

and in consequence the chief heating occurs at the joint as required. The superior conductivity of copper is another reason, beyond those already given, for the difficulty of welding the metal. A given current C will now produce only a fraction of the heating (equal to C^2R watts) which it would produce in a similar iron rod, R being greater in the latter case.

The mechanical pressure between the ends of the rods is an important point when welding; the pressure must be regulated to suit the size of rod and the plasticity of the metal when at welding temperature.

Since excessive heating will permanently injure iron

and steel (mechanically) it is necessary to use considerable pressure when welding them, but to keep the temperature well below the melting point. On the other hand, copper actually fuses for a moment at the weld, and hence the mechanical pressure required is much less. A great advantage of electric welding is that the heating is confined to a minimum of metal near the weld.

The arcing voltages of iron and copper are of interest, but in resistance welding (as opposed to arc welding) the formation of an arc must be prevented if possible.

In all cases, and particularly in the case of copper, owing to the ready formation of copper oxide, a weld should be completed at one operation, or the oxide formed will present great difficulty when trying to complete the process.

A properly made weld will show a slight uniform bulge at the joint, and this may be removed by filing or grinding, while a sand blast or wire brush will remove any adhering oxide.

Hammering the joint after cooling not only cleans it, by chipping off oxide, but also tests the mechanical properties of the weld.

ARTILLERY PRACTICE INDOORS.

TESTING FIELD PIECES IN ARMORIES.

BY DR. GEORGES VITOUX.

ARTILLERY practice usually presupposes the possession of very extensive practice grounds. It is difficult to imagine artillerymen testing field pieces and siege guns in armory halls, but Lieut. Le Masne has invented an apparatus by the aid of which practical exercise in the essentials of gunnery can be obtained in rooms of moderate dimensions.

The object of the apparatus is to give an accurate representation of the conditions of actual warfare, when a battery is called upon to direct its fire upon a more or less distant, visible or concealed, post occupied by the enemy. In these circumstances the commander of the battery must determine as accurately as possible the distance of the point of attack, the instant of fire and the angle of elevation required to produce the maximum effect.

These conditions are met by Le Masne's apparatus in the following manner: A panoramic drawing of a landscape is made on a scale of 1 to 1,000, so that when viewed from a distance of 5 yards it will produce the same effect as the real scene produces when viewed from a distance of 5,000 yards from the nearest point of the foreground. This picture is placed in a vertical position and at short distances in front of it are placed four strips of small height on which are drawn, on proportional scales, the features of the nearer landscape at distances of 4,000, 3,000, 2,000, and 1,000 yards. The five pictures include all the points of attack on one side of the field.

Above the pictures several little cars are supported on a frame in such a manner that they can be moved up and down, to right and left, and forward and backward, the extent of each displacement being measured by a scale. These cars represent pieces of artillery and each is provided with a little ball which represents a projectile. The ball is attached to the car by a cord which is drawn up, bringing the ball close to the car, until it is released by pressing a spring, when the ball falls to a distance which is regulated for each case by the operator or "gunner."

The gunner stands behind the pictures and makes all the adjustments of the frame, cars, and cords according to orders given by the commandant, who stands 5 yards in front of the pictures. The cars and frame are concealed from the commandant by a curtain which may be lowered to any desired extent immediately in front of the apparatus. The pictures are sufficiently transparent to enable the gunner to locate indicated points from behind.

The officer, having chosen his point of attack, estimates its distance, decides on the arrangement of his battery and determines the angles of elevation and azimuth of each piece with reference to a point of the horizon, as seen in the large picture. He communicates these data to the gunner, who brings the battery (the frame of cars) to the height of the horizon point, regulates the length to which each cord shall be paid out and moves the cars forward, backward, and laterally according to directions, with the aid of the graduated scales. At the order "Fire!" the gunner releases the balls. If the commandant's estimates and calculations are correct and his orders have been followed exactly, each ball stops immediately above its point of attack, in one or another of the partial pictures. If the ball is found to be too far forward the shot has fallen short, if it is too far back the mark has been overshot. In either case the next shot can be corrected as in field practice.

But this is not all. In order to reproduce still more exactly the actual conditions of warfare, a device is added which enables the officer to attack a point concealed by a hill and revealed only by the momentary flashes of the enemy's guns. Behind the pictures is a row of keys each of which, when depressed, causes a rod surmounted by a little glass ball to rise for an instant and then vanish. The officer makes his instantaneous estimates of distance and

direction with reference to these balls, which represent flashes of cannon.

The apparatus of Lieut. Le Masne is both simple and practical and enables valuable exercise in the art of gunnery to be obtained in the halls of barracks

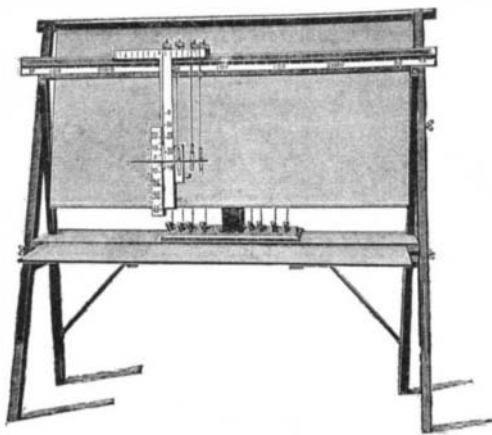


FIG. 1.—APPARATUS FOR INDOOR ARTILLERY PRACTICE. REAR VIEW.

and military schools, at practically no expense. This is a very important result, for field practice is necessarily greatly limited by the great cost of shells and powder and by various other difficulties. Of course the indoor method is designed only for supplement, or rather to precede field practice, not to supersede it. It has already been adopted by some artillery regiments and for the instruction of officers of the reserve corps and the territorial army and very successful experiments have been made with it by the artillery society of Paris.—La Nature.

