (Prelim. Rep. of Com. on Disinfectants). *Formaldehyd* must be given the first place among volatile or gaseous disinfectants because of its high germicidal value and its non-toxic properties; also because it does not injure gilt work or articles made of wool, silk, cotton, linen, or leather. Iron and steel are attacked by the gas, but copper, brass, nickel, and zinc are not, and polished steel resists its corrosive action. Formaldehyd gas is obtained for practical use (*a*) by the oxidation of methyl alcohol by means of a lamp specially constructed for this purpose; (*b*) by the volatilization of paraform; (*c*) by the volatilization of an aqueous solution of the gas. A forty-per-cent. solution put up by German manufacturers under the name of formalin has been largely used. (A sixty-per-cent. solution of formaldehyd gas in methyl alcohol is sold in Germany under the name of "Volzin.")

In practice the last-mentioned method (*c*) appears to be the most useful. A suitable apparatus for rapidly boiling the formalin will be required. Calcium chlorid is usually added to the solution of formaldehyd to prevent polymerization. The "formol gas generator" of the Kny-Scheerer Company, of New York, has been used with success in the United States army; also the smaller and less expensive "formaldehyd gas generator" of Lentz—manufactured by Charles Lentz & Sons of Philadelphia. Experiments made under the direction of the Chicago Board of Health show that apartments may be disinfected by hanging up in them sheets wet with formalin. All experimenters agree that the penetrating power of formaldehyd gas is slight, unless the vacuum process is employed, and that it can be relied upon only for the disinfection of surfaces and of clothing freely exposed to its action by being suspended in a disinfecting chamber or apartment requiring disinfection. According to Professor Robinson, surface disinfection of the sick-room and of articles suspended in it requires the use of two litres of wood alcohol, oxidized by the use of a suitable lamp, for a room having a capacity of three thousand cubic feet, or the volatilization of 250 c.c. of formalin for every one thousand cubic feet of air space. The rooms should be kept closed for twelve hours.

Fumigation of the sick-room and of infected clothing by sulphur dioxid is still practised to a considerable extent, and the value of this agent as a disinfectant has been demonstrated by numerous carefully conducted experiments. Dry sulphur dioxid has but little germicidal action when brought in contact with dried infectious material, and none at all upon the spores of bacteria. But when the material to be disinfected is moist, or the atmosphere of a room is charged with vapor, the disinfecting power of this gas is considerable, and it should not be rejected because it does not destroy the spores of the anthrax bacillus, which have been largely used as the test in experiments relating to the germicidal value of this and other chemical agents. We now know that the typhoid bacillus, the diphtheria bacillus, the bacillus of glanders, the cholera spirillum, and the various pathogenic micrococci do not form resistant spores, and we have satisfactory evidence that the specific infectious agent of smallpox may be destroyed by the proper use of sulphur dioxid. As in the case of formaldehyd gas, only superficial disinfection can be effected by the usual method of sulphur fumigation. This consists in carefully closing the room to be disinfected, after hanging up articles of clothing, curtains, etc., so that they may be freely exposed to the action of the gas. Three pounds of sulphur should be burned in the room for every one thousand cubic feet of air space, and at least twelve hours should be allowed for the action of the disinfectant before the room is opened. After the disinfection of an apartment and its contents by a gaseous disinfectant and free ventilation for the escape of the gas, it will be well to wash all exposed surfaces with a solution of mercuric chlorid of the strength of one part to one thousand, or with a two-per-cent. solution of carbolic acid, and to whitewash plastered walls.

Disinfection of Ships.—Sulphur dioxid has been largely used in the disinfection of ships and apparently with success, when properly done at a quarantine station by experienced officials. In the case of ships infected with yellow fever, it acts upon infected mosquitoes, which are promptly destroyed by this gas. The directions given with reference to the disinfection of apartments on shore are those that apply as well to the disinfection of the various compartments of a ship.

George M. Sternberg.

