

exact size of the glass and pressed down to the jelly. Then put on the regular cover.

CRYSTALLIZED FRUIT.

"This can be made at home very nicely. Select nice, firm fruit. Cook it a little in clear water, the amount of cooking you will soon learn. Place the cooked fruit into very thick, hot sirup, and let it stand for about two days; then drain off the sirup, which will now be very thin, and boil it down until it is thick again, put in the fruit and let it heat through and stand for about four days, then repeat the process, letting it stand longer every time. When the sirup no longer gets thin, remove the fruit and dry it in the sun or in an evaporator with gentle heat. It may be rolled in granulated sugar to fully dry it, and then may be packed in boxes for use. By using the first sirup for jelly, and making up some entirely new, the process can be hastened and the fruit will dry better, but will not be of quite so good a flavor. Try it. It will cost you fifty cents a pound to buy such fruit confections, and they are nice for dessert when such confections are required."

THE MANUFACTURE OF ALUMINUM FROM CRYOLITE.

We give three engravings illustrating the manufacture of aluminum from cryolite at the works of the Alliance Aluminum Company, at Wallsend, near Newcastle-on-Tyne. The works have been erected under the direction of Dr. Netto, to whom the method for obtaining aluminum from cryolite by the direct action of sodium without the use of chlorine is due. Our illustration (Fig. 1) represents a battery of furnaces employed for the preparation of the sodium required in the process. They are built in continuous blocks, each furnace occupying a space 8 ft. x 8 ft. x 6 ft. high. In the center of each furnace is fixed a cast iron retort 3 ft. high and 2 ft. wide at its broadest part, with a spout projecting from its base, through which the liquid slags are drawn as the retort fills. The retort is covered by a cylindrical box luted on gas tight with slaked lime, and containing orifices through which the mixture to be treated is fed into the retort. It is also fitted with a tube, to which is attached the sodium condenser. After heating the retort a charge of gas carbon is introduced and brought to a bright red heat, and then molten caustic soda (previously melted in a cast iron vessel by means of the waste heat of the furnace) is allowed to slowly run through a siphon on to the surface of the hot carbon. In a few minutes thick clouds of vapors issue from the retort, which readily kindle and burn with an intense yellow flame at the mouth of the condenser. The flow of caustic soda is regulated by the workmen, who judge of the progress of the reaction from the intensity and volume of these flames. The metallic sodium drops from the mouth of the condenser into shallow iron trays, from which it is quickly transferred to air tight iron drums for further use. Each retort makes about 60 lb. of sodium per diem, but has to be constantly watched to prevent the condenser from becoming plugged with the condensed sodium, which has therefore to be removed by an iron rod from time to time, and about 1,600 lb. of sodium may be manufactured from one retort before it is necessary to replace it. Our illustration (Fig. 3) represents the interior of the aluminum factory, which at present contains four reverberatory furnaces in two blocks, each block 23 ft. by 8½ ft. by 9 ft. high. Each furnace is charged from the top with a mixture of cryolite and salt, which when quite melted is drawn off into an iron converter mounted on wheels and trunnions, in which the third and final operation is carried out. We illustrate this operation in Fig. 2, in which is shown the method employed for introducing the sodium into the molten cryolite. Two men, as soon as the sodium is thrown into the fused mass, plunge into it an iron dipper, which is moved up and down until all action ceases. After this dipping process, the bulk of the slags are poured off into a large iron pot, while the aluminum is found in the shape of a button at the bottom of the converter. The yield of metal amounts to about 8 per cent. of the weight of cryolite, and four parts by weight of sodium are required to furnish one part of aluminum.

For special classes of aluminum the operation is carried on in crucibles, since in this way a better control

of the liquid mass of cryolite and flux is obtained, as the crucible stands in the furnace during the whole operation of dipping. The crucibles are made of fire-clay, and when heated the sodium is introduced by fastening a block of the metal on to an iron rod and covering it with a circular piece of metal provided with holes, and also a slit, into which the rod slides. The circular piece of metal is attached to a rod of iron, which thus acts as a cover to the sodium. By repeating the sodium dipping a better grade of metal is obtainable. Four qualities of metal are now being made by this process, varying from 90 to 99 per cent. of aluminum.

A small percentage of aluminum is found distributed

know of such methods, thanks to Charles Goodyear and others. Before any of these methods were known the manufacture of India rubber had been carried on either by direct mechanical treatment of the gum after simple cleaning or by the action of some volatile solvent.

