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.

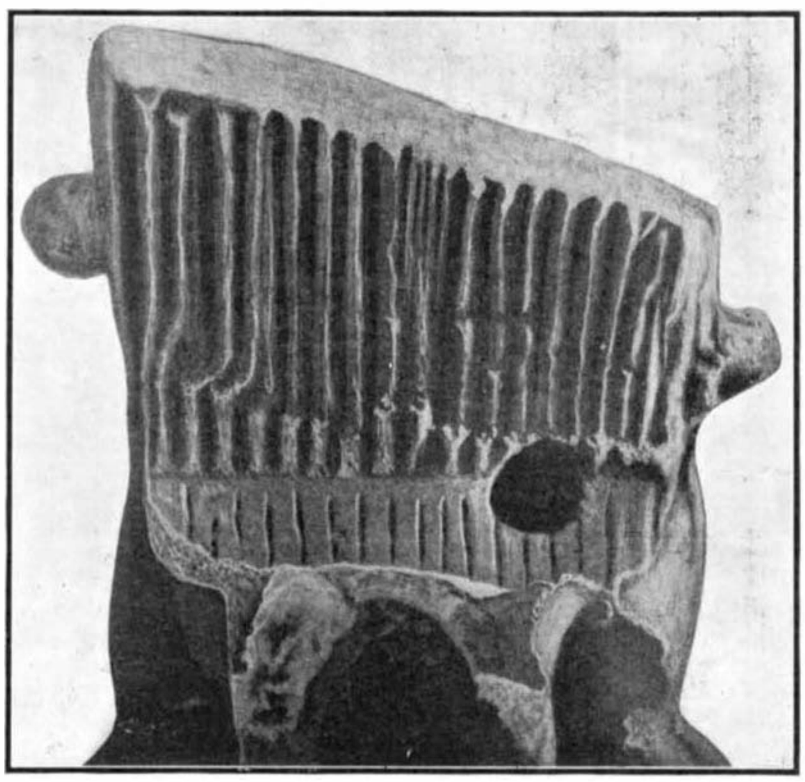


Fig. 3.—Enlarged View of Keyboard.

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 the water box is half filled, the water finds its way also inside the inverted bell and rises to the same level. On depressing the handle of the air pump, the plunger (*B*) is raised and the air is forced out of the barrel (*A*) through the pipe *E* and the valve *F* into the wind chest (*G*); being unable to escape or to return, owing to the closing of the valve, it passes down the pipe (*H*) into the inverted bell (*J*) standing in the water. As the pumps are rapidly and alternately worked, the air forces the water out of the bell (*J*) into the water box (*K*), but the superincumbent weight of the expelled water compresses the air both in the bell and in the wind chest above. In the working model the water rises 3½ inches in the water box when the bell is emptied, and this is the pressure of the wind in the organ; but constant care has to be taken by the blowers to maintain the water at about the same level. If there is too much air in the bell or compressor, it finds its way out at the bottom and bubbles up through the water, giving the "boiling" effect noticed by ancient writers.

Above the wind chest is a cross channel (*N*) running immediately under a row of pipes; in the reproduction there are three rows of pipes, and so three parallel cross channels. Above the channels again is fixed the "sound board," as organ builders term it, consisting of an upper and a lower board, through both of which are pierced vertical holes communicating with the pipes above. Between the two boards are inserted small sliders of metal called "regulæ" (*P*) pierced with holes corresponding to those in the sound board (●); but in their normal position their flat surfaces, which are well oiled, close the outlets (see Diagram II.). Each slide is terminated at one end by a wooden head (●) to prevent its passing in too far; and at the other end it is attached by a short iron hook (*S*) to the lower point of the key lever (*T*) which is centered (at *V*) on a short pin. By depressing the key (*T*) with the finger the slide (*P*) is pushed into its groove as far as the regulating pin (*R*) when the holes correspond exactly with the openings in the sound board, and the compressed air passing up from the wind chest below causes the pipes to sound. A metal spring (*V*), as described by Vitruvius, brings the slider back again to its normal position when the finger is removed. In the organ of Hero's day a horn spring with a gut attachment was used for the same purpose. The sliders of the working production have been copied from some found among the parts of a small organ discovered at Pompeii and now in the museum at Naples. The form of the key levers is distinctly shown in the pottery model and in the enlarged view of the keyboard (Fig. 3). The hole observable on the right-hand side is probably the spot to which the hand of the pottery organist was affixed—his legs fortunately still remain in position on his elevated seat. From these the true scale of the original instrument has been worked out. Its height was about 10 feet and its width 4½ feet as shown in the diagrams. The front row of pipes, which is the best preserved, shows nineteen in number, and the keyboard, when perfect, consists of nineteen keys, each about 8 inches long and 2 inches wide. On one side of the instrument as represented by the potter there are slight indications of the stop handles. These stops, which are carefully explained by Vitruvius, are like small taps (see Diagram I, *M*) and admit at will the compressed air into the various cross channels (*N*). (Diagram II., in which the right-hand stop is shown open.) These have been modeled on specimens of Roman taps still existing.

