

city which the water retains at its return to the pump, diminishes the energy required for the operation of the pump and thus contributes to the attainment of a high efficiency. The production of a vacuum at certain places (cavitation) and corrosion which is commonly attributed to such local vacuum, are avoided almost entirely with the turbo-transformer, without any special provision. Still, if increased security in this direction is desired, the circulatory path may be connected with a stand pipe or with other means for insuring the preservation of a constant pressure within the apparatus.

#### A MAMMOTH OFFICE BUILDING DISSECTED.

We are much more apt to be impressed by a building that exceeds all others in point of height rather than bulk, mainly because our eyes are constructed to take in only the superficies of an object and hence give us but an inadequate conception of its cubical content. For instance, it is not half so sensational to state that the coal consumed by a transatlantic liner in a single trip would occupy a bin 60 ft. square and 50 ft. deep as to state that a train over a mile long would be required to cart this amount of coal from the mines to the vessel. Again the great pyramid of Cheops, which is the bulkiest monument built by man is frequently used as a unit by which to show the enormity of our annual crops, our output of coal, the production of iron and the like, but frequently this results in filling the reader with astonishment at the hugeness of the pyramid itself rather than impressing him with the enormous bulk of the product compared therewith.

Public interest in large buildings has been so occupied with the loftiness of the Metropolitan and Singer towers in recent years that other buildings, much larger, when their three dimensions are considered, have received practically no attention. For example the City Investing Company's building, though many times bulkier than the towers just referred to, has been almost completely overshadowed by the neighboring Singer tower because the latter reaches up a hundred odd feet higher.

However, the tower type of building has about reached its limit of height, not on account of any structural difficulties, but because the revenue from offices hardly provides sufficient return on the original investment. For this reason, the sky-scrapers of the future will have to be wide and deep as well as tall. Our sky piercing towers have established the records but the real work of raising the sky line of New York will be done by the large buildings that are growing up to these record heights. It is only fair that these huge, though not so tall buildings, should receive recognition.

The largest office building now in course of construction is an annex to the Whitehall Building on Battery Place. The original structure is only twenty stories high, but the Annex is to consist of thirty-one stories, and will rise to a height of 415 feet from the curb. While this is about 75 feet less than the extreme height of the City Investing Building, it represents a larger rental capacity when combined with the old building, the office space in the two being 550,000 square feet, or more than in any other building in the world. The Annex is built on a plot of 51,515 square feet, and the total cubical capacity of the building, exclusive of the foundations, will be 11,000,000 cubic feet.

Before commencing the actual construction of the building, it was necessary to excavate 17,000 cubic yards of earth. This is equivalent to digging a narrow trench 18 feet wide and 6 feet deep all the way from the Battery to Madison Square.

In order to convey an adequate idea of the tremendous proportions of this building, our artist has dissected the structure and assembled the principle materials about the Madison Square Garden and Tower, as shown on the front page illustration. The structural steel work, representing 14,000 tons, has been built up into a single girder of standard proportions 19 feet square, the metal being correspondingly heavy, and this extends to a height of 308 feet. The girder compares favorably with the Madison Square Tower. In constructing the walls of the building seven and a half million common brick will be used, and these, if built up into the form of a brick of standard proportions, would completely overshadow Madison Square Garden. In addition to the common brick, 900,000 face brick will be required in the building as well as 3,000 tons of ornamental terra cotta and the latter molded into a single capital would occupy the dimensions given in the illustration. Within the building there will be 450,000 square feet of partition tile and 120,000 square feet of column covering. 45,000 barrels of Portland cement will be used. The cinder fill for the floors will be about half a million cubic feet, which, if put into a rural sidewalk of standard dimensions would reach nearly all the way from New York to Philadelphia. It is astonishing how much glass is required in the building. If made into a single sheet it would cover 60,000 square feet, or more than an acre and a half. Even such a thing as the

window weights is an enormous item, as will be evidenced by comparing the huge window weight in the illustration with the man shown at the right hand side. While modern office buildings are constructed of fire proof materials, a certain amount of wood is absolutely necessary. For the floors alone of the Whitehall Annex, 800,000 board feet of yellow pine will be required, while for the base molding, 80,000 feet will be used.

