THE NEW EXPERIMENTAL LOCOMOTIVE FOR PURDUE UNIVERSITY.

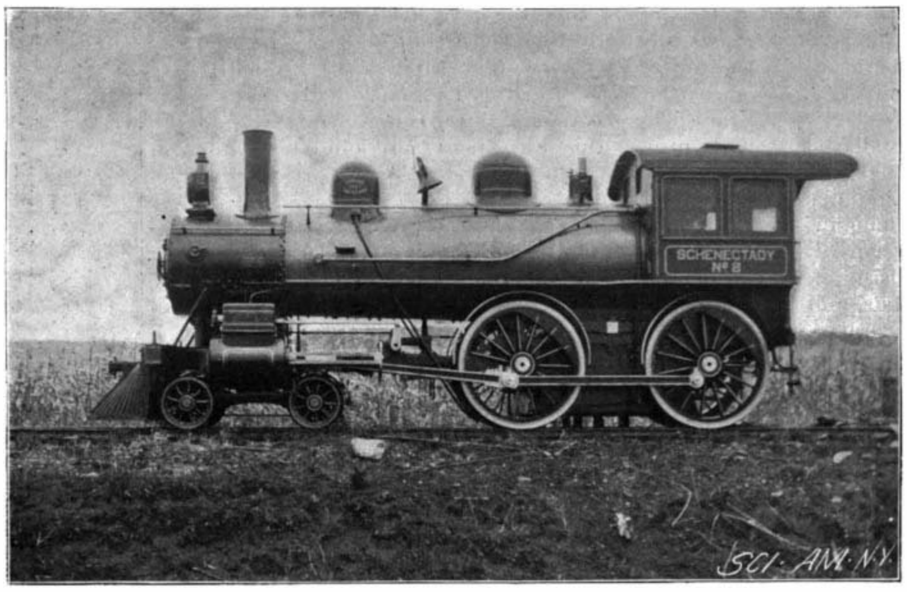
The engineering world has benefited greatly from the laboratory tests which have been carried out from time to time upon the Schenectady locomotive which was built some years ago and shipped to the university for laboratory work. The advance which has taken place of late years in locomotive designs has rendered this machine somewhat out of date, and it is now to be replaced by a new locomotive of which we present an illustration. The engine is of the American eight-wheel type, and at first glance it would not appear to differ from the common type. As a matter of fact, however, it possesses many special features determined by the Purdue authorities, and various interesting details inserted by the builders.

The cylinders are bored out to 20 inches diameter and are provided with bushings 2 inches in thickness, so that their present dimensions are 16 inches diameter by 24 inches stroke. The bushings will be bored out to give various dimensions, and the saddle has been so constructed as to permit of a 30-inch low pressure cylinder being added for the purpose of testing the locomotive as a compound. Allan Richardson valves are used. They have a maximum travel of 6 inches with a 1⅛-inch outside lap. Steam ports measure 18 inches by 1⅝ inches and the exhaust port 18 inches by 3 inches. The boiler carries a working pressure of 250 pounds to the square inch. The firebox is 6 feet long and 34¼ inches wide, the grate area being 17¾ square feet. The drivers are 5 feet 9¼ inches in diameter and they carry a weight of 61,000 pounds, the total weight of the engine being 96,000 pounds.

The crank pins and crosshead pins, the piston rods and main axles, are all made of fluid compressed acid open hearth nickel steel annealed, and all except the piston rods are hollow and oil tempered. The great mortality of these parts in locomotives has led engineers to seek for some metal of high elastic limit and elongation which would successfully resist the severe alternating stresses to which they are subjected. When steel was first substituted for wrought iron in locomotive crank pins, a soft, low carbon steel was generally employed, and failures due to "fatigue of metal" were almost as frequent as before. The broken pins showed what has been called "a fracture in detail"—a gradual parting of the steel extending inward all around the piece, undoubtedly produced by the working strains repeatedly approaching the low elastic limit of the soft steel. On substituting a higher carbon steel with an elastic limit of 45,000 to 50,000 pounds per square inch, failures were greatly diminished without changing the diameter or shape of the pins. Steel of still higher elastic limit and proportionately greater elongation gives correspondingly better results, and many of the representative railroads of the country are considering the adoption of and others have already adopted nickel steel wherever it can be used on their locomotives; and where the form and size of the forgings will allow of such treatment, they are made hollow in order that they may be oil tempered to still further increase the physical properties of the metal. Test bars from the forgings for the locomotive show the following results in test specimens ½ inch diameter and 2 inches long between measuring points:

Tensile strength	91,000 pounds.
Elastic limit	57,000 "
Elongation	25·05 per cent.
Contraction	56·45 "

We are indebted for the above particulars to Prof. W. F. M. Goss, the director of the engineering laboratory at Purdue University.