A difficult and intricate question was the pitch of the pipes and the scale of notes they gave. Fortunately an anonymous Greek writer of the second century A. D. tells us that the hydraulus players used but six out of the fifteen recognized scales or "tropes," and that these were the Hyperlydian, Hyperiastian, Lydian, Phrygian, Hypolydian, and Hypophrygian—the first and last being an octave apart. Following the generally accepted standard of pitch, and placing the last five of these scales together, the following series of sounds are required:

G A B♭ B♮ c d e♭ e♮ f f♯ g g♯ a b♭ b♮ c′ c♯′ d′ e′

nineteen notes for the nineteen keys of the organ, the highest or Hyperlydian scale being played on the octave stop. The front or unison pipes are stopped as in the ordinary syrinx, and fitted with regulating pins (as at *W*) suggested by the remains of some organ pipes found at Pompeii. The other two rows, which are pitched as octave and superoctave, are open pipes and furnished with sliding rings (*X*), which are described by several Greek writers, though probably they were in this case only used for tuning purposes, the intricate changes of tonal systems being at this date no longer in use. It will be observed that the pipes are all of the same diameter, a peculiarity also found in the pipes of the Pompeiian or-

Fig. 1.—Front View of the Hydraulus.

Fig. 2.—Rear View of the Hydraulus.

Fig. 4.—Side Views of the Hydraulus.

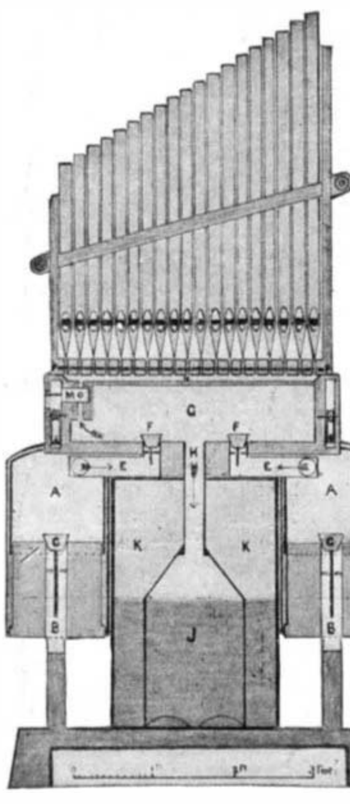


Diagram I.

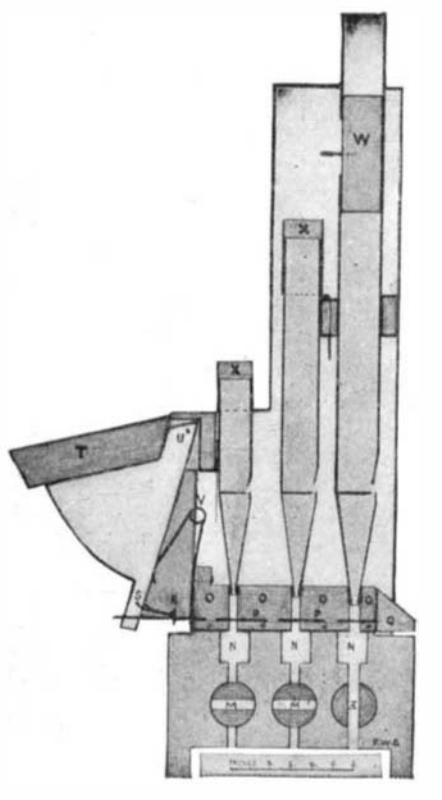


Diagram II.

