Please do not bend

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Cheques and money orders to be made payable only to Mr. Charles Gilbert.

Office for Publication and Advertisements, No. 37, *Bedford-street, Strand, W.C.*

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ENGINEERING.

FRIDAY, OCTOBER 25, 1867.

GUN-COTTON.

ALTHOUGH it is now twenty-one years since, in 1846, Schönbein brought gun-cotton fairly before the public, and although more or less explosive substances, almost identical with gun-cotton in their composition, had been discovered many years previously by Braconnet and Pelouze, it is really only within a recent date that this material has been produced in such a form as to be capable of anything like practical application. The great value of gun-cotton as an explosive agent has long been known and appreciated; but its advantage in this respect was until within the last few years marred by the fact that its power could not be controlled with any degree of certainty. As formerly made, also, gun-cotton was not a stable substance—that is, it became altered and deteriorated by storage, a fault now known to be entirely due to a defective process of manufacture. Thus it was that gun-cotton fell into disrepute, and many people who in 1846 considered that Schönbein's discovery would lead to the use of gunpowder being abandoned, altered their minds, and began to look upon gun-cotton as being an interesting chemical production, but one of but little, if any, practical value.

In 1862, however, Baron von Lenk, then a captain in the Austrian artillery, brought gun-cotton again prominently before the public. Baron von Lenk established two great facts, first, that by exercising proper care in the manufacture, gun-cotton could be made more stable and uniform in its character; and, secondly, that its explosive power was capable of being regulated by mechanical means. Baron von Lenk's plan was to regulate the violence of the explosion by forming the gun-cotton into yarn, and plaiting up the yarn more or less tightly, according to the purpose for which the gun-cotton was intended. In the case of cartridges for firearms, also, various other mechanical contrivances were tried for ensuring the gradual combustion of the gun-cotton and the consequent moderation of the explosive power; but these contrivances, ingenious as many of them were, were only to a certain extent successful. The plaited gun-cotton could be made to burn with almost any required degree of slowness in the open air; but, when enclosed, the plaits forming the main bulk of the charge were likely to become deranged by the explosion of the portion first fired, and the consequence was a great degree of uncertainty as to the manner in which the charges so prepared might operate.

Following Baron von Lenk, Mr. Abel, the well-known director of the chemical establishment of the War Office, has introduced most important improvements in the manufacture of gun-cotton, and its adaptation to various practical purposes. Mr. Abel has not only thoroughly tested and verified the discoveries of Baron von Lenk, but he has introduced many new methods of treating the material, which are of very great value. The main feature in Mr. Abel's plans is that he reduces the cotton-yarn, after its conversion into gun-cotton, into a pulp, this pulp being afterwards utilised in various ways according to the purpose for which the gun-cotton is intended.

At Messrs. Prentice's works, at Stowmarket, where the manufacture of gun-cotton has been carried on extensively for several years past, the system of pulping the cotton is now in regular use, and we propose, next week, to describe the whole process of production. At present we intend only to touch upon the more salient points. In the first place, they bestow great care on the thorough cleansing of the cotton-yarn before conversion, and, secondly, they are equally careful to remove all traces of acid after conversion by a most elaborate system of washing. Lately, in addition to this washing, the pulp has, at the suggestion of Mr. Abel, been finally treated with an alkaline solution, so that even the slightest traces of acid are thoroughly destroyed. In the case of mining charges, the gun-cotton pulp is subjected, whilst in the moist state, to great pressure in moulds, and it is thus formed into cylindrical "charges" of any required length or diameter. These charges are afterwards covered with a peculiar kind of paper, termed artificial vellum, and are then carefully dried at a temperature of about 140°.

For producing gun-cotton cartridges for fire-arms a different process is followed. In this case the gun-cotton pulp is mixed with a certain proportion of ordinary cotton pulp—an important point in the manufacture—and then made into a thick kind of paper, which is afterwards cut into slips, rolled up into cartridges, enclosed in a case, and covered with a thin coating of india-rubber, some exceedingly ingenious machines being employed for carrying out the various operations. When in full work, these machines turn out 16,000 cartridges per day, a fact which will give some idea of the extent of the manufacturing operations at Stowmarket. The cartridges, we should mention, are manufactured in a distinct department of the works, and the power of production above mentioned refers to this department alone, the manufacture of the mining charges occupying an independent section of the establishment.

The system of manufacture now followed by Messrs. Prentice—a system which, as we have said, we shall describe in detail next week—has not been arrived at without much expenditure both of time and money. There has probably not been a process connected with the manufacture of gun-cotton, proposed during the last few years, which has not been more or less experimented upon at Stowmarket, and it is a great feature in their system of manufacture that any process has been, and is, at once discarded on it being proved that a better one can be substituted for it. By proceeding in this way they have at length got gun-cotton under command, and they are now capable of producing a material the explosive power of which can be regulated almost as desired. We say, *almost*, because there is still at least one purpose for which gun-cotton has not yet been adapted with perfect success, and this is as an explosive to be used in heavy ordnance. The production of a form of gun-cotton suitable for use in ordnance is, however, probably only a matter of time.

For small arms, and particularly for mining purposes, the advantages of gun-cotton seem to be very thoroughly established. As compared with gunpowder, it has the advantage of not being injured by moisture, and it can thus be stored in a wet state with perfect safety, and dried as required for use. It must, however, be *thoroughly* dried, and this is a point which should be kept in mind by all who use gun-cotton. In the case of mining operations, it enables a greater amount of explosive power to be concentrated in a given space than when gunpowder is employed, and the fact of its producing no smoke when exploded is also a great point in favour of its use for underground working. It is now being very extensively used for mining purposes both at home and abroad.

FERRO-MANGANESE.

IN the history of the Bessemer process the name of ferro-manganese will, under all circumstances, have an important place. The manufacture of this substance (which has now been interrupted, or perhaps finally given up, by the parties who first succeeded in making it, practically and commercially) may have proved unprofitable as far as the past and present state of the market, and of the steel manufacture, is concerned; but there can be no doubt that with the further extension of the Bessemer process, and with the application of it to the manufacture of the softest kind of steel or malleable metal, such a substance will have to be again brought into the market, and it will ultimately find its place amongst the metallurgical products of every-day use in steel-making by almost all modern processes. The manufacture of ferro-manganese was commenced, at Mr. Bessemer's suggestion, by Mr. Henderson, of Glasgow, who invented and patented a process for the production of alloys of iron and manganese, containing a high percentage of the latter metal. A Siemens furnace was erected for carrying out this process at the Phœnix Foundry, Glasgow, about three years ago, and the manufacture of ferro-manganese was commenced with apparently good commercial results, and certainly with the greatest success, as far as the quality of the product was concerned. The metal has a price in the market depending upon its percentage of manganese, the steel-makers paying 1*l.* per ton of ferro-manganese for each per cent. of pure manganese contained in it. A ton of ferro-manganese, for example, guaranteed to contain 23 per cent. of manganese, was sold at 23*l.*, and at that price it was upon a par, as far as manganese is concerned, with the average of German spiegeleisen which (containing about 7 per cent. of manganese) stood at 7*l.* in the quotations of iron-merchants in this country. The mode of manufacture, according to the prescriptions of the patent laws in this country, ought to have been clearly and intelligibly described by Mr. Henderson in his final specification but this document is one of the most remarkable articles of its kind, and defies any attempts to put an intelligible construction upon its mysterious wording. In fact, we have no hesitation in stating that this patent of Mr. Henderson's is void and illegal, on account of the non-fulfilment of the first and most important condition upon which a patent is granted in England, viz., the filing of a clear and intelligible specification.

