

### A GIFT OF PHILANTHROPY TO SCIENCE.

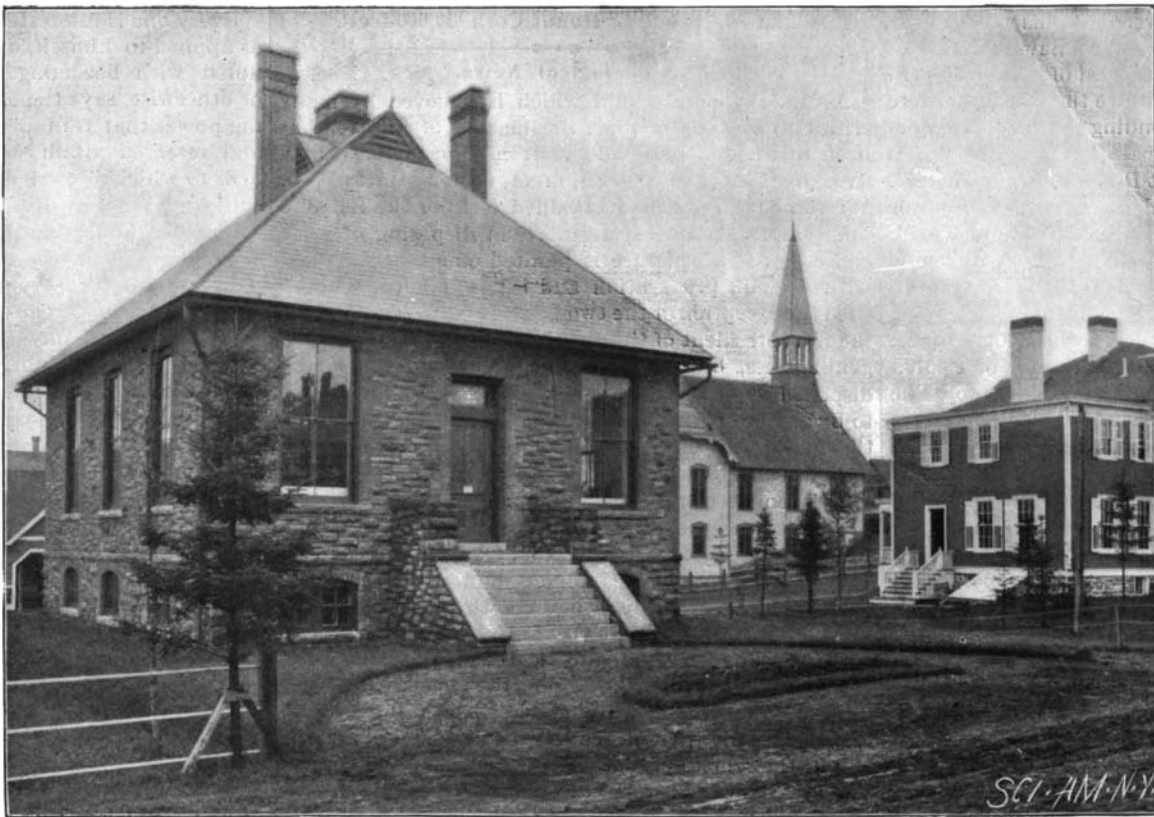
THE SARANAC LABORATORY FOR THE STUDY OF TUBERCULOSIS.

BY E. R. BALDWIN, M.D.

This institution is situated at Saranac Lake, New York, in the heart of the Adirondack Mountains, and was presented by the late George C. Cooper, of New York, to Dr. E. L. Trudeau, whose name is familiar to visitors in this healthful region. The laboratory, which is the first of its kind, has no commercial features, but is devoted solely to researches in tuberculosis. In this it is exceptional, being equipped for this special work, and meets an urgent demand in this country, where few facilities are available for such research, and at a time when medicine is hopeful for the conquest of all infectious diseases; for only by such research in laboratories can we expect to accomplish this end and lessen empiricism.

The importance of interlinking research and treatment in tuberculosis had been evident to Dr. Trudeau from the earliest days of the Adirondack Cottage Sanitarium for pulmonary diseases, and with such improvised apparatus and meager quarters as were then available, a series of researches had proved the importance of such work and given promise of beneficial achievements. Mr. Cooper, an intelligent observer of the practical work of the sanitarium—a charity which also received his benefactions—soon realized that more adequate facilities for investigations here and upon this special theme would give rich promise, not only of important achievements in science, but also of direct and immediate benefit in the practical aims of the sanitarium. This broad conception of the importance of establishing a close relationship between research and practice soon crystallized into a purpose to secure such a relationship here upon a firm and lasting basis. This beneficent and clearly conceived purpose of Mr. Cooper was carried out with characteristic absence of ostentation, and is only one example of his liberality in the cause of education and in the relief of suffering. His aim was realized during his lifetime, and is an expression of the spirit manifest in the family which gave to New York the Cooper Institute. Mr. Cooper was not satisfied with the mere establishment of the material facilities for investigation, which his gift of the laboratory afforded, but, in association with Mr. John Garrett, of Baltimore, gave a fund sufficient to carry on researches for several years, while a brother of the latter, Mr. Horatio Garrett, now deceased, provided a fund for a library.