To heat the building, 65,000 sq. feet of radiator surface will be furnished and if a single radiator were made to provide this amount of radiating surface it would rise almost to a level with the roof of the Madison Square Garden. The boiler equipment of the building will consist of 21,000 horse-power, and the engines of 2,000 horse-power. The combined candle-power of the electric lamps will be 190,000 and there will be over 3,000 electric fixtures, with 65 miles of conduits and wiring. Ten miles of plumbing will be necessary and 20 miles of steam pipes. While these are only a few of the items required in the construction and equipment of the building they suffice to show that a large structure may possess a great deal of interest quite apart from its height.

#### How Rolls was Killed.

It will probably never be quite clear in what way Rolls was killed, but there can be no doubt that in this case, as in several recent accidents, the immediate cause of the disaster was the failure of the machine itself. It is, of course, possible—and, in fact, probable—that this failure was caused by the aviator trying to make a very sudden change in his course in order to alight in the exact spot desired, and that this involved putting over the tail plane to such an angle as to bring a greater strain on it than it was intended to bear. What is certain is that the framing of the tail broke, the machine became uncontrollable, and fell on its head. The rudder was found attached to the framework after the accident. The accident in any case emphasizes the lesson that the factor of safety in the various parts of aeroplanes requires a great deal more consideration than it always gets. It is always possible that aviators will put either their elevators or rudders hard over, and there may in practical flight be cases where this is absolutely necessary. Now no one would consider the steering gear of a boat or motor car satisfactory if simply putting it hard over when in motion caused it to break, and the reliability of these parts in aeroplanes must be brought up to that of other machines. It may be objected that this would cause extra weight, but it would be better for the machine to be slightly heavier and safe.

That it would be quite possible to make the machine heavier without preventing its flight is evident from the fact that flights have been made with a passenger, and, in fact, sometimes with more than one passenger. It is, however, true that giving the parts a larger factor of safety might reduce the weight available for engine power or fuel, and consequently interfere with "records," and therefore competitions in which making records is the principal point may not be altogether good for practical progress. If one could have a "reliability trial" on the lines of the motor car trial, it would probably do much more good.

The death of Mr. Rolls will be a very great loss to English aviation. He was one of the pioneers in motoring, driving for some years as an amateur. Aviation was, however, taken up entirely as a sport, and not, as in many cases, as a means of making money, and there can be no doubt of the value of such men in the progress of aviation. It was really the enthusiastic amateur who developed the motor-car, as he found its defects, and had no trade interests to prevent his saying what he thought. Mr. Rolls was generally considered a bold, but not a rash, aviator, and no one who saw him rounding the marks at Bournemouth could doubt his skill. It will be recollected by most that he is the only man to have made the double journey across the Channel.—Engineering.

#### The Current Supplement.

In the beginning of 1908, the South African Chamber of Mines in co-operation with the Transvaal Government, arranged for a practical trial of small rock drills for stoping. Two prizes of £4,000 and £1,000, respectively, were offered. The results of this year's competition are published in the opening article of the current SUPPLEMENT No. 1805. An excellent article is one entitled Superheating at Sea. Mr. Harrington Emerson arraigns Our Inefficient Industrial Organization and points out how it can be improved by the adoption of a "staff" as in the army. Some interesting novelties and inventions are described and illustrated. The Paris correspondent of the SCIENTIFIC AMERICAN writes on The Radioscope, an instrument devised for use in making measurements of radio-activity of various substances. The summary of Sir J. J. Thomson, F.R.S., on Light and Electromagnetism is continued. Impulse and Reaction Turbine Systems are critically analyzed.

