two services if certain persons had the telegraph and others the telephone. This would make it necessary to have both and to pay a subscription to the two lines separately. This is why, without mentioning other objections, it would seem that private telegraphy by independent lines does not as yet represent the ideal from the viewpoint in question, aside, of course, from special applications such as railways, for war purposes, etc.

It is, therefore, from this point of view, pleasing to learn that an Italian electrician, M. Malcotti, of Rome, has been studying this question since 1901, but with the idea of devising a magnetic telegraph for use upon railways. This he finally succeeded in doing by means of the Hiljes apparatus above mentioned. But, subsequently, his attention became specially directed to a study of the application of the telegraph to telephone lines, which seemed to him to be of the most interest. After an examination of the question, he became convinced that it was necessary that the apparatus devised for this purpose should answer the following conditions: (1) That it should be applicable to any telephone installation whatever, even one with a central battery, without requiring any change or interfering with the service; (2) that it should nullify the danger of another apparatus interfering with the correspondence exchanged, and, at the same time, assure the secrecy of the latter; (3) that it should respond to the exigencies of an extensive exploitation, and that the net cost of installation should be small.

Is it possible for existing telegraphic apparatus to fulfill such conditions? It seems not, and the reason is that the telephone installations are based on two different systems, viz., that with individual microphone batteries at the residences of the subscriber and that with a central battery, which is known generally as the "common energy system."

In the first case, the important point is to so arrange conditions that the telegraphic currents shall have no influence upon the central exchange communicators which signal the termination of a conversation and which must be actuated solely by the call current. When the line consists of but a single wire, it is impossible to do this with any kind of telegraph apparatus. But if the line consists of the usual two wires, these can be used in parallel and the ground employed for the return. This is feasible if the central exchange is isolated. Does this system make necessary any alterations at the central exchange? A case where changes are necessary is exceptional. Besides, the common energy system with central batteries is obtaining a firmer footing every day because of the advantages that it presents. And how is it possible to install telegraphic apparatus like that mentioned upon one of these lines? It must be noted that an ideal apparatus should be capable of operating with any sort of installation, not only to make sure of an extensive exploitation, but also to permit of a modification of the latter in measure as the profits and needs of the service increase.

The problem remained unsolved until the apparatus devised by M. Malcotti, and called by him the "telecryptograph," made its appearance to surmount, it is claimed, all difficulties. This apparatus, which is said to have given satisfactory results during the course of some private experiments in Italy, and which is to be tested ere long upon the principal telephone lines of America and Europe, has, up to the present, been described in too incomplete a manner to allow of a very accurate idea being formed of it. It is, upon the whole, a secret printing telegraph, as its name indicates, and the distinguishing feature of the system is that it operates in the very same manner as the telephone, or by currents that do not disturb the central exchange, and which permit, therefore, of installing the apparatus independently of the telephone systems everywhere employed. The first condition mentioned above is thus entirely realized, as is also that of secrecy. In fact, it is possible to attune two apparatus to an agreed upon figure, or note, so to speak, so as to prevent any other apparatus from catching the communication exchanged. If a communication be transmitted in the absence of a subscriber, his apparatus not being attuned, the telegram will be received, but registered in an undecipherable manner. Upon his return, however, he can decipher the message automatically because he knows the cipher agreed upon. Transmitting in cipher, however, is merely optional, as it is possible to transmit, even in a legible manner, according to the usual process. It will be seen, then, that secrecy can be guaranteed while the communication is passing over the line wire to the receiving station, and that this guarantee is as perfect, even, as that offered by a closed letter.

It is not necessary for the central exchange to install the telegraphic apparatus, inasmuch as there is nothing to prevent two subscribers in correspondence from being called by "central." In a word, the apparatus does not interfere with the service. This is an important point.

The telecryptograph, therefore, would seem to solve the problem completely. But will it answer the practical exigencies of use with as much success as is asserted? This is yet to be seen, and it will prove of interest to know the details of the system, which we hope to illustrate some time in the near future. In the interim, we illustrate, in Fig. 1, the apparatus of the first type, which the inventor has greatly improved and transformed. It consists of a 5½x9½-inch box containing the entire transmitting and receiving mechanism. The apparatus prints on a paper ribbon and is actuated by means of a ratchet mechanism operated electrically, the necessary current being supplied by a small local battery. On the right of the apparatus (see Fig. 2 also), there is a sort of key that serves for attuning, as we have already explained.