The Saranac Laboratory, as will be seen by the exterior view, is a substantial, fireproof, stone building, located near the Adirondack Cottage Sanitarium, which is a well known resort for consumptives. It consists of one story and a basement. The interior is finished with white enameled brick walls, which permit of easy disinfection, while being simple and attractive. The laboratory, as will be noticed by the illustration on the front page, is spacious, has high ceilings, perfect light, and ventilation



SARANAC LABORATORY FOR THE STUDY OF TUBERCULOSIS.

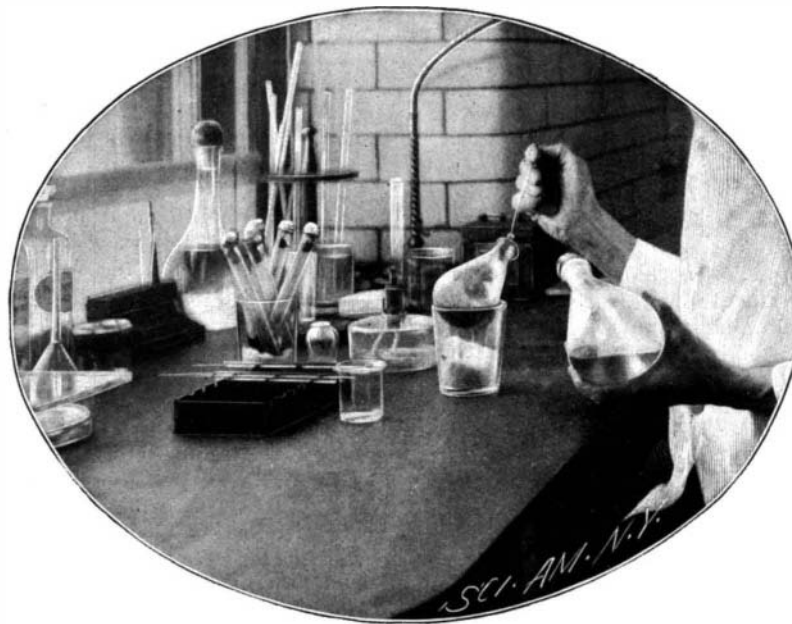
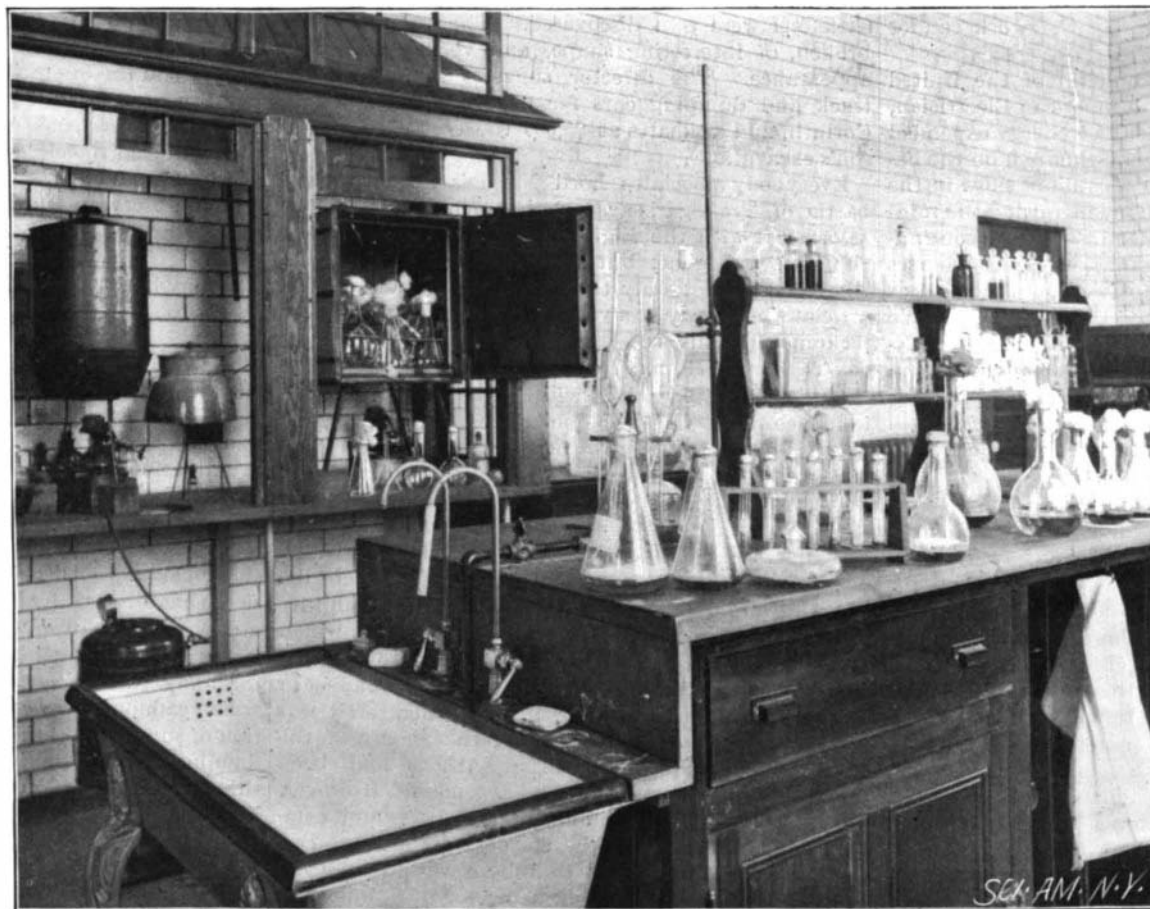


