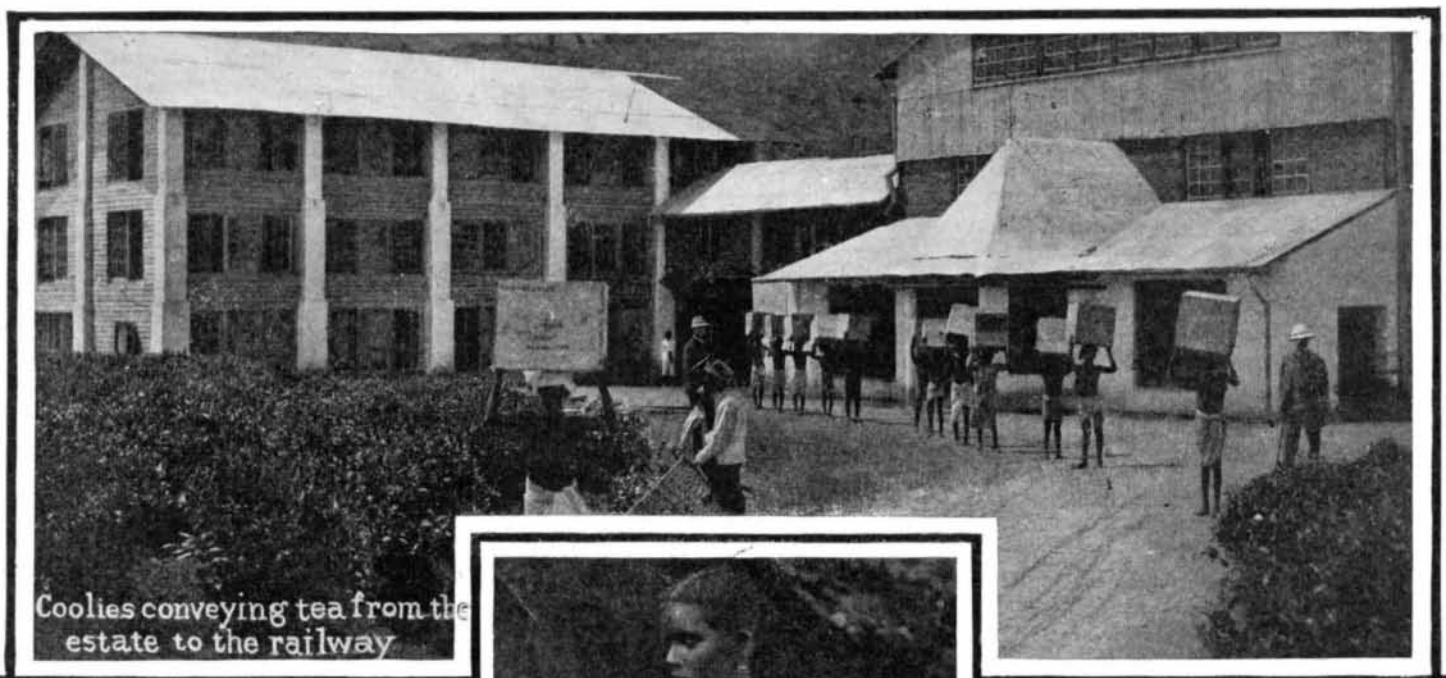
hours of the day and evening. The tone of these bells is exquisitely sweet, and strongly reminiscent of the sweet chimes that may be heard floating from any old cathedral tower in Europe. The marvel of these bells, however, is that they are constructed entirely of cast steel; for the German maker, thanks to his perfect knowledge of the chemistry and furnace treatment of metals, has learned to so manipulate the steel, that it will produce when cast into bells (as this peal at the World's Fair amply demonstrates) tones that are just as sweet as those of the more costly bell metal with which we are familiar. The peal on exhibition has been purchased by one of the large Eastern cities, and three other sets have been ordered in this country.