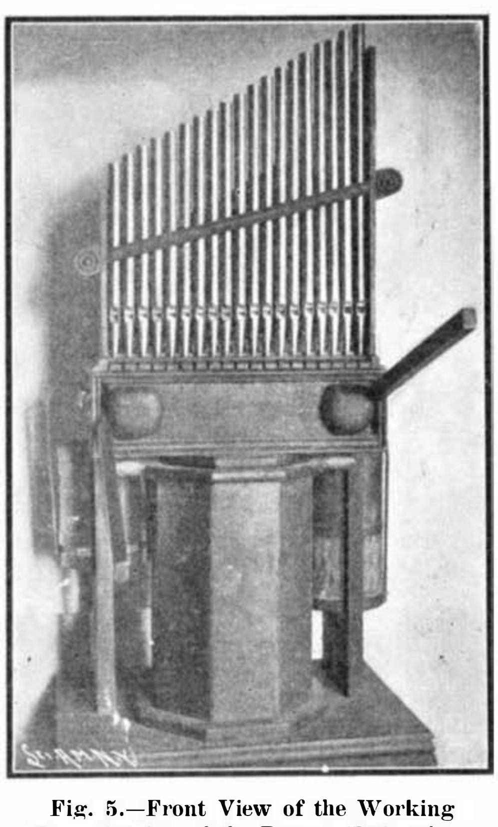


Fig. 5.—Front View of the Working Reproduction of the Roman Hydraulus.

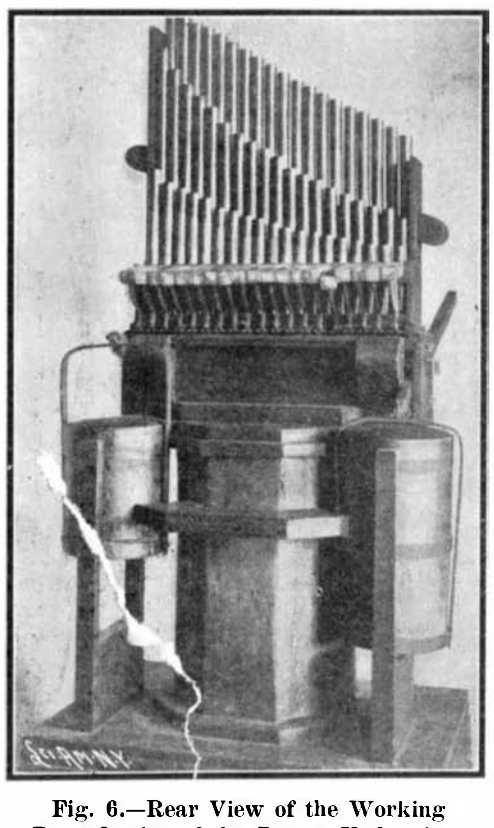


Fig. 6.—Rear View of the Working Reproduction of the Roman Hydraulus.

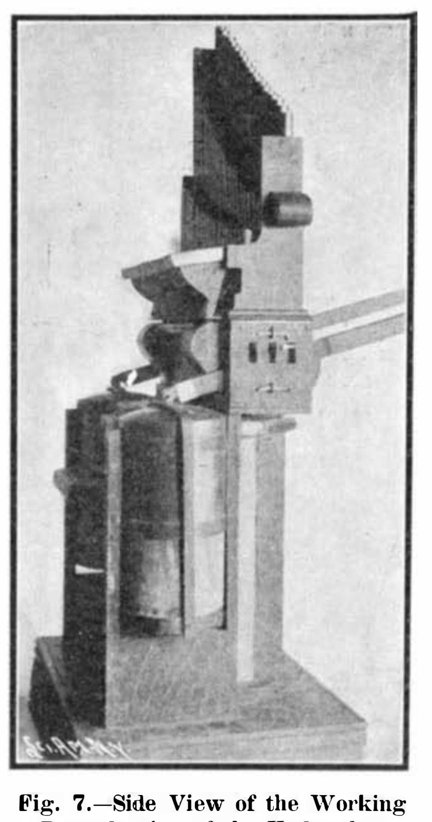


Fig. 7.—Side View of the Working Reproduction of the Hydraulus.

MODEL OF A WATER ORGAN FOUND AT CARTHAGE.

gan at Naples. To place the water organ side by side with our magnificent modern instruments would be as unfair as it would be absurd. More than two thousand years divide them, but that the hydraulus can still afford pleasure was conclusively shown at a demonstration given lately in London, when the ancient Greek music in use at the time the pottery model was made (such as the Ode to Chronos and the Hymns to Nemesis and Kalliope) was rendered in the original language with hydraulus and kithara accompaniment to the enthusiastic appreciation of a large audience.