The recent model is more practical. At the sides of the keyboard unwind two paper ribbons, upon each of which are printed in small and very legible characters the dispatches received and a copy of those sent, in such a manner that they can be distinguished from one another even should they be cut from the roller. The apparatus, which is very simple, is secured to the telephone. A spring that replaces the local battery sets in motion the apparatus, and it is possible to receive and transmit at the same time with or without secrecy.

Science Notes.

From experiments carried out the following conclusions are drawn by R. J. Strutt: (1) A radio-active gas or emanation can be obtained by drawing air over hot copper, or by bubbling it through hot or cold mercury. (2) By repeated circulation through mercury very considerable activity can be obtained, of quite a different order from that of metals as ordinarily observed. (3) The mercury emanation deposits radio-active matter on the walls of the vessel containing it. This deposit remains after blowing out the gas, and possesses at first perhaps one-sixth the activity of the latter. This induced activity falls to half value in 20 minutes. (4) The emanation itself decays in activity according to an exponential law, falling to half value in 3.18 days.

M. Blondlot now gives some additional information regarding the heavy emanation which he found to proceed from different bodies. This emanation possesses weight and falls downward by gravity. It acts almost like a stream of water proceeding from the substance. A silver coin is generally used, but if it is rubbed clean the emanation ceases entirely. It is then sufficient to heat it to 100 deg. C. in the air for a few minutes. When cold it now gives off the rays as before. The same holds good for pure silver, copper, mercury, iron, zinc, and bronze coins. Lead is an exception, and when freshly cleaned it gives off the emanation. On the contrary, after tarnishing, like lead pipe, it no longer acts. All the liquids he tried were active—water, salt water, pure sulphuric acid, glycerine, turpentine, alcohol, and in general all odoriferous liquids. The inactive bodies are platinum, iridium, palladium, gold, dry glass, fused sulphur, etc. M. Berthelot thinks that the emanation is not due to the metal itself (or other body) but to a very slight chemical action which is produced at the surface. The action of liquids, whose vapor tension is never absolutely zero, and of odoriferous bodies might be due to the formation of volatile compounds. It will thus be of interest to take up the question from a chemical point of view.

A cemetery belonging to a garrison of Longobards has been found near Ascoli on the Tronto at an important pass across the Apennines. The site of the fort is the top of an island of rock now occupied by a little hamlet called Castel Trosino. All the warriors were laid with their faces to the east. Near the head was found a comb made of horn or bone and a round shield with iron boss. On the right lay a long, straight iron sword in a scabbard of hide. Against the right shoulder was laid a long wooden spear and on the left a dagger in a highly ornamented sheath, decorated with gold, as well as a bow and arrows in a quiver. The buckle of a broad belt was generally present and often decorated appliqué for belt and scabbard, fashioned of gold, silver, or bronze. Small gold plates seem to have been sewed to the coat in the shape of a cross. One grave contained a heavy cuirass of plates bound together with iron wire. The horsemen had big shears for clipping manes and a large bronze feed trough with two movable handles; often bits, saddles, and harness were laid beside the dead. The women wore gold hairpins with rounded flat heads, gold earrings of different shapes, finger rings, and gold plates. One ring has the names Gerontius and Regina engraved on it. Crosses and necklaces of gold, and beads of glass, silver bracelets, pottery vases, and plates of glass, cups, combs, and other articles of the toilet accompany the remains of women. Gold coins of the Byzantine emperors cover the reigns tasius (491-518) and Mauritius Tiberius (582-602) the year 578 Faroald of Spoleto, Duke of the Lombards, conquered Ascoli. The cemetery is therefore attributed to a garrison which he placed at an important pass between the lands on the Adriatic and the country to the west. These graves have escaped the plunderer because no stones were placed above them. Most of the objects have been placed in the Museum of the Thermæ at Rome.

COFFEE AND COFFEE CULTURE.

BY C. B. HAYWARD.