Fig. 4.—TRANSPLANTING CULTURES OF TUBERCLE BACILLI



SARANAC LABORATORY—INTERIOR MAIN ROOM.

through dust filters; is provided throughout with electric lights, abundant water supply and hot water heating apparatus. This room contains the principal bacteriological and chemical apparatus. At the extreme end of this room, on the right, will be noticed one of the incubators, a nearer view of which may be seen in our large upright illustration. On the left is seen a private workroom in the distance.

Another view on the accompanying page shows the chemical apparatus and the position of the dry and steam sterilizers in the inclosed hood; also a sink and work table. On the upper front page is pictured a larger view of the flasks containing cultures of the tubercle bacilli growing on the surface of fluids, while the tubes on the right illustrate its growth on slices of boiled potato and agar. The incubator, or culture oven, is a metal chamber surrounded by a water jacket and thick asbestos covering, insuring a uniform

temperature, maintained by means of a lamp placed under the thermostat. Overheating is prevented by an electrical alarm controlled by a thermometer. The whole is inclosed in an outer glass case with doors.

There are also two private workrooms, besides a library specially devoted to the literature of tuberculosis, a room for animal examinations, and a room for living animals under observation in the basement.

It is by the study of such growths or cultures that the life history of this sinister germ is made out and a clear understanding is obtained of its action in the human body. Through these cultures, also, studies can be carried on upon various agencies which it is hoped may be beneficial in the treatment of the disease.

The bacillus of tuberculosis is naturally treated with respect in this laboratory. Precautions against infection are constantly employed in handling flasks and other receptacles containing the bacilli. The same is true of the animals, whose cages are constructed of galvanized iron, so that they can be soaked in a tank of strong lye after being cleansed. The animal room, as well as the examination room, is occasionally flushed out with the hose, and sterilization by boiling is practiced on all apparatus before cleansing.

Guinea pigs and rabbits are chiefly employed for experimental purposes, and animal tests of many old and new remedies used in the treatment of tuberculosis form especially interesting branches of the work. New methods of treatment can be properly controlled only in this way, as it is impossible to secure uniform conditions in man; and experience shows that deductions made from animals very generally apply to human beings. This feature renders the laboratory valuable to the neighboring sanitarium in thus bringing scientific methods of diagnosis and treatment to the aid of the patients.

The equipment of the Saranac Laboratory provides for a great variety of work on the subject of tuberculosis, and, although so much has been revealed through the labors of Koch and others, there still remains a wide field unexplored in this

too familiar disease. There are many problems yet to be solved relating to public and private hygiene, including the spread of tuberculosis in man and domestic animals. There are many less practical but still highly interesting questions concerning the biology of this parasite, its variations in virulence and poisonous products; and, furthermore, the possibilities of alteration by changing its growth conditions.

There is great need for educational work in the matter of infection in tuberculosis, and it may be pertinent here to mention briefly some facts relating to it which have thus far been amply demonstrated:

1. The sputum of consumptives is the source of infection in by far the greater proportion of cases.
2. The breath alone does not contain the bacillus.
3. Sunlight with drying destroys the vitality of the bacillus in twenty-four hours' exposure.
4. The bacilli in sputum may preserve vitality for months, when deposited in badly lighted and ill ventilated places.