In classical times the water organ was the admired adjunct of the public games and the luxurious theaters. Its association with the orgies of pagan Rome and the contests of the gladiators did not recommend it to the Christians. With dying Rome, it died; and those ingenious devices of keys, stops, and other details were lost until at the close of the eleventh century musicians astonished the men of their day and generation with a newly-found keyboard—a rough and rude contrivance indeed when compared with the "light touch" and "varied strains" of the old hydraulus.

The Inevitable Ether.

In an article which Miss Agnes Clerke writes in Knowledge on "The Inevitable Ether," and which is remarkable no less for its brilliant summary of the modern theories of the "ether" than for the literary fastidiousness with which it is written, the steps by which the conclusion that mass and energy may be interchangeable are traced. "The glory of the heavens is transitory," writes Miss Clerke, "but to the very brink of that mysterious ocean the science of the twentieth century has brought us; and it is with a thrill of wondering awe that we stand at its verge and survey its illimitable expanse. The glory of the heavens is transitory, but the impalpable, invisible ether inconceivably remains. Such as it is to-day, it already was when the *Fiat Lux* was spoken; its beginning must have been coeval with that of time. Nothing or everything according to the manner in which it is accounted of, it is evasive of common notice, while obtrusive to delicate scrutiny. Its negative qualities are numerous and baffling. It has no effect in impeding motion; it does not perceptibly arrest, absorb, or scatter light; it pervades, yet has (apparently) no share in the displacements of gross matter. Looking, however, below the surface of things, we find the semi-fabulous quintessence to be unobtrusively doing all the world's work. It embodies the energies of motion; is, perhaps, in a very real sense, the true *primum mobile;* the potencies of matter are rooted in it; the substance of matter is latent in it; universal intercourse is maintained by means of the ether; cosmic influences can be exerted only through its aid; unfelt, it is the source of solidity; unseen, it is the vehicle of light; itself non-phenomenal, it is the indispensable originator of phenomena. A contradiction in terms, it points the perennial moral that what eludes the senses is likely to be more permanently and intensely actual than what strikes them."

TOMATO VINES THIRTY FEET LONG.

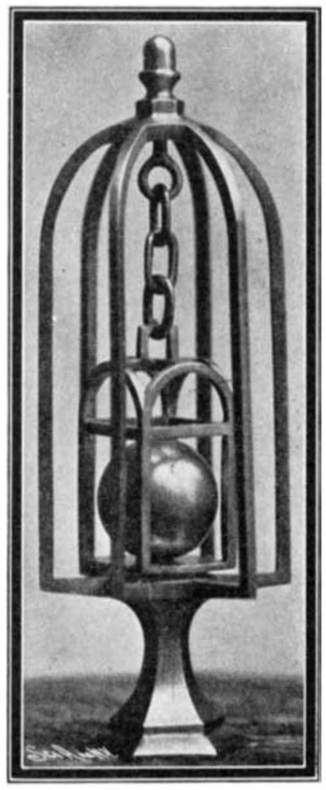
BY H. L. JONES.

Throughout the winter months, when easterners were crouching about their fires and shivering, and nature growths were either asleep or frozen stiff with the cold, Mr. F. J. Bates, of Pasadena, Cal., was in his garden climbing an 18-foot ladder to gather his various crops of tomatoes. He has three plants which have reached a length of 30 feet. They are of the species "Ponderosa," but these particular plants have surpassed in growth anything previously attempted by their kind. The seeds were planted in May, and three months from that time they had climbed to the top of a 20-foot trellis. When they reached this remarkable height they waved their flower-tasseled heads wonderingly, then turned around and grew backward until they have attained a length of 30 feet. As the vines are still sprinting, Jack's beanstalk must sink into obscurity and transfer its fame to these irrepressible tomato plants. They have had no especial care or cultivation, and have had no protection from the weather, yet in spite of every disadvantage they have kept on growing and fruiting in the most astonishing fashion. The trunks of these vines are $1\frac{1}{2}$ inches in diameter. The foliage is thick and luxuriant, and at all times blossoms, green fruit, and ripe fruit can be seen on the vines. Enormous quantities of tomatoes have been picked from these three plants. The fruit is of unusual size and has an extraordinarily fine flavor.

TOMATO VINES THIRTY FEET LONG.

A CURIOUS PIECE OF CASTING.

We have already presented to our readers pictures of Mr. D. Galvin's interesting castings. Perhaps the accompanying illustration shows the most curious piece that Mr. Galvin has thus far succeeded in producing. The casting, we are assured, was made from wooden patterns and sand. Nothing else was used.