The early history of coffee as an economic product is involved in considerable obscurity, fact and fable being blended to an extent which renders any exact knowledge of it previous to the fifteenth century almost impossible. It is said to have been known as early as 875 A. D., but a pamphlet published by an Arab sheik in 1566 seems to shed the first light upon its origin and early use. It is there stated that coffee was introduced into Arabia from Abyssinia about the opening of the fifteenth century, and that it had been known as a beverage in the latter country from the most remote period. Its peculiar properties were taken advantage of by the Mohammedans in connection with their prolonged religious ceremonies, but its use as a devotional antisoporific stirred up the fiercest opposition on the part of the orthodox element of the priests. Coffee was declared to be an intoxicant, and was accordingly prohibited in the Koran, but in spite of this the coffee-drinking habit spread rapidly. Coffee culture has become as inseparably associated with Arabia as tea with China.

For two centuries the world's supply of coffee was obtained from the province of Yemen in southern Arabia, where the well-known Mocha is still cultivated. Knowledge of the taste and value of coffee spread but slowly, so that it was not until the middle of the sixteenth century that it reached Constantinople. Here it also incited the bitter hostility of the priests. An excessive tax was imposed upon coffee houses, notwithstanding which they flourished and extended. After the lapse of another hundred years, coffee reached Great Britain, where it was introduced by a Mr. Edwards, a British merchant long resident in Turkey. The first coffee house in London was opened in St. Michael's Alley, Cornhill, by his Greek servant, Pasqua Rossie, in 1652, and, remarkable to relate, the introduction of the beverage into England met with the same opposition as in the East. In 1675 Charles the Second attempted to suppress coffee houses by royal edict, in which it was stated they were the resort of disaffected persons, "who spread abroad divers, false, malicious, and scandalous reports, to the defamation of His Majesty's government, and the disturbance of the peace and quiet of the nation." In England, as well as other countries, the most effective check on the consumption of the beverage was found to be a high duty, which led to much smuggling. Coffee is spoken of as being used in France between 1640 and 1660, and thereafter coffee drinking may be said to have become an established habit throughout the civilized world.

Up to 1690 the sole source of supply was Arabia, but in that year it was introduced into Java by the governor-general of the island, and the climate was found to be so well adapted to it, that cultivation was begun on a large scale. One of the first plants grown in Java was sent to the botanical gardens at Amsterdam, and seed from it was sent to Surinam, resulting in its introduction into that country in 1718. Ten years later it found its way to the West India islands, and from that time its cultivation has been general throughout the inhabited portions of the tropics.

The regions best adapted to its culture are well-watered mountain sdopes, varying from one to four thousand feet in altitude and between the parallels of 15 deg. north and 15 deg. south latitude, although it is cultivated from 25 deg. north latitude to 30 deg. south in situations where the temperature does not drop below 55 deg. Fah. According to the altitude at which it is grown, the bean varies in size and color, that from the highlands being small and light green, and nearer the coast of a yellow tinge and much larger; the wild trees of Liberia, which flourish in lowlands, producing the largest beans known, which are, however, inferior in quality, as is the case with the majority of the African product. Eastern coffee generally may be distinguished by its yellow color and large beans, as compared with the smaller green berries of Central and South American growth.

The tree in its wild state is slender, reaching a height of twelve to twenty feet, but under cultivation it is pruned to grow not more than six or eight feet high, for convenience in picking. The leaves resemble those of the laurel, though not so dry and thick, and are evergreen, while the flowers are somewhat like the jasmine. The trees are completely covered with blossoms, which perfume the whole countryside for days they last. The fruit resembles the cherry much in all stages of development, and especially when ripe, when it is a dark purple. The two semi-elliptic seeds are inclosed in a parchment-like skin, and surrounded by considerable pulp, which is very sweet when ripe. In Costa Rica the coffee-harvesting season is marked by an epidemic of dysentery on the part of the juvenile population, through over-indulgence in this pulp. In cultivating, the plants are grown from seed, and set out when about six months old; they begin to bear at the end of three years, and continue to do so for about twenty years. Considerable space is left between the trees, and plantains, bananas, and other fruits are grown about them, for the double purpose of shade and provision. The first year's crop is small, but when in full bearing, each tree will yield from one to five pounds, according to location and variety.

