

wrought iron gratings which were finished up by the emery wheel, and which they could not have done at all at the price otherwise. When they first put up the wheels there was a good deal of prejudice against them; but, fortunately, one of their men had used them before, and was therefore put on the job, and in a short time the prejudice was to a great extent overcome, but not entirely. He found the best way was to let the men who were on piecework use the wheels, and then their prejudice soon vanished; in fact, now the men were asking for more machines. He had tried a great many different makes of emery wheels, and found some of them liable to a fault often alleged against them, namely, that they glazed and the work stuck to the surface of the wheel; but that had never occurred with any of Ransome's wheels.

Mr. Wentworth Scott said he could speak to the advantage of these wheels in polishing small surfaces. A short time ago a mechanical dentist submitted several specimens of work to him to examine, to see which were freest from striæ or uneven marks, and without knowing what had been the instrument or tool used in each case, he selected the surfaces which had been cut by emery wheels as superior to the others. Perhaps Mr. Bateman might be able to inform him whether he had sufficient experience of the wheels cemented together by oxychloride of magnesium to be able to say whether they would continue working for a long time without disturbing the vibration of the particles; in other words, whether an old wheel was nearly as good as a new one, or whether any radical change took place, causing a serious difference in its mode of doing its work. He should also like to know whether, in using the emery wheels for cutting magnets, you could avoid the objection, which was formed by any mechanical method of cutting the surface, that it injured the magnetism.

Mr. Sterne (of Glasgow) wished to compliment Mr. Bateman very much on his paper. He was one of the largest emery wheel manufacturers in this country, but he did not know that he had anything to add to what had been so well said. He could confirm what had been said with regard to the prejudice which existed to the introduction of any new machine. About twelve months ago two tool grinders were introduced into a large Government establishment. The two workmen employed upon them immediately complained that they had sore eyes, and wished to go into the infirmary. The foreman was kind enough to put a sheet of glass in front of the machine, but still the next two men had the same complaint. The manager stated that he thought he had one remedy, and that was to order two more machines, and since that time no less than twenty-five emery grinding machines have been added by the request of the men themselves. In America emery machines were in use in almost every shop.

Mr. Tepper said he had seen emery wheels used satisfactorily to cut the edges of mill-stones, and he believed they were largely used for this purpose in America. There was a prejudice among the workmen in England, but it was fast being overcome.

Mr. Daniel asked whether the emery wheel was applicable for every purpose for which the smallest file could be used, as, for instance, in cleaning up small cast work, such as a statuette the size of one's middle finger. This would be covered with a great number of small lines, and he should like to know whether emery wheels were capable of removing these in the same way as the small riflers or files now used.

Mr. Botly thought it was hardly correct to say that a file could not cut anything harder than itself, because in a cutlery manufactory with which he was personally acquainted files were used to shape the different articles. He did not believe that scissors or razors could ever be polished by emery, but must be finished off with crocus.

Mr. Wilson said he would like to make a remark from the engineering point of view. Some eight years ago he had his attention called to emery grinding, and he had two wheels cemented by the oxidized oil process. He found that to grind surfaces mechanically flat, as he wanted, it required a great deal of skill on the part of the workman, and he came to the conclusion that it was of very little use to an engineer unless he had a mechanically moved table, which were not at that time made by any of the emery wheel manufacturers. He therefore abandoned the wheels and made a present of them to his iron-founder, who still used them. Since then he had had some of Mr. Sterne's admirable tool-grinding machines, and was very well satisfied with them. He first had a 15-inch wheel for more than twelve months, and only about an inch was worn off it, and the tools were ground in half the time and at much less expense. Since then he had had a 3-foot wheel, which had only worn away about half an inch in six months, whereas in that time they would have worn out a grindstone costing £3 or £4—

Mr. Sterne having stated that the 3-foot emery wheel would cost £9—

Mr. Wilson said he calculated it would last two or three years, while they used to use a grindstone, costing £2 5s., every four months, so that he should save £7 or £8 on the cost of renewals, besides which the tools got a much finer cutting edge, and he could see the advantage in the cost of the work that was executed. So far as doing mechanical work, such as grinding up a shaft or a crank pin, he did not think they would supersede the lathe until they adopted, in combination with the emery wheel, hydraulic forging, so that as little metal as possible was left to be taken off. If you left a quarter of an inch to be cut off, a steel tool would take it off quite as quickly.

