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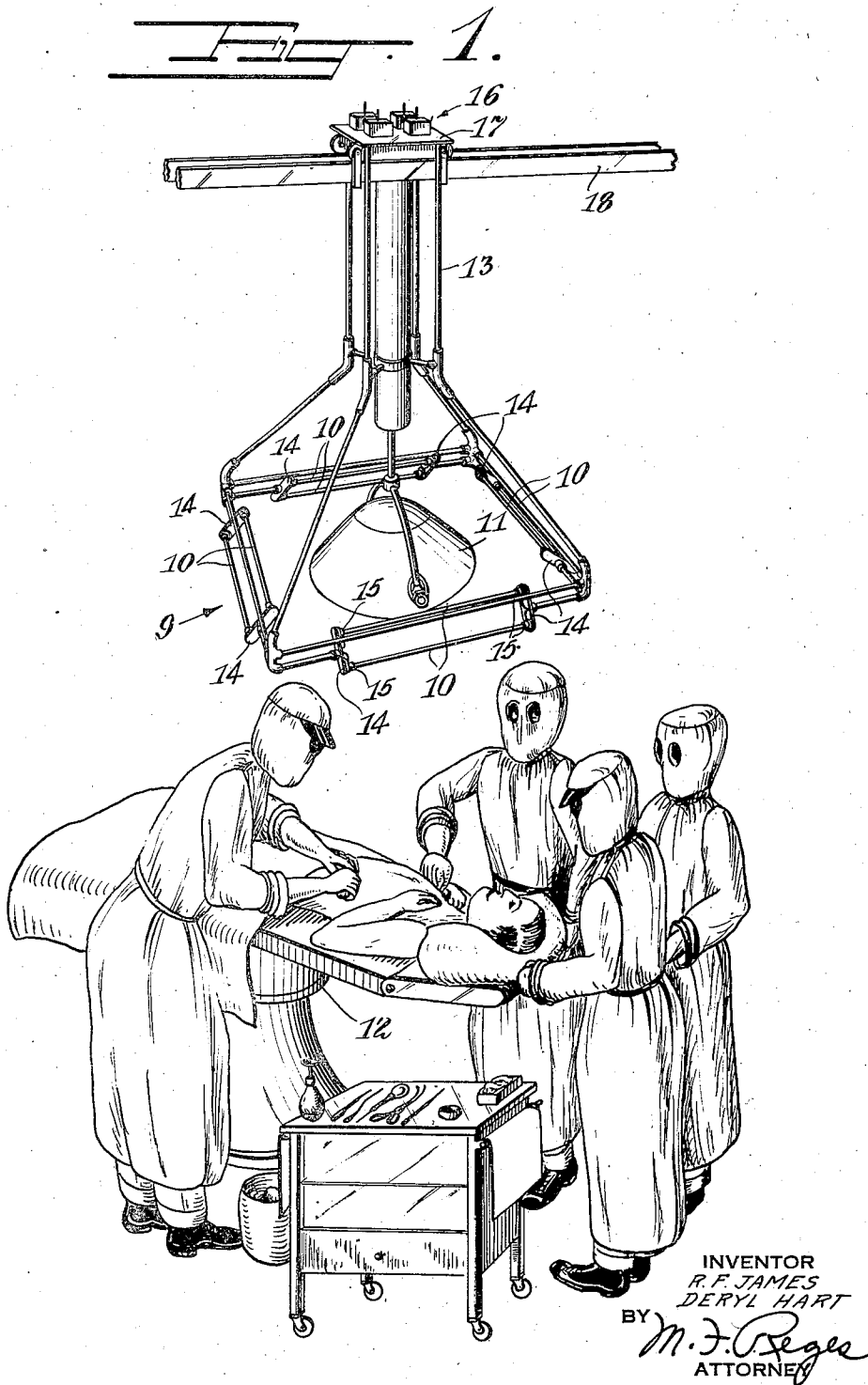
R. F. JAMES ET AL