The mode of manufacture, as carried on in the Phœnix Foundry, consisted in mixing carbonate of manganese—a substance obtained in soda works as one of the products of the manufacture of bleaching-powder—with an almost equal quantity of a pure calcined iron ore, also drawn from a soda works, in which it formed a kind of refuse. The original substance which yields this iron ore is a kind of iron and copper pyrites found in large quantities on the south coast of Spain. This one consists principally of iron, copper, and sulphur, and each of these elements can be obtained from it by a special process. The first operation, and the one carried out at the soda works, is the conversion of the sulphur into sulphurous and finally into sulphuric acid. The ore is for this purpose calcined, or burnt, in a current of air, which converts the sulphur into gaseous acid, and leaves the residuum of iron and copper in the shape of a porous dry mass. The operation of burning this ore is at present very largely carried out at the St. Rollox Works, Glasgow, where one of the largest and finest apparatus for the manufacture of sulphuric acid is in operation. The residue is next passed into the works of the British Metal-extracting Company (Limited)—a company formed for working some of Mr. Henderson's patents for an improved mode of extracting metallic copper from its ores. Mr. Henderson calcines his ores with a mixture of salt and sulphur. He thereby causes the separation of free chlorine gas from the salt, and causes this latter to act upon the copper in the ore, which, in combination with the chlorine, forms a soluble and even a volatile substance which is drawn out in solution from the ore by means of hot water. The copper is in this manner removed in its dissolved state, and the solid matter withdrawn from this process consists of oxide of iron purified from all its admixtures, and in a state of mechanical aggregation which makes it very suitable for reduction. This iron ore, obtained as a residuum or waste product from the copper works, was the second raw material employed by Mr. Henderson for making ferro-manganese. The two substances, viz., carbonate of manganese and oxide of iron, were mixed with charcoal-powder or coke-dust, and the whole mass charged without the use of crucibles into the Siemens furnace. The reduction of both metals, iron and manganese, took place simultaneously, and the percentage of manganese increased with the temperature, but not with the quantity of manganesic matter put into the charge, all surplus of the latter going into the slag, and eating through the fire-bricks of the furnace in a remarkably short time. This destruction of bricks by the chemical action of the manganese slag was, in fact, the great trouble and difficulty in this process. It went so far that the powder carried into the regenerators by the current of gases, and afterwards heated when in contact with the bricks, melted and destroyed even these portions of the furnace, and necessitated frequent repairs. The bottom of the furnaces was lined with coke-dust and graphite, and this stood better than the exposed surfaces of the fire-bricks in the other portions. The metallic alloy of iron and manganese produced ranged in its percentage from

MANUFACTURE OF GUN-COTTON.

The places at which the manufacture of gun-cotton has ever been extensively carried on are but few in number. Soon after Schönbein, in 1846, made known the manner in which the material could be prepared, its manufacture was taken up to some extent at the powder-mills of Bouchet, near Paris, and in this country Messrs. Hall also commenced making it at their works at Faversham. At the latter works, however, a disastrous explosion occurred, which was attributed by the jury to the spontaneous combustion of the cotton; and after this the manufacture was discontinued, a large quantity of gun-cotton which happened to be on stock at the time being buried. This was in July, 1847. In France, also, the manufacture was abandoned after a time, the French Commission being unable to produce a material possessing the required qualities; and in Prussia, where the manufacture of gun-cotton had also been taken up by the Government, the experiments, which were carried on for eight years, were brought to an end by the blowing up of the factory. More recently, the process of manufacture advocated by Baron von Lenk was taken up strongly in Austria, where a special factory was erected at Hirtenberg; but Baron von Lenk's system did not prove perfectly successful, and in 1865 the Austrian Government gave orders that the ordnance which had been specially constructed to be used with gun-cotton should be altered so that they could be used with powder, the use of gun-cotton being from that date practically abandoned in the Austrian service.

Notwithstanding these failures, however, the advocates of gun-cotton—and notably Professor Abel, the director of the chemical department of our War Office—continued their researches; and, thanks to these, the manufacture of gun-cotton has been very greatly improved, and is now established on a better basis than ever. At the present time gun-cotton is being manufactured in this country at two places, the one being the Government Powder Works at Waltham Abbey, and the other the extensive works of Messrs. Thomas Prentice and Sons, of Stowmarket, a firm who, by their extensive experiments on a manufacturing scale, have done much to bring the gun-cotton manufacture to its present state. The two chief features in the processes now followed, as distinguished from those carried on by Baron von Lenk, are the pulping of the cotton after its conversion, and the admixture of this pulp, in some cases, with a certain proportion of plain cotton pulp, for the purpose of retarding the charges, or diminishing the rapidity of their combustion. The various processes followed during the manufacture of the cotton will, however, be best explained by a description of Messrs. Prentice's works at Stowmarket, which we now propose to give.

The gun-cotton factory of Messrs. Thomas Prentice and Co. is situated on the outskirts of the town of Stowmarket, by the side of a stream which furnishes a supply of water for washing purposes, and also drives a water-wheel, by which the pulping machinery is worked. The factory consists of two distinct divisions, one devoted to the manufacture of mining charges, and the other to the production of cartridges for small arms, there being besides some shops common to both departments, where the conversion of the cotton and its formation into pulp are carried on.

The raw material is received principally in the form of "waste." Formerly gun-cotton was made exclusively from cotton wool, but Baron Von Lenk introduced the use of cotton in the forms of hanks or skeins, it being urged that these were more readily penetrated by the acids than the wool, which tended to cake into a mass when immersed. Now, however, it is found that cotton in almost any form answers equally well for the manufacture of gun-cotton, the processes now followed ensuring thorough conversion in all cases. The first thing done is to thoroughly cleanse the raw material. This is effected by boiling it in an alkaline solution, then drying it in a centrifugal machine, and then again boiling it in clean water. After the second boiling, it is again partially dried in a centrifugal machine, and any remaining moisture is thoroughly removed, partly by exposing the cotton to the atmosphere, and partly by placing it on shelves in a drying chamber heated artificially to about 120°. The drying of the cotton has to be very thoroughly effected, as any moisture which might remain in it would, by combining with the acids used for conversion generate heat, and set up a destructive action. The centrifugal drying-machines, which are extensively used at various stages of the manufacture are of ordinary construction, each consisting of a cylinder with wire-gauze sides, caused to revolve horizontally at the rate of from 500 to 800 revolutions per minute. A number of the machines at Stowmarket are worked from shafting driven by a horizontal engine, and others are driven each by a special engine placed close to the machine, these engines having their crank-shafts arranged vertically, and the fly-wheel of each engine being connected directly by a belt to the pulley on the spindle of the corresponding drying-machine.