The Chairman remarked that probably the crank pin was shaped first in the lathe, and then, being case-hardened, the emery wheel was used for the purpose of truing up any little distortion which had arisen from the case-hardening.

Mr. Wilson said the sellers of emery wheels professed that whatever could be done in a lathe or planing machine could be done with a wheel. If you employed the system of hydraulic forging, so that the work came out almost clean, then the wheel would answer very well to finish off with.

Mr. McCullagh (North London Railway Works) said the crank pin was first forged and turned, and then case-hardened, and finished on the emery wheel. There was always a little distortion from the case-hardening.

The Chairman asked how the collars were got out. They appeared to have a good radius.

Mr. McCullagh said that the emery wheel was cut to the required shape with a diamond tool.

Mr. Mather (South-Western Railway) explained how the slide-bars exhibited were faced up. They got hollow in working, and used to be got up again with an ordinary copper lap and emery. They were now put in a machine having an emery wheel of 2 inches in diameter and 4 inches in width, which was made to revolve, and had also a side

motion to preserve the uniformity and perfect level of the bar. Each bar took about an hour to trim up. They were hard steel, not case-hardened.

The Chairman said he understood that the bar had a longitudinal traverse under the wheel, which had a motion of rotation, and also a transverse traverse in respect of the bar, but lengthways with respect to its spindle.

Mr. Mather said yes. They were traveled rather slowly under the wheel. For the last three months they had used metaline bearings, which appeared to answer very well. Before that they used brass bearings, which were very quickly, on account of the small particles of emery getting in among the oil and being carried into the bearing by the lateral motion. They had now used the metaline bearing for three months. No signs of wear were perceptible. He was rather skeptical about a bearing without any oil, but the result seemed to be satisfactory. In reply to the Chairman he said there was a considerable pressure on the bearing, because after the work had passed under the wheel once or twice it was screwed down with some force.

Mr. Wilson said he had seen some machinery made by Messrs. Poole—an American firm—for trimming up the cylinders of paper-making machines. They required to be absolutely true, and it was found they could be got up better by an emery wheel than in any other way.

Mr. Blashfield asked if this method was employed at the Aberdeen works for cutting and polishing granite. He believed there was some economical method in use for working it.

Mr. Tepper, in answer to the Chairman, said that both emery and corundum wheels were used for cutting mill-stones.

Mr. Blashfield asked if he referred to French burr stones or granite.

Mr. Tepper said he had seen both cut by the emery wheel. It was done in about one-third the time occupied by hand labor.

Mr. Thomson said the small specimen of moulded stone was very nicely done, but if you were cutting a moulding 1½ inches wide, and the emery wheel ground out of shape, how would you keep it in order? He was the patentee of some stone-working machinery, and had seen all the attempts to produce stone mouldings; many of these would do very well for woodwork, but it was the greatest fallacy in existence to try and produce stone mouldings with a tool of corresponding shape; it was like taking a carpenter's moulding plane and telling a mason to plane a stone moulding with it. You might get the tool in the right shape, but it would soon grind out of shape; and you could not produce one or two thousand feet of moulding alike. He agreed that the emery wheel might be useful for stone working, but only by taking a thin wheel, and so controlling it as to make it cut the required pattern. He had patented a machine in which he could use a diamond, emery, or any other tool, and the work was moved up to it by a pair of cams, which never got out of shape, because they were not exposed to wear.