DISINFECTION.—The important part which disinfection plays in the prevention of infectious diseases demands for it the most careful consideration. Prior to 1880 but little was known of this subject which was of any definite scientific value. However, during the past twenty years exhaustive bacteriological research has demonstrated the great value of some of the agents known as disinfectants and the utter worthlessness of others. It may be said that we have entered upon a new era in sanitation and are now scientifically familiar with this subject. This advance is largely due to the stimulus given to bacteriological investigation by the work of Pasteur and Koch, who for the first time gave to us conclusive evidence of the germ origin of many of the infectious diseases. Before the period referred to, the character of the disinfection employed was influenced largely by theory. This can hardly be a subject for criticism, as at that time but few data existed upon which could be based a truthful estimate of the germicidal value of alleged disinfectants.

Much confusion exists as to the proper meaning of the term disinfectant. It is commonly confounded with antiseptics which do not necessarily destroy pathogenic organisms but simply inhibit or hold in check their activity or propagation, and with deodorants which neutralize or destroy offensive odors and may have no germicidal action. Strictly speaking, therefore, no agent is a disinfectant unless it destroys all germs with which it comes in contact. Custom, however, permits of considerable latitude in the use of this term, which is frequently improperly and loosely applied to many articles, both proprietary and otherwise, which are advertised and recommended for use in disease and to prevent infection, without the slightest evidence that they are germicides. That the value of disinfection in the prevention of infectious diseases, and the necessity for discrimination in the selection of agents for this purpose, are not more clearly and fully appreciated is largely due to the fact that sufficient instruction on this subject is not included in the curriculum of medical colleges. The recent action on the part of the faculties of these institutions in New York City in establishing a special course of instruction in practical sanitation deserves the highest commendation.

It is only necessary to observe carefully the various methods of disinfection now employed to appreciate that there is yet much to learn regarding this important branch of sanitary science. We still find the saucer of carbolic placed under the bed, the spraying of the sick-room with a proprietary solution, and occasionally the burning of a small piece of sulphur in the apartment still occupied by the patient. It seems hardly necessary to say that these measures, which bear the marks of antiquity, are absolutely worthless; unfortunately, however, they are still relied upon as effective germicidal agents. Bacteriological research has proven that enough sulphur dioxide to disinfect an apartment would arrest respiration in both man and animals, and although formaldehyde in sufficient quantity to disinfect does not always kill insects, vermin, and the lower order of animals, it would undoubtedly prove fatal to man. This will also apply to the use of sprays, etc. Therefore an apartment cannot be disinfected until the termination of the case. Disinfection is only too often performed in a perfunctory and careless way and left in the hands of those who are not familiar with modern scientific methods.

In order properly to perform disinfection we must be able to distinguish true disinfectants from agents which have no germicidal value. We must also know when disinfection is required, and the means of performing the same. This involves a careful study of the material liable to transmit disease. Without a clear perception of the law governing modern disinfection, and the agents by which this work is accomplished, we are in the position of using tools with which we are not familiar. The literature of disinfection at the present time embraces so much definite information that there can be no valid or reasonable excuse for the employment of inefficient or improper methods.

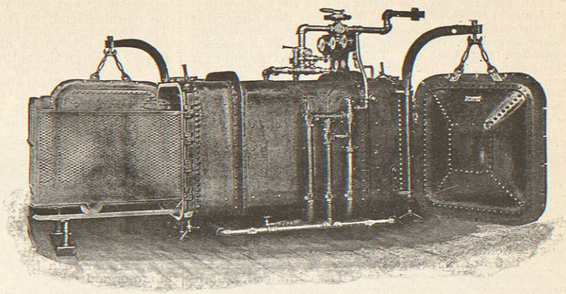

Fig. 1597 A.—Modern Steam Disinfecting Apparatus.