The cotton, after having been thoroughly washed and dried, is weighed out in the drying-room into charges of 1 lb. each, each charge being placed in a wooden box in which it is passed into the converting-room. There each charge is placed separately in a bath containing the mixed acids, the mixture in which the cotton is submerged consisting of three parts, by weight, of sulphuric acid and one part of nitric acid, this mixture being allowed to cool down—a process which occupies two or three days—before the cotton is placed in it. After immersion, the charges of cotton are strained until each contains only about ten times its weight of acids, and each charge is then placed in an earthenware jar, and covered down. In order to prevent any heating of the cotton from taking place, the jars containing it are arranged in a kind of shallow trough, through which a current of cold water is kept constantly flowing. The building in which the conversion of the cotton is effected is ventilated by a shaft in which an artificial current is maintained; but the ventilation can scarcely be called perfect, and it is doubtful whether the fumes arising from the acids could not be more completely removed by a series of flues connected with the shaft and arranged so as to draw off the air from the floor of the room close to the bath in which the acids are contained. This system of ventilation has been advocated by General Morin, and has, we believe, been found very effective in similar cases.

The action which takes place when the cotton is immersed in the mixed acids is as follows: Cotton, when pure, is one form of cellulose, and is an organic compound consisting of thirty-six equivalents of carbon and thirty equivalents of hydrogen—both combustible or oxidisable elements—together with thirty equivalents of oxygen, its composition being thus expressed by the chemical formula $C_{36} H_{30} O_{30}$. Nitric acid, on the other hand, is a powerful oxidiser, and if added to cotton, and its action assisted by heat, it will rapidly oxidise, not only the hydrogen, but a portion of the carbon which the cotton contains. In the manufacture of gun-cotton, however, instead of the action of the acid being assisted by heat, care is taken to abstract any heat as soon as it may arise, and the action of the acid is thus moderated, only a certain proportion of the hydrogen being oxidised, and the carbon being unaffected. The nitric acid, is as we have said, mixed with three times its own weight of sulphuric acid, and the purpose fulfilled by the latter is that of intensifying the action of the nitric acid by absorbing the water with which even the strongest nitric acid is diluted, and also the water set free by the action of the nitric acid upon the cotton. The hydrogen removed from the cotton is replaced by an equivalent quantity of nitric acid, which has lost a portion of oxygen, and has thus become peroxide of nitrogen, and it is the introduction of this component which gives the gun-cotton its explosive qualities. The peroxide of nitrogen is a powerful oxidising agent—although not so powerful a one as the nitric acid—and it only requires the aid of heat to enable it to oxidise the carbon and the remainder of the hydrogen contained in the cotton, and convert them into gases with explosive rapidity. The heat necessary for setting up this action is supplied when the cotton is ignited, and the action is aided by the oxygen contained in the cotton itself. The proportion of the hydrogen originally oxidised by the action of the mixed acids depends upon the strength of those acids, and upon the purity of the cotton subjected to them. According to Mr. Hadow, of Kings' College, who has devoted much time to the investigation of the chemical changes which go on during the process of conversion, there are four distinct varieties of gun-cotton, each containing a different proportion of peroxide of nitrogen. When pure cotton, and the most concentrated nitric and sulphuric acids—of the specific gravities 1.5 and 1.84 respectively—are used, he states that nine equivalents of the hydrogen contained in the cotton are replaced by nine equivalents of peroxide of nitrogen, its composition being thus expressed by the formula, $C_{36} H_{21} 9(NO_4) O_{30}$. This Mr. Hadow gives as the composition of Baron von Lenk's gun-cotton; in the three other varieties he states that the number of equivalents of hydrogen replaced by peroxide of nitrogen are eight, seven, and six respectively. By the process of conversion the cotton is not altered in appearance, but it is materially increased in weight in the proportion of about 7 to 4.

To return, however, from this somewhat long digression, to the manufacture of gun-cotton as carried on at Stowmarket. The cotton, after being exposed to the action of the acids for forty-eight hours in order to ensure its thorough conversion, is removed from the jars, and placed in a centrifugal drying-machine, which removes the greater proportion of the free acids. On its removal from the centrifugal drying-machine it is plunged suddenly into a strong fall of water received by a tank, in which the gun-cotton placed in the fall is allowed to remain for a short time. The object of placing the gun-cotton in the fall of water, or "drench-bath," as it is called, is to ensure the sudden and complete submersion of the material, and thus avoid the heating and decomposition of the cotton which would take place at the surface of the water if the cotton was immersed gradually. On its removal from the drench-bath, the gun-cotton is again dried in a centrifugal machine, and then placed in a bath through which a current of water constantly flows for forty-eight hours. After this it is again dried, and then placed in a second bath for a similar period, these alternate washings and dryings being repeated until the gun-cotton has passed through eight baths successively, remaining forty-eight hours in each.

After having been removed from the eighth bath and dried, the cotton is ready for pulping, a process which is in itself a washing of the most effective kind. This process we must next proceed to describe.

(*To be continued.*)

PLUMBAGO STEEL.

To the Editor of Engineering.

Sir,—Two or three items in your article on "The River Don Steel Works," published last week, bring to mind a fact I am in possession of, which might be of interest to those engaged in the manufacture of steel, and one which, if acted upon, may lead to an improvement in the present mode of steel-making. Some three or four years ago, when steel-making was first commenced at Syracuse, N.Y., Messrs. Sweet, Barnes and Co. had a Sheffield melter, who advanced the idea that we could not make the best steel so long as we used plumbago crucibles. Partly to test the soundness of this notion, and partly perhaps to gratify our love for novelty, we instigated the following experiment:

About 8 lb. of bar iron, such as we were using for steel-making, but of small section, was cut into suitable lengths, and one-half packed in an old crucible with layers of charcoal between, and sealed up the same as iron is usually packed for converting; the other half of the iron was packed in the same way in every respect, except that powdered plumbago was used for packing instead of charcoal. The two crucibles were then placed in the same fire, and subjected to the same heat for about four days. The result from the one packed in charcoal was, what all expected, *blister steel*, and from the other, what but few would have expected, *blister steel also*, and to all appearance of equally good quality; in fact, we could not detect any difference in the two, though whereas the charcoal had lost a considerable in bulk, there seemed to be about as much plumbago as before. The part which we will now call plumbago steel, for want of a better name, was melted, using plumbago and manganese in the same proportions as charcoal and manganese are usually used in the melting pot, and cast into a 1¼ inch round ingot. The ingot was drawn down in the usual way, and from one end of the bar a chipping chisel was made, which proved to be above the average quality, and from the other end of the bar a paring chisel, which was admitted by all wood-workmen who tried it to be equal to the very best they had ever seen.

Now, if plumbago carbon was very injurious to steel, steel made from plumbago entirely ought to be very poor, which is not the case.

Although the result of the experiment was very flattering, the argument against continuing it was that a very expensive material, and one difficult to obtain, had been used in the place of a cheap one; besides, at that time, the manager of the works had plenty of experiments of his own to try. So much less plumbago than charcoal was consumed in converting the iron into steel, that a careful trial might show the former to be as cheap as the latter; and, again, if plumbago was used with the manganese, there certainly would be less danger of its burning out as charcoal will do when the crucibles are kept hot for a long time before melting.

"As we are to look for improvement in the unlikely as well as the likely," even the Bessemer steel makers might carbonise their iron, if not as cheaply, at least as definitely with plumbago as by the use of spiegeleisen, and perhaps with even better results as regards quality.

I am, &c.,

S.

Creusot.—There appears now no reason to doubt that this great establishment has secured an order for eighty locomotives for Russia. The price named as that at which the contract was taken is 86*l.* per ton. It was necessary, in order to obtain the contract, to pay down a *cautionnement* of 32,000*l.*, and the locomotives are to be delivered at Riga before half the purchase money is paid over. In other words, Russia requires long credit.