It seemed at the time as if the gum was likely to fall into disuse, or that its applications would have to be circumscribed on account of its physical defects. Besides the principal ones already mentioned, are these, that contact with grease, fat, or oil was hurtful, that it was too adhesive and sticky to be practicable in many of its desired applications, that continued use and tension soon impaired its elasticity, and that it imparted

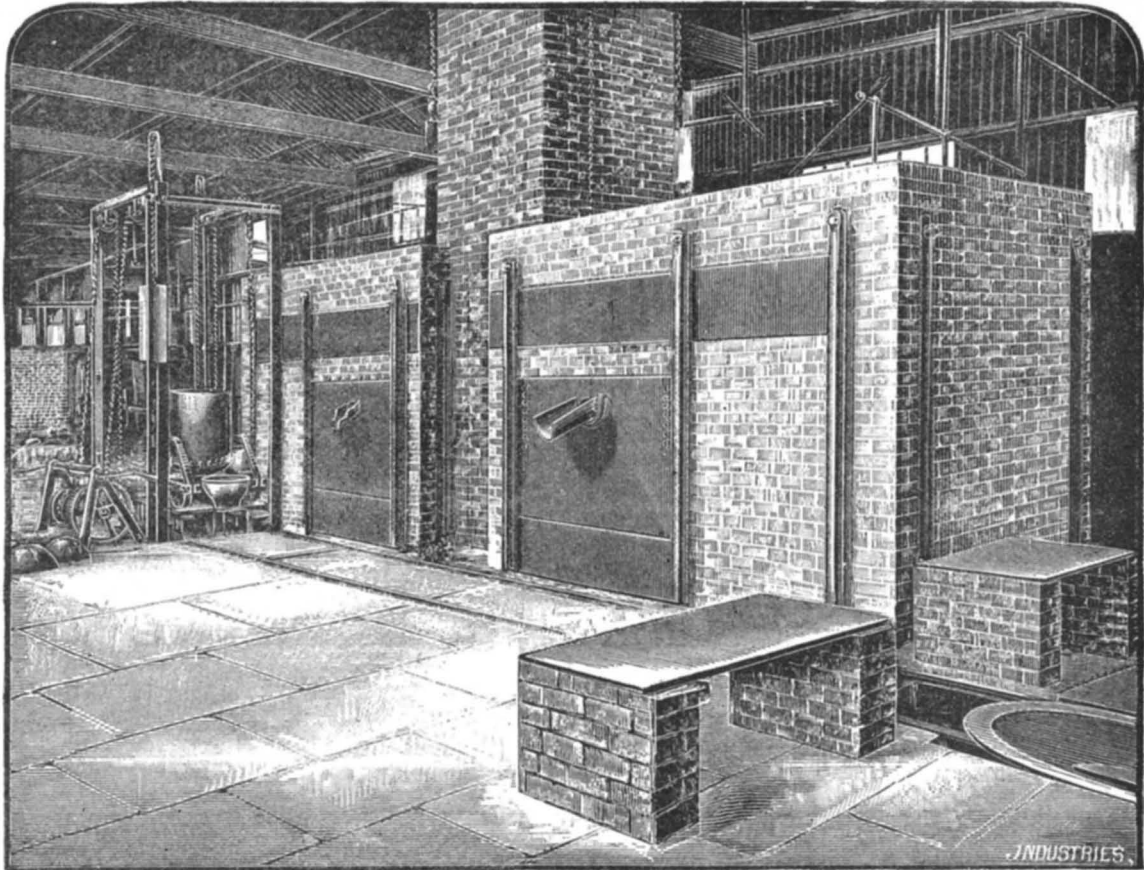


FIG. 3.—INTERIOR OF THE ALUMINUM FACTORY.

through the slag, from which it is recovered in the form of aluminum bronze, by fusion with copper in a reverberatory furnace.

VULCANIZATION OF RUBBER.

By RICHARD GERNER, M.E.

BEFORE we inquire into the meaning and the process of *vulcanization*, let us ascertain why India rubber, for the purposes of its application in the industrial arts, needs to be *vulcanized* at all. In general, ordinary India rubber retains its most characteristically useful properties through a very limited range of temperature, as a very moderate degree of cold on the one hand or of heat on the other suffices to render it valueless, as regards the major part of its industrial uses. At the freezing point it is rigid and hard, in fact frozen. At the boiling point it becomes so soft as to be valueless as an elastic material. The consequence is that India rubber in its natural condition has a very limited applicability.