2,249,610

METHOD AND APPARATUS FOR MEDICAL PURPOSES

Filed June 13, 1936

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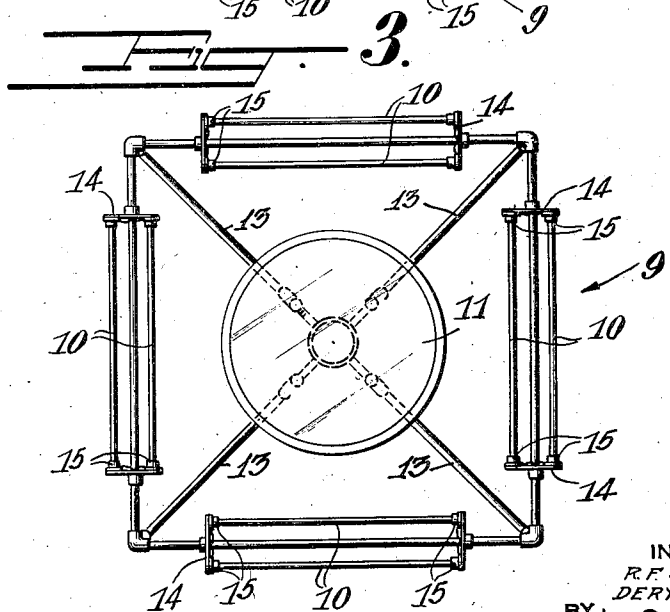
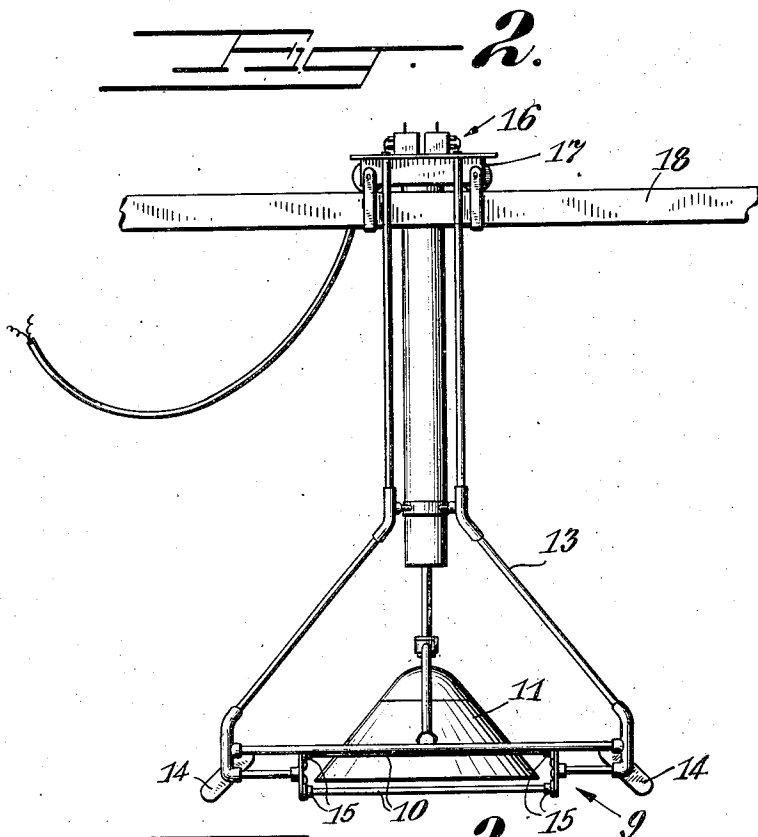
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4 Sheets-Sheet 2