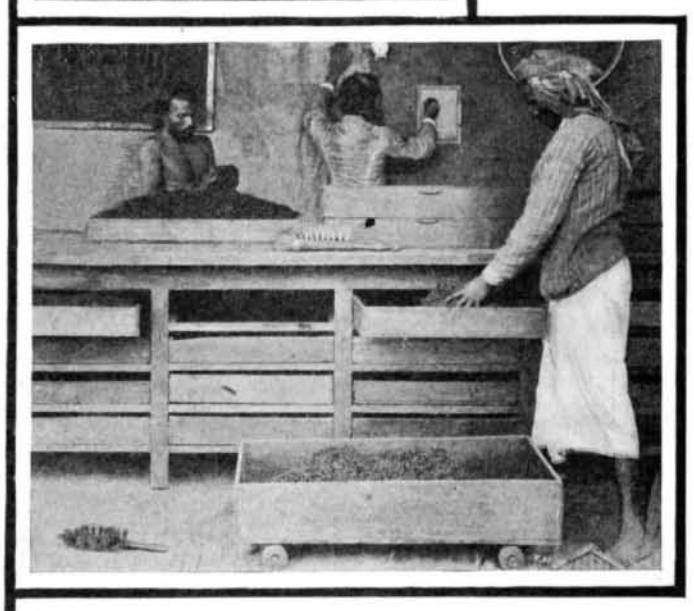
In the current issue of the SUPPLEMENT will be found an illustrated article dealing with the German exhibit as a whole, with detailed descriptions of the various sections in the exhibition palaces.



Coolies conveying tea from the estate to the railway

Planting Tea.

A Tea Plucker.



Preparing the Tea for Rolling.

THE CULTIVATION OF TEA IN CEYLON.

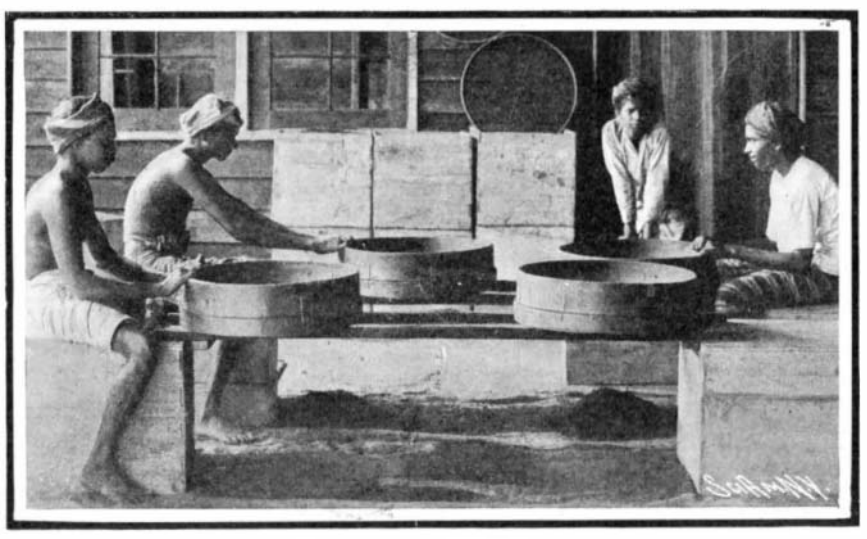
BY CHARLES C. JOHNSON.

Ceylon tea's steady advance in popularity in the United States and Canada calls attention to the strong contrast between the methods of preparation of tea in Ceylon and in China and Japan. In the latter countries the work is done to-day in the same fashion as a century ago, largely by hand. In Ceylon machinery is utilized wherever possible, and the entire process of preparation has become largely mechanical. In both China and Japan individual tea cultivation is very general. As the season for harvesting tea approaches, native representatives from the tea interests, whose headquarters are in the cities, visit the growers, and ascertain how much tea they will have for sale and the price they expect to receive. In this way small lots of tea are sold, ranging from fifty to two hundred and fifty pounds, according to the extent of the land under cultivation. Teas thus purchased are taken to one of the large cities and placed in factories, where they are often refinished, after which they are graded and mixed with other lots of tea received at market in the same manner.

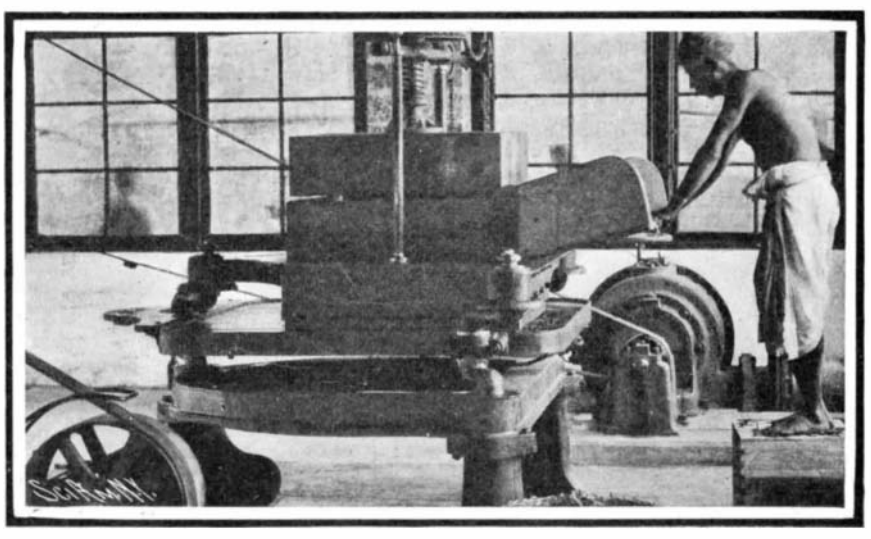
Packing Tea in Chests.