#### A Universal Differential Pressure Chamber.

BY JOHN B. HUBER, A.M., M.D.

There is now no region of the human body sacred from the surgeon's knife. No day passes in any hospital of fair dimensions that the abdominal cavity is not invaded. Who, several decades ago, dared venture upon entering the cranium? Yet to-day this is done frequently; brain tissue is relieved of pressure by depressed fractures, adhesions occasioning epileptic seizures are separated, cysts are evacuated, cerebral abscesses are drained, blood clots are removed not only from the surface of the cerebrum after injury, but also from the most deep-seated and vital tissues, as in apoplexy.

Until very recently, however, the surgeon has paid the thorax deep respect—that cage which imprisons the lungs, the pleura, the heart, and the great vessels; because, while the cerebrum and abdomen contain organs not immediately essential to existence, we should die almost instantly if the heart and the lungs (especially the latter) are put out of action, and because the resilient and elastic lung tissue tends to collapse, on opening the thoracic cavity, under the atmospheric pressure of fifteen pounds to the square inch, to which the surface of our bodies is subjected.

Before 1904, the thorax had indeed been entered, but not safely, unless inflammatory adhesions between the pulmonary and costal pleura protected the collapsible lung tissue against the ordinary atmospheric pressure. But such operations were not justifiable, except when the patient's case was desperate. The surgeon must operate within the thorax as safely as anywhere else within the economy; besides the possibility of an immediately fatal issue, the serious disease, acute pneumothorax, must be feared from such an operation.

In laboratory work on animals a cannular or an inhalation tube has been tied in the incised windpipe, through which air has been rhythmically forced by bellows, and by which means artificial respiration has been maintained as long as needed; but such devices were not applicable for human beings.

So surgeons have recognized that such operations as thoracotomy and pneumectomy cannot be done with impunity without the aid of differential air pressure. Much experimentation had been done to this end, with the result that both the lungs and the esophagus may now be safely invaded. The heart may be exposed to view, the pericardium opened and the myocardium incised. All this is not the easiest thing in the world; nevertheless, the skilled surgeon may now proceed with confidence upon operation most hazardous a few year since.

Among a number of devoted physicians who experimented in differential pressure surgical work, Brauer and Sauerbruch, in Europe, established fundamental principles. The result was that in 1904 there were operating chambers in use in Europe. Brauer's apparatus is a single positive pressure chamber akin to that presently to be described. That of Sauerbruch is a negative pressure chamber, the patient's head being outside of it in the ordinary atmosphere, his body being in the chamber. As in all pioneer work, they were open to various objections. They were made of metal; voices reverberated in them; surgeon and anesthetizer were separated by a solid wall; the noise made telephoning impossible; the operator could not see his patient's face; there was not sufficient room; there was no provision for breakdown of power; there was negative pressure only, or positive pressure only.

Up to the spring of 1908 the existing apparatus was of two types; one working from atmospheric pressure downward, negative pressure; the other from atmospheric pressure upward, positive pressure. There was none working both ways. Wherefore Dr. Willy Meyer of New York city, and his brother, Mr. Julius Meyer, an engineer, built a double chamber for use in positive and negative differential pressure. It was in this chamber that I saw the whole left lung of a dog removed, *cito, tute et jucunde*, as our medical forebears used to put it. A description of this chamber follows:\*