Indeed, the meaning of this is that if we knew no method of treating or *curing* the gum, so that it will retain its good qualities under the influences of heat and cold, the manufacture of India rubber would not be one of the great industries. But happily we do

an unpleasant odor to the goods. At the most critical period of the history of India rubber, the method or process of *curing* the gum so that it would have a perfect elasticity and an unimpairment of its most valuable qualities under all reasonable temperatures, and under contact with the deteriorating agents alluded to, was invented. This is the renowned process of *vulcanization*, which has saved India rubber from being an unimportant element in the industrial arts, and which has raised it to the dignity of an indispensable article.

Sulphur, which is used both in a pure state and in its combinations, will be considered only in connection with its employment in the rubber industry. Pure sulphur occurs in the market in two forms, as *flowers of sulphur* or as pulverized roll, bar, or stick sulphur. Both are employed in the industry. The first qualification is that the sulphur should be chemically pure, free from all trace of acid, and also from the moisture which acidulated sulphur tends to absorb from the atmosphere. Ordinary flowers of sulphur are prepared by passing sulphur vapor into large chambers constructed of masonry, so that this vapor shall condense into minute crystals resembling snow. They are almost invariably acid in their reaction. This acid may be removed by washing with an abundant supply of water and then drying it at a gentle heat. All samples of sulphur ought to be tested with litmus paper before be-

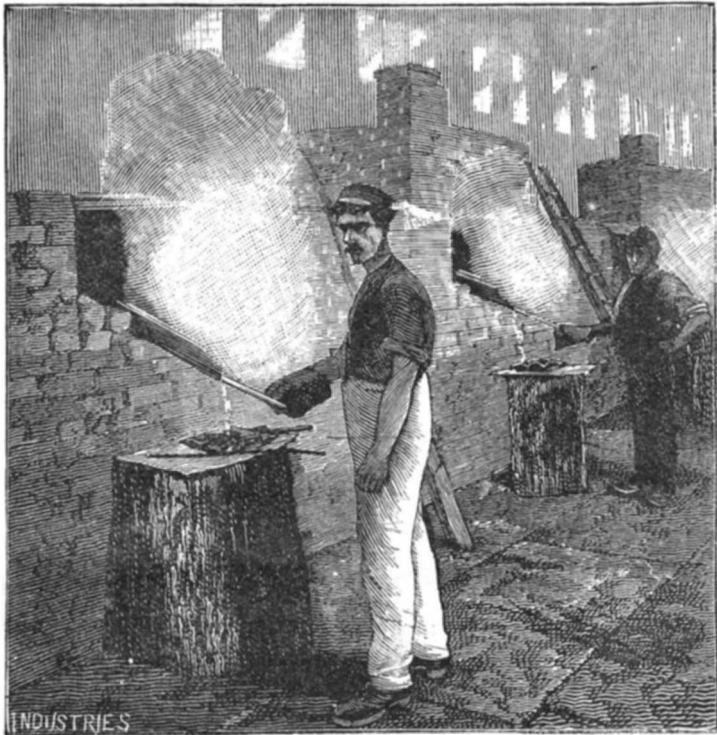


FIG. 1.—FURNACES FOR THE MANUFACTURE OF SODIUM.