In Ceylon, the system is wholly different. Land has been purchased, and is placed under cultivation to an extent of hundreds of acres at the same time. A factory is constructed and equipped with modern machinery suitable for rolling and firing teas, and affairs are managed according to European business methods. A superintendent is placed in charge of the estate, with from one to two thousand natives to perform the labor, for the care of whom he is responsible to the government.

The tea seed, having been carefully selected, is sown as soon as possible, as it quickly loses vitality. It is tended, shaded and watered, for the young plant is an object of tender care until it goes through the process of transplantation. When once established, it requires cultivation until three years old, at which time it is plucked, and at the end of the season pruned.



How the Tea is Sifted.



Tea-Rolling Machinery.

THE SCIENTIFIC CULTIVATION OF TEA.

The process of manufacture commences with plucking. The bushes having been pruned and cultivated throw out vigorous fresh growths, and these in turn put forth shoots and leaves called by planters a "flush." The smaller shoots on each side of a flush are what is taken from the plant at each picking. These are described as two leaves and a bud.

Plucking is performed by women, who pass down between the lines of bushes, plucking the young leaves and dropping them into the baskets they carry. Their energies are stimulated by the fact that their daily pay is regulated by the weight of leaf they bring in, and they are checked from plucking old leaf by minus marks being placed against their names for any large leaf found in a basket.

After being weighed in, the leaf is taken to the withering room, usually placed so as to have the heat from the engine room. Here it is spread out in thin layers on the lattice-work shelves with which the room is fitted, to wither or wilt until the excess moisture evaporates. Were this not done, and were the leaf put through the next stage as it came from the bush, full of moisture and sap, it would be so brittle that it would break into fragments. In the course of the night the leaf is sufficiently withered, and is then soft and flexible, and can be twisted without snapping.

When sufficiently withered, the leaf is passed down waiting chutes to the rolling tables. There are various patterns of machines, but the principle is the same in each, viz., two plane surfaces, revolving one over the other, somewhat after the fashion of millstones, but with a freer swinging action, so as to roll and not grind the leaf. The faces of both the upper and lower tables are of wood, and the leaf is rolled under sufficient pressure to give it the desired twist without breaking it.

The process of rolling having broken open the leaf cells, facilitates the chemical changes which follow, and which are grouped together and termed fermentation by planters. These changes are very obscure, and have not been subjected to searching chemical analysis. So far as appearances go, the most important of these is oxidation. The leaf being taken from the rollers is still more green than any other color. At this stage it is spread out, and soon assumes a copperish brown color, due to oxidation.

The fermented leaf is then spread upon trays, and passed into closed machines, of which there are several patterns. But, as in the rollers, the principle is the same in each—to fire the tea by exposure to a suitably regulated current of hot air, drawn through the machine by means of fans. This process corresponds with "pan" and basket firing, but the firing in modern factories does not allow the leaf to be subjected to the direct heat of the fire, and the temperature can be regulated to a nicety to attain the end without destroying the essential qualities of the leaf.

Next is the final stage, the whole process after the leaf is withered occupying less than two hours with modern machinery. Up to this stage all the leaf as brought in by the pluckers has been treated together; but as each of the leaves and the bud represent different qualities and differing values, it is now necessary to separate them. This is done by means of graduated sieves, made to oscillate by means of a pulley.

The "tip" in varying proportions, with some of the leaf nearest to it, makes Orange, or Flowery Pekoe, of proportionately varying values; the small leaf makes Pekoe, with which a small quantity of "tip" remains. The large leaf makes Souchong, and the mixture makes Pekoe Souchong. Broken Orange Pekoe, etc., are simply the broken leaves of their respective qualities, and are preferred by some consumers. In the sorting process some dust and fannings are also separated.

When sufficient tea has been collected to form a "break," it is refired at a low temperature, to get rid of any moisture absorbed from the atmosphere, and packed at once in lead-lined boxes, when it is ready for market.

Successful tea cultivation in Ceylon dates from 1841, on the Rothschild estate. Several specimens of the tea plant were imported from China that year. Successive experiments proved satisfactory, and resulted in the tea produced being pushed in the European markets. In 1877, 2,000 pounds of tea were exported from Ceylon. Now many millions of pounds are exported annually to England alone. Ceylon tea is similar in almost all respects to India tea, and the product of these two countries has practically displaced the teas of China and Japan in England.