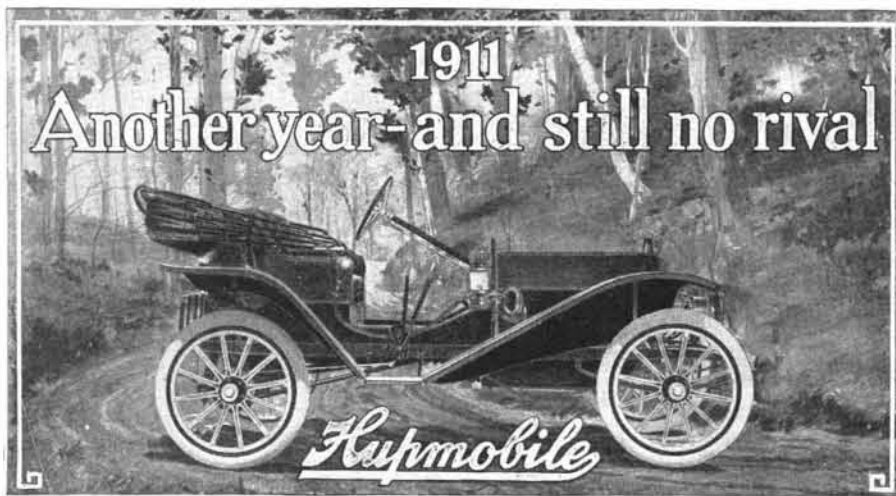
There is an outer negative pressure chamber (the operating room) within which is a positive pressure chamber (the anesthetizer's room). It is thus possible to operate under either negative or positive differential pressure; under a combination of the two; or from one to the other in the same operation.

The advantages of combining two chambers to form one apparatus are: The operating table remains fixed under whatever pressure the operation is done; and there is avoided the moving of the table from inside to outside necessary with the European tables, should it be considered feasible to change the pressure from positive to negative, or *vice versa*. Moreover, in this Meyer chamber there is ample space for the surgeon and his assistants and nurses, arranged for by the projecting head box, in which there is an aperture closed by a rubber collar, adaptable to the size of the

(Continued on page 113.)

\* Based on Dr. Willy Meyer's paper, "Pneumectomy, with the Aid of Differential Air Pressure," in the Journal of the American Medical Association, December 11th, 1909.

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Bernard Palissy, the Famous French Potter and His Works	Chas. A. Brassler
"Crystal Brook," A Co-operative Colony	Jerome Walker, M.D.
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Some Novel French Chimney Pots	Frances B. Sheaffer
"A Nook in a Formal Garden"	
Furniture for the Home—Garden Furniture	Esther Singleton
The Handicraftsman—Methods of Beautifying the Common Gas Light	Catherine A. Jensen
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(Concluded from page 112.)

ment; one 10 horse-power motor serves to actuate the entire system. The bell cranks have been done away with and ordinary cranks are substituted. The cars have also been improved.

It will be curious to note what another year will bring forth in this delightful pleasure center which is the dean of all such places.

### A Universal Differential Pressure Chamber.

(Continued from page 102.)

neck, the bulging of which collar is prevented by guillotine shutters. The operator can see the patient's face, and the anesthetizer the body—not directly, however, but through a mirror; and attention is, therefore, not distracted from the work of anesthetizing. The anesthetizer and the head of the patient are in the smaller positive differential pressure chamber, which is of size ample for the use of oxygen and other apparatus, and has an airlock providing access and egress while the pressure is on, and without interruption thereof; from this chamber the ether fumes are ventilated off every minute.

The operating chamber needs no air lock. Its pressure can at any time be raised from negative to atmospheric pressure, while the differential pressure required for the operation is being maintained without interruption, so that the door leading to the outside can then be opened. A triple reserve is provided in case of breakdown. There are two independently driven sets of pumps—one for pressure, and one for vacuum; so that in case of any mishap to one unit an immediate change can be made from one kind of differential to the other; in the event of accident to both units a hand pump is provided, for maintaining the positive differential pressure in the anesthetizing chamber. The motors run at constant speed. The variation of the air pressure in the chambers is effected by manipulations of two air valves, set by hand to the desired gage readings—a matter so simple that mistakes are excluded. The valve is simply a cock.