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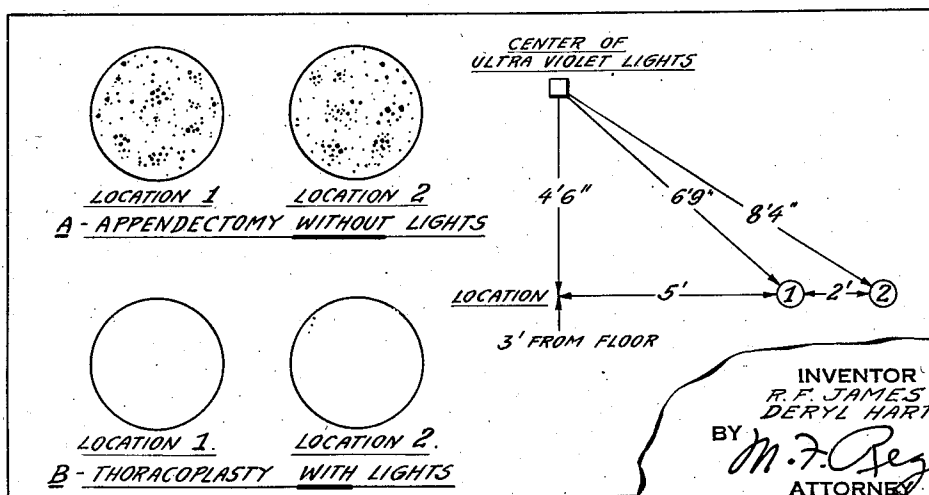
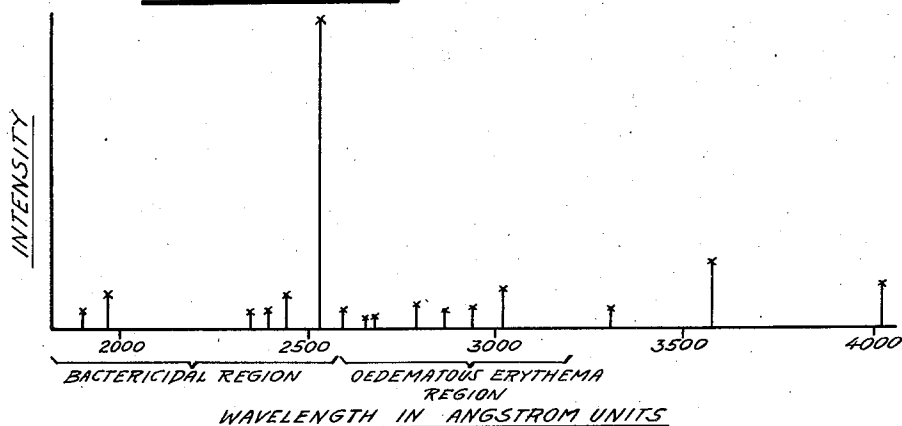
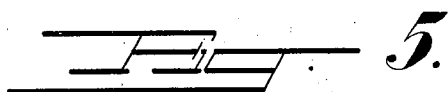
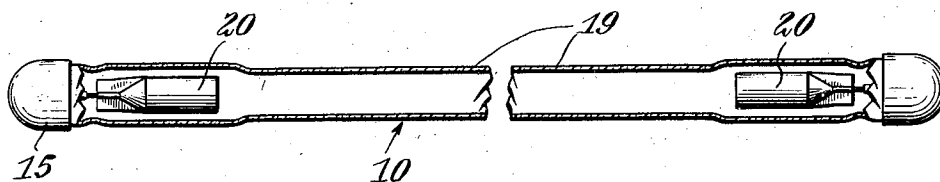
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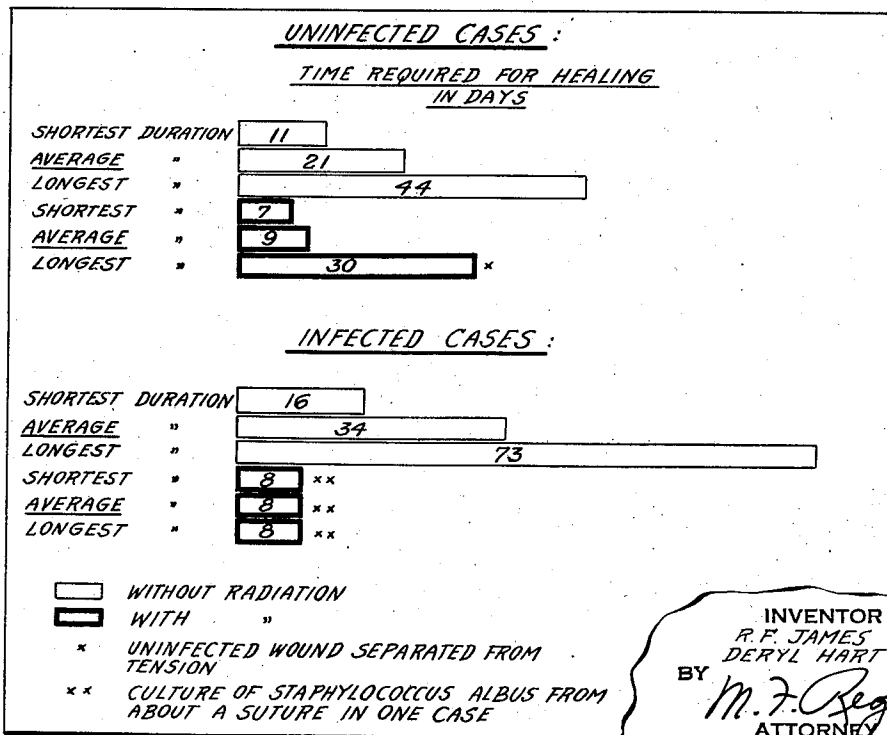
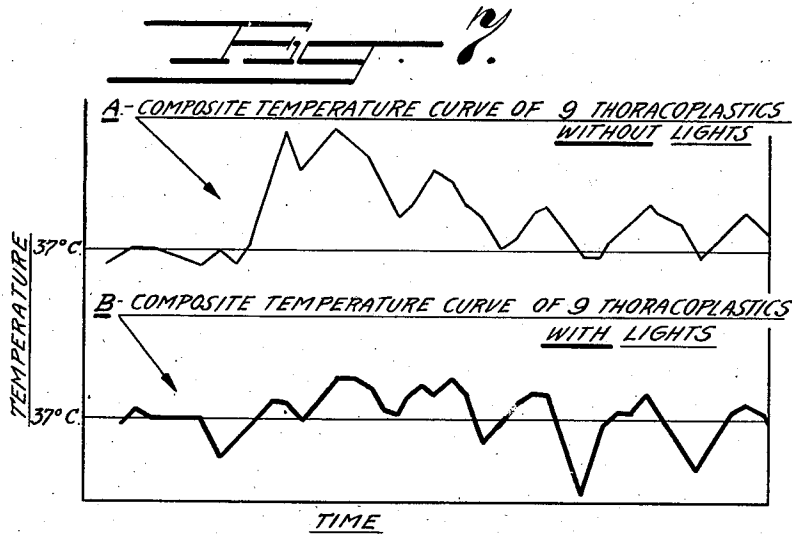
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METHOD AND APPARATUS FOR MEDICAL PURPOSES

Filed June 13, 1936

4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,249,610

METHOD AND APPARATUS FOR MEDICAL PURPOSES

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Application June 13, 1936, Serial No. 85,692

9 Claims. (Cl. 128—396)

This invention relates to the science of medicine and surgery and is more particularly concerned with minimizing the danger of infection from organisms transmitted through the air between patient and attendant or between patient and patient.