Many persons believe that the history of Ceylon tea in England will repeat itself in the United States, but if it does the result will be of far less importance to the tea industry. English people drink tea as the Americans do coffee. In Canada the situation is much the same. In the northern sections of the United States tea is popular, although much less favored than coffee, and here, within the last five years, the Ceylon "greens" or green teas have made considerable headway in the displacement of the green teas of Japan and China, principally the former, for our annual importation of green teas from Japan exceeds 40,000,000 pounds. In the Southern States the relative consumption of tea is small, a fact noticeable in all sections whose climate is of a tropical or semi-tropical nature.

Indirectly, the war between Japan and Russia militates against the teas of the former country, from which our principal supply of green teas comes. Recruiting for the Japanese army has sadly depleted the skilled labor utilized in the preparation of Japanese teas. The inevitable result of insufficient skilled labor, coupled with an effort to keep the quantity produced from lessening, is a coarsening of the tea leaf, a fact likely to have an ultimate effect on sales in America, to the benefit of Ceylon teas.

A very large proportion of Ceylon teas received in the United States comes *via* England. The teas are shipped in bulk from Ceylon to England, where they are rehandled, blended, and put up in various-sized packages, both for export and home consumption. Some of the Ceylon tea planters favor a direct market in the United States and Canada, and are striving to find means for its establishment.

THE WATER ORGAN—A ROMAN KEYBOARD INSTRUMENT.

BY THE REV. F. W. GALPIN, M.A., F.L.S.

As we watch the fingers of the pianist flying over the compass of his instrument, or sit entranced by the wealth of harmony which the organist commands as he touches his manuals, seldom do we realize how much curious history and laborious ingenuity lie hidden within those rows of black and white keys. To tell their tale would require a volume; perhaps a sketch of their later development may be given in a subsequent paper. At present we are concerned with a period anterior to the production of the modern keyboard, and we are to deal with an instrument practised and admired by Greeks and Romans.

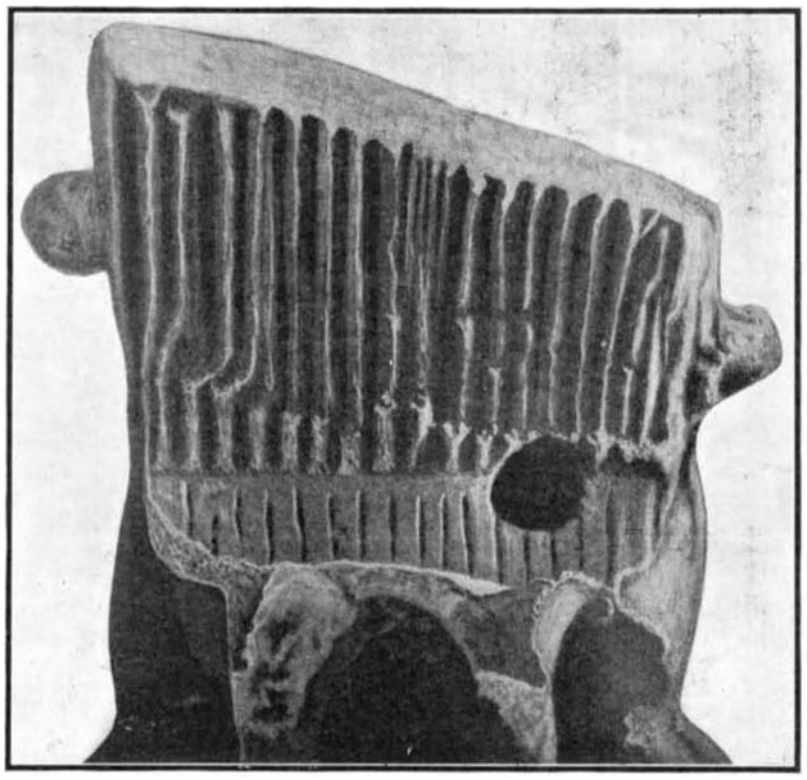


Fig. 3.—Enlarged View of Keyboard.

THE WATER ORGAN.

A Roman keyboard instrument! The title sounds absurd, for do not our textbooks assure us that the keyboard was invented in the eleventh or twelfth century of our present era? Yet, owing to a discovery made among the scattered ruins of Carthage, we are able not only to state positively that the use of keys was well known to the ancients, but also to reproduce a working model of the instrument whereof they formed so interesting and important a part.