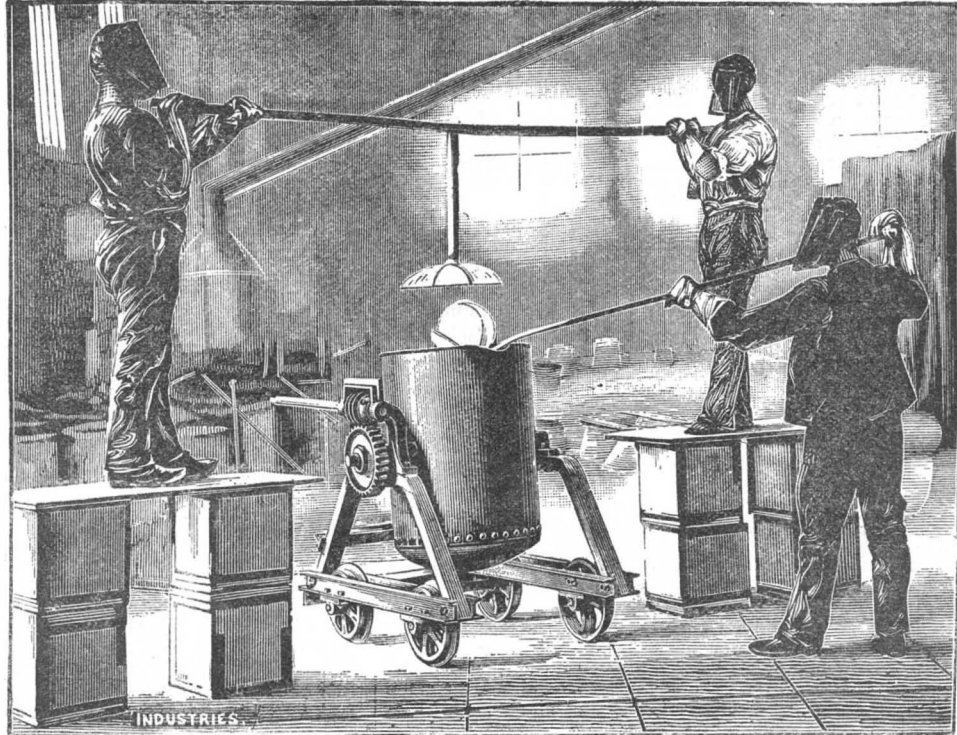


FIG. 2.—INTRODUCING SODIUM INTO MOLTEN CRYOLITE.

THE MANUFACTURE OF ALUMINUM FROM CRYOLITE.

ing employed in the manufacture. If blue litmus paper turns red, the presence of acid is thus indicated. The so-called *milk of sulphur*, or precipitated sulphur, is, on account of its very fine state of division, especially adapted for admixture with India rubber, but it is too expensive, and liable to be damp. Flowers of sulphur are also more expensive than pulverized bar, roll, or stick sulphur, and therefore the latter is more commonly employed.

The manufacture of pulverized sulphur is now a separate and extensive industry, as enormous quantities are used by rubber manufacturers and others. Henry Gerner recommends every large consumer to prepare it himself. Sulphur melts at 239° Fahr., of the significance of which more anon. Of the sulphur salts, or sulphur in its combination, sulphide of antimony is the most frequently used. For rubber manufacture it is prepared by boiling the native sulphide in a solution of caustic soda, and precipitating the solution thus obtained with a slight excess of hydrochloric (muriatic) acid. This, when washed and dried, is ready for mixing with the India rubber. It contains a percentage of free sulphur, which, as we shall see, is indispensable. The sulphides of lead, mercury, and zinc, the polysulphides of the alkalies and of the alkaline earths, and the hyposulphites, as of lead and zinc, are also frequently employed.

The remarkable changes effected in the India rubber by the introduction of sulphur into the same was pointed out by a German chemist, Luedersdorf, of Berlin, in a work published as early as 1832, but it is doubtful whether Goodyear ever saw this work. The fact remains that the industry must thank the latter for the introduction of the process of *vulcanization*. If we take a strip of India rubber and immerse it for a few minutes in a bath of molten sulphur, of a temperature, say, of 250° Fahr., the gum absorbs the liquid sulphur and turns light yellow, according to the length of the time it is permitted to remain in the bath; it absorbs from 10 to 50 per cent. This is merely a dissemination of the pure sulphur throughout the pores of the gum, and the characteristics of the latter remain unchanged. It is still subject to the stiffening influence of cold, and dissolves in the ordinary solvents. But when further heat is applied to the sulphureted gum, or if it is permitted to remain long enough in the sulphur bath, a change takes place. What the precise nature of the change is appears to be not very well understood, neither by the manufacturers nor by the writers on the subject, let alone by the public at large. What happens is that from 1½ to 3 per cent. of the sulphur enters into *chemical* combination with the India rubber, and no more. The bulk of the sulphur is only mechanically held in suspension, but in an amorphous state, in the gum. Any percentage of sulphur that is incorporated with India rubber enters under heat into this physico-chemical combination with the gum, the resultant products varying in nature with the percentage of sulphur introduced.