As few articles of food go through so many and varied processes before appearing in marketable form, it will be of interest to follow the progress of coffee from the blossom to the cup. The trees break forth in a mass of bloom early in the spring, but the complete covering of delicate white blossoms which may be seen in one of the illustrations disappears in a very few days. A period of four to five months has elapsed before the trees have reached the next stage illustrated; and as the bean is firmly attached to the branch, and the region is not subject to heavy storms, the crops are not depleted by windfalls, the tree showing almost as complete a covering of fruit as of blossoms. This may be seen by looking closely at the illustration, which represents the *hacendero* on a tour of inspection, to see if the crop is ready for picking. This latter operation is accomplished by a large force of peasants, each with basket slung over shoulder, in a short time, and the fruit is hauled in lumbering ox-carts of medieval pattern to the patios or drying yards. The latter are literally huge cement floors, which form admirable tennis courts when not being put to their legitimate use, and on a large *finca* (plantation) will cover several acres.

Here the berries are spread out in a layer a few inches deep and then hoed up into rows, being continually turned, so as to present all the fruit to the sun. In one of the engravings the old and new methods are shown side by side, the coffee drying in the sun on the patio and being dried by machine, the latter resembling a huge roaster, and acting in much the same manner. The former cherry-like fruit has now become a tough, black, and wrinkled nondescript, resembling pebbles as much as anything, and with which it is more or less mixed. From here it is shoveled into the large fermenting tanks, where it is covered with water and allowed to remain some time, being continually stirred and having the extremely malodorous water drawn off at intervals. From this process it emerges completely cleansed of the large amount of soft pulp which has hitherto covered it, but the beans are still held face to face by a thin and very strong parchment-like covering, which can only be removed economically by machinery. This is accomplished by a huller, which breaks the beams apart and blows off the covering. The impurities, such as black and worthless beans, stones, etc., are then picked out by hand, and the coffee is bagged ready for shipment. The roasting and grinding are both familiar operations, and are always done where the coffee is to be used, as it loses its aroma quickly in any other but its green state.

MODERN LOCOMOTIVES AT THE ST. LOUIS EXPOSITION.

BY THE ST. LOUIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Although the display of modern locomotives in the Transportation Building of the St. Louis Exposition is not marked by that strong international flavor which went so far in lending to the Chicago locomotive display its surpassing interest, it must be admitted that the American locomotive builders have made a most handsome exhibit. Indeed, the number, variety, and thoroughly up-to-date character of the American locomotives render the display of such value and interest that, in spite of the paucity of foreign exhibits, the exhibit is well worth a visit to St. Louis on the part of any railroad man.

We have already, in previous issues of this paper, illustrated several of the leading locomotive exhibits, and in the double-page engraving of the present issue we have grouped a series of the more interesting exhibits that we have not as yet treated. Of the five locomotives manufactured by the Baldwin Company and herewith presented, the three shown in the upper left-hand cut stand at the head of the three long lines which include the greater part of this company's exhibit; while the two other photographs are of a pair of compound express engines which stand on sections of track outside the Transportation Building. The engines at the head of the first and second lines of display are handsome specimens of the very popular Atlantic type of passenger engine, No. 554 having cylinders 20 inches diameter by 28-inch stroke, a heating surface of 2,655 square feet, and a total weight in working order of 183,700 pounds. No. 306 is also a passenger engine of the Atlantic type, but of less weight and power, the cylinders being 19 inches by 28 inches stroke, the heating surface 2,879 square feet, and the weight 169,090 pounds. The huge engine at the head of the third line is the largest and most powerful engine in the world of what might be called the American standard freight type. It has a total weight of 287,240 pounds, and it is only exceeded in weight by the huge articulated locomotive which stands at the head of the Baltimore & Ohio exhibit. The latter engine, however, is of an entirely original type in this country, and stands in a class by itself. The big Baldwin freight engine is of what is known as the Santa Fé tandem compound type, and it is one of several that have been built for hauling trains over the mountain division of the Santa Fé system. The four cylinders are placed in tandem, two on each side, the 19-inch high-pressure cylinders being placed ahead of the 32-inch low-pressure cylinders, and having a common piston rod. The cylinder stroke is 32 inches; the driving wheels are 57 inches in diameter; the total weight of the engine is 287,240 pounds, and the total weight of engine and tender is 450.000 pounds. The total heating surface is 4,796 square feet. The tender has a capacity of 8,500 gallons of water and 10 tons of coal or 3,300 gallons of oil. The total length of the engine over all is 77 feet 10 inches, and as it stands in the Transportation Building it looks every inch of its length and every pound of its great weight. The first engines of this type that were built were placed in service last winter, and since November have made about 30,000 miles each. The heaviest grades are encountered when crossing Raton Mountain, where the ruling ascending grades are very heavy, reaching as high as 158.4 feet to the mile for a distance of between nine and ten miles. The service of these engines has been satisfactory in every respect. Upon test, one of them has taken a train of 2,400 tons up a grade of one per cent for a distance of seven miles at a rate of 18 miles per hour—a feat which the master mechanic of not more than ten or a dozen years ago would have declared impossible.