Despite the precautions ordinarily taken prior to and during the care and treatment of patients, in many cases serious complications result from infection of the patient. Heretofore the belief more generally prevailed that infections resulted from skin contamination or improperly sterilized supplies in view of which the most drastic precautions were observed in eliminating this source of infection. For example, the time of sterilization was increased, the skin of the patient was most carefully washed with soap and water and then again washed with alcohol and ether and other antiseptic solutions. However, such precautions have not eliminated the danger of infection, as for example, during operations. It was felt that the cause of infection must lie somewhere else than on the supplies and upon the skin of the patient and the conclusion reached was that the air carried certain organisms which caused such infections. An effort, therefore, was made to eliminate, as far as was physically and chemically possible, the pathogenic organisms from the air.

To this end the rooms in which the patients were being treated were frequently painted and washed daily with an antiseptic solution, and by forced ventilation the contaminated air was replaced by clean washed air taken from above the roof of the building in which the rooms were located.

These precautions, however, were not effective in materially reducing the number of pathogenic organisms in the air which caused infection. Therefore, it was found necessary to investigate this matter further in order to ascertain if the air was not impregnated with pathogenic organisms from other sources.

It was suspected that the noses and throats and possibly the skin of the individuals using the rooms were responsible for this contamination of the air. Cultures taken from the noses and throats of these individuals proved this to be the fact and, therefore, as a precautionary measure, the number of individuals entering the rooms was reduced to a minimum. Masks were worn over the noses and mouths at all times, and all persistent carriers of pathogenic bacteria, such for example, as staphylococcus aureus or streptococcus, were kept out of the rooms at all times.

Although these precautions, together with the precautions previously mentioned in connection with clean air and care of the room, reduced air contamination by from 60 to 80%, nevertheless the number of organisms in the air were not reduced sufficiently to eliminate all infections and it was found that in almost every infected case the organism cultured from a wound, for example, was identical with the culture from the air in the room.

Upon investigating this situation, it was quite definitely shown by numerous culture tests that most of the infections were caused by the hemolytic staphylococcus aureus, and that the organisms entered a wound, for example, from the air rather than from the skin of the patient, and further that the air was contaminated by the personnel entering the room and also by the patients.

Particularly in surgical cases it was ascertained that, while infections with suppuration were rare, culture of the drainage tracts and incisions showed the presence of the hemolytic staphylococcus aureus, or other pathogenic bacteria, (as high as 33% in thoracoplastics). Additionally in such cases, all supplies and all procedures in operating room technique were checked by cultures and found to be satisfactory except for the air which was heavily contaminated. The staphylococcus aureus was usually present at times in large numbers. The operating room personnel and the general population were found at times to have the staphylococcus aureus (frequently hemolytic) in the nose and throat in as high as 78% of cases and apparently they were the source of the air contamination. As stated heretofore with all the precautions mentioned above, it was not possible to reduce the number of organisms in the air sufficiently to eliminate all infections.

In endeavoring to more precisely control this situation and eliminate the danger of infections from air-borne pathogenic organisms, resort was made to the use of ultra-violet lights, such as commonly found upon the market. In one of the tests a therapy ultra-violet lamp was tried and it was demonstrated that a sprayed culture of hemolytic staphylococcus aureus could be killed at a distance of eight feet from the lamp within sixty seconds. This sterilization of the air was also attempted by means of a carbon arc lamp, but which had, apparently, no effect on the organisms.

These sources of radiation, however, for many reasons were not suitable for the purpose because

of other unsatisfactory effects on the patient. Inasmuch as the primary concern was the elimination from the air of the infection-causing organisms, so that such organisms would not drop into an incision, for example, and cause infection; and simultaneously therewith prevent any detrimental reactions in the patient, a device was selected capable of emitting radiations which killed the objectionable organisms and which, at the same time, did not produce any detrimental reactions in the patient. The radiation device used was of special design and provided a high intensity of radiations in the region of 2500 A. u. wave band, together with a lesser intensity of radiations in the wave band region around and below 2000 A. u. with a relatively low intensity of radiations in the wave lengths above 2600 A. u. It was found that by placing such devices in the form of a cluster at a distance of approximately six to eighteen inches above the operating team's heads, for example, the radiations therefrom produced remarkable results.

For example, in a hundred patients operated on under this cluster of specially designed and positioned radiation devices, it was found that the patients had no infected wounds; no wound cultures taken showed any growth; there was less temperature elevation during the post-operative course; the patients experienced less pain; and a smoother and more rapid convalescence was had by the patients.

These operations were run in parallel with a control group of cases and in all of the control group it was found that in 5 to 35% of the cases infection had occurred; the temperature during the post-operative course was much higher; the patients experienced more pain; and the convalescence was not as smooth and rapid as was the case with the patients who were operated on while the devices were functioning to emit their radiations.