After the introduction of the sulphur, and before the application of heat, the compound is called simply *mixed rubber*. The application of heat *cures* or *vulcanizes* the India rubber. The product is called *vulcanized rubber*. In practice, the India rubber and the sulphur are usually mixed together mechanically by suitable machinery, and the curing process takes place in a boiler or vessel called a *vulcanizer*, or in a steam press. Sulphur has a threefold action on India rubber, according to the percentage introduced. If the percentage is a small one, say 5 per cent., and the mixture is vulcanized, the result is a soft, gray, elastic body, which is the common *vulcanized rubber*. If the percentage of sulphur is a medium one, say 25 per cent., the result is a semi-hard body, of the consistency of leather, which also has its uses in the industrial arts. If the percentage of sulphur is a great one, say 50 per cent., the result is a hard, black, pliable body, which is *vulcanite* or *ebonite*. In the sequel, soft vulcanized India rubber will be called simply *vulcanized rubber*, and the hard vulcanized India rubber by the name of *vulcanite*. Some Germans apply the latter name to the soft product.

All excess of sulphur in vulcanized rubber beyond that actually required is said to be undesirable, but it is unavoidable, as a greater percentage than that stated cannot by any means be made to combine chemically with the gum, and yet the presence of this percentage alone is not sufficient to vulcanize. A part of the excess may be washed out by boiling in a dilute solution of caustic soda, or of sulphite of soda, but it injures the product, and leaves it cellular. This is called *sulphurized rubber*. It will be understood that it requires the presence of *pure* sulphur to properly vulcanize India rubber, but for the purposes of the rubber manufacturer, as much as 75 per cent. of the sulphur may be replaced by a sulphur salt, such as sulphide of antimony, or of lead, mercury, and zinc. It is the sulphide of antimony that produces the *red rubber* often seen in the market. The presence of a sulphur salt beside the pure sulphur is supposed to enhance the virtues of the vulcanized product, but this is at best doubtful. A solution of the mixed polysulphides of lime, at a temperature of about 275° Fahr., being Gerard's process, vulcanizes thin sheets of the gum by exposure to it. Thin sheets may also be embedded in sulphur and made to absorb about 10 per cent. of it, and then vulcanized. Exposure to sunlight has a certain vulcanizing action on mixed rubber. In the Parkes cold process the gum is placed in a mixture of one part of chloride of sulphur to 40 of bisulphide of carbon. It is vulcanized in a few minutes. When the gum is kneaded with a certain amount of *dry* chloride of sulphur for a few minutes, it also becomes vulcanized. The process does not apply to bulky goods, as the vulcanizing action does not penetrate far below the surface. Other vulcanizing agents are nitric acid and the halogens. A piece of thin sheet rubber dipped into bromine becomes vulcanized almost instantly. We shall now study the process of manufacture of India rubber.

I shall confine myself at present to the description of the manufacture of common vulcanized rubber, and reserve hard rubber or vulcanite for a special occasion. The cleansed raw India rubber, as already stated, is taken on to a pair of *mixing rollers*, which are capable of being heated by steam, and of which the surfaces are quite smooth. They are rotated at unequal speeds, three to one being a common difference between their rates, and one of them is heated to a higher degree than the other, the purpose of which is to cause the material to adhere to the slower-going and hotter

roller nearest the operator. By means of set screws the rollers can be placed nearer to or farther from each other. A charge, technically called a *batch*, or about 30 lb. of India rubber, is run through the rollers until it is quite soft and homogeneous. When the gum is in this condition, powdered sulphur is sprinkled upon it from above, and this sprinkling on of the sulphur and the working are continued until all the material is thoroughly incorporated. The quantity of sulphur varies with the required nature of the product; in ordinary cases the proportion is from 5 to 10 per cent. of sulphur. This breaking down of the rubber, and the incorporation of the sulphur, takes at least an hour. The temperature required to reduce the India rubber is a very high one, being about 280° Fahr., which tends to further convert its fibrous constituents into viscous ones. The high temperature is, however, unavoidable. When the mixed rubber is ready, it is in a state to be employed directly for various manufacturing purposes, unless it be required to incorporate with the same certain admixtures by way of adulteration, to cheapen the product, and, it is needless to add, to degenerate its quantity. It is the common practice to mix metallic salts and mineral earths with the India rubber during the incorporation of the sulphur, and it sometimes happens that the amount of adulteration is enormous, upward of *five hundred* per cent. in extreme instances. The presence of any large proportion of inert matter naturally detracts considerably from the elasticity of the gum, and as most rubber goods are sold by weight, it is just as well for consumers to know that the bulk of the rubber goods purchased is not pure gum, but lead and zinc salts. The powders most extensively employed for thus lowering the quality of the rubber are the following: Clay, chalk, or whiting, French chalk or talc, sulphate of baryta, plaster of Paris, oxide of zinc, sulphide of zinc, sulphate of lead, various oxides of lead, oxycarbonate of lead or white lead, magnesia, silica, fuller's earth, ground scraps of old rubber, lamp black, and a great many other salts and earths. It depends upon the use to which the product is to be put whether the mixed rubber can be adulterated at all, or what the degree of adulteration shall be. When the batch comes from the mixing rollers, it is either stored away for future use, after

