stract study is not unfrequently the poorest penman in the class; while the honors in this department are carried off by some one who has had the advantage of hand training at home.

CAST STEEL GUNS.

*Experiments with the New Artillery made from Steel without Blows.**

By M. GAUTIER, C.E.

At the last meeting of the Institute, I exhibited several 8-in. and 10-in. shells, made out of steel without blows, which had been simply cast, tempered, and reheated. These had penetrated armor plate of a thickness equivalent to their diameter at an angle of 30°. These remarkable results were obtained not only in France but also by the Italian and Russian navies. In such oblique firing the work of perforation becomes complex. The first action on contact is one of compression; this is followed by a certain amount of flexion, which tends to bring the projectile to a position perpendicular to the plate at the point of least thickness; at last, after penetration of the conical heat, comes the friction of the cylindrical portion against the rough edges of the hole, which tends to elongate the shell longitudinally. Such a metal resisting both tension and compression against instantaneous deformation is remarkable. We then confidently expressed a hope that the time was nigh when artillery would be made from steel without blows as powerful as from the best forged steel, and not much more difficult to manufacture than the old cast-iron and gun-metal cannon. This result has now been obtained, the first experiment having been tried on the 17th of August last, in one of the French Government arsenals.

On whatever basis we study the resistance of elastic tubes, it is easy to see that the portion of a cannon made in one piece which suffers the most must be that portion wherein deflagration of the powder occurs. This action decreases rapidly, so that in certain cases the doubling of the thickness of metal does not increase the resistance by more than 10 to 19 per cent. In order to overcome this inequality of molecular work in heavy ordnance; it is well known that a succession of concentric envelopes has been employed, applied in close contact to one another and compressing the central portion in a permanent manner. When the powder is exploded this compression, which decreases from inside out, must be overcome, after which the metal acts only by traction in a regular manner, from the center to the periphery. The French heavy artillery is based on this principle, and is formed of three elements: 1, the central tube which has most duty to support and is made from hammered cast steel; 2, the body, which is cast iron, although a better material might be found; 3, the frettes in puddled steel, which produce the desired compression.

The most severe test which the steel without blows could be made to resist was by employing it in the shape of a simple tube.

Such a one was cast at Terre-Noire of a diameter of 8 in., and this was bored by a hole 5 in. in diameter, so as to leave only 1½ in. of metal on the outside. Nothing else was done besides a tempering and reheating, after which it was grooved and a screw head adopted to carry the breach.

Before proceeding to the conclusive experiments, several pieces of the metal cut perpendicularly to the axis of the tube were tested with the following results:

		Limit of Elasticity. Tons per Square Inch.	Charge of Rupture. Tons per Square Inch.	Lengthening. Per Cent.
At the back....	No. 1.	20.0	42.5	11.1
"	No. 2.	22.2	39.6	8.7
In front	No. 1.	22.5	38.1	15.1
"	No. 2.	22.7	38.5	15.0

Several pieces 1½ in. square and 6 in. long were next submitted to the shock of a ball weighing 40 lb., and allowed to fall from increasing heights. The supports were 5 in. apart, and rested on an anvil weighing 1,800 lb. These pieces resisted well, and one of them did not break when the ball fell from 8 ft. in height, which gave it a bend in center of about 1 in.

The French Government having imposed for the trials of all steel tubes destined for the Navy:

	Tons per Square Inch
Limit of elasticity.....	21
Charge of rupture.....	38

It will be seen from the above that the tube in steel without blows answered more than the requirements. For the experiments with powder the tube was mounted on a portable carriage, after having been placed in a suitable collar.

Twenty shots were first fired with the ordinary war charge of 9 lb. of powder and the 40 lb. shell; after this 10 shots with a shell weighing 47 lb., and from this time forward the charge of powder was successfully increased by ½ lb. every ten shots, the shell remaining identical until the 100th shot was fired. At this point the chamber was quite full, and the charge had to be rammed in order to get it into place, and much difficulty was found in closing the gun. The experiment was stopped at this point as the official regulation test had been accomplished. After each 10 shots the tube was washed out with care, and measured by means of precise instruments in every portion of its course. No fissure of any kind was discovered, and the deformation of the chamber was found to be less than half of the average in forged steel tubes. Other tubes will be submitted to trial very shortly, two of which will have an internal diameter of 4 in. only. One has been cast of 13½ in. outside diameter for a gun, the body of which in cast steel is to weigh 19 tons. As the central tube is the more delicate portion of the cannon, I have little doubt of success in manufacturing the body also in steel without blows, and that we will soon turn out, with very limited means of manipulation, artillery castings weighing 20 tons each. Experience will soon teach us if we are right in this matter.

The remarkable results of those first experiments show, if nothing else, that we have had to deal with a metal possessing very interesting and valuable properties, well worthy the attention of engineers.