Steel Shafts.—The Bolton Steel and Iron Company has lately forged a Bessemer steel shaft 11 in. in diameter, and 30 ft. long, under their 25-ton steam-hammer.

KRUPP'S STEEL ORDNANCE AND PROJECTILES.

The illustrations on page 433 show some further details of the construction of steel ordnance and shot, as made at the celebrated steel works at Essen. Figs. 1, 2, and 3 represent the breech-loading arrangement, invented and patented by M. Krupp, and adopted by him for guns of larger sizes, say up to 9 in. bore. The breech-piece is cylindro-prismatic, and in principle this breech arrangement is the same as that adopted for the smaller guns, and described in our number of the week before last, page 387. The difference between the two systems consists only in the details of the mechanism for opening and closing the breech, since the simple and quick working arrangement used for the smaller guns could not be conveniently handled if applied to large guns, on account of the insufficiency of the muscular power of the gunners. The wedge-piece is in this case moved in and out of the gun by a flat-threaded screw, H, Fig. 1, which runs across the breech, and works upon the thread of a half-nut, S. The end of the screw is held by a collar, R, so as to be attached to the wedge-piece, while the half-nut is attached to the solid breech of the gun. A handle being attached to the end of the screw, H, at *f*, and turned, the screw will bring the wedge-piece out of the gun, or move it back into its seat, according to the direction in which the loader is being turned. This movement is used only for the quick removal and insertion of the wedge, and a second contrivance is required for giving the final pressure, so as to bring the wedge home to its seat, and close the gun gas-tight. For this purpose a second more powerful screw is provided, and sunk with its nut into the body of the wedge-piece. It is shown in section at F and *g*, Fig. 1. This screw comes into action after the wedge-piece has been so far brought home into its seat as to allow of the insertion of the stop-pin, B, by means of the handle, D, working the screw, C. The stop-pin passes into the groove provided in the steel piece, F, which forms the nut for the screw, *g*. As soon as the nut is arrested in its movement by the stop-pin, B, the action of the screw, *g*, can be brought into play, and this screw pushes the wedge-piece home into its seat, using the stop-pin as a fulcrum for the thread of the nut. The same handle is used for working the two screws, *g* and H, since the two never work simultaneously. The operation of opening and closing this breech is quicker than may at first sight be supposed from examining these drawings. The two screws are moved one after the other by the same man who keeps the handle in his hand, and sets it on to the end of either screw as required. Another man attends to the insertion and removal of the stop-pin at the proper moment, and after a short exercise the gunners work together with great precision and rapidity. The largest kinds of Krupp's guns have another breech arrangement, yet similar to those two in principle, *i.e.*, the cylindro-prismatical wedge. We illustrated M. Krupp's large gun at the Paris Exhibition on page 480 of our third volume, where this breech arrangement is shown.

Figs. 4 to 10 show different sizes and constructions of projectiles made by M. Krupp. Figs. 4, 5, 6, and 7 show solid shot of cast iron covered with lead for the 4-pounder, 6-pounder, 12-pounder, and 24-pounder guns respectively. The weights are as follows:

Shot.	4 lb.	6 lb.	12 lb.	24 lb.
	lb.	lb.	lb.	lb.
Solid iron core ...	7.9	11.9	26.6	52.3
Lead casting ...	3.1	5.5	10.5	16.3
Total ...	11	17.4	37.1	68.6

Fig. 9 shows a flat-fronted steel shell coated with lead for an $8\frac{1}{2}$ in. gun (English measure); the front is not made quite plain, but rounded to a large radius, as shown in the drawing.

Fig. 8 is a shell with a sharp point somewhat similar to Major Palliser's construction. This is 8 in. (Prussian) diameter; the steel body weighs 143.3 lb.; the lead coating, 44 lb.; the bursting charge is 2.7 lb., making the total weight of this projectile 190 lb.

Annexed are the results of some experiments made with M. Krupp's guns:

These trials were made at Essen on the 25th of November, 1866, and the following days, ending 2nd of December, 1866, in the presence of General Major Neumann and of several other officers. The guns tested were three 4-pounder steel guns with breech-loading arrangements of three different constructions. They were selected from a number of 400 guns of the same kind now in course of manufacture for the Prussian Government. The principal dimensions are, length of barrel, 74 in.; length of rifled bore, 47.85 in.; length of cylindrical chamber, 18.20 in.; diameter of bore, 3 in.; diameter of chamber, 3.16 in.; number of grooves, 12; pitch, 137 in.; thickness of metal at chamber, 1.72 in.; at the mouth, 1.25 in.; diameter of trunnions, 3 in.; weight of each gun, 516 lb.; weight of the breech-pieces 40 lb., 60 lb., and 55 lb.; weight of loaded shell, 8.6 lb.; charge of powder, 1 lb.

The breech arrangement of No. 1 gun consisted of double wedges, both of square section, and closed by means of a screw fixed to the wedge placed at the back; the gun No. 2 had a double wedge, consisting of a square front wedge and one of half-round section at the back; and No. 3 was arranged with Krupp's patent single wedge, opened and closed by means of a quick-threaded screw having its nut in the solid portion of the breech. The weakest section of the breech at the seat of the wedges was about 26 square inches in each of the guns. All other details were alike in all the three guns. The trials were made for the purpose of ascertaining the strength of the guns and breech-pieces with increasing charges. For this solid shot of $10\frac{1}{2}$ lb. each was employed also for testing the tightness of the breech arrangement with small charges and with imperfect materials for the packing-discs inserted with each charge. For the former point, shell of 8 lb. weight has been chosen, and for the latter some plates made purposely of brittle cast iron were employed instead of the proper discs. Some cylindrical pieces of 3 in. diameter, 12 in. long, of 20 lb. weight, and 2 ft. long, weighing 40 lb., were also kept in readiness.

The charges fired from each gun are shown in the following Table:

Number of rounds.	Charge of powder.	Projectile.	Cylinder.
		lb.	
10	2.	solid, $10\frac{1}{2}$	none.
10	0.3	shell, 8.6	for testing the packing with small charges.
10	2.2	solid, $10\frac{1}{2}$	none
10	2.4	"	"
10	2.6	"	"
10	2.8	"	"
150	3.	"	"
1	3.	"	with cast-iron packing-disc.
1	3.	solid, 11	cylinder, 12 in. long, 20 lb. weight.
1	3.	"	cylinder, 24 in. long, 40 lb.

The above was the extreme test of the programme, and the further trials were made to ascertain the final strength of the guns.

Number of rounds.	Charge of powder.	Projectile.	Cylinder.
		lb.	lb.
1	3	solid, 11	60
1	3	"	80
1	3	"	100
1	$3\frac{1}{2}$	"	20
1	$3\frac{1}{2}$	"	40
1	$3\frac{1}{2}$	"	60
1	$3\frac{1}{2}$	"	80
1	$3\frac{1}{2}$	"	100

With the last charge the powder filled the entire space of the chamber, and the projectile with the cylinders completely filled the barrel, and the latter even projected 17 in. in front out of the muzzle of the gun. With this extreme charge all three guns showed very nearly equal signs of destruction, viz., a widening of the chamber by about $\frac{1}{16}$ of an inch in diameter. The breech pieces did not show the same equality of resistance. No. 3 proved the best in every respect, and remained in perfect working order after the tests. No. 2 also remained intact, but showed an inferior degree of lightness towards the end of the trials, and No. 1 commenced to give way with the 3 lb. charges of powder. The screw and nut required to be exchanged for continuing the trials, but they failed a second time. Still, it was possible to conclude the experiments with No. 1 gun, same as with the others. The cast-iron packing discs used in some of these trials broke as intended when the respective charges were fired, yet the damage done to the breech-piece or wedge was so unimportant that it did in no way affect the continuation of its functions. The conclusions arrived at were, that the guns are of sufficient strength, and that all three modes of breech fastenings are sufficiently good for military purposes, preference being given to the breech-piece No. 3.