In the preliminary tests to determine the ability of these tubes to perform satisfactorily for the intended purpose, cultures of the hemolytic staphylococcus aureus and a mixture of many organisms were first sprayed on culture plates and exposed to the radiations from these devices and it was found that the organisms were killed at a distance of five feet from the devices within less than 1 to 5 minutes, the time depending upon the density of the inoculation. It was also ascertained with the devices functioning that practically no organisms could be cultured from the air within a radius of eight feet from the radiation devices. It was found, however, in the corners of the room (thirteen feet from the center of the cluster and eleven feet from the nearest device) that the number of viable organisms falling out of the air was reduced by from 60 to 90%. It was also determined that the air in an entire room could not be completely sterilized with only eight of the devices, and that when the tubes were turned off re-contamination quickly occurred if people were present.

To determine that the radiations from these tubes would produce no detrimental effects upon a patient, blonde individuals were subjected to the radiations from eight devices for a period of eighty minutes at a distance of five feet. Such individuals received only a slight reddening of the area of the skin exposed to the radiations, this reddening clearing up within twenty-four hours.

Wounds in rats and dogs were exposed to the radiation from the eight devices at a distance of five feet for from 30 to 90 minutes and it was

found that the wounds healed better than in the control animals. It was further found that there was no increase in adhesions following an exposure of the peritoneum to this radiation.

In a number of surgical cases, for example, these remarkable accomplishments resulted from placing a cluster of tubes, such as illustrated in the drawings, in a position with respect to the patient and the operating team so that the air in the zone beneath the cluster of lights and surrounding and adjacent to the operating team's heads was subjected to radiations of such intensity and wave length as to destroy any organisms in the air coming from the noses and throats of the operating team together with those which might float in from the surrounding air. The position of these lamps with respect to the patient was such that the more highly bactericidal radiations therefrom were so absorbed by the intervening air as to be reduced to a negligible intensity. At the same time, the intensity of the radiations in the region of the 2500 A. u. wave band, these also being bactericidal in character, was such as to project such radiations to the region or zone in the vicinity of the patient, thus destroying any pathogenic organisms which might float in from the surrounding air without passing through the zone of intense radiation in the vicinity of the operating team's heads.

Likewise the intensity of the radiations from the device in the region above 2600 A. u., that is in the so-called erythema region, was so reduced in intensity that at the distance the device was placed above the patient, such radiations would not cause any detrimental reactions in the patient. By thus controlling the intensity and character of the radiations emanating from these devices, the air-borne organisms, which were concentrated in the region adjacent the throats and noses of the operating team, were effectively destroyed and, at the same time, the pathogenic organisms in the region adjacent the patient were likewise destroyed. Since the radiations in this latter region were of such character and of insufficient intensity to cause any detrimental reaction upon the patient, no harm befell the patient. Such detrimental reaction would be, for example, an irritation of the tissue such as a violent reddening, blistering, or erythema of the skin with discomfort following thereafter.

From the results obtained it is apparent that the intensity and character of the radiations are such as to produce a beneficial reaction in the patient. Although it is not known precisely the mechanism by which this beneficial reaction is produced, it is quite clear from these results that such a beneficial reaction was secured, as all patients operated upon under the devices recovered more rapidly, experienced less pain and discomfort, and the incisions quickly healed with freedom from infection.

In such operations known as thoracoplasties, many surgeons make the incision for the second operation approximately an inch from the first scar because of the danger of encountering a small focus of viable organisms which might inoculate the new incision. When performing such operations under the radiation devices, it has been found that this old technique may be altered by making the second incision in the first without danger of inoculation of the new incision.

It is, therefore, an object of the invention to provide a method whereby a patient may be treated in such a manner and under such con-

ditions as to minimize the danger of infection caused by air-borne organisms without detrimentally affecting the patient.

A further object is to improve the method of performing surgical operations or treatments by preventing the contamination of the patient by air-borne organisms.

A still further object is to improve the method of performing surgical operations by destroying air-borne organisms in and about the patient during such operations by means of radiations in that portion of the spectrum which is particularly lethal to such organisms.

Another object is to improve the method of performing surgical operations or treatments by immersing the patient and the attendants in preselected radiations of such intensity and wave length as to be lethal to organisms coming within the sphere of action of such radiations and which simultaneously therewith will not injure, but will produce instead a beneficial action upon, the patient.

A more specific object of the invention is to perform surgical operations or treatments upon a patient in a zone of radiations of such intensity and character as to effectively destroy bacteria in the vicinity of the operating team's or attendants' heads, and simultaneously provide a zone of radiations of such intensity and character around the patient as to be lethal to bacteria and, non-injurious, and beneficial to the patient.

These and other objects of the invention will become apparent by reading the following more detailed description, and by reference to the annexed drawings, in which

Fig. 1 illustrates in perspective an arrangement of the radiation devices with respect to a patient being operated upon and with respect to the operating team;

Fig. 2 is an elevation of the radiation device unit;

Fig. 3 is a bottom plan view of the radiation device unit;

Fig. 4 is a partial longitudinal sectional view of one of the radiation devices;

Fig. 5 is a graph showing intensity of radiations as ordinates and wave lengths as abscissae;

Fig. 6 illustrates culture plates showing the number of bacteria present in the air with and without the radiation devices, said bacteria being obtained from the air within the region about eight feet from the patient and at the same level;

Fig. 7 is a chart showing composite post-operative temperatures of patients operated upon with and without the use of the radiation devices; and

Fig. 8 is a chart showing the time required for healing of the incisions of patients operated upon with and without the use of the radiation devices in a series of cases where infection was present and where it was absent.