It is worthy of note that victims of the disease usually have an acquired or inherited susceptibility. Direct inheritance of pulmonary tuberculosis is probably extremely rare.

Fig. 1 is a reproduction from photographs by Edward Leaming, M.D., made at the College of Physicians and Surgeons, New York, of bacilli magnified 1,000 diameters, found in the sputum of a person affected with tuberculosis. The minute elongated black specks, sometimes arranged to form the letters V and X, are the bacilli, and are distinctive in shape, to be readily detected and recognized wherever seen when properly stained.

It can easily be comprehended from the photograph how these little parasites can float about in dust when the expectoration, carelessly deposited, is dried and pulverized.

The cultures of tubercle bacilli are comparable to the hothouse cultivations of many plants, though they require more delicately combined conditions for their development. They must have moisture, absence of light, and a fairly uniform temperature, near to that of the human body. A first culture of the bacillus tuberculosis is one of the most difficult of all the pathogenic germs to obtain; failures often following attempts to grow it from a tuberculous animal, or—what is still more difficult—directly from the sputum of a consumptive. Such sputum usually contains numerous rapidly growing bacteria besides the slow growing tubercle bacillus, so that the tubes become contaminated easily long before the latter gets a start.

It is customary first to inoculate a guinea pig or a rabbit with a small particle of the expectoration, which, unless the animal shortly dies of septicaemia, quite uniformly results in death from tuberculosis after six weeks or within three months. From the diseased organs, and especially from the lymphatic glands, bits of tissue containing the bacilli are obtained entirely free from other germs which were present in the inoculated sputum, but were unable to develop in the animal after a short time, leaving the field clear, so to speak, for the tuberculosis germ. These bits of tuberculous tissue are transferred on sterilized forceps and platinum needles to tubes of hardened blood serum, upon the surface of which they are rubbed.

Koch first succeeded in growing this germ upon coagulated blood serum, which furnishes nutriment most nearly like the animal tissues, their natural pabulum.

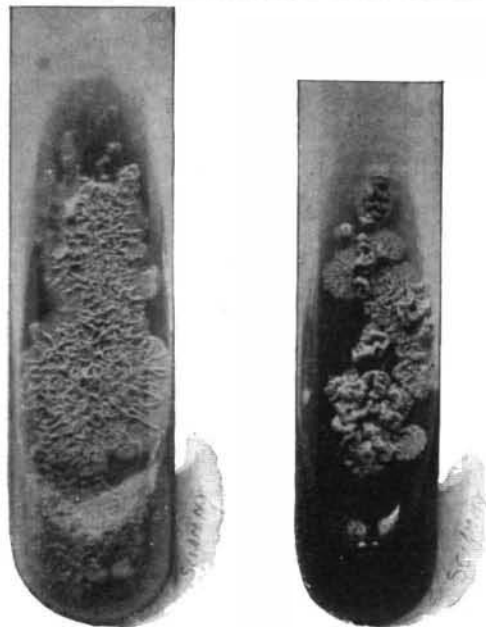


Fig. 2. TUBE CULTURE B. TUBERCULOSIS—CULTURE ON AGAR AGAR. Fig. 3.

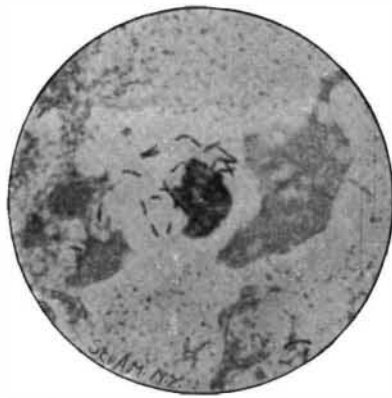


Fig. 1.—TUBERCLE BACILLI IN SPUTUM×1000 DIAMETERS.

It is, in fact, very difficult to start cultures on any other substance except potato.

Figs. 2 and 3 are excellent photographs showing the growth of these bacilli on agar agar or Japanese gelatin.

After the artificial cultivations are started on serum or potato, it becomes fairly easy to continue rich growths on agar, beef broth, and even upon solutions of salts containing phosphates, sulphates, carbonates and glycerine. This is done by transplanting from an actively growing culture a particle or flake of the crust-like mass of germs to sterilized tubes or flasks of fresh media. The details of this process are needed in the study of the growth products of the bacillus tuberculosis.

Tuberculin is made from flasks of bouillon grown six weeks, during which time the fluid becomes charged with the soluble products of growth. The original tuberculin of Koch, which caused so much excitement five years ago, consisted of such cultures simply evaporated to one-tenth their volume, and filtered free of bacilli.