Two Baldwin compounds, Nos. 507 and 1,587, stand on the outside of the Transportation Building. No. 1,587 is a four-cylinder compound built for the C., B. & Q. Railroad on what is known as the Vauclain system, in which the high pressure cylinders are placed above the low-pressure, the piston rods connecting to a common crosshead. This engine is of a type that has done most successful work in high-speed passenger service. The high-pressure cylinders are 15 inches, the low-pressure 25 inches in diameter, and the common stroke is 26 inches. The other compound, No. 507, is the more interesting machine, because it is of a more novel type, being built on the four-cylinder balanced system. The 15-inch high-pressure cylinders are placed side by side beneath the smoke-box, and are connected to a pair of cranks turned in the leading driving axle. The low-pressure cylinders are on the outside of the frames and connect to the same axle. The adjacent high-pressure and low-pressure cylinders on each side of the engine are placed with their cranks at 180 deg., an arrangement which makes it possible to dispense with the reciprocating counterbalance which is necessary in the ordinary type of engine. The system has shown excellent results, the running being very smooth, and the hammer blow on the rails at high speed being practically eliminated.

Standing adjacent to the Pennsylvania locomotive-testing plant is one of the celebrated De Glehn compound four-cylinder locomotives, which have won such a great reputation for themselves during the past few years on French railways. It is owned by the Pennsylvania Railroad Company, was built specially for them, and forms part of their exhibit. A placard states that it has been purchased with a view to testing the type under the conditions of American railway service, and adopting such elements as may prove to be suitable and useful. This compound is one of the twenty locomotives that are to be tried out on the exhibition testing plant; and after it has been tested it will be placed in regular service on some division of the company's lines. The particulars of the engine are as follows: Two high-pressure cylinders 14 3-16 inches diameter by 25 3-16 inches stroke, and two low-pressure cylinders 23⅝ inches diameter by 25 3-16 inches stroke. The high-pressure cylinders are connected to the rear driving axle, the low-pressure cylinders to the forward driving axle. The valve gear is of a modified Walschaert type. The high-pressure and low-pressure reverse levers are separate; but provision is made for interlocking them when desired. The driving wheels are 80 5-16 inches in diameter, and the total load upon them is 85,000 pounds, the total weight of the engine being 161,700 pounds. The heating surface of the tubes is 2,435.7 square feet and of the firebox 181.8 square feet, and there are 33.9 square feet of grate surface. The steam pressure is 225 pounds to the square inch. This fine engine is credited by the French builders with having developed 1,700 horse-power in service, and it will be interesting to see whether similar results can be obtained under the careful observations of the testing plant.

One of the high-speed locomotives that were used in connection with the official high-speed experiments on the Marienfelde-Zossen line has been shipped to America, and is being exhibited at the World's Fair. This locomotive, built by the Hannover'sche Maschinenbau Gesellschaft vormals Georg Egestorff, Linden vor Hannover, is a four-cylinder compound express engine of the Atlantic type. The engine is fitted with a Von Borries simplified valve gear and a Pielock superheater, giving a heating surface of 310 square feet and superheating the steam to about 300 deg. C. The boiler has 241 solid-drawn iron tubes of nearly 2 inches outside diameter and 14 feet 7 inches length between the tube plates.

There are four cylinders, set in a line across the engine, above the truck. The two high-pressure cylinders are placed between the frames, and the two low-pressure cylinders outside, each pair being cast in one piece with their corresponding steam chests. The two groups of cylinders are bolted together, and carry the smokebox. They rest on the frames, which are of the bar type at the front of the engine, and of the usual plate form behind. The valves of the high-pressure cylinders are piston valves with inside admission, those of the low-pressure cylinders balanced Trick valves. The four pistons are all coupled to the forward driving axle.