The chamber is of knockdown construction and transportable; there is nothing about it to get out of order. Two different materials are used: iron, which forms a light open framework, sufficiently strong to resist air pressure, and requiring for its construction nothing foreign to everyday structural iron work routine, and balloon material, which is airtight and is kept to the desired shape by the framework. In the positive pressure chamber the fabric is arranged inside the metal frame; in the negative pressure chamber the fabric is outside the framework. This structure was built to withstand hard usage; and it has had it. Truckmen, railwaymen and others have done their worst with it. It has repeatedly been tested and retested; it has been erected, knocked down, carted from place to place, transported to various hospitals in various cities. One man and a helper can knock it down in about an hour; they can put it together again in less than four hours; soldiers especially drilled should do it in even less time. It is practicable in war. It is disinfected by formalin vapors, which are ventilated off by the pumps.

This structure belongs neither to the kind of apparatus that works from atmospheric pressure downward, nor to that working from atmospheric pressure upward. It is *sui generis*. The aim in its construction has been to overcome and remove the limitation of differential pressure chambers to atmospheric pressure as the fixed basis at one end of the difference in pressure; and to enable the establishing of the basis anywhere above or below, or at atmospheric pressure, at will. This was accomplished by combining two differential chambers in one apparatus, in which these modifications were possible:

- (1) The rooms may be separate;
- (2) they may have one corner in common;
- (3) or one wall in common—in all which

(Continued on page 114.)



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**Inquiry No. 9016.**—Wanted, machinery necessary for an installation of a plant for refining salt by a modification of the Bessemer process.

**WANTED.**—Manufacturers to submit estimates (for large quantities) or communicate with us concerning U. S. Patent No. 858,684. Cast in white, hard, non-brittle metal. W. Adelman, 220 Washington St., Hoboken, N. J.

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### WANTED.

**PATENTED ARTICLES WANTED.** In the line of hardware specialties and tools by a responsible concern. Patents must be valid and satisfactory. Either purchased outright or on royalty. Only thoroughly practical articles or novelties can be used. For further information address "Conservative," Box 773, New York City.

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**Inquiry No. 9099.**—Wanted, address of manufacturers of machinery for making wire cables.

**Inquiry No. 9109.**—Wanted addresses of the manufacturers of the Dion Desk Clock.

**Inquiry No. 9113.**—Wanted name and address of the manufacturers of the Russell Patent Automatic Ink Well.

**Inquiry No. 9115.**—Wanted a machine for making pen nibs, similar to Wm. Mitchell's G. & J. nibs and Waverly nibs.

**Inquiry No. 9120.**—Wanted, the address of the Ideal Fuel Feeder Co.

**Inquiry No. 9137.**—Wanted, a device that will braid leather strips for horse whips.

**Inquiry No. 9138.**—Wanted, the address of manufacturers of machines capable of forming a number (12 or more) of pieces of paste about 38 mm. x 32 mm. x 6 mm., made of lead oxide and sulphuric acid, and placing them into a frame having a separate compartment for each piece, the space between each piece and the next being all round 4 mm. The process could be somewhat similar to biscuit making.

**Inquiry No. 9143.**—Wanted, name and address of the manufacturers of an air mattress.

**Inquiry No. 9144.**—Wanted, manufacturers of machinery for making soda water tubes, commonly known as straws.

**Inquiry No. 9145.**—Wanted, to buy machinery to load blasting caps or detonators.

**Inquiry No. 9152.**—Wanted, the address of the Graham Safety Lamp Filler and Ventilator.

**Inquiry No. 9153.**—Wanted, name and address of manufacturers of a knotless clothes line.

**Inquiry No. 9155.**—Wanted, the address of manufacturers of an electric milking machine.

**Inquiry No. 9163.**—Wanted, manufacturers of a crane worked by clock work.

**Inquiry No. 9167.**—Wanted, the address of the German-Quartz Co.

**Inquiry No. 9168.**—Wanted, the name of manufacturer making the Morse Eureka Spring Terminal, sometimes called spring clip.