Tuberculin, or the "lymph," is still used as a remedy in a very limited way, in spite of the condemnation it receives as a consequence of unfortunate results in the past. A few selected cases are undoubtedly benefited by it, but by far the most important sphere of usefulness for tuberculin is for the diagnosis of tuberculosis. Its extensive employment for this purpose in cattle needs no mention, as its value is well established.

The use of tuberculin for detecting early tuberculosis in human beings is becoming more general, though the odium that was cast on it during its indiscriminate use four or five years ago still clings to it in the minds of many physicians. The striking effect of this fluid is in selecting the hidden disease and causing local congestion therein, while at the same time producing constitutional disturbances such as fever, malaise and muscular pains, all of which soon disappear. No effect follows in the great majority of persons when tuberculosis is absent.

Inasmuch as the successful arrest and cure of tuberculosis depend upon its early detection, we can no longer neglect any aid that laboratory methods have

already revealed. If these alone are considered, we owe a great debt to Koch and his brilliant work.

There are three invaluable methods of diagnosis in obscure cases, which in the order of frequency of application are:

1. The microscopical examination of sputum and other secretions for the presence of tubercle bacilli.

2. The inoculation into susceptible animals of suspected sputum, etc., in which the microscope fails to reveal the bacilli.

3. Tuberculin injection, where the first two methods fail, or there is no sputum or other discharge available for examination.

When the disease is present, it can be detected in some one of these ways with almost absolute certainty, even in its earlier stages.

Probably the most important problem or line of research engaging the attention of laboratory workers in medicine at present is the subtle one of immunity from or acquired insusceptibility to tuberculosis and other diseases. We cannot yet say whether we shall ever by artificial means be able to protect the human body against the invasion and spread of the bacillus tuberculosis, yet we may cherish this possibility in view of the recent specific antitoxin so unquestionably useful in diphtheria. The discovery of a specific remedy for tuberculosis has always been the



SARANAC LABORATORY—INCUBATOR OR CULTURE OVEN.

dream of enthusiasts, and it may be that ere long research will develop methods for the production of antitoxic serum efficacious in this disease. Experiments in this direction have thus far led to results not without promise, but as yet without any demonstrated practical value. It seems reasonable to expect the development of some means of neutralizing the poisonous products of the bacilli in the body, as has been done in diphtheria, even if a complete cure be not thus effected.

When we consider the process accompanying natural recovery from consumption, which we call increase in resistance, the loss of which constitutes the main factor in susceptibility, we must conclude that the success of a specific remedy involves many influences in our complex civilization which raise or lower bodily vigor; and that the permanence of any immunity produced must also depend on these factors. An open-air life in a favorable climate, combined with nutritious food, accomplishes more surely the prevention and cure of consumption than any remedies yet known, though the latter may assist. The world will doubtless cling to such verities until science shall point out better methods, discovered step by step in laboratory study.

While state and national authorities are concerned with varying degrees of interest and success in furthering the economic interests involved in the prevention of diseases among cattle, the human animal in this country has as yet certainly been largely ignored in official measures for the public weal. Among the multitudes of safeguards now put about life, can we afford to neglect studies which look to the control of this widespread disease in man?

We are indebted to Mr. G. W. Baldwin, the photographer of Saranac Lake, for the excellent photographs from which our illustrations are made.

#### The New Navy Bill.

Whatever regret may be caused in some quarters by the fact that the new navy bill as reported by the House Naval Committee makes no provision for the addition of any new battleships to those already built or building, one cannot but rejoice that the changed aspect of our international relations is in some measure the cause of the omission, the sense of the pressing need for an immediate increase in the navy having moderated with the return of tranquillity in our foreign relations.

The last naval bill with its large appropriation of over thirty millions was passed at a time when the political sky was overcast and possible complications with England and Spain were threatening. The intervening twelve months, thanks to skillful and well directed diplomacy, have seen a great clearing of the air, the effect of which is undoubtedly seen in the provisions of the present bill.

It is true that, as reported by the sub-committee, the bill recommends an even larger appropriation than last year, the total being \$32,165,234; but it must be borne in mind that although \$13,146,155 of this sum are asked for "increase of the navy," and for "armor and armament," a large proportion of the latter sum is for carrying on the construction of the five battleships which have recently been authorized and are now in the early stages of construction. There is no doubt that the fact of our having in all six first-class battleships under way has also tended to reduce the recommendations for new ships. Including the Iowa, now nearing completion, the battleships under construction have an aggregate displacement of 57,580 tons, and as will be seen from the details given below they will constitute a homogeneous fleet of practically the same size, speed, and fighting power:

The Iowa, of 11,300 tons displacement and 16½ knots speed, carrying four 12 inch, eight 8 inch, and six 4 inch guns besides 26 smaller guns.