In order to lessen, as much as possible, the disturbing influence of the reciprocating parts, the cranks of the high-pressure and low-pressure cylinders upon the same side of the engine are set at an angle of 180 deg. to each other. The cranks of the two sides are at right angles to each other. This arrangement renders it possible considerably to reduce the size of the counterweights, since the reciprocating parts balance each other almost perfectly. As these forces are balanced upon the same axle, they do not strain the frame or other parts of the engine. The arrangement therefore contributes very materially to the ease of the motion of the engine, besides diminishing the wear upon the wheels and the track by hammering. On some trial trips these engines have shown remarkably smooth running at speeds up to 80 miles per hour.

The valve gear is of the Heusinger Walschaert type. The great peculiarity of the valve motion of this engine, however, lies in the fact that both valves on one side of the engine are driven by a single gearing. The two valves are controlled by a single link, which receives its motion from one eccentric, but the stem of each valve is coupled to an advance lever which receives its motion from the crosshead of the corresponding piston.

For the outside valve the link movement is transmitted by a rod with levers of different lengths after the Von Borries patent, so proportioned that the ratio of steam admission is 55 to 30 for low-pressure and high-pressure cylinders in forward and backward gear.

Before being shipped to St. Louis the locomotive was run on the Hanover division of the Prussian State Railway seven days in regular fast train service, and has proved able to haul vestibuled car trains of 300 tons weight with a constant speed of 61 miles per hour on the level and 50 miles per hour on grades up to 1 in 200. The starting is effected smoothly and without any difficulty by a direct admission of live steam into the steam chests of the low-pressure cylinders. This admission is governed automatically by the regulator valve.

So far the Prussian State Railways have twenty-nine of this type of locomotive running or under construction, a lot of nineteen having been ordered this year.

The principal dimensions of the engine are the following: Cylinders, 14 inches and 24 inches diameter by 24 inches stroke. Diameter of driving wheels, 6 feet 6 inches. Steam pressure, 199 pounds. Heating surface, 1,922 square feet. Weight, 132,700 pounds.

For several reasons the massive articulated locomotive which forms the subject of one of our illustrations is easily the most original among the exhibits of locomotives in the Transportation Building at the St. Louis Exposition. In the first place, it has the characteristic (ever dear to the American heart) of being the biggest thing of its kind in existence. Another distinctive feature is that this locomotive, which was built by the American Locomotive Company, is constructed on the principles of a very successful type of compound locomotive that has been used for many years in Europe for heavy freight service. It is known as the Mallet type, after the inventor. In this system the compounding is divided between two separate engines, each of which is carried on its own separate frame. The high-pressure engine is carried on the main locomotive frame, and the low-pressure engine is carried on a forward six-wheeled radial truck, which