* Paper read before the Iron and Steel Institute at Newcastle.

ELASTICITY OF METALS AT DIFFERENT TEMPERATURES.

By G. PISATI.

THIS is a continuation of the author's researches on the elasticity of metals as measured by torsion (this Journal, 1877, i, 38). In this portion of the memoir the author gives in detail the results he has obtained with wires of iron and steel both annealed, of copper and brass both hard and annealed, of hard gold and aluminum, and with platinum both hard and annealed. From the numbers obtained it would appear that the hard metals have generally a higher modulus of torsion than the corresponding metals when annealed, but that for each metal the difference between the moduli decreases with elevation of temperature, and that in such a manner that the curves of the moduli would ultimately intersect; this actually happens in the case of copper at 250°. The total number of oscillations is usually greater for the annealed metals, although the contrary is the case with brass from the ordinary temperature to 165°, and for platinum above 220°, but in order to compare rigorously the influence of annealing on the various metals as affecting the total number of oscillations occurring at various temperatures, it would be necessary to make experiments with perfectly similar wires of hardened and annealed metals under precisely identical conditions.

It is noteworthy that after the second series of experiments made with the annealed brass wire in the manner employed by the author and previously described, the total number of oscillations, instead of increasing or remaining constant, diminished rapidly until they were nearly the same as those of the first series, a corresponding change occurring in the mean duration of the oscillation. It would seem also that at no temperature does aluminum rigorously fulfil the law of Weber and Gauss, the experimental numbers differing considerably from the calculated ones.—*Gazzetta Chimica Italiana.*

GLASS IMPERVIOUS TO GASES.

By G. QUINCKE.

THE author's experiments prove that glass 1.5 mm. in thickness is capable of retaining for 17 years, without sensible loss, hydrogen gas having a tension of 100–126 atmospheres, or from 1,500 to 1,900 lbs. per square inch. The same result was obtained with carbonic acid gas under somewhat lower pressures.—*Pogg. Ann.*

A SELF-ACTING PRINT WASHING MACHINE.

By W. A. NICHOLAS.

A is a dish to contain the prints, with openings each end to carry off the water. BB, vessels to receive the water after running through the prints. CC, shoots to conduct the water from the dish. DD, self-acting syphons to draw the water off from bottom vessels. EE, two short legs to keep the machine from rocking over too far. F, stand. To set it in motion proceed as follows: Place the prints in the top dish; turn on the water; as soon as the water rises to one of the openings, one of the shoots (C) will convey it to the opposite side under vessel; as soon as that gets sufficiently weighted with water, it will cause the machine to rock over to the other side, thereby giving the prints a good moving about; the water will then run out of the opening at the other end of the dish, and be conveyed by the shoot to the opposite end under vessel; while that is going on the syphon D draws off the contents of the now full vessel, then

by lightening it ready to rise again as soon as the other fills; as each vessel fills and empties itself, so it rocks backward and forward. Mine has a fall of between three and four inches, which knocks the prints about with sufficient force to turn some of them over—it does not break them.

I would not be without mine on any account, as all I have to do is to turn on the water, and I know that about every two pints of water that runs through the prints gives them a good shake-up. Mine is very simply made. The top dish, fourteen by ten by four inches deep, is made of japanned tin, as also the under vessels, and the frame of light wood working on a loose axle. As will be seen by the sketch, the syphons are let through the sides of the vessels, so that when it cants over the syphons become covered by the water, which, of course, causes them to act. Distance from axle to top of dish, eighteen inches, same from axle to outside edge of under vessels.—*Photographic News.*

CLEANING OF PLATES AND LENSES.

All persons who work in photography know, or should know, that to clean lenses, and to preserve the polish of their surfaces, they should not be wiped with a cloth, but after having removed the dust by means of a brush, they should be covered with a thin coating of grease, then wiped with a piece of very soft chamois. An amateur asserts that for this purpose there is nothing better than chicken grease. Without contesting the merit of this fatty body, we simply use tallow, which we recommend not only for lenses, but also for plates which are to be collodionized. The dealers in glass plates for clichés coat them with grease, and simply wipe them before delivering them to photographers, and it is known that these plates generally give very pure clichés without any other cleaning. Many methods have been suggested for removing the varnish from old plates. A mixture of benzine and alcohol in equal parts, agitated and poured on the plates, generally acts very quickly and very well. The last traces of reduced silver which may yet adhere are then removed by iodized alcohol (alcohol 100, iodine 0.50). When the surface is properly cleaned it is rubbed over with the finger or a tuft of cotton lightly impregnated with tallow, and wiped dry. Plates thus prepared may be kept indefi-

nately, and are protected from dampness, the enemy which too often interposes itself between the collodion and its support. It is well to rub the plates, whatever may have been the previous mode of cleaning, with a little talc, which increases the adherence of the sensitized coating, and does away with the gelatine or albumen, the use of which would otherwise be indispensable for the preparation of dry plates.—*Bulletin Belge.*

RAPID COLLODION.