The Kearsarge and Kentucky, of 11,500 tons and 16 knots speed, carrying four 13 inch, four 8 inch, and fourteen 5 inch guns, the last being rapid-firers, with 26 smaller guns.

The three ships of the Alabama class, of 11,520 tons and 16 knots speed, carrying four 13 inch guns and fourteen 6 inch rapid-firers, with 28 smaller guns.

These ships, which should all be in commission within the next three or four years, will constitute a formidable addition to our first line of defense. Taken with the three first-class battleships of the Indiana class, which are of less displacement but greater offensive power, they will give the United States a fleet of nine first-class battleships, admirably adapted by their similarity in speed for maneuvering in fleet formations.

At the same time it should be remembered that all naval preparation should be anticipatory, especially in the construction of battleships. With the plant that already exists in the country it would take at the very least three years to build and equip one of these floating fortresses, and not all the patriotism and wealth of the country could lessen the time of construction by an appreciable amount. The day when it was possible to "create" a navy passed away with the passing of the shipwright with his ax and his adz. Modern battleships are no longer created; they are the result of a steady growth, whose period is measured by years instead of months.

For this reason it would, perhaps, be a wise policy to institute a regular programme of shipbuilding, with provision for the regular addition of so much tonnage each year. By such an arrangement the cost would be evenly distributed, the burden of it lightened, and the nation would be saved from the dangers of panic expenditure on the one hand and of absolute neglect of the navy on the other.

Regarding the important question of the price of armor plate for the new ships the report says:

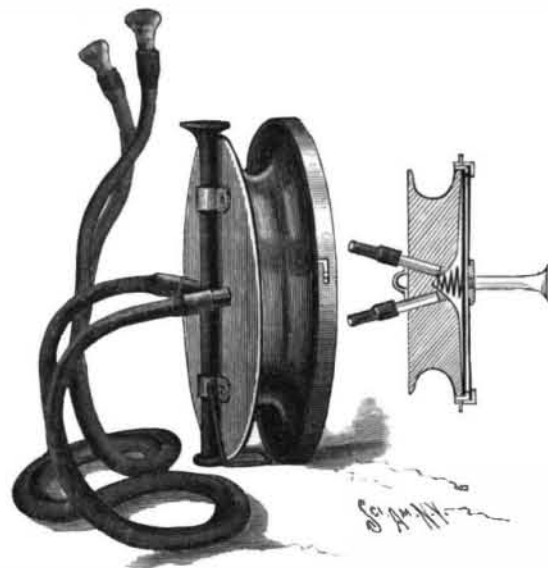
"In dealing with this question of cost, however, the committee has regarded it as one of such technical character that the information at its command is not sufficiently definite to enable it to fix with certainty a price per ton upon such a product of manufacture, and it has been indisposed to do so."

A lump sum is provided for the purchase of armor for the three ships now building, and the maximum price of \$400 per ton named by the Secretary of the Navy is practically adopted. This figure must not be exceeded; at the same time he is free to secure the armor at a lower price if he can do so.

Nobody will dispute the fact that "the question of cost" is one of a "technical character" any more than they will the fact that if American manufacturers have been selling Harveyized armor to the Russian government for half the price they were charging the home government, the question of cost has a decidedly commercial character as well. Granting that in the present emergency the suggestion of Secretary Herbert represents the best compromise that can be made, it is to be hoped that in the thorough discussion which the bill will receive in the House and Senate, the actual facts regarding the Russian order and the cost of manufacturing armor plate in this country will be established.

#### A "PHONENDOSCOPE" OR IMPROVED PHONOSTETHESCOPE.

A simple device for rendering distinctly audible on a magnified scale small sounds in the human body, or in



THE BAZZI AND BIANCHI "PHONENDOSCOPE."