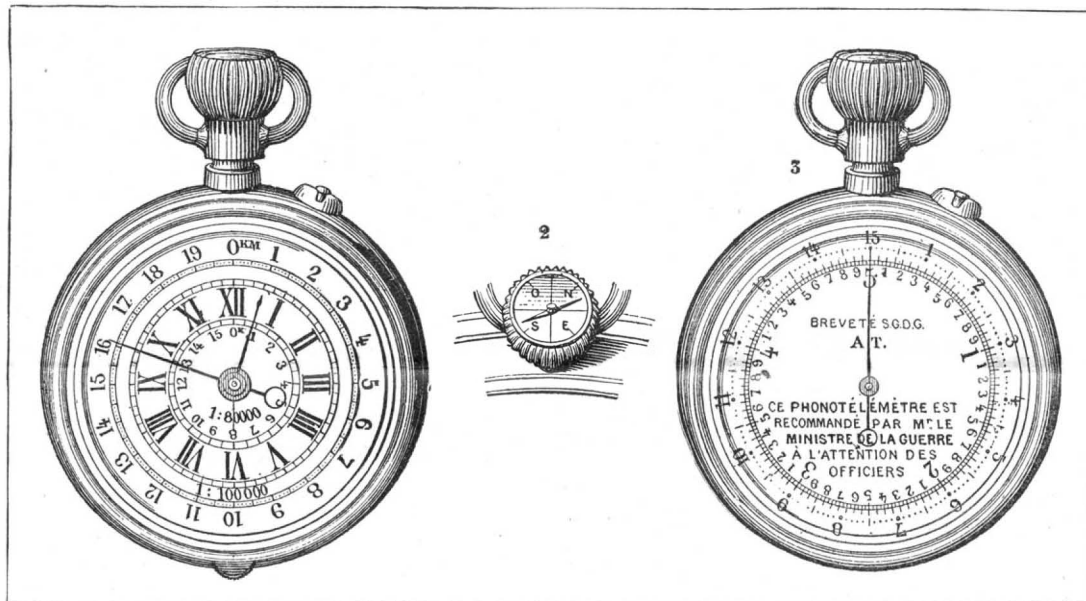
ments. Air may be the medium, or it may be water, or it may be soapstone. The goods being placed in the vulcanizer and the cover clamped down, "live" steam is turned in and left on for a length of time varying with the requirements of the product, whether it be light or heavy, thick or thin, almost pure or heavily adulterated. The time varies from half an hour to several hours. The temperature required for vulcanization also varies with the nature of the product, being from 260° Fahr. to 300° Fahr. The latter temperature is about as much as it can stand. When the rubber is adjudged to be properly vulcanized, the steam is *blown off*, the cover unclamped, and the goods taken out. They are then cleaned and packed, unless they require some special treatment, such as polish or deodorization, and are ready for the market. Other methods of vulcanization have already been indicated. With reference to statements in patent specifications, by inventors of improvements in the industry, relative to the time and heat of vulcanization, even the patent expert is puzzled to understand why these times and temperatures cannot be stated within reasonably narrow limits; but it is evident that these differ with every shade of difference in the mixture, the thickness, and the required nature of the goods.—*India Rubber Trades Journal*.

THE PHONOTELEMETER.

THE experience of schools for artillery practice has demonstrated the utility of having, upon opening fire, as accurate a knowledge as possible of the real distance of the mark. The different means hitherto employed for estimating distances all possess more or less serious inconveniences.

Telemeters, which are based upon geometrical methods, are in most cases unwieldy, and always require trained operators; their management requires a certain amount of time, and the results that they furnish may be vitiated by numerous accidental errors due to various causes. In order to use them, it is indispensable to see distinctly the point whose distance it is desired to find.