LOCOMOTIVE FOR THE PURDUE UNIVERSITY LABORATORY.

Cylinders, 16 to 20 inches by 24 inches; drivers, 5 feet 9 inches; steam pressure, 250 pounds; weight, 96,000 pounds.

THE GUN FACTORY AT THE UNITED STATES WASHINGTON, D. C, NAVY YARD.

The modern cannon is a work of the highest mechanical order. In former days the gun founder often cast very beautiful cannon of artistically elaborate design. To-day the gun leaves the assembling shops a rigorously plain structure, yet in degree of accuracy of workmanship exceeding almost any class of mechanical work. Our illustrations give views from the Washington navy yard, where in the course of years a gun assembling plant has been organized which now represents about $2,000,000 investment. In its mechanical excellence it is believed to be the equal of or to exceed any similar shop. The operations performed in the navy yard are the machining and assembling of the different pieces received as forgings from the steel works. The parts composing the barrel or body of the piece are turned and bored. They are then put together with shrinkage. The breech mechanism is constructed and put together and the gun is ready for mounting and for trial at the proving grounds. The size of main battery guns is specified by stating the diameter of the bore. At the navy yard the calibers of such guns thus far manufactured are 4-inch, 5-inch, 6-inch, 8-inch, 10-inch, 12-inch, and 13-inch. The capacity of the largest lathe provides for a gun of 16-inch bore, though so large a piece is never made there now.

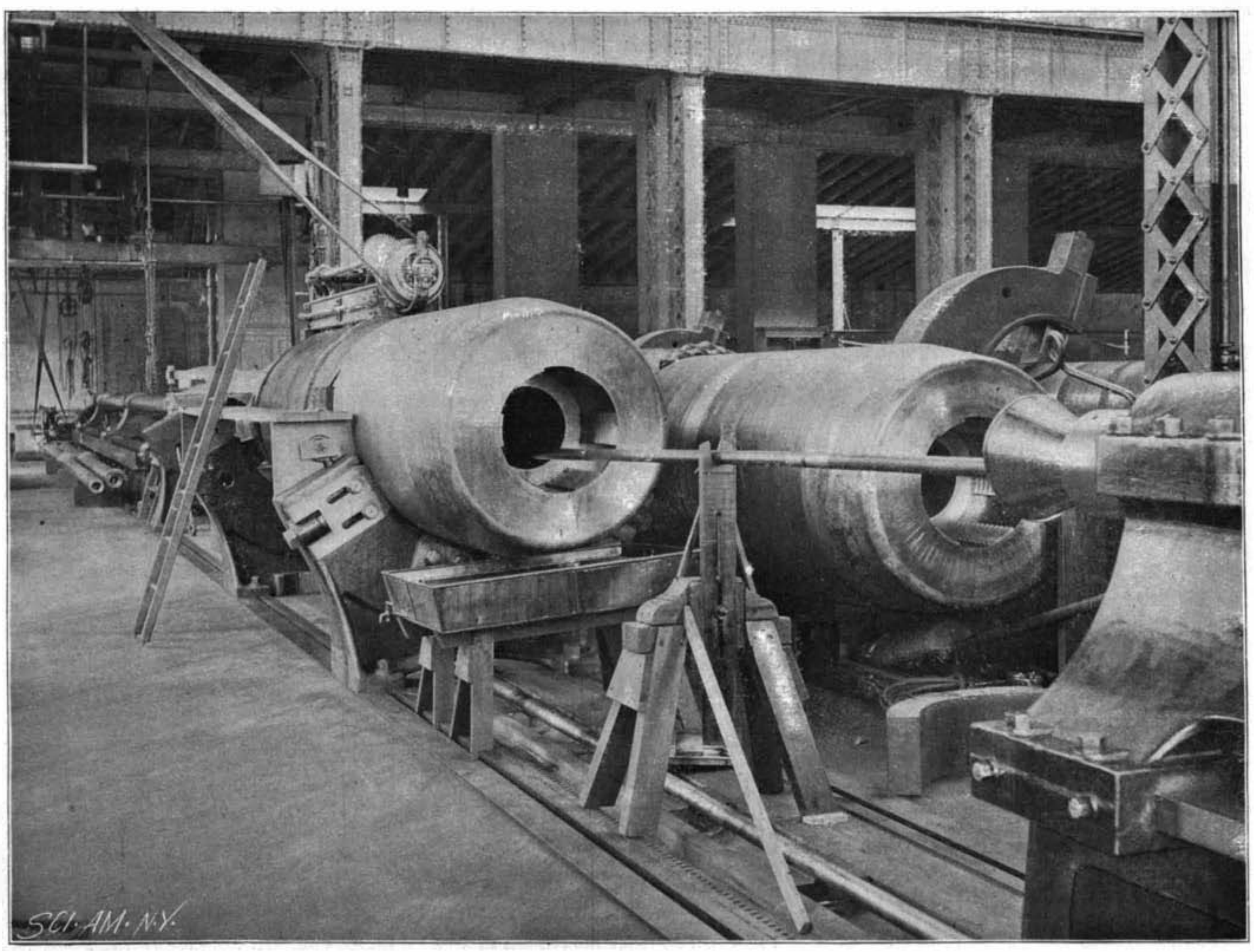
The gun is built up of three parts—tube, jacket and hoops. Taking the 4-inch gun as the simplest in construction, it consists first of the tube. This is a tubular piece of steel bored out to the 4-inch caliber and rifled, forming the barrel of the piece. It extends from the muzzle of the gun to the rear of the powder chamber. The gun is prolonged a few inches more to the rear, by the extension of the next piece, termed the jacket. The tube is turned in the main to an exterior cylindrical contour with some variations in diameter producing shoulders to give a lock or grip for the jacket or hoops.