bodies in general, is represented in section and in perspective in the accompanying illustration. It was patented by Eugenio Bazzi and Aurelio Bianchi, of Florence, Italy, in several European countries, in 1895, and a patent therefor has recently been issued in the United States. The improvement is based essentially on the fact that a vibratory elastic membrane, united with a body of larger mass and greater inertia, when laid upon another body in which small sounds occur, cause a vibratory action to be set up in the membrane, while the large mass of the heavy solid body is but very slightly or imperceptibly affected. As shown in the sectional view, the inert disk of heavy metal or weighted wood has a central hollow cavity covered by a membrane of hard rubber or similar material constituting a diaphragm, and inside the space thus formed is a weak spring pressing upon the diaphragm. The membrane is packed tightly against the edge of the disk by a clamping ring, and over the membrane is a somewhat thicker hard rubber plate, which preferably has a central orifice where may be secured a hard rubber or metal rod, which, when not in use, may be detachably fastened on the rear side of the instrument. In the rear of the disk are two holes which terminate in the central hollow, and here are inserted hearing trumpets or flexible tubes leading to the ears of one using the instrument, when the latter has been placed in position where the sounds to be noted or detected are looked for. Either the knob on the end of the rod, or the hard rubber outer plate of the instrument, is placed in contact with the body where the sounds are expected, and the tone vibrations cause movements of the plate far greater than those of the box, the heavy disk being comparatively inert, and these vibrations are communicated to the sense of hearing through the connected tubes.

#### GRANT'S MACHINE FOR SOLVING NUMERICAL ALGEBRAIC EQUATIONS.

BY GEORGE B. GRANT, PASADENA, CAL.

There is no branch of algebra upon which more labor has been spent than upon the "theory of equations," which treats mainly of the determination of the roots of equations of the form

$$ax^5 + bx^4 + cx^3 + dx^2 + ex + f = 0$$

and Sturm's theorem is the only complete solution of the difficult problem of finding the roots of such equations when their coefficients are numerical. To quote Prof. David E. Smith, a recent writer on the history of mathematics, "All processes were, however, exceedingly cumbersome until Sturm (1829) communicated to the French Academy the famous theorem which bears his name and which constitutes one of the most brilliant discoveries of algebraic analysis.

But there is more than one way to look at almost any subject, and this paper is to describe a machine to determine these roots approximately with but the least amount of assistant calculation.

The object is to discover the numerical values, called "roots," which, substituted for the unknown quantity,  $x$ , in any numerical example, such as  $7x^3 + 3x^2 - 15x - 4 = 0$  for example, will satisfy that equation and reduce it to zero. Theoretically, Sturm's theorem will completely determine all the real roots, but that method is so difficult to apply to decimal fractions that it is always abandoned after the integers have been discovered, and the solution completed by some other process. The machine is subject to a similar limitation, for, unless the mechanism is of the most delicate and costly description, it will give roots that are reliable only to one or two decimal places. It is, therefore, like Sturm's theorem, a means for so far locating the roots that they may be worked, if required to be very accurate, by some such rule as Horner's method.

There are two sets of scale beams, one more in number than the degree of the largest equation the machine is required to solve. Half of these beams are pivoted to balance on a fixed post and the other half are mounted on a movable post. On each beam is a coefficient weight which may be set in either positive or negative position on it by means of a scale of coefficients. The position of the movable post is shown by a scale of roots. This is essentially the whole machine, although there may be many refinements for unusually accurate work.

An examination of the engraving will show that it is a multiplying weighing machine, each beam being coupled to the next, so that the effect is continually multiplied. When all the pins are in the same vertical line the multiplier is unity, and when each pin is at the fulcrum of the beam it is working in the multiplier is infinity. Between these two points, unity and infinity, the multiplier is the proportion of the fixed distance of the pin from the fulcrum of its own beam to its variable distance from the fulcrum of the beam it is working in. This proportion, which is denoted by  $x$ , is uniform for all the beams for the same position of the movable post.

If the weight on the lower beam be set at any figure on its scale denoted by " $\pm a$ ," the effect on the second beam will be " $\pm ax$ ," for the effect of the weight on its own beam at the unity point is indicated by the scale, and that effect is multiplied by  $x$  at the unity point of the next beam. As the second beam has a weight set at " $\pm b$ " that will be added at its unity point so that the total effect on that beam will be " $\pm ax \pm b$ ." This, in turn, is transmitted to the third beam and multiplied by  $x$  as well as added to the weight " $\pm c$ " on that beam, making the total effect " $ax^2 \pm bx \pm c$ ." Similarly, the effect on the fourth beam is " $\pm ax^3 \pm bx^2 \pm cx \pm d$ ," and so on as far as the system extends. That being the compound effect of the weights acting on each other in succession, it is seen that the six beams will balance only when the resultant or total effect is zero, that is, when

$$\pm ax^5 \pm bx^4 \pm cx^3 \pm dx^2 \pm ex \pm f = 0$$

and that is the algebraic equation of the fifth degree in its most general form. Therefore, if the coefficient weights be set in their several positions and the post moved until the beams balance, the scale of roots will then show the proportion  $x$  and solve the equation.