Referring to Fig. 1 of the drawings, radiation devices 10 are arranged in the form of a rectangular cluster 9 about a centrally-positioned illumination-furnishing source 11, the cluster of radiation devices being positioned approximately seven feet above the floor upon which the operating table 12 stands. These radiation devices are mounted in a frame support 13, having electrical contacts 14 for engaging the end electrical contacts 15 of the radiation devices for the purpose of supplying energy from a source, such as a transformer 16 to the radiation devices. There are two radiation devices

electrically connected in series on each side of the cluster and these devices are arranged so that the uppermost device is disposed inwardly from the other and toward the illumination source 11, whereby each pair lies in a diagonal plane forming one of the sides of a pyramid with a square base and a vertex directly above the light source 11, and the devices do not shade one another in directing the desired radiations diagonally downward toward an operating area immediately below said light source, so that they converge at a central vertex above the level of the patient therebeneath. A transformer is provided for each two radiation devices. The frame support is suitably wired to carry electrical current from the transformer 16 to the electrical contacts 14 and is suspended from a trolley block 17, the latter being mounted for movement on a rail 18.

The position and arrangement of these radiation devices is of importance in order to effectively accomplish the purpose for which the devices are designed. These radiation devices each comprise an elongated tube 19 of a special glass adapted to efficiently transmit ultra-violet light of the desired bactericidal characteristics and known as high transmission glass, having at the opposite ends a pair of electrodes 20.

The diameter of the glass tube is of importance since the current density of the discharge produced in the gaseous atmosphere within the tube 19 must be such that the proper intensity and character of radiations are emitted by the device so that the device operates with a temperature only a few degrees above room temperature. The gaseous atmosphere is carefully selected and comprises a very small quantity of mercury and a mixture of neon and argon in the proportion of 60 and 40% respectively, the pressure being approximately 8 mm. of mercury. The current density is approximately 160 ma. per square inch.

The radiations emitted by the device, as stated heretofore, must be of such intensity and wave length as to be lethal to bacteria and yet not harm the patient. It will thus be seen that the radiation generator, and particularly each device 10 thereof, may be considered as emitting a wedge of the ultra-violet radiations substantially restricted to a predetermined band, and of a character and intensity lethal to air-borne organisms, near the vertex of which wedge the heads of the members of the operating team are disposed, so that the generated radiations are particularly effective, because of their great intensity at that location, for destroying air-borne organisms exhaled by the team. The patient is positioned at a greater distance from the vertex of the wedge, or vertices of the wedges, so that the radiations are there weaker than at the heads of the operating team, whereby they are of insufficient intensity to be harmful, said radiations, however, being of a character and intensity to not only exert a bactericidal effect, but promote natural healing of the incised tissue. The operation is performed while the radiations are being generated and the relative positions of the participants maintained. During said operation, air-borne organisms exhaled by the operating team enter what might be considered as the first zone, or that near the ultra-violet radiation generator, and are destroyed during their travel to what might be considered as the second zone, or that adjacent the patient, before reaching the incision.

Referring to Fig. 5, there is illustrated the approximate relative intensities of the wave lengths of the radiations emitted by these devices. As shown by this figure, the effective lethal or bactericidal radiations are those falling within the spectrum from about 2600 A. u. downwardly or toward the shorter wave lengths. Those in the longer wave length band, i. e., those above 2600 A. u. are ordinarily used for producing erythema with pigmentation and oedema. It is to be noted with respect to the latter that the intensities of these longer or erythema radiations are relatively low compared to the bactericidal radiations around 2500 A. u. and also that the radiations below 2500 A. u. are diminished in intensity as compared with those radiations around 2500 A. u.

Since the radiations above 2600 A. u. cause erythema with subsequent pigmentation and oedema, it is obvious that since these are of relatively low intensity, very little harm can be expected in the way of irritating the tissue of the patient. The radiations below 2500 A. u. also, when of sufficient intensity, produce an erythema, but of different character. In the former the skin becomes darkened in color and blisters, whereas in the latter the skin becomes reddened. Too much of the former energy is harmful and may cause the skin to blister with possible disastrous results; hence the reason for diminishing the intensity of such radiations. At the same time, it is desirable to have a sufficiently high intensity of the shorter radiations which will be effective to destroy bacteria within approximately a foot of the radiation device, which, together with the radiations around 2500 A. u. will effectively destroy the bacteria emanating from the noses and throats of the operating team.

It is thus apparent that a zone of bactericidal radiations is created and maintained about the operating team's heads. Simultaneously with such action the radiations with wave lengths around 2500 A. u. which are not readily absorbed by the air, will be projected down to the zone or region around the patient to effectively destroy any bacteria coming within this region. The shorter radiations, namely, those around 2000 A. u. are easily absorbed by the air, hence these shorter radiations do not reach the patient with sufficient intensity to bring about the destruction of the bacteria with sufficient effectiveness in the period of time in which the operation is performed.