Trade of the Mersey.—The export trade of the Mersey appears to be temporarily depressed. The value of the exports from the great river in September was 6,355,990*l.*, presenting a decrease of 1,482,746*l.* when contrasted with September, 1866. The exports from the Mersey in the nine months ending September 30 this year were valued at 57,938,049*l.*, against 67,149,487*l.* in the corresponding period of 1866.

Doncaster.—Mr. Rawlinson, C.E., has delivered a report on the sanitary condition of this town. He suggests that the town should obtain its water supply from the springs at Horton Roberts, and that it should be conveyed thence in pipes along the turnpike road. Mr. Rawlinson further proposes that the sewage of the town should be applied to irrigation purposes.

Royalty and Railway Signals.—Messrs. Saxby and Farmer, who have so successively upheld the supremacy of our English system of railway signals at the Paris Exhibition, where they have been rewarded by a gold medal, and received the personal commendation of the Emperor Napoleon, have likewise received a royal compliment from the court of Berlin. By permission, Messrs. Saxby and Farmer presented to the Queen of Prussia a set of beautiful photographs, illustrating their system of signals in use at Cannon-street, Charing-cross, and other important places, and have been honoured by the following gracious and flattering letter of encouragement from the Queen's private secretary: "Her Majesty the Queen of Prussia has ordered me to express her thanks to you for the photographs you sent her; she congratulates you on your ingenious invention, which excited her interest on her last journey to England, and of which these photographs give so good an idea."

Railway Extension.—Opening of the Denburn Junction.—The junction line of railway connecting the Caledonian line with the Great North of Scotland system at Aberdeen has just been opened for public traffic. Hitherto the only means of communication between the two railways named has been by a line of rails along the quays at Aberdeen, and as the companies had no authority to use locomotive power, which indeed would have been impracticable, or at least dangerous, on crowded quays, only goods carriages were run between the two stations, through passengers having to go by 'bus a distance of over a quarter of a mile. The junction now opened goes through the heart of the city by the valley of the Denburn. The works, which were undertaken by the late Scottish North-Eastern Company, the Great North of Scotland contributing, under the Act, a considerable proportion of the cost, include two short tunnels, and also a magnificent joint station, south of Union Bridge, where all the passenger traffic reaching Aberdeen will now be concentrated. The station is 500 ft. in length and 202 ft. broad, and the roof alone cost 9000*l.* The line of railway newly made and now opened is only a mile and a half in length; but as a good deal of house property had to be bought, its construction has been very expensive. By means of this short line there is now an unbroken communication between the extreme north and south of the kingdom. The Denburn Junction line, short as it is, has been about two years and a half in course of construction.

MANUFACTURE OF GUN-COTTON.

(*Continued from page* 408.)

The pulping machinery at Messrs. Prentice's works is, as we have already stated, driven by a water-wheel. The pulping-machines, of which there are two, are similar to those employed in paper-mills. Each machine consists of a kind of trough of O form in plan, this trough having a central longitudinal partition of a length about equal to its parallel sides. On one side of this partition, at the centre of the length of the trough, is placed a cylinder, or drum, revolving on a horizontal axis, this drum carrying the beaters or cutters, which, acting in conjunction with the cutters fixed at the bottom of the trough, tear the cotton to pieces, and reduce it to pulp. The drum is placed so that, as it revolves, its cutters come almost in contact with those fixed at the trough bottom; and the fixed cutters being inclined to the direction of the axis of the drum, the latter, as it revolves, draws the cotton over them, and gives rise to a kind of combined cutting and abrasive action. The trough is nearly filled with water, in which the cotton is placed; and on the drum being started, its action causes a sufficient current to be set up round the central partition to keep the cutters supplied with material, the mixed water and cotton being, however, kept stirred up by an attendant.

The process is continued until the material is reduced to the required pulpy consistency, when it is ready either for being formed into mining charges, or being made into paper, which is afterwards used for cartridges for small arms. For the latter purpose, however, the pulp is not made of gun-cotton solely. Paper made entirely of gun-cotton would burn too rapidly, and, in consequence, have too violent an explosive action, to be used advantageously for making small-arm cartridges, and to avoid this violent action the pulp for this paper is made partly of gun-cotton and partly of ordinary cotton, the proportion of the latter being varied according to the amount of "retardation" which it is desired to obtain. This method of regulating the rapidity of combustion of the "gun-paper," as it may be called, is due to Professor Abel, and it is an admirably simple and effective one, and what is more, it gives as good results when the explosive is contained in a gun as when it is burnt in the open air. This was not the case with Baron von Lenk's plan for obtaining the same end. The Austrians endeavoured to moderate the explosive power of the gun-cotton in their cartridges by subdividing the material into a greater or less number of portions, which it was intended should be fired successively, the cotton being in some cases, for instance, disposed in a series of concentric cylindrical coils separated from each other by paper tubes. These plans were very ingenious, and when the cartridges were ignited in the open air appeared to give tolerable results; but in practical use the case was different. When confined in a gun, the explosion of the first portion of such a cartridge was liable to destroy the whole of the arrangements for insuring the successive ignition of the other portions, and the consequence was that, practically, but little, if any, moderation of the explosive power of the cotton was effected. On the other hand, in Professor Abel's "retarded paper," as it is termed, the particles of gun-cotton are separated to a greater or less extent by the intervening particles of ordinary cotton, the extent of this separation depending upon the amount of ordinary cotton contained in the pulp. This subdivision of the explosive material is effected throughout the whole of the paper of which the cartridge is composed, and it is evident that it is effected in such a manner that the explosion of the portion first ignited can in no way affect the remaining portion.

Altogether, this system of making "retarded" paper—or we should rather say pulp, for the latter need not necessarily be made into paper—appears, theoretically, to afford the means of regulating with the utmost nicety the explosive power of the gun-cotton, and this theoretical deduction seems to be fully borne out by the practical results obtained. Of course, a great deal of experimental research has been necessary to ascertain the best proportions of ordinary cotton to be mixed with the pulp for different purposes; but Messrs. Prentice have spared no trouble of this kind, and we believe that they have now definitely settled upon the strength of "retarded" paper which it is best to employ for different classes of small-arms.