Over the rear portion of the tube is shrunk on the jacket. This is another approximately cylindrical piece, which covers between one-third and one-half of the length of the tube. Thus in the gun described the tube is 160 inches long and the jacket is 74 inches long. The gun is further strengthened by additional pieces, termed hoops, also shrunk on. In the 4-inch gun a hoop 38 inches long is shrunk over the tube immediately forward of the jacket. A very short hoop 12 inches long is shrunk over the forward end of the jacket and rear end of the 38-inch hoop. These complete the parts of the gun. Hoops which are forward in position are termed chase hoops. The larger guns are more complicated. In some cases the chase hoops extend to the muzzle, and the jacket is strengthened by jacket hoops, so that the gun is in part built up of three layers. Thus one type of 13-inch gun has four jacket hoops, each directly forward of its neighbor, and forward of these come four principal chase hoops, besides two small finishing hoops, giving twelve pieces for the barrel.

The gun forgings are made from open hearth steel cast originally in ingots, each weighing about twice as much as the finished piece is to weigh. The ingot is forged down, rough bored and turned nearly to the finished dimensions, and test specimens are taken from one or both ends after the forging has been annealed, oil tempered and again annealed. If satisfactory, it is accepted by the government.

The gun shop work is principally turning and boring, there being nine principal lathes. The work has to be done with the utmost accuracy; for shrinkage, it is done to $\frac{1}{1000}$ inch. As standard, the workman receives a point gage. This is a simple rod of steel, with polished ends, whose length is precisely the diameter of the work. Its length, which is as accurate as can be determined by a dividing engine, is marked on it. The workman sets his calipers by this gage.

The great masses of metal are clamped to the face plates of the lathes and have their weight carried in steady rests. Seats are turned often in the piece for the steady rests. The lathes are gigantic structures. The largest can take in a gun 48 feet 7 inches long and weighing 110 tons. It is about 115 feet long and cost nearly $100,000. It is now used for boring the



POLISHING THE BORE OF A LARGE GUN AND CUTTING A KEYWAY ON THE EXTERIOR FOR A BRASS SLEEVE.