The usual type of radiation sources now found on the market such, for example, as the carbon arc, mercury quartz burner, etc., have a spectral energy distribution of such a character that, in order to obtain sufficient intensity of the bactericidal radiation to effectively kill bacteria, too high an intensity of the longer wave lengths and of the very short bactericidal radiations is obtained, whereby detrimental reactions upon the patient are brought about.

The effectiveness of the radiation device for destroying bacteria is shown in Fig. 6 wherein culture plates are shown. On the upper pair of plates of this figure it is to be noted the presence of a large number of dots representing bacteria present in the air when no radiation device was being employed. In the lower pair of plates of this figure the absence of such dots is plainly evident, and since this plate was exposed to the air when the radiation devices were functioning, it is quite clear that the bacteria in the air were

destroyed, or their growth and multiplication inhibited.

These culture plates were made with an operating team present and are, therefore, truly representative of conditions as they actually exist.

The beneficial action upon the patient of the radiations emanating from these devices is depicted in Figs. 7 and 8. In Fig. 7 curve A is a composite temperature curve of nine patients following operations without the use of radiation devices, while the curve B is a composite temperature curve of nine patients following the operations with the radiation devices functioning.

The benefit derived by the patient is quite evident since, in the lower graph the temperature was lower, there was less infection and less discomfort to the patient. It is quite evident that in the nine operations performed under the radiations the post-operative temperature curve is considerably lower. The time in which the temperature reached normal in post-operative cases is much shorter with the radiation devices than without them.

Fig. 8 is a chart depicting the period of time required for healing of the incisions in a series of operations made under the radiation devices and a series made without the radiation devices.

In some cases without the radiation devices no infection was detected and in other cases infection was present as indicated by the chart. It is quite evident that this period healing was considerably shortened with the devices operating, thus benefiting the patient. It was also observed that the incisions healed more rapidly in those cases where the operations were performed with the radiation devices in operation, the wounds healing per primum. Additionally, there was no fluid from or sloughing of the incision, the incisions requiring no drains in the cases where the radiation devices were employed. Furthermore, all patients operated on under the radiation devices convalesced more rapidly with considerably less discomfort and pain. Because of this rapid and clean healing of the incisions, it has been found in performing such an operation known as thoracoplasty, that the usual technique in operating may be altered with safety. This new technique is the making of the second incision in the first incision instead of removed therefrom as has been the practice heretofore.

These remarkable results are attributable to the employment of the special radiation device arranged in such a manner as to create zones of radiations, in the one of which the bactericidal radiations are particularly intensive and effective in destroying air-borne organisms where most needed, and in the other of which the bactericidal action of the radiations are still present but in which the accompanying radiations are so reduced in intensity as not to harm the patient.

Although the invention has been specifically described as relating to surgical operations, it is within the purview of the invention to contemplate all medical treatments where there is danger of infection from air-borne organisms or where beneficial action upon the patient is desired without any detrimental results occurring to the patient.

We claim:

1. An apparatus for preventing the infection of a patient by organisms transmitted by the air, while being operated upon or otherwise treated, comprising in combination with an operating table or other support, a cluster of radiation devices positioned above the table or support at

such a distance as to flood the patient and the operating team with bactericidal radiations, said devices having a radiation curve in which the intensity of the radiations of wave lengths around 2500 A. u. is predominant, as compared with the radiations on either side of said wave lengths and being arranged in pairs to define a relatively large area, the devices of each pair defining one of diagonal planes forming the sides of a pyramid, the vertex of which is centrally disposed above said cluster.

2. Irradiating apparatus for surgical use comprising a trolley block mounted for movement on a rail, a transformer carried by said block, four supporting elements depending from said block, with their intermediate portions braced with respect to one another, and their lower portions flared downwardly and outwardly, a rectangular frame each corner of which connects with one of said depending elements and each side of which carries a plurality of electrical contacts, radiation devices comprising elongated tubes extending generally parallel to the elements forming the rectangular frame, so as to outline the area enclosed thereby, and engaging said contacts, wiring between said contacts and transformer, whereby said radiation devices are operable therefrom, and a source of illumination supported from said trolley block and disposed in said rectangular area.

3. In an operating room, apparatus mounted for movement over an operating table, said apparatus comprising a movably mounted supporting element, a transformer carried thereby, supporting rods depending from said element, each of said rods extending downwardly therefrom and then flaring diagonally outward, a straight sided frame having each corner connected to one of said rods, each side of said frame carrying contacts, an elongated ultra-violet generator paralleling each side of the frame between said contacts, and means electrically connecting said contacts to said transformer.