In the consideration of this subject we must first realize the value of nature's disinfectants—fresh air and sunlight. Not to understand or utilize their power means that our efforts to prevent or control infectious diseases will frequently meet with doubtful success. Of all that bacteriological research has taught us, nothing has been of more importance than the knowledge we now possess of the wonderful germicidal power of the agents to which I have just referred. The disappearance of infectious diseases in communities where there are no modern or organized means of combating this danger is largely due to sunlight and fresh air, which are always available and therefore can be brought in contact with specific germs. It has been proven that most of the pathogenic organisms are quickly destroyed when exposed to sunlight and air, whereas they frequently resist the action of chemical and other agents. This fact carries with it great significance, as it places in our hands at all times a germicidal power which, if properly used, contributes largely toward protecting a community against infectious disease, and is particularly valuable when other means of disinfection, such as steam, sulphur, etc., are not at hand. When we fully appreciate the great value of air, sunlight, and cleanliness we have taken the first step in modern sanitation.

In speaking of the different disinfectants, I shall refer only to those in general use and which are scientifically known to be true germicidal agents.

Steam.—Of the disinfectants which it is within our power to create steam is by far the most valuable, inasmuch as absolute dependence can be placed upon it if properly employed. Its action is quick and deep penetration is assured—the latter being a most important consideration. These invaluable qualifications are not possessed by other disinfectants. The experiments made with steam at the New York State Quarantine laboratory, in 1897, showed that a moist temperature of 230° F., if kept up for a period of fifteen minutes, killed the bacilli of anthrax, bubonic plague, diphtheria, etc.—both those near the surface and those which were lodged deep down in the centre of unopened bundles; *i.e.*, it killed them under conditions similar to those which would be encounted in any work of general disinfection. Moreover, it was found that a moist temperature of 135° to 150° F., with an exposure of fifteen minutes, generally killed all the organisms employed in the test except anthrax, when they were more directly exposed as in superficial disinfection, but not when deep penetration was required. In the experiments in which a temperature of 230° F. was employed, the self-registering thermometers placed with the infected discs in the centre of large bundles of clothing, bedding, and blankets showed but little or no diminution in the temperature at that point, whereas in tightly rolled and closed packages of newspapers, weighing three pounds or more, the inside temperature sometimes showed a reduction of thirty or forty degrees; repeated tests showed that this result was uniform and that material usually presented for disinfection, such as clothing, bedding, etc., is easily penetrated by steam. The importance of this is evident, as in public or general disinfection it is impracticable to open and spread out all material received for disinfection, which requires great expenditure of time. The results of the experiments above referred to are in accord with those of other investigators, and it may be accepted that a temperature of 230° F., with an exposure of fifteen minutes, is destructive to all pathogenic organisms even in the spore forms. Although the ordinary cotton and woollen materials generally used in the manufacture of clothing, bedding, carpets, etc., are not injured by steam, it destroys articles made of rubber, leather, fur, material stiffened with glue, etc., and is apt to injure silks and satins and other delicate fabrics. In the modern method of steam disinfection, ordinary mail composed of letters and papers can be subjected to steam without injury or defacement of writing. Fortunately, however, modern sanitation does not regard this material as a menace to the public health, and the disinfection of mail has been practically abandoned. The potency of steam as a disinfectant, its reliability for deep as well as for superficial disinfection, and its rapidity of action, make it imperative that every community should be prepared to employ this agent when necessary. There can be no reasonable excuse for not complying with this modern sanitary requirement, as a simple and effective apparatus can now be purchased of the makers at a very reasonable price. A steam chamber into which can be squeezed a mattress is sufficiently large for disinfection in a small town. The purchase of an apparatus of this character is really a matter of economy, inasmuch as many articles, such as presumably infected mattresses, etc., can be saved, when otherwise it would be deemed necessary to burn them. It would be of comparatively little interest to enter into a detailed account of the evolution of the steam disinfecting chamber, which has passed through many changes until it has now reached a stage where it seems to comply with modern scientific requirements.