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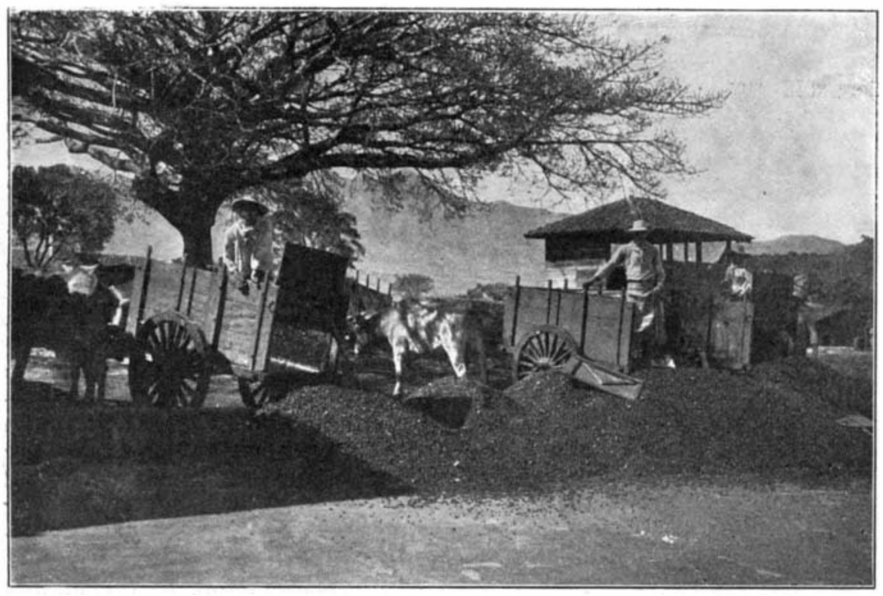
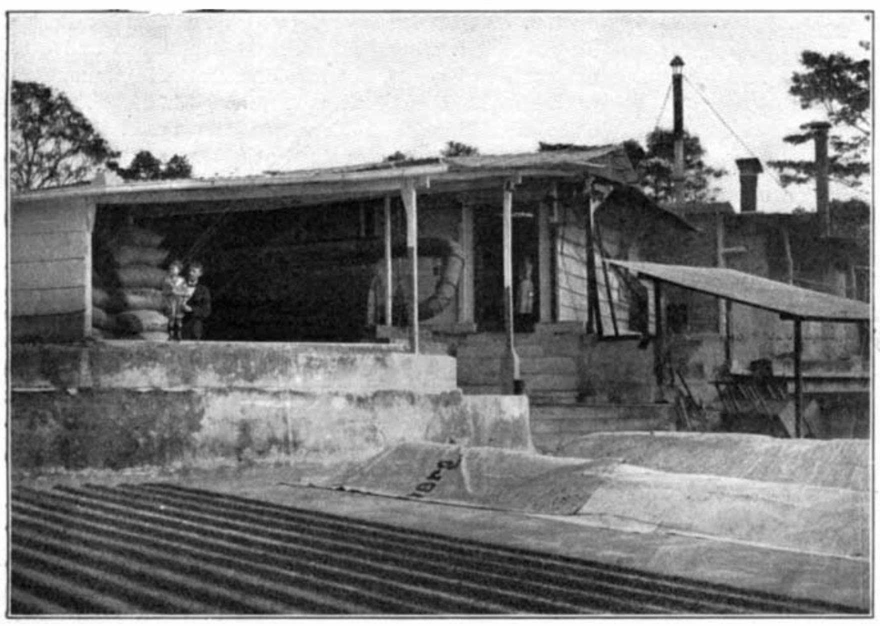
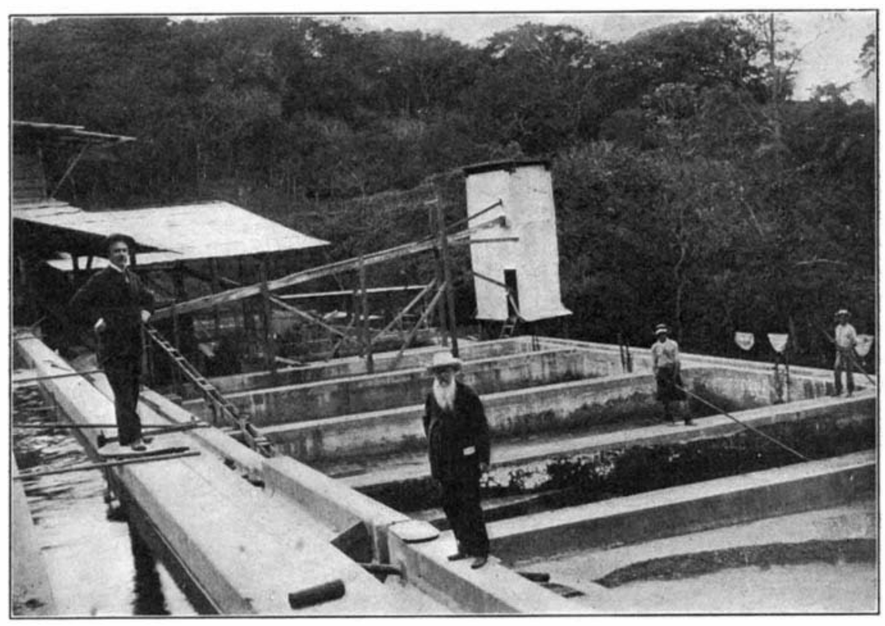


Unloading Coffee in Fruit on Patio.