A CURIOUS PIECE OF CASTING.

The height of the casting pictured, from the top to the base, is 12 inches, its width 4 inches. The ball is $1\frac{7}{8}$ inches in diameter, and the frame around the ball has an exterior measurement of $1\frac{3}{4}$ inches. The thickness of the metal of the frame, outside of the base, is 1-16 of an inch. Three of these castings will be exhibited in the Division of Mines and Metallurgy at the St. Louis Exposition.

Irrigation Profitable in the Humid Parts of the United States.

The advantages of irrigation in the humid climates, merely as a supplement to rainfall in ordinary or extra dry seasons, are forcibly presented in Bulletin No. 148 of the Office of Experiment Stations recently issued by the United States Department of Agriculture. The reports of a number of irrigation plants in the vicinities of eastern cities go far to show that as population increases and land becomes more valuable the zone in which irrigation can be profitably employed will be extended, as it has been in Europe, where the farmers have found that there are few sections where irrigation will not pay simply as an insurance against drought.

The bulletin states that a grower of berries in the vicinity of Poughkeepsie, N. Y., has found that artificial watering guarantees a perfect stand and rapid growth of newly-set plants, the highest quality of product, and maximum crops. Owing to dry weather and high temperature during the season of 1903 his berries had colored and hardened but did not sweeten. The application of 10,000 gallons of water in a fine spray and 25,000 gallons between the rows put the berries in fine condition for picking. He also found that to irrigate after applying chemical fertilizers dissolves and distributes the plant food and lessens the danger of injury to plants.

To water market gardens near New York city, on Long Island, and in New Jersey, small plants consisting of pumps, storage tanks, and piping are used with such success that their owners claim large returns on the money invested. One man stated that he would not attempt to garden for profit without such an assurance of plenty of water when needed. Some gardeners buy water from city supplies and find it more satisfactory than to install their own pumping plants.

Descriptions of pumping plants of various sizes and styles with their storage basins and distributing pipes are given in this bulletin so that those intending to try artificial watering may profit by the experience of several successful irrigators.

Striking testimony in favor of irrigation is furnished by the careful comparison of crops from irrigated and unirrigated plats of strawberries, asparagus, nursery stock, and onions at the Missouri Agricultural Experiment Station. Not only were yields larger, but in the case of asparagus unirrigated rows were affected with rust while the irrigated plants were entirely free from the disease.

A portion of South Dakota which is noticeably benefited by a supplementary water supply lies in the James River Valley. In the first attempts to utilize this supply of underground water, wells were made so large that the excessive cost resulted in financial loss. Within the last year or two the plan of sinking $1\frac{1}{2}$ to 2-inch wells has been tried and its success is leading to their extended use. A good 2-inch well will furnish water for half a section of land. An oversupply of water in the first experiments produced conditions that prejudiced many farmers against the practice, but later tests show that no injury need be feared where water is properly used. All cases of deterioration are directly traceable to an oversupply of water. An excessive amount of water in the soil will smother the rootlets and on evaporation will leave a deposit of salt, so that care must be taken that the soil does not become too wet. The bulletin as a whole shows the great advantage of irrigation as a means of increasing production and as an insurance against drought, even where the expense of securing a water supply is great.

What is said to be the first harbor for airships was that erected for the aerial contest at St. Louis. The ground made use of for this purpose covers about fourteen acres, inclosed by a wall for the protection of the vessels making ascent and descent, which operations will be greatly facilitated by a substantial shield of this character. At the southeast corner of this structure are two stalls for airships, each one 180 feet long and 40 feet wide and 30 feet high. There is also a shed 180 feet long and 20 feet wide where are all the facilities for making airship repairs and accommodations for the storage of ballast and other impedimenta. The wall inclosing the harbor is 30 feet high. The lower part of this structure is proof against the passage of wind, being absolutely tight to a point twelve feet above the ground. The upper part of the barrier is of latticework, which has the effect of tempering the breezes to a considerable extent. One of the practical results of the interest aroused in aerial matters by the contests arranged for at St. Louis is the investigation of the upper air of this country by the means of balloons containing automatically-recording instruments, and by this means it is expected to secure some very valuable data. The work is under the supervision of A. Lawrence Rotch, of the Blue Hill Meteorological Observatory.

Owing to the success of the cross-Channel turbine steamer "Queen," running between Dover and Calais, the South-Eastern and Chatham Company has ordered two more to be ready by next May or June.