The pulp for making the retarded paper is reduced to a finer consistency than that used in the manufacture of the mining charges, and, to prevent mistakes, a small quantity of colouring matter is mixed with it, and the paper produced has thus a pink tint. The paper is all made by the ordinary hand process, the over an open fire placed in the centre of a large clear space. The forging is held by a large crane, and the different pieces which require to be welded together are held in their proper position by a temporary framing made of strong bars which are connected by screwed bolts. The welds which can be made under the steam-hammer are scarf welds, the surfaces being all planed to the proper angles at the joints, so as to ensure facility of welding; but there are certain welds required in building up an intricate forging which must be made by hand. The stern-frame of a screw-steamer, for instance, which is welded together after the holes for the bearings of the propeller-shaft are bored out in each single portion to a diameter only ½ in. smaller than the finished size, must be finished by hand in this manner, as the steam-hammer would destroy the relative position of the two finished and bored portions. The mode of welding such pieces by hand is the so-called V-weld, the two pieces being formed with V-shaped ends, and two wedge-pieces being inserted between these ends so as to fill up the spaces formed by them. The temporary bracing which holds all parts in their proper relative position is not disturbed by the operations of the blacksmith's hammers in closing the welded joints. The holes for the propeller-shaft are finally bored out when the stern-frame is in its place. The binding of ship-keels, ships' bows, and of similar forgings is effected upon a very large plane-bed or surface-plate, and the work is done by hand to templates made of wood or sheet iron.

The mechanical workshop, which is a recently erected and very well fitted place, contains the usual plant of very large and powerful machine tools; but the forge in Scotland-street is, in this respect, fitted out in a more remarkable style. Some of the self-acting tools in that shop are unique for their size and weight. There is a turning-lathe of 5 ft. centres and 40 ft. length of bed, made by Messrs. Collier and Co., of Salford, and which was described by Mr. Fletcher at the Glasgow meeting of the Institution of Mechanical Engineers as one of the largest tools and, perhaps, the heaviest lathes ever made. Another monster tool is a slotting-machine, by Messrs. Shanks and Co., weighing 105 tons, and having its main pillar cast in one piece with the bed carrying the cross slides. Some multiple drilling-machines for boring a number of holes simultaneously, and used for making the rivet holes in ship-keels, are amongst the most modern additions, and a hollow lathe for turning crank-shafts similar to the one at work in Mr. Penn's engineering shop, and recently described by us, was fitted up only a few days ago. The forge in Scotland-street contains nine steam hammers, most of which are of large size. The heaviest hammer has a 7 ton head, and has the steam admitted above the piston, which increases its effect. The span between pillars is 20 ft. clear, and the main frame is Condie's improved design. Almost all the hammers have Condie's moving cylinder, and only one large Rigby hammer has been added to this plant at a more recent date. The furnaces are arranged in pairs, and have boilers over their flues for utilising the waste heat. The two cranes required for each hammer stand on the same side close to each other, so as to leave the central part of the forge between the steam hammers perfectly clear for passage. There are several lines of rails laid right through the forge, and connected by turntables and sidings with the main line passing the works. The forgings have hitherto been made of scrap iron exclusively, and no puddle iron or "new" iron has been manufactured in the Lancefield forge. The scrap for the first-class forgings is made from bars cut to the proper lengths by shears and then piled in a very regular and uniform manner. At present, however, some puddling furnaces are being set to work for puddling pig iron and finery iron, and a finery will be added very shortly. A fine rolling mill has also been erected, and is now used as a forge train for making scrap bars, but rolls for making bars, angles, and plates are intended to be added to this very shortly. The forge train has 22 in. rolls running at forty revolutions per minute. The general arrangement of this forge is very convenient, and an ample area of ground is provided within its enclosure for future extensions. The sizes of some of the largest forgings made by the Lancefield forge will be best suited for illustrating, not the limit, but the extent of its power of production. Amongst the Great Eastern forgings were the stern-frame, weighing 25 tons, the crank-shaft, weighing 31 tons, and the propeller-shaft, 47 ft. long and 35 tons in weight, and these have not been exceeded in more recent years; but the Lancefield Forge Company have since then made most of the heavy forgings for several of the great Cunard steamers built on the Clyde.

MANUFACTURE OF GUN-COTTON.

(*Concluded from page* 431.)

We have seen that, in the case of the mining charges, the pulp is, during the process of manufacture, subjected to very severe compression, and by this means a very great quantity of explosive matter is obtained in a small bulk. A mining charge, in fact, manufactured by the processes now followed at Stowmarket possesses an amount of explosive power six times as great as that of a similar bulk of gunpowder, and this concentration—if we may term it so—of the explosive material is in many instances of great value. Thus, when hard materials have to be blasted by charges contained in holes bored only to a moderate depth, a gun-cotton charge, occupying only one-sixth the length of hole that would be taken up by a gunpowder charge of equal power, allows of a greater length of tamping being employed, and also concentrates the explosive action at greater distance from the working face. There is also now abundant evidence that gun-cotton is in other respects a more effective explosive for mining and quarrying purposes than gunpowder. Thus, in breaking up large boulders by means of a charge inserted in a vertical hole bored from the top down to near the centre of the boulder, if a gunpowder charge is employed, its tendency is, if the block is of large size, to blow out a conical mass from the upper part of the boulder, the apex of this inverted cone being situated at the point where the charge was placed. With gun-cotton, however, the case is different, it being found that it exerts a powerful splitting action below as well as above the point where the charge was situated. This effect appears to be due to the extremely rapid action of the gun-cotton; but, whatever may be the cause, it is an effect which is regularly found to occur in practice, and one which makes gun-cotton particularly valuable for quarrying purposes.

The fact that gun-cotton, when exploded, produces no smoke is another fact that renders it peculiarly applicable for tunnelling or mining work. In some instances, where gun-cotton has been used in confined situations insufficiently ventilated, complaints have been made that its employment gave rise to headaches amongst the men. Such a result, however, has only been caused by an improper and, we may add, wasteful use of the gun-cotton, it being due to the employment of charges too heavy for the work they were required to perform, and which charges were consequently but imperfectly consumed. In addition to its beneficial effect upon the ventilation, the absence of smoke when gun-cotton is employed enables the workmen to return to the work sooner than they otherwise would do. The mining charges, manufactured by Messrs. Prentice, are now largely employed in mines and quarries both in this country and abroad, and their use is rapidly becoming extended as their value becomes known. Besides the regular charges, the manufacture of which we have described, the firm are now making a peculiar kind of gun-cotton yarn, specially adapted for splitting off slabs of slate. A hole being formed behind the slab to be separated, a sufficient length of this yarn is inserted and ignited, no tamping being used. We understand that this yarn is found to answer its purpose capitally, and that it is now being extensively used in Wales.

Before leaving the subject of mining charges, there is another advantage possessed by gun-cotton to which we should allude, and that is that it is not injured by moisture. When we say it is not *injured*, we do not mean that it is not *affected*, and this is a point upon which some persons who have used gun-cotton appear to have fallen into error. Some users of gun-cotton, having been informed that the material is not injured by wet, have let their charges become damp, and have then complained that the gun-cotton did not give good results when fired, whereas the failure was entirely due to their own carelessness. Instead of saying that gun-cotton is not injured by moisture, it would, perhaps, be better to say that it is not *permanently* injured, or, in other words, that its explosive qualities, which are impaired when the material is damp, can be completely restored by simply re-drying it. The re-drying should, of course, be performed with great care, the temperature not being allowed to rise above, say, 140°. In most cases it will be found less trouble to take the necessary precautions to keep the charges dry as they come from the manufacturer, than to allow them to become damp, and subsequently re-dry them; but in some instances the fact of gun-cotton not being permanently injured by moisture is very convenient, as it enables the material to be stored in large quantities in a damp state, without incurring any danger or risk of explosion. Gun-cotton, when moist, is, in fact, not explosive, and it is for this reason that it should be in a *thoroughly* dry state when used, a thing which those who employ it will do well to continually bear in mind.