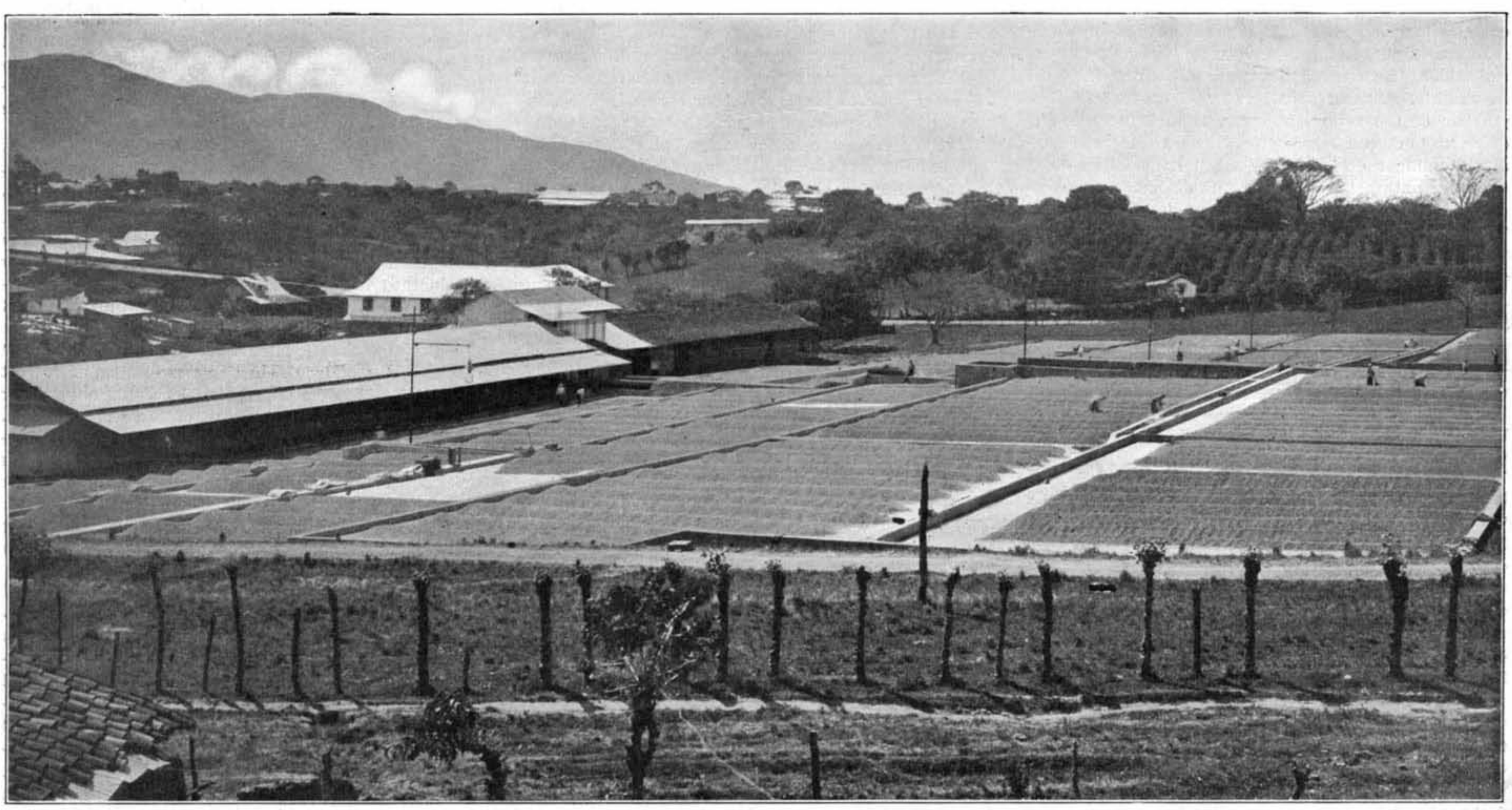
Packing Coffee for Shipment.



Drying Coffee in Sun and in Drying Machine.



Tanks for Fermenting Coffee.



Drying Coffee in the Sun at San Jose.

A TYPICAL COFFEE PLANTATION IN SOUTH AMERICA.—[See page 194.]