Mr. Bateman, in reply, said the first question asked was as to the effect of vibration on the magnesium wheel. His purpose was not to criticize minutely different kinds of wheels, but to draw attention to the process generally. He did not know what the effect was, and if he did he should not say, because his object was not to push a commercial article, but to bring forward an industrial process. With regard to magnets, his experience had only gone to the shaping of them before magnetization, but his impression was that the process might tend to disturb the magnetism. Magnetism might be induced by striking a bar suspended in a proper position, and very likely the jarring of the emery wheel might have an effect on a magnet. With regard to very small fine work, an emery wheel would not go into corners, nor could you get any rotary tool to perform work with the same degree of delicacy as a fine tool guided by skilled fingers. If it could be used advantageously it would be a very small wheel on the end of a flexible shaft, and brought to bear on the required points, much in the same way as a dentist sometimes operated, by means of a small corundum wheel on the end of a flexible shaft worked by a treadle, which was in truth the parent of the American machine to which he had referred. He should be inclined to agree with Mr. Wilson that the advantage of the emery wheel was not to remove metal by the ton, but by the ounce, although it could be taken off in considerable quantities, and there were occasions in which this would be useful. In brazed tubes, for instance, it was found quicker to grind a lump right off than to stop the machine and chip it. He was obliged to Mr. Tepper for his information with regard to burr mill-stones, which was new to him. He had not had much experience in stone cutting, but he tried some experiments some two years ago in Scotland, and cut a good many feet of ornamental moulding; but the specimen of stone operated on had a very remarkable formation; they occasionally came across a point of some unknown substance which struck fire with the emery wheel like hard steel, and when they came to this hard point the emery wheel got red hot for half an inch. It did the wheel no harm, but he considered this tendency to firing fatal to the process, though no doubt it was due to the peculiarity of the stone. Very probably Mr. Thomson's plan would work better than an ornamental wheel, but a diamond tool, if used properly and sufficiently often, would keep the wheel in any desired shape. You should not wait until it lost its shape before you applied the tool. You wasted the wheel very much less by using the tool freely than by letting the wheel get out of truth and go jumping against the work. With regard to brick cutting, Mr. Reynolds, of Southwark street, had done a great deal of admirable work in this way, and he would advise any one interested in it to consult with him. Granite was dressed very much nowadays; but he did not think it was done with revolving emery wheels, but by hand rubbers of different sections.

THE BLAIR PROCESS.

*On some Recent Improvements in the Manufacture of Iron Sponge by the Blair Process.**

By J. IRELAND, Engineer, Manchester.

THE members of this Institute are no doubt conversant with the process of making iron sponge with which Mr. Blair's name is associated. It will be the object of this paper to describe the improvements which have recently been made in the working plant, and also in the method of treating the ore. The iron sponge reducing furnaces erected at Pittsburgh were designed to work when the ore under reduction took about thirty hours to bring to a metallic state; but in the early part of 1876 Mr. Blair discovered, during

some experiments, that by the addition of a small quantity of alkali to the carbonaceous matter mixed with the ore, the action of reduction was quickened to a remarkable extent, and ore which took thirty hours to reduce without alkali could be perfectly done in six hours with it. Subsequent investigation showed that lime in a fallen state answered as well as any other alkali, and on account of its cheapness was most suitable for the purpose. The quantity of lime required being only about five per cent., the extra cost was quite insignificant when placed against the great saving in time. When, however, Mr. Blair came to work the existing furnaces under the new condition of quickened reduction, he found the arrangement could not in any way be altered to suit it. Perhaps a brief description of these furnaces will make the matter more easily understood.

Each reducing furnace consisted of a group of three vertical retorts, each retort being 3 feet internal diameter and about 28 feet high, surrounded by an outer casing of brickwork, leaving a combustion chamber between the inside of the brickwork and the outside of the retorts. The retorts and outside brickwork stood upon a cast iron entablature, supported on columns 12 feet from the ground; below the entablature, and forming a continuation of each retort, were wrought-iron cylinders, each surrounded with a water jacket for more quickly cooling the iron sponge, and having at the lower extremity a sliding sleeve for discharging it. In the top of each retort a cast iron pipe or thimble, 2 feet diameter and about 6 feet long, was inserted, leaving an annulus of 6 inches between it and the inside of the retort.

The retorts were heated externally by gas jets, the air for combustion being supplied through apertures immediately above each jet. When the retorts were thoroughly heated and all in working order, the gas generated from the ore under reduction ascended up the inside of the pipe inserted in the top of the retort, and, on meeting with the air, flamed and so heated the pipe. The ore and carbonaceous matter were fed into the retort down the 6-in. annulus between the retort and pipe, and, forming a narrow column heated on both sides, was thoroughly heated up before reaching the wide retort below. Thus the ore, on entering the wide retort or reducing zone, was all of one uniform heat, both in the center and on the outside, and hence uniform reduction was the result. This initial heating, as it is called, must be done if the ore is to be thoroughly and uniformly reduced. It was this part of the furnaces which would not suit the quickened action of reduction taking place in the body of the retort below; the ore could not be heated up as quickly as the reduction took place, and hence the two did not work in harmony.