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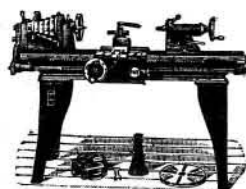
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This machine is the regular hand machine supplied with a power base, piston, countershaft, etc., and can be worked as an ordinary power machine or taken from its base for use as a hand machine. Pipe 1/4 in. to 1 1/2 in. diameter handled easily in small room. Illustrated catalogue—price list free on application.

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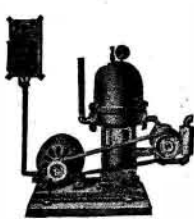
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(Continued from page 113.)

the two rooms can be either outside each other or one inside the other; and (4) two rooms may be one partly outside and partly inside the other one. Meyer selected the combination of two separate rooms, one inside the other.

The following air pressure combinations can be made:

1. Pressures in both chambers deviate in the same direction from the open air.

A. Inner positive chamber combined with outer positive chamber.

B. Inner negative chamber combined with outer negative chamber.

2. Pressures in both chambers deviate in opposite directions from the open air.

C. Inner positive chamber combined with outer negative chamber.

D. Inner negative chamber combined with outer positive chamber.

The positive chamber in the negative chamber (2 C) is that devised by the Meyers; and now used in the Rockefeller Institute in New York city. It was selected for construction because: (1) it enables the nearest approach to operating in open air by building up the differential pressure of one-half positive and one-half negative pressure; (2) the anesthetizing room can be used independently as a positive pressure chamber—as in the Brauer apparatus; and (3) the anesthetizing chamber can readily be transformed into a negative chamber in the negative chamber (1 B) by simply reversing the motor of the pump that ventilates the anesthetizing room, so that the pump is converted from a blower into a suction pump. If the valves are now set to produce higher rarefaction of air in the operating chamber than in the anesthetizing room, the latter remains relatively a pressure chamber; and, by maintaining the proper differential the thorax can safely be opened with negative pressure over the mouth as well as over the open thorax. For example, an operation was done under such conditions with a local barometric pressure of 760 millimeters (29.721 inches) Hg., 744 millimeters (29.291 inches), over the open thorax, and 750 millimeters (29.527 inches) over the patient's mouth; which is equivalent to doing the same operation at a higher altitude than that in which the work was done.

By merely ventilating the outer room at atmospheric pressure and putting the inner room under increased pressure, the two combined chambers become simply a positive differential pressure apparatus.

Thus in this Meyer apparatus operations can be done: (1) under positive differential pressure; (2) under negative differential pressure; (3) under part positive and part negative differential pressure; (4) under a gradual change from positive to negative pressure, and vice versa; (5) under a repeated change from positive to negative differential pressure and vice versa; (6) under negative differential pressure at an altitude above sea level higher than that of the place where the operation is done; (7) under negative differential pressure as in (6), but at gradually or repeatedly changing altitudes. Therefore this apparatus is rightly termed a "universal differential pressure chamber;" and the narcotizing room, when independently employed, is termed a "positive differential pressure chamber," because it must always and under all circumstances have a higher pressure inside than outside of it.

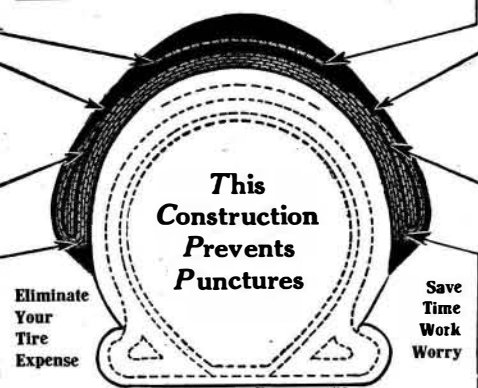
Space will not permit a detailed consideration of many most interesting factors: for instance, how the combination 1 A is not likely to be used, since it would in effect be lowering the patient's open thorax into a shaft below the surface of the ground, and depressing the patient's mouth still further. On the other hand, the combination 2 D should have importance, not in thoracic surgery (Concluded on page 115.)