4. Ultra-violet radiation generating apparatus adapted to be disposed above a patient and about six to eighteen inches above the heads of an operating team, said apparatus comprising a supporting element, rods depending therefrom, each of said rods having its lower portion flaring diagonally outward, a straight sided frame having its corners connected to said rods, electrical contacts carried by said frame, a pair of ultra-violet generators paralleling each side of said frame, and each comprising an elongated glass envelope adapted to efficiently transmit ultra-violet light, said pairs lying in diagonal planes, which extend substantially parallel to the diagonally extending portions of the associated rods and merge at a central vertex thereabove, so as to, without interference, direct diagonal radiations on an operating area therebeneath, without danger of shadows from members of the operating team, each envelope having a filling of neon, argon and mercury vapor at low pressure, said generators being operable at such a potential that a discharge of about one hundred and sixty milliamperes per square inch occurs in each envelope, with the generation of ultra-violet radiations predominantly in the band lying between 2500 and 2600 A. u. with some radiations of shorter wavelength, whereby a zone of intense bactericidal rays may be created adjacent the heads of the operating team to effectively kill nose, throat and other air-borne organisms above said patient during the operation, and another

zone of bactericidal rays may be created on and around the patient, weaker on account of dispersion and air-absorption, but still effective to prevent wound infection and exert a beneficial action on healing.

5. Ultra-violet radiation generating apparatus adapted to be positioned above a patient during the performance of an operation, and about six to eighteen inches above the heads of an operating team, said apparatus comprising electrical discharge tubes, each having an elongated glass envelope adapted to efficiently transmit ultra-violet light, at least some of said discharge tubes being arranged, end to end, to define a relatively large normally horizontal area, and all lying in diagonal planes merging at a central vertex thereabove, so as to without interference direct diagonal radiations on an operating area therebeneath, without danger of shadows from members of the operating team, each envelope having a filling of neon, argon and mercury vapor at low pressure, said generators being operable at such a potential that a discharge of about one hundred and sixty milliamperes per square inch occurs in each envelope, with the generation of ultra-violet radiations substantially restricted to those in the bactericidal range, whereby a zone of intense radiations of this character may be created above the patient around the heads of the operating team to effectively kill nose, throat and other air-borne organisms above said patient during the operation, and another zone of bactericidal radiations may be created on, and in the horizontal plane of, the patient, weaker on account of dispersion and air absorption, but still effective to prevent wound infection and exert a beneficial action on healing.

6. Ultra-violet radiation generating apparatus adapted to be disposed above the heads of an operating team and a correspondingly greater distance above a patient being operated on by said team, comprising a plurality of ultra-violet ray generators each consisting of a glass envelope adapted to efficiently transmit ultra-violet light, said generators lying in diagonal planes merging at a central vertex thereabove so as to direct diagonal radiations on an operating area therebeneath, each envelope having a rare gaseous filling admixed with mercury vapor at low pressure, and said generators being operable at such a potential that ultra-violet radiations predominantly in the band between 2500 and 2600 A. u. with some radiations of wavelengths below 2500 A. u., are produced, whereby a zone of intense bactericidal rays is created adjacent the heads of the operating team to effectively kill air-borne organisms exhaled by said team above said patient during the operation, and another zone of bactericidal rays is created on and around the patient, weaker on account of dispersion and air absorption, but still effective to prevent wound infection and exert a beneficial action on healing.

7. Apparatus for supplying light and bactericidal radiations comprising a frame support, a plurality of elongated tubular ultra-violet light generating devices secured to the lower portion of said support, said devices being arranged to outline a relatively large area and disposed in pairs to define diagonal planes, which planes merge at a central vertex thereabove, so as to without interference direct diagonal radiations on an operating area therebeneath without danger of shadows from members of an operating team, and an independent source of visible light disposed within said area.

8. Ultra-violet radiation generating apparatus adapted to be disposed above the heads of an operating team, and at a correspondingly greater distance above a patient being operated on by said team, comprising a plurality of ultra-violet ray generators each consisting of a tubular glass envelope adapted to efficiently transmit ultra-violet light, said generators outlining a relatively large area and arranged in pairs defining planes disposed so that the generators of said pairs direct radiations, without interference, diagonally downward, so that said directed radiations converge at a central vertex above the level of the patient therebeneath, each envelope having a rare gaseous filling admixed with mercury vapor at low pressure, and said generators being operable at such a potential that ultra-violet radiations predominantly in the band between 2500 and 2600 A. u. are produced, whereby said converging radiations form a beam which effectively kills air-borne organisms exhaled by said team above said patient during the operation.

9. Ultra-violet radiations generating apparatus

adapted to be disposed above the heads of an operating team and at a correspondingly greater distance above a patient being operated on by said team, comprising a plurality of ultra-violet ray generators, said generators being paired, each consisting of a tubular glass envelope adapted to efficiently transmit ultra-violet light, said envelopes being positioned to define a relatively large area, and disposed so that said generators, without interfering with one another, direct radiations diagonally downward to converge at a central vertex above the level of the patient therebeneath, each envelope containing a rare gaseous filling, admixed with mercury vapor at low pressure, and said generators being operable at such a potential that ultra-violet radiations, predominately in the band between 2500 and 2600 A. u. are produced, whereby said converging radiations form a beam, which effectively kills air-borne organisms tending to impinge on the wound of the patient during said operation.

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