After several alterations, Mr. Blair abandoned the system of external heating, and decided to adopt that of passing a stream of hot carbonic oxide through the mass of ore and carbonaceous matter. The writer, however, has since made some improvements in the first-named furnace, which are subsequently described, where the initial heating of the ore is performed as quickly as is possible to be done by transmitted heat, and which is much quicker than the inserted pipe. The new form of reducing furnace adopted by Mr. Blair has several important features. The following is a description of it:

A vertical retort made of fire-bricks, with an external wrought iron casing, stands upon a cast iron entablature supported on columns. The retort is continued below the entablature by a wrought-iron cylinder with water jacket, or, as the writer proposes, instead of one wrought-iron cylinder and water jacket, four small ones are suspended, and thus split up the hot sponge into small columns, by this means effecting the cooling much more quickly. At the lower extremity of each water jacket is a conical mouthpiece and valve, so that the iron sponge can be discharged periodically into any receptacle placed under.

The lower part of the retort from where the gas is admitted is larger than the upper portion. This is done so as to form an overhang immediately above the aperture where the gas is admitted, thus forming a chamber round the mass of ore, etc., and allowing the gas to permeate it uniformly. At the top of the retort is an outlet for the escape of the gas after passing through the ore, which is connected by a horizontal pipe to a vertical one descending to the ground, and there connected to the chimney flue. In the horizontal pipe above named a steam jet is inserted, so as to form a vacuum in the top part of the retort, to induce a regular current of gas through the ore, etc. The retort is fed by an ordinary bell-hopper.

The carbonic oxide is generated in a gas-producer placed a few feet from the reducing furnace, and connected to it by a flue of sufficient capacity. The gas-producer is circular in section, formed of wrought-iron plates, lined internally with fire-bricks, and standing on an entablature, which, in turn, is supported to the requisite height by columns of brickwork. Below the entablature, and suspended from it, is a wrought-iron continuation, tapering to a conical discharging valve for allowing the ashes to be from time to time removed.

Apertures for admitting air for combustion in the gas-producer are placed in its circumference, fitted with slide covers to regulate the admission of air.

Mr. Blair, having made arrangements with the proprietor in America of the Ponsard producer, used it in preference to the ordinary Siemens one, as the admission of air is more easily regulated. The writer has used one of the circular ones described, and finds it answer the purpose equally as well as the Ponsard. The object of using a carbonic oxide gas is primarily to supply heat to the ore, etc., to be reduced. What reduction is effected by the gas is a secondary matter; and in this point the process differs from other attempts where carbonic oxide has been used solely for reducing the ore. It will be seen that in using the steam jet to induce a stronger current of gas through the ore under reduction, the temperature in the gas-producer will be increased, and the gas in time become hotter than required, the result being that the mass against which the gas impinges in the reducing furnace, being almost entirely metallic, would become welded together, and so interfere with the regular working of the furnace. To obviate this, a very simple and ingenious arrangement has been made by Mr. Blair, by which the temperature of the gas can be kept at almost one uniform heat. The gas, after passing through the reducing furnace, is still almost entirely carbonic oxide, and on passing by the steam jet becomes mixed with steam; in order to condense it a water spray is introduced at the top of the descending flue to the chimney. A little above the air apertures in the gas-producer are two pipes connecting it and the descending flue, so that some of the gas which has already passed through the reducing furnace can be again sent through the gas-producer and used over again, and at the same time cool down its temperature. By regulating the slide covers of the air apertures in the gas-producer and the damper in the flue to

* Paper read before the Iron and Steel Institute.

the chimney, an equal quantity of air and gas can be supplied to the producer. It is found, in practice, the two can be so regulated that an almost uniform temperature can be maintained in the reducing furnace, and a saving effected in fuel; in fact, by the cooling action of the return gas, any temperature can be obtained. The reducing furnace just described will reduce about 200 tons of ore to a metallic state weekly, the dimensions of the retort being 5 feet diameter in the upper and 6 feet 6 inches in the lower part, by 16 feet in height. The height of the whole structure is 36 feet, and the cost about £700.

The fuel used in the gas-producer is coke; and if the iron sponge made is intended for steel-making, the coke should not contain more than .75 of sulphur—the less the better—otherwise the iron sponge will be affected by it. But where pure ore can be had, and coke from washed coal not containing more than the above-named amount of sulphur, this form of reducing furnace is undoubtedly the best for producing iron sponge in large quantities, and the whole of it thoroughly metallic.

