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 :

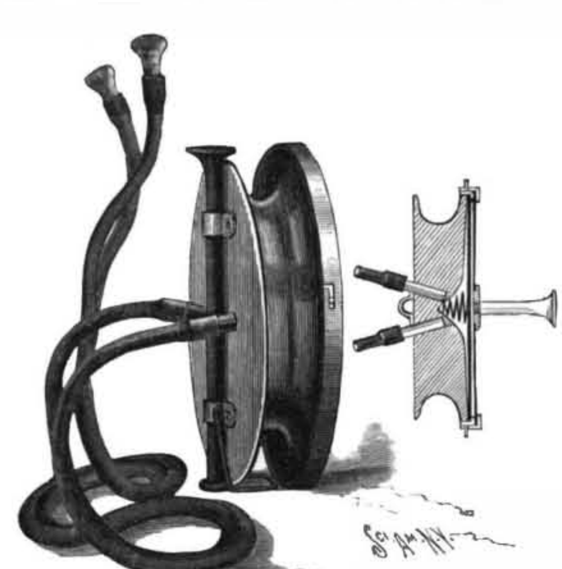
"In dealing with this question of cost, however, the committee has regarded it as one of such technical character that the information at its command is not sufficiently definite to enable it to fix with certainty a price per ton upon such a product of manufacture, and it has been indisposed to do so."

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