It is, however, time that we should take leave of mining charges, and should proceed to the description of the other department of Messrs. Prentice's works—that devoted to the manufacture of cartridges for small arms. We have already stated that in these cartridges the gun-cotton is used in the form of "retarded" paper, or, in other words, of paper composed partly of gun-cotton and partly of plain cotton pulp. The paper is made by the ordinary hand process, and when it is received into the cartridge-making department, each sheet has first printed, on one end of it, a series of "headings" denoting the description of cartridge for which it is intended. These "headings" are so placed that when, in the next process, the sheets of paper are cut up into slips, each slip bears its proper mark. The cutting of the paper is performed by ordinary paper-cutting machines worked by hand. The slips are all cut to gauge, and are, therefore, of almost exactly uniform size; to secure perfect accuracy, however, they are, before being made up into cartridges, carefully weighed, and all reduced to the precise weight required in the case of the particular class of cartridge for which they are intended.

The next process consists in rolling up each slip into a cylindrical coil, and for performing this operation a number of very simple but, nevertheless, ingenious machines are employed. It so happens that in each particular class of cartridge there is a certain degree of tightness of coil, which gives a better result than any other, and it is therefore desirable that, in coiling up the slips, this requisite degree of tightness should be maintained uniformly in every case. The machines employed to attain this end have been designed to imitate closely the action of the human hands when employed in rolling up a paper coil. If a partially formed coil of paper be placed between the finger and thumb of the left hand, and a further quantity of paper be wound on by turning the coil with the forefinger and thumb of the right hand, it will be found that the tightness of the coil will depend upon the pressure which the last mentioned thumb and finger exert upon it during the process of winding. In the machines employed at Stowmarket, the pressure of the finger is replaced by that of a wooden lever, which is loaded so as to exert—of course uniformly—the exact pressure required. Each machine consists of but very few parts. One end of the slip of paper to be rolled is inserted in a slit formed in a small mandril revolving in suitable bearings, and this mandril being turned by hand, the slip is coiled on it, the pressure upon the coil of the end of the lever already mentioned ensuring an uniform degree of tightness. On the coil being completed, the mandril is withdrawn from it (the fact of the slit in the mandril extending to the end of it enabling this to be done), and the end of the coil is then secured with shellac. Each machine is worked by a girl, another girl close by securing the ends of the coils.

After coiling, the charges are again carefully weighed by an examiner, and, if of the correct weight, they are then ready for "waterproofing." The waterproofing process consists in coating the charge with a thin skin of india-rubber, and the machine by which this is effected is of exceedingly ingenious construction. It consists of a simple wooden frame, carrying a small horizontal cylinder, or tube, in which a piston can be moved to and fro by means of a pedal placed so as to be conveniently acted upon by the foot. The piston is provided with two small spikes projecting from the front side of it, these spikes supporting the charge when it is projected from the tube, as will be described presently. Beneath the cylinder is an india-rubber air-bag, which can be compressed by means of a second pedal, and which, when thus compressed, forces air into the cylinder near the front end. Around the front end of the cylinder is a flange, or collar, which is kept moistened with a solution of india-rubber, and which is provided with a kind of ring-guard, capable of being brought down in front of it by the action of a third pedal; whilst the pressure of the foot on a fourth pedal causes a pair of nippers to close just in front of the mouth of the cylinder.

The manner in which this machine is used is as follows: The piston being drawn back into the cylinder, one of the charges to be covered is inserted in the latter, and a thin disc of india-rubber is placed against the flange with which the end of the cylinder is provided. The solution of india-rubber on the flange causes the disc to adhere to it, and the disc is then further secured by bringing the ring-guard down upon it. The pedal connected with the air-bag is next pressed upon, and some air thus forced into the cylinder. The end of the latter being closed by the india-rubber disc, the air cannot escape, but the disc is bulged out through the ring-guard, and caused to assume a spherical form. By pressing the pedal connected with the piston, the charge is forced out of the cylinder, and caused to project into this thin india-rubber sphere, the charge when thus projected being supported by the small spikes with which, as we have stated, the piston is provided. The nippers are then made to close behind the charge, the piston drawn back, and the neck of what we may term the india-rubber "bubble" is tied round with silk by the girl in charge of the machine. This being done, the charge can be removed completely coated with a very thin film of india-rubber, the "bubble" shrinking and clipping the charge closely as the air escapes from its interior. This "waterproofing" machine, although requiring a somewhat lengthy description to explain its construction and mode of action, is really a very simple apparatus, but it is, no doubt, one which has required much labour to bring to its present perfection. It is an extremely ingenious application of simple mechanical contrivances to accomplish what at first sight might appear a very difficult operation, and it serves its purpose admirably, the charges being covered with india-rubber with great rapidity, and in the most perfect manner.

After being waterproofed, the charges are made up into cartridges, or, in other words, are placed in the cases containing also the shot or bullet, as the case may be. For placing the wads in the paper case, a very neat little contrivance is employed. If it was attempted to force the wads directly into the paper case, the mouth of the latter would in most instances be burred over and the case spoilt. To avoid this, each case is placed in a cylindrical mould open at both ends, and formed of two parts hinged together, so that the cartridge-case can be inserted in it and removed from it readily. This mould is bored out to two different diameters, a portion of its length having a diameter equal to the internal, and a portion a diameter equal to the external, diameter of the cartridge-case. The case being placed in that portion of the mould which is of the larger diameter, with its end close up against, and protected by, the shoulder formed by the alteration in the size of the bore, the smaller part of the bore of the mould is in a line with the interior of the cartridge-case, and the wads can thus be forced down through the smaller part of the mould into the cartridge-case without injury to the latter.

After the charge, wads, &c., have been inserted, each cartridge-case is closed by rolling over the end of the case on the end wad. Some simple machines are used for turning over of the ends of the cases, which is effected by a sort of burnishing action, the end of each case being pressed against a pair of small revolving tools, which bend the edges of the case inwards and roll it down smoothly upon the wad. After having been closed, the cartridges are ready for making up in parcels and packing, operations which require no special description.

The small arms cartridges made by Messrs. Prentice and Co. have hitherto been manufactured for use in breech-loading guns only, and special cartridges have been prepared for almost every variety of these arms, whether used for sporting or military purposes. The objection to using gun-cotton cartridges for muzzle-loaders is that they are liable to be injured by careless ramming; but as muzzle-loaders are rapidly becoming an exceptional class of guns, the non-adaptability of gun-cotton for use in them is a matter of but comparatively little consequence. For sporting purposes the gun-cotton cartridges are now very largely employed, Messrs. Prentice turning them out in the busy season at the rate of 16,000 per day. The fact of the gun-cotton cartridges producing no smoke is a great advantage in the field, and it is one, amongst others, which sportsmen are rapidly acknowledging.