LOW-PRESSURE STEAM TURBINE EFFICIENCY AND COST.

MR. CHARLES B. BURLEIGH presented a paper at the Saratoga Springs meeting of the National Association of Cotton Manufacturers, entitled "The Low-pressure Steam Turbine." The Electrical World publishes the following abstract:

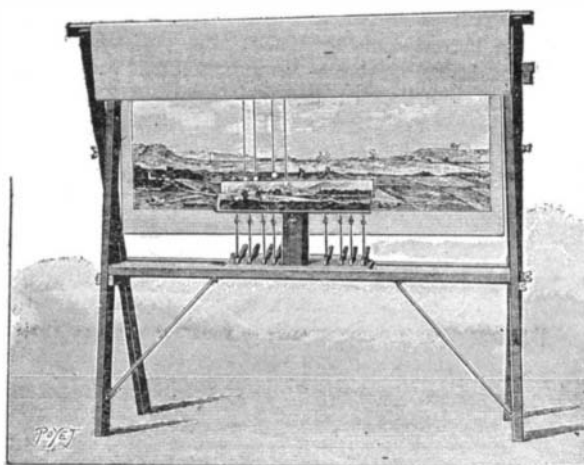


FIG. 2.—APPARATUS FOR INDOOR ARTILLERY PRACTICE. FRONT VIEW.

The author gave some interesting data concerning the performance of two 800-kilowatt Curtis turbines used in connection with reciprocating engines having a combined rating of 8,200 horse-power. The turbines receive steam from a common exhaust-main at a pressure of 1 pound per square inch above atmosphere, and exhaust into a condenser which maintains an average vacuum of 28 inches.

The coal consumption for all purposes at this station during the first six months of 1905, before the turbines were installed, averaged 4.48 pounds per

kilowatt-hour. The coal consumption for all purposes for the first six months of 1906, after the turbines were installed, averaged 4.08 pounds per kilowatt-hour, showing a saving of 0.4 pound of coal per hour. As the total output of the station for the first six months of 1906 was 20,346,890 kilowatt-hours, there was a saving of 4,069 tons of coal, or 8,138 tons for the year, which, at an expenditure of \$3 per ton, amounts to \$24,414.

It is estimated that the original steam equipment cost \$100 per kilowatt, and to have increased the equipment on the original lines would have required an investment proportionately equal to the original investment; the low-pressure turbines, with cooling towers, however, were installed at an expense of approximately \$50 per kilowatt, and as the turbines are utilizing the energy in the steam previously unused, the fuel consumption has not been increased. In other words, considering a 1,500-kilowatt unit operating with one of the 800-kilowatt low-pressure turbines under the new arrangement, 2,300 kilowatts were made available at no more expense as regards fuel and attendance than was previously necessary to deliver 1,500 kilowatts to the distributing mains. As a matter of fact, the plant has actually delivered 19.5 per cent more energy with approximately 2 per cent less fuel.

Estimates were also given of the economy obtained with a 500-kilowatt low-pressure turbine in a railway generating station at Scranton, Pa., and an 800-kilowatt turbine at East St. Louis.

MAGNETIZED WELL TUBES.

THE fact that well tubes driven to great depths are more or less magnetized is familiar to all well borers. Ordinarily the magnetic strength is only sufficient to support tacks and the like but some well tubes become magnetized so strongly that they sustain screws, bolts, and large nails placed in contact with them. The tube of a well in Wheeling, W. Va., which has been examined by Prof. William Hallock is so strongly magnetized that it can support a crowbar. This tube is 4,500 feet long. Dr. Lane, State geologist of Michigan, asserts that the tube of a well at Grailing, in that State, became so strongly magnetized that it taxed the power of one man to haul up the steel measuring tape which, though 2,600 feet long, weighed only 25 pounds. A tape used in measuring the depth of a well at Sheboygan became so strongly magnetized and attracted by the tube that it could not be determined when the weight of 20 pounds, attached to the end of the tape, reached the bottom. As might be expected, compass needles are seriously affected in the vicinity of these magnetized well tubes. The well borers, however, are unanimous in asserting that the magnetism of the tubes gradually diminishes and often disappears entirely in a few years. The magnetization of driven well tubes appears to be only a fresh illustration of the well known law that elongated and nearly vertical objects of iron and steel are easily magnetized by the terrestrial magnetic field, if they are subjected to friction, blows, torsion, or other mechanical action. The direction of the terrestrial magnetic field in high latitudes is nearly vertical. At Paris the dipping needle makes an angle of 64 degrees with the horizon. If a piece of iron wire is vigorously twisted while it is held parallel to the dipping needle, or simply vertical, it will be found to be strongly magnetized.

Celluloid.—Twenty-five parts of ordinary celluloid are dissolved in 250 parts of acetone and a solution of 50 parts of magnesium chloride in 150 parts of alcohol added until a paste is produced which occurs with a mixture proportion of about 100 parts of the first solution and 20 parts of the second solution. This paste is carefully mixed and worked, then dried and furnishes an absolutely non-combustible material.