M. GOUGENHEIM has sent to the Photographic Society of France a number of bottles of a rapid collodion, of which the following are the formulæ:

COLLODION.

Ether.....	6700 parts.
Alcohol.....	5955 "
Cotton.....	1 part.
Double iodide potassium and cadmium..	46 parts.
Iodide of ammonium.....	30 "
Iodide of cadmium.....	20 "
Bromide of cadmium.....	22 "

DEVELOPING SOLUTION.

Filtered water.....	500 parts.
Sulphate of iron.....	50 "
Sulphate of copper.....	10 "
Acetic acid.....	17 "
Alcohol.....	10 "

SILVER BATH.

Neutralized at seven per cent.

INTENSIFIER.

Distilled water.....	250 parts.
Pyrogallol acid.....	3 "
Acetic acid.....	10 "
Alcohol (36°).....	10 "

SOLUTION OF NITRATE OF SILVER FOR INTENSIFICATION.

Distilled water.....	50 parts.
Nitrate of silver.....	1½ "

—*Bulletin Belge.*

SENSITIVENESS OF BICHROMATE SALTS.

It is not altogether a matter of indifference which of the double compounds of chromic acid with oxygen and a base is used as a sensitizing medium, since their susceptibility to decomposition by light differs greatly, and so consequently does their sensitiveness to light. The ease with which they are crystallized and the difficulty of dissolving them are greatly detrimental to their sensitiveness to light, which depends upon:

1. The quantity of the ingredients required in the preparation of the salt.
2. The equivalent of the metallic oxide combined with the chromic acid.
3. The stability of the compound formed by the acid with a metallic oxide.
4. The use with which the monochromate salt of a metallic oxide can be decomposed. This property is, however, peculiar to the ammoniac salts.

The greatness of the quantity of a salt which can enter into a preparation depends upon its solubility in water, as when very soluble a salt is not so quickly formed by drying in prepared crystals. In this quality the bichromate salt of potassium is considerably surpassed by the bichromate salts of ammonium, lithium, sodium and calcium.

The two last named double salts are so deliquescent that they can be added to organic matter in almost unlimited and increasing quantities. They also furnish preparations very sensitive to light; but their deliquescence is a great hindrance to their manufacture and to their being largely used in commerce. The lithium salt is also excluded from practical use on account of its high price; it is the same with the double salts of the oxides of the earthy metals, as their solutions act on organic matter almost like free chromic acid, and are decomposed in its presence without exposure to light, the second equivalent of the chromic acid being too feebly combined with the base.

There remains, therefore, only the ammonium salt, which is very soluble in water, and, like the potassium, is sold in beautiful large crystals.

The second condition required to produce great sensitiveness to light is a small equivalent of the metallic oxide. The smaller the number of equivalents of the base the greater the proportion of chromic acid present in equal quantities of the prepared salt, and, therefore, the greater its sensitiveness to light.

On computing the proportions of chromic acid present in the double salts they will be found to correspond to the following scale:

100 parts of bichromate of potassium contain 68.2 parts of chromic acid, and 31.8 of the metallic oxide.
100 parts of sodic salt contain 76.4367 parts of chromic acid, and 23.5633 of the metallic oxide.
100 parts of bichromate of lithium contain 94.356 of chromic acid, and 5.644 of the oxide of the metal.
100 parts of the calcium salt contain 78.22 parts of chromic acid, and 21.78 of the basic oxide.
100 parts of the ammoniac salt contain 79.46 parts of chromic acid, and 20.54 of the basic oxide.

According to these figures the lithium salt contains the largest, and the potassic salt the smallest, percentage of chromic acid.

The sodic, potassic and ammoniac salts vary but little from each other, and, on the grounds already stated, the ammoniac seems the most suitable of these three salts for use as a sensitizing compound.

The third requirement for the production of sensitiveness—namely, the degree of cohesion between the chromic acid and the metallic oxide—is also most favorable in the ammoniac salt.

The monochromate salts of potassium, sodium and lithium have an alkaline reaction, and the bases of their compounds seize the second equivalent of chromic acid in the double salt better than the ammonoxide, and are not so easily and quickly decomposed as the latter by the action of the light.

Lastly: ammonoxide is distinguished from other bases by the rare property of being so sensitive to light in its monochromic compound with chromic acid as in its double compound with that acid. If any chromic double salt be neutralized with caustic ammonia the latter evaporates from the compound after drying, leaving the original double salt. The sensitiveness of the preparation is thus not impaired in the slightest degree by this addition.

Bichromate of ammonium, when neutralized to the single salt with caustic ammonia, owing to the partial evaporation