The machine as here shown will directly find only the roots situated between unity and infinity, both positive. If the slot is continued past the fulcrum, toward the negative end of its beam, the machine will find negative roots also, but it is much more practicable to simply shift the weights on the fixed post each to the same reading at the other end of its beam, thereby changing the signs of all the roots of the equation and enabling the negative ones to be determined as if they were positive. If the slot is continued beyond the unity point the machine will find roots smaller than unity, but would never quite reach the root zero, so it is necessary to make a separate search for any roots there may be between plus unity and minus unity, after so transforming the equation as to shift all of its roots in the positive direction two integers.

It is plain that if a weight is set at 0, or taken off its beam, that coefficient is 0, so that the machine will

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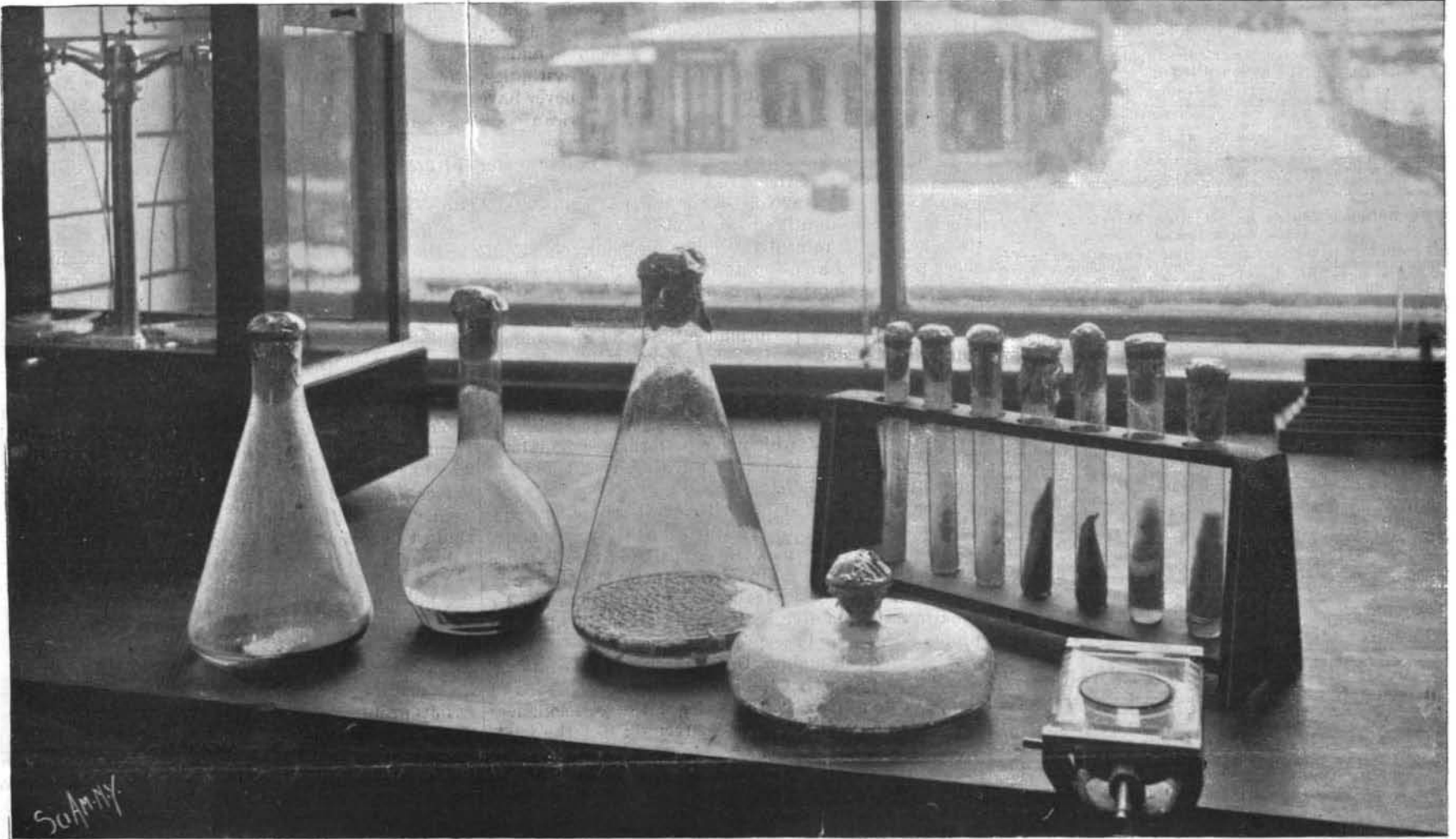
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CULTURES OF BACILLI TUBERCULOSIS.



LABORATORY AT SARANAC LAKE, N. Y., FOR THE STUDY OF TUBERCULOSIS—INTERIOR OF MAIN ROOM.—[See page 152.]