In concluding our account of Messrs. Prentice's works, at Stowmarket, it is only just that we should remark upon the completeness of the arrangements for carrying out the manufacture of gun-cotton according to the best known methods. During the many years which the manufacture has been carried on at Stowmarket, extensive modifications have from time to time been made in the various processes carried out, and these have necessitated corresponding and in many cases expensive alterations of the plant. The fact of a new and improved process, requiring new plant for carrying it out, has never been allowed to interfere with its adoption at Stowmarket, and it is, in fact, only by conducting a series of expensive experiments on a manufacturing scale that Messrs. Prentice have brought their system of manufacture to its present state of perfection.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1867; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 498, 8d.) Henry Purnell, of Glasgow, patents an arrangement of engines or pumps, having oscillating cylinders the trunnions of which are provided with inlet and outlet passages, the oscillation of the cylinders governing the admission of the steam or water to, or its exit from them. These engines and pumps are single acting, and the peculiarity of the arrangement consists in placing the inlet and outlet openings on one side of the trunnions, so that the working surfaces are kept tightly pressed together by the strain put upon them during the working of the engine or pump.

No. 499, 10d.) Arthur Kinder and William Barns Kinsey, of 92, Cannon-street, patent improvements in gas-engines. According to these plans, the crank-shaft of the engine is placed between the cylinder and the crosshead, to which latter a return connecting-rod is coupled. The crosshead just mentioned is connected with another crosshead on the main piston-rod by double rods passing above and below the crank-shaft. The cylinder also is placed in an open water-tank, and water is caused to circulate through the piston, piston-rod, and slide-valve. The patent also includes making the cylinder with short ports, as well as a particular form of slide inlet valve, and a method of regulating the speed of the engine by means of a perforated sliding-plate, with which the valve just mentioned is fitted.

(No. 500, 10d.) William Deakin, of Great Barr, and John Bagnall Johnson, of Tettenhall, patent a method of making "caps" for spinning, and similar articles, from seamless steel tubes, these tubes being gathered or thickened into a close dome shape at one end. If a thickness greater than can be obtained by gathering in the tube is required, a plug is inserted, this plug being welded in by the subsequent shaping process. The "caps" are finished by placing them on a vertical mandril or support, and subjecting them to a few end blows from a suitable stamp hammer.

(No. 511, 1s. 6d.) John Marshall, of Trafalgar, road East, Greenwich, patents fitting glass water-gauges for steam-boilers, &c., with valves so arranged that, although they do not interfere with the ordinary working of the gauge, they will, in the event of the glass breaking, be forced against their seats and so prevent the escape of steam and water. The gauge is fitted with two cocks only, instead of three, as usual, and the arrangements adopted to enable these cocks to be used for "blowing through" are very ingenious.

(No. 516, 10d.) John Alison, of Brightlands, Reigate, patents a form of vertical boiler in which the inside firebox is provided with a number of curved water-tubes extending from the roof to the sides. A fire-clay plug is placed on the central space between the tubes, so as to cause the heated gases to pass round amongst the tubes on their way to the central flue, extending from the roof of the firebox to the smoke-box. We have strong doubts about the newness of this arrangement.

(No. 518, 8d.) George Daws, of Penge, patents an arrangement of self-acting railway signals, designed to maintain the signal on any given post at danger until the train by which that post was last passed has passed two signals in advance. An arrangement for calling the engine-driver's attention by sounding a gong and shutting off the steam, in the event of the signal in advance being at danger, is also included in the patent. The apparatus is altogether complicated, and, we fear, quite unreliable.

(No. 523, 1s. 2d.) Edward Funnell, of 54, East-street, Brighton, patents a complicated combined alarum and railway signal, of more than doubtful utility. A description of the apparatus would be impossible without the aid of drawings.

(No. 527, 10d.) Clement Martin, of Hammersmith, patents a peculiar arrangement of steam-engine, in which the cylinder, as well as the piston, reciprocates. The crank-shaft has three cranks, each having a throw equal to one-fourth the total stroke, and the central crank is placed opposite the other two. The central crank is connected to the piston by a connecting and piston rod in thé ordinary way, whilst the other two cranks are connected to the cylinder, the effect of the arrangement being that the piston and cylinder reciprocate in opposite directions. This arrangement possesses no practical value, and the objections to it are numerous and obvious.

(No. 530, 6d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of John Ashton Greene, of Brooklyn, U.S., a neat method of joining the ends of belts by turning up these ends and connecting them by I-shaped pieces of metal passed through slits formed in the belt, and then turned one-fourth round, so that the T-shaped ends lay across the slits.

(No. 535, 10d.) Andrew Howat, of Farnworth, near Bolton, patents an arrangement of coal-cutting machine, in which one or more cutters, propelled direct by a piston working in a cylinder supplied with steam or compressed air, are employed. The cylinder is mounted on a truck, in such a manner as to be adjustable to various angles. The details of the machine could scarcely be described without reference to drawings.

(No. 538, 5s. 2d.) John Saxby and John Stimson Farmer, of the Patent Railway Signal Works, Kilburn, patent numerous improvements in apparatus for working railway signals, points, and switches. As might be expected from Messrs. Saxby and Farmer's experience as manufacturers of railway signals, this patent includes many improvements of considerable value, and which merit a more full description than it would be possible to give of them here. We shall, therefore, for the present postpone any description of them.

(No. 539, 8d.) Henri Adrien Bonneville, of 38, Porchester-terrace, Bayswater, patents, as the agent of Joseph Grosley and Louis Albert Merckens, of Kremlin, an arrangement of dredging-machine, specially intended for removing silt, &c., from the beds of rivers or other watercourses, in which a current exists. In this machine the dredging is performed by a series of teeth and buckets fixed to the periphery of a large vertical wheel, the axis of this wheel being carried by a pair of boats, one on each side of the wheel, and means being provided for varying the "dip" of the wheel according to the depth of water. The boats are secured to an anchor, so that they can be allowed to float down the stream gradually, and they are furnished with dam-boards, against which the stream may exert its force, it being intended that the down-stream motion of the boats should actuate the wheel, which, in its turn, should raise the silt as it revolves and discharge it into a shoot. It is also stated that where no current exists the wheel may be turned by any convenient motive power. We much doubt the efficiency of the apparatus.

(No. 547, 1s.) James Livesey and John Edwards, of 9, Victoria-chambers, Westminster, and William Jeffreys, of 43, Cooper's-road, Old Kent-road, patent applying to railway-signalling apparatus a "back lock" in such a manner that one lever is caused to lock another by its direct communication with the back lock. Another part of the patent refers to fitting switches with an apparatus so arranged that when a train passes over the points the switches are locked, and kept locked until the train is clear.

(No. 550, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of William Gorham Angell, of Providence, U.S., making wood screws with a central circular hole in the head instead of with a nick, as usual. It is stated that screws so made can be readily driven by the aid of a tapered round or square plug or driver inserted in the central hole.

(No. 551, 4d.) Alexander McDougall, of Manchester, patents methods of utilising the substance termed by miners "blue clay" or "chanel." This "blue clay," Mr. McDougall states, is mainly a mixture of clay and crystals of iron pyrites, or bisulphide of iron, there being, however, sometimes a certain proportion of spar; and these substances he proposes to separate by a mechanical washing process, so that the bisulphide can be employed for the manufacture of sulphuric acid or other preparations of sulphur, and the clay for the manufacture of sulphate of alumina, which may afterwards be used for the production of alum or other purposes. The clay may also be used as a fireclay, or for the manufacture of bricks.

(No. 556, 1s.) Adolphe Gilbert Chalus, of Rue Sainte Appoline, Paris, patents various forms of gas-burners, in some of which the gas is heated before being consumed. The patent also includes some forms of gas-regulators, and other details, which could not be described without the aid of drawings.