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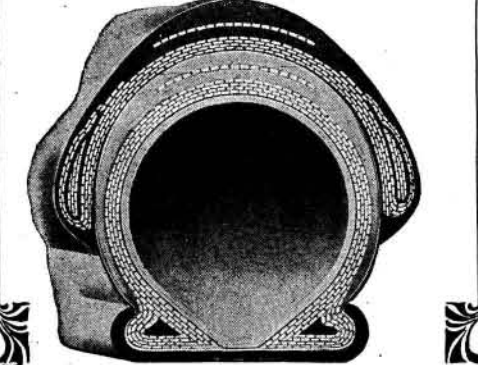
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(Concluded from page 114.)  
—because negative pressure at the mouth and positive pressure at the open thorax would accentuate the pneumothorax—but in cranial surgery, because by means of it the blood can be drawn away from the brain, and by varying the pressure the quantity of blood thus temporarily withdrawn from circulating through the heart can be controlled. (In this latter combination the patient's body is put into the inner chamber.) Again, in a case of collapse, artificial respiration was produced with the positive differential chamber by rhythmic movements of the valves handle, increasing the pressure quickly, and lowering it again to atmospheric pressure.

To what pressure can the operator and his assistants expose themselves? Where is the danger line? Even should the negative chamber be exhausted to a differential pressure of 50 millimeters (1.968 inches) Hg., thus being strained to the limit of its capacity, they would still be within the limits of possible everyday experience; for in our climate barometric fluctuations of 50 millimeters Hg. are nothing unusual. The differential pressures used in thoracic surgery seldom exceed 7/8 millimeter (0.276-0.315 inch) Hg., corresponding to a difference in altitude of from 250 to 300 feet; that is, the patient's mouth is lowered about 300 feet below his opened thorax. However, surgeon, assistants, anesthetizer and nurses are not under differential pressure at all; their entire bodies are under only one pressure.

This combination of medical and engineering science was begun early in 1908. Numerous difficulties were met; on December 23rd, 1909, the Universal Differential Pressure Chamber was tested: it was first used in the Rockefeller Institute on January 8th, 1909; on May 7th, 1909, it stood complete, as here described.

It may be *apropos* to consider briefly, other contrivances by which atmospheric changes are made for medical purposes. There is the Kuhn pulmonary suction mask, which at two hourly intervals is placed over the nostrils and mouths of sufferers from pulmonary tuberculosis, asthma, anemia and certain heart affections, the purpose being to produce a rarefaction of the air in the chest, with a consequent hyperemia. Then there is the pneumatic cabinet, which Dr. C. E. Quimby and other physicians in this city have for at least a decade past been using for pulmonary and cardiac affections. On entering this cabinet one breathes the ordinary atmosphere from without through a rubber tube, while he is subjected to negative pressure. An odd sensation here is that in expiration one has actually to push out the air from one's lungs, and with some little effort. Another is a compressed air chamber, seemingly as large as a fair-sized living-room; there is at least one of these in London, though I do not know of any in New York city.

To return to the Meyer apparatus: One reaches the most satisfying conclusion that, in view of the numerous pathological conditions which occur in the human chest, many operations can be done in this region, by means of this apparatus as safely as anywhere else in the economy. One may work thus under differential pressure, whether or not there are adhesions between the pulmonary and costal pleura. Deep stab and shot wounds of the chest may be repaired; tuberculosis cavities and abscesses—gangrenous and otherwise—may be opened and drained, the ordinary operations upon the pleura will be done with greater ease and safety; the mediastinum and the cardia may be invaded much more frequently and securely than formerly; foreign bodies will be extracted from bronchi when located by the X-rays; portions of diseased lung may be excised; one or more lobes, even the entire lung, may be amputated.