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.

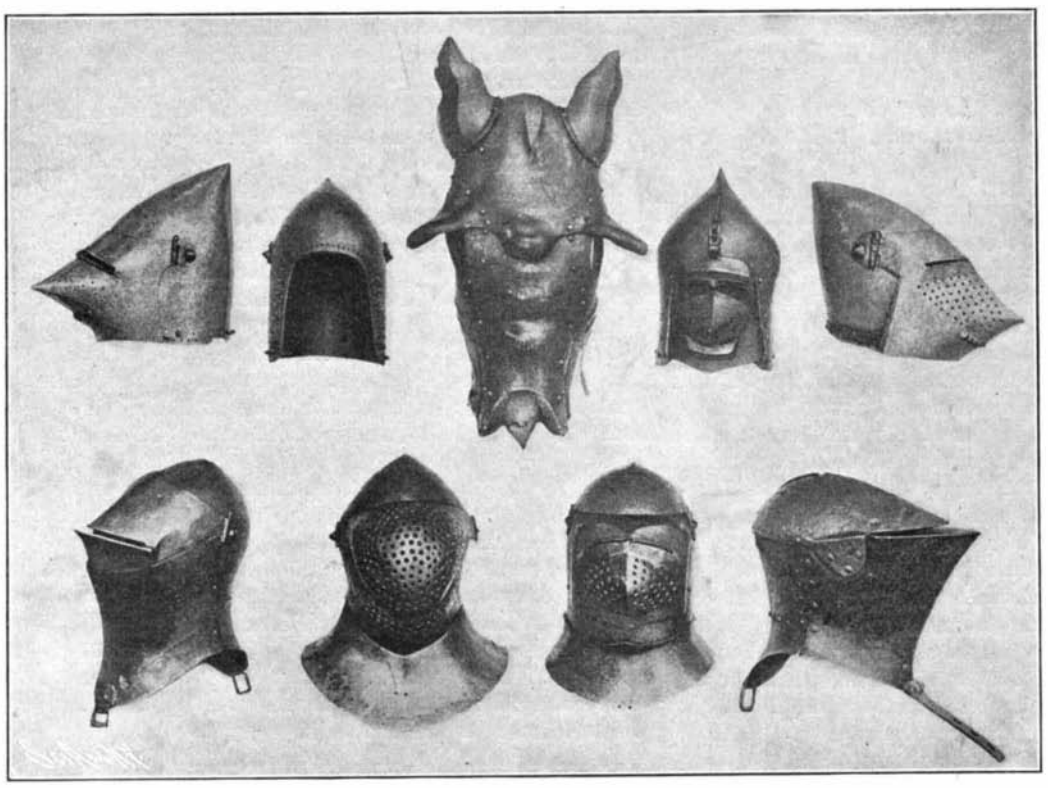
For several reasons the massive articulated locomotive which forms the subject of one of our illustrations is easily the most original among the exhibits of locomotives in the Transportation Building at the St. Louis Exposition. In the first place, it has the characteristic (ever dear to the American 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

is attached by a vertical hinge to the main frame, a flexible coupling being arranged in the steam pipe, leading from the high-pressure to the low-pressure cylinders. The high-pressure cylinders are 20 inches diameter by 32 inches stroke, and the low-pressure cylinders 32 inches diameter by 32 inches stroke. The enormous boiler has a diameter of 84 inches. It carries 5,366.3 square feet of heating surface in its tubes, and 219.4 square feet of heating surface in its firebox, making a total of 5,585½ square feet for the whole boiler. The firebox has a total length of 108⅛ inches, a width of 96¼ inches, and the grate area is 72.2 square feet. The total weight on the driving wheels, which are 56 inches in diameter, is 334,500 pounds, this being the total weight of the engine. An interesting fact is that the 436 tubes in the boiler have a total length of not far short of two miles. With a boiler pressure of 235 pounds to the square inch, and using live steam in all four cylinders (which the enormous boiler capacity renders possible, not merely at starting, but steadily when the engine is under way) this remarkable locomotive can exert a drawbar pull of 82,000 pounds, and a drawbar pull of about 71,500 pounds when she is working compound.

Now as to actual results attained. Previous to sending the engine to St. Louis, the engine was tested under the conditions of actual service at Schenectady, when she took a 63-car train weighing 3,150 tons up a one per cent grade. As to what she could do on the level, it can safely be said that she would be capable of hauling a train of considerably over twice that weight at a speed of from ten to twelve miles per hour.

Three different companies at the Fair exhibited complete passenger trains, the cars representing the very latest development of the car-builders' art. The Pullman Company had a train of cars in which every modern improvement and the latest ideas on interior finish and furnishing were exemplified. The N. Y. C. & H. R. Railroad Company exhibited a complete Empire State Express train, which was recently illustrated in this journal, the train being complete, even to the new balanced compound locomotive at its head. We present in our two-page group of illustrations a photograph of another complete train exhibit, made by the Missouri Pacific Railroad Company. This train was made up of six cars as follows: First a United States railway postal car, 63 feet 6 inches long over buffers, and 10 feet wide, the framing of which is made in accordance with railway mail service specifications; then a standard baggage and express car, 63 feet 4 inches long over buffers and 10 feet wide over side sills; then two vestibule coaches, 69 feet 8¼ inches long by 10 feet wide; a chair car of same length and width; and a dining car 79 feet 4¼ inches by 10 feet in width. A special feature of this car is a private dining room, with an oval table large enough to seat six people. The whole train, which was built by the American Car and Foundry Company, is of interest as exhibiting the modern tendency to abolish extremely heavy and over-rich interior decoration and resort to a lighter and simpler style. Also, there is a noticeable tendency to increase the size of the windows, even those of the ordinary day coaches being of exceptional width, providing a long stretch of unobstructed outlook. The engine at the head of the train is a six-connected, simple engine, with cylinders 20 by 26 inches; 69-inch driving wheels; and a heating surface of 2,930 square feet. The working pressure is 200 pounds to the square inch, and the total weight of engine 183,200 pounds.