Around the *hydraulus*, or water-organ, a great mystery is supposed to hang, and more than one learned writer has confessed himself unable to understand it or to explain its principle and construction; while others have made wild guesses at the purpose for which the introduction of water was required. We hear of "boiling" water and the steam rushing through the pipes of the organ, or we read of "bubbling" water designed to give a weird, tremulous effect to the sounds produced. All such like guesses are quite unworthy of the subject, for there still exist two ancient treatises which upon careful study explain the whole principle of the instrument.

The hydraulus was invented by Ctesibius of Alexandria some time between 300 B. C. and 250 B. C. Probably long before his day a rudimentary form of organ existed, evolved from the syrinx or from the bagpipe; but to this celebrated mechanician belongs the credit of first applying the water principle to the instrument and of adding those little levers, now termed "keys"; for, as Philo of Byzantium (c. 200 B. C.) affirms, it was Ctesibius who invented "the kind of syrinx played by the hands which we call hydraulus." This great work was minutely described by his own pupil Hero in his book entitled "Pneumatica" (ch. 75), and about 15 B. C. Vitruvius in his treatise "De Architecturâ (Book X.) gives us another full account of the instrument as he knew it. From these two writers we learn that the water was used for the same purpose as that for which the modern air reservoir is now loaded with heavy weights, namely, to give that compression to the air inside the wind chest of the organ which is necessary to make the pipes "speak" properly and to prolong the sound during the process of refilling the bellows or "feeders." Nor would there have been any mystification at all on this point, but for an irreparable loss. Both the aforenamed writers allude to drawings and designs accompanying their descriptions, and in both cases the originals are lost, such designs as are given with the texts of these authors being either due to the imagination of the editors or to the suggestions of a lingering tradition. The form of hydraulus is delineated, it is true, on medals and in mosaics; but the outlines are rude and indistinct, and only one part of the organ is fully shown—the part away from the player, which we should call the back of the instrument, but which the Romans considered and decorated as the front.

There exists, however, in the Museum of S. Louis at Carthage, near Tunis, a small representation in baked uncolored clay of an hydraulus and its player. The model—7 1-16 inches in height and 2¾ in breadth—evidently portrays some distinguished organist and his instrument. It was made by a potter named Possessoris, who has placed his name on the front of the wind chest. From other works by the same hand it is known that he lived during the early part of the second century A. D.

Now this little model gives us a perfect view of the shape and outward construction of the water organ at the height of its popularity. We can examine it on all sides, and as the details have been most scrupulously represented, we have been able, with the aid of Hero's and Vitruvius' explanations to construct a complete working reproduction of the instrument. For the photographs of this valuable relic here shown (Figs. 1 to 4) we are much indebted to the Rev. Père Delattre, the learned curator of the museum, while the remaining illustrations and diagrams give some idea of the writer's own working reproduction.

On referring to Figs. 1 and 5 and Diagram I (letter *K*), there will be seen in the lower center of the organ the water box, an altar-shaped reservoir containing the water and, except for a movable lid, open to the air at the top. On either side are the air pumps (*A*), barrel-shaped structures each fitted with a wooden plunger (*B*) in which is a small valve (*C*) for admitting air when the plunger falls. This form of valve is well described by Vitruvius, and has been copied in the reproduction from one remaining in part of a Roman fire engine now in the British Museum, London. It occurs again in the wind chest at *F*. In the air pumps or "feeders" described by Hero and Vitruvius the actual valve is of a different form; in the first instance, a flat plate placed inside the top of the barrel and kept in position by two pins, and, in the later description, a metal disk with a central boss (cymbalum) rendered more sensitive by a counterpiece sometimes fashioned like a dolphin. Across the top of the water box is the wind chest *G*, and above it at either end will be noticed in the pottery model (Fig. 1) two large holes. These are due to the exigencies of the potter's art, and supported two short sticks of wood or clay to represent the long handles of the blowing levers. These levers were in reality centered on either side of the organ, as will be seen in Figs. 5 and 6, where one plunger is shown drawn up (see also Diagram I, *D*). This position was evidently an improvement on the earlier design, in which (according to our authors) the levers were centered on separate uprights inserted into the base of the organ, the plunger being therefore pushed up the barrel instead of drawn up, as in the present instance. We know that many alterations were made in the instrument from time to time; and even the Emperor Nero, who would have shown himself an adapt performer on the hydraulus at the public games, had circumstances permitted, busied himself during the last days of his precarious existence in discussing and suggesting further improvements. Inside the water box (*K*) there is an inverted bell or funnel of metal (*J*) raised off the bottom by little feet, so that when