Measurements by sight require much practice, and the operators most experienced in this exercise run



THOUVENIN'S PHONOTELEMETER.

1. Watch and curvimeter. 2. Compass. 3. Telemeter counter on the back of the watch.

having been sprinkled with sulphur, like dough with flour, or it is at once utilized. In the former case it must be *warmed up* again immediately before use, either on a pair of special *warming-up rollers* or on the aforesaid mixing rollers. Let us presume that the mixed rubber is to be made into sheets, as that is usually the most important feature of rubber manufacturing, all other phases of the industry being more or less specialties. For this purpose it is taken to a large rolling machine, being a heavy framework bearing from three to four smooth rollers, also capable of being heated by steam. This is called a *calender* (or *calender* or *calander*).

The rollers are heated up to a temperature which varies with the degree of adulteration of the mixed rubber; the greater the adulteration, the lower the temperature. The mixed rubber must have the corresponding temperature before its introduction between the rollers. In the case of the calender consisting of three rollers, the mixed rubber is first passed between the top and the middle one, adhering to the latter, and then through the middle and bottom one. It then passes around and under the latter, and thence usually on to an axle, where it is wound up together with a layer of cloth, or well sprinkled with soapstone, to prevent the surfaces from adhering to each other. In other instances it passes from under the bottom roller of the calender on to and over small rollers, or a drum, thence to an endless belt, and it may be at the end hereof either wound up on an axle or it may be cut and transferred to frames. In all other cases the mixed rubber, instead of being taken to the calender, is brought to other machines for diverse purposes. The rubber is now ready to be vulcanized.

Rubber is vulcanized either in vulcanizers or in steam presses. Vulcanizers are vessels provided with a steam-tight cover which can be securely clamped down. They are of all sizes and shapes, and placed either horizontally or vertically. In the former instance they are usually very large, the cover being hinged to one side of the opening, and have tracks running into them, on which are cars containing the goods to be vulcanized. All the vulcanizers and steam presses are in communication with the steam supply pipes of the works, and are provided with pressure gauges and thermometers in order that those in charge may be enabled to regulate the inflow of steam and the temperature within. The *vulcanizing medium*, that is, the medium in which the goods are placed when run into the vulcanizer, may be gaseous, liquid, or solid, according to various require-

ments, especially at great distances.

Instruments for estimating distances, based upon the velocity of sound, possess, as a general thing, the advantage of being easily manipulated, of demanding no previous apprenticeship, and, for observations, of requiring neither putting in station nor display of *personnel* capable of attracting the enemy's attention. Such are the qualities possessed by the small instrument that Captain Thouvenin, assistant to the director of artillery at Vincennes, has just had constructed, and which he calls a phonotelemeter.

The apparatus consists of a watch with a curvimeter on the face (Fig. 1), of a compass on the stem (Fig. 2), and of a telemeter counter on the back of the watch (Fig. 3).

We have nothing to say relative to the utility and use of the watch and the compass, but we shall give a few details as to the curvimeter, and especially as to the counter—the essential part of the new apparatus.

The Curvimeter.—The face of the watch is provided with two graduations, the first and external one of which corresponds to a map to the scale of 1-100,000, and the second and inner one to the staff office map to the scale of 1-80,000. To use it, the hand is put at zero by revolving the wheel, and, with the latter, the line whose distance is required is followed, and then the graduation of the dial that corresponds to the scale of the map to be measured is read.

The Telemeter Counter.—The telemeter counter is placed on the back of the watch (Fig. 3). The works of the latter move a hand over a dial divided into 15 seconds, and each of the latter is divided into ten equal parts, as are the durations of the travel of projectiles on fuses and on the bridges of cannons. The distances are inscribed upon the dial of the telemeter in the following manner: The kilometers are represented by the large black figures 1, 2, 3, 4, 5; hektometers by small red figures; the 50 meters by black divisions upon the circle; and the 25 meters by red divisions between the black ones.

To use the instrument, it is first wound up. To this effect, it suffices to wind up the watch and to fasten it by means of a snap hook to one of the sides of the field glass. At the moment the flash of a gun, cannon, or lightning is observed, the hand is set in motion by giving the winding stem a quick, slight pressure. The same action arrests the hand at the instant at which the noise of the detonation is heard, and the same action brings the hand back to the zero point.