The Helmet and Shield of Louis XIV.



A Collection of Casques and Head Pieces; the Second Helmet from the Left in the Top Row is Supposed to Have Been That Worn by Joan of Arc.

After prolonged delay the Italian government has at last introduced the measure sanctioning construction of the Apulian aqueduct. This project consists of an irrigation system for the arid tableland of Apulia. The aqueduct is to cross the Apennines by means of a tunnel 7½ miles long, and will have several subsidiary canals, so that twenty-one communes of the province of Foggia, and all those of the provinces of Bari and Leece, will receive an adequate supply of water. These communes contain a population of nearly two millions. It is estimated that the scheme will cost $25,000,000, and will not be completed before the year 1920.

THE DINO COLLECTION OF HISTORIC ARMOR.

BY ISABEL R. WALLACH.

The collection of armor gathered by the late Duc de Dino, Marquis of Talleyrand-Perigord, and now the property of the Metropolitan Museum of Art in New York, is a revelation of the degree of beauty to which metal work may be carried, and also of the wonderful effects achieved by the medieval armorers. Truth of line, integrity of purpose, and strength of construction distinguish each piece, and bear testimony to the fidelity and skill of the craftsman. Inlay and overlay, chasing and pierced work, damascene and etching,

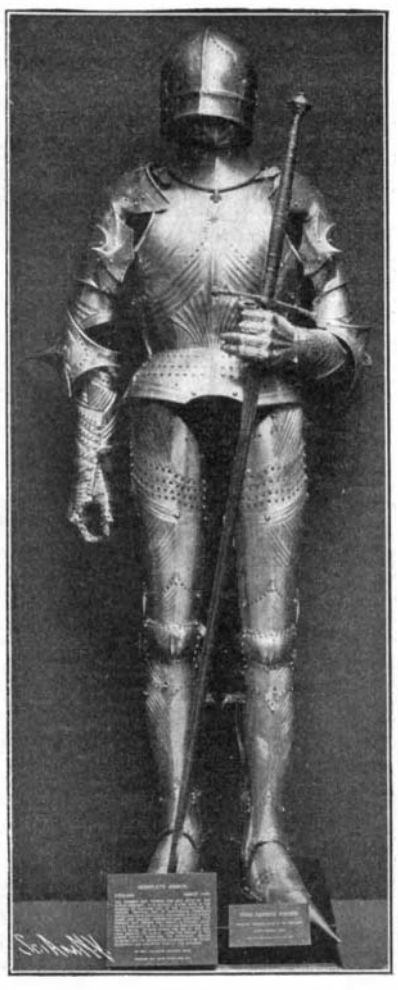
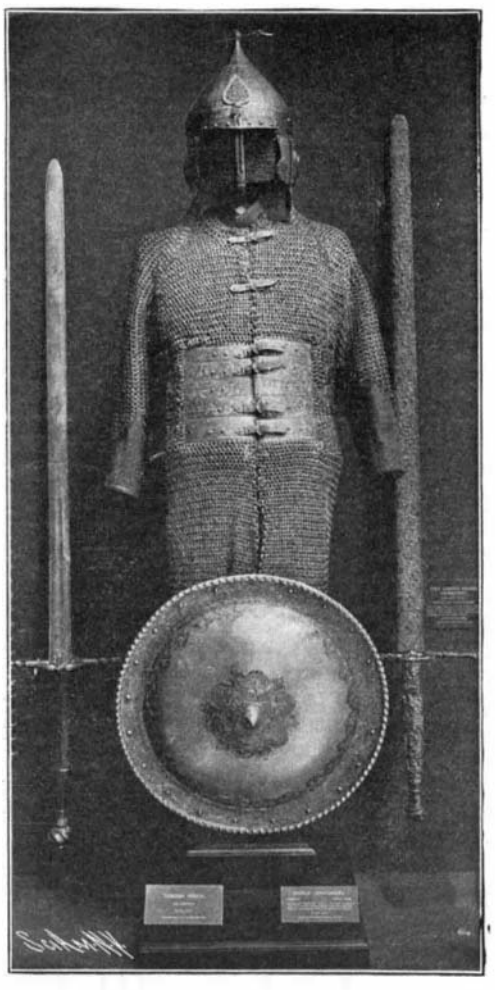


Plate Armor of Florid Workmanship (1490). Typifies the Best Work of the Gothic Armorer in the Anatomical Modeling of Steel.

Striped Armor, Black and Silver Etched, of German Workmanship. The Shoe and Gauntlet are Made of Separate Plates to Secure Flexibility and Suppleness.



A Turkish (Saracen) Coat of Chain Mail (XVI. Century). The Shield is of Contemporaneous German Workmanship, and Probably Designed for a Spanish Knight.

One of the four extant Gothic suits dating from 1450, considered the most valuable in the Dino Collection. This suit bears the marks of the armorer's proof-tests.

THE DINO COLLECTION OF HISTORIC ARMOR.