In the autumn of last year the writer was requested by the Indian Government to reduce some of the iron ore of which there are large deposits some fifty miles distant from the Warora coalfields, the condition being that the ore must be reduced with Warora coal, a quantity of each having been sent over here from India. The ore is magnetic, very rich and pure, containing over 70 per cent. of metallic iron. The coal, on the other hand, is very poor, being a black lignite, containing about 15 per cent. of ash and 10 per cent. water, besides a great number of sulphur pyrites, and it will not coke. From the nature of the coal, it was evident the form of reducing furnace last described, where the heated gas was passed through the ore, was not suitable, and therefore the old form of furnace must be used, in which the heat is transmitted through the retort; but here again some different arrangement must be made to heat up the ore more quickly. The writer ultimately concluded to abandon the inserted pipe or thimble, and divide this part of the retort into a number of smaller ones, so as to present as small a column of materials to the action of the heat as possible. A small furnace, some 21 feet in height over all, was erected on this principle, with a reducing retort about 18 inches diameter and 10 feet 6 inches high, and a cast-iron pipe on the top 8½ inches diameter to heat up the ore. This furnace works well, and has been in constant operation since September last. Some twenty tons of the Indian ore have been operated on, and iron sponge of uniform and excellent quality produced, part of which has been since made into first-class tool steel, and some of it melted in a cupola into pig metal. The Indian Government are so far satisfied with the experiment that the question of erecting works on this principle for the manufacture of iron and steel in India is now under consideration by the Council. Various other ores have been reduced in this furnace with the same uniform result.

Though of small dimensions, this reducing furnace is on the principle proposed for working with transmitted heat; and in furnaces of larger diameter, the number of small heating retorts, placed on the top of the larger or reducing one, will be increased as the diameter of the latter increases: thus a reducing furnace of 3 feet diameter will have four small retorts above it, and 5 feet diameter will have seven. The top of the large retort is arched over against a circular key-brick, having a hole through its center, one of the small retorts standing on the top of it. The remainder are placed round, each resting on two of the arches, so that the ore, etc., when heated, falls down between the arches into the large retort below. The spaces between the arches being almost square, and the small retorts round, a space is left at each corner, through which the gas generated from the ore under reduction can escape into the combustion chamber round the small retorts, thus helping to heat them. To cool the iron sponge as quickly as possible after reduction, it is split up into three or more columns (according to the size of the furnace) in the wrought-iron cylinders below, each cylinder being surrounded by a water jacket, through which a slow current of cold water is passed; and on being discharged from the mouthpieces is sufficiently cool that oxidation does not take place. A reducing furnace of this description, 5 feet diameter and 40 feet high, will reduce sixty to seventy tons of ore to a metallic state weekly, and the cost is about £600.

The cost of producing iron sponge by this process will vary according to the locality in which the work is carried on, but, with the large reducing furnaces mentioned, the cost will be about 22s. per ton, exclusive of the ore. It is, however, confidently expected that, where several of the furnaces are in operation, the cost will be less. The question of the subsequent use of iron sponge is an important one. Where the ore is rich and pure, iron sponge made from it can be at once made into tool steel, the quality of which cannot be equalled by that made from the best brands of Swedish bars. In the case of ore which is not so rich, but still suitable for steel-making, the writer is of opinion the best way of utilizing the sponge made from it is to melt it in a cupola furnace into pig metal, and while in a molten state pour it into a Siemens-Martin furnace, and in this way convert it into steel. The pig metal obtained in this manner will contain about 1.5 carbon and practically no silicon, the greatest amount of the latter yet found by analysis being 0.25, and the lowest 0.19. If this metal is poured while molten into an open hearth furnace as proposed, there ought to be no serious difficulty in getting six heats from each furnace in twenty-four hours, in place of the two or three heats now obtained. Iron sponge melts readily in a cupola furnace, and the risk of oxidation is less than when it is thrown into a bath of pig iron in an open hearth furnace. The same remarks apply to the manufacture of wrought iron. From the nature of the particles of iron in iron sponge being so minute, it cannot be balled up in an ordinary balling furnace without considerable oxidation; on the other hand, if melted in a cupola furnace, the resulting metal, containing so little carbon and silicon, if taken in a molten state from the cupola to the puddling furnace, very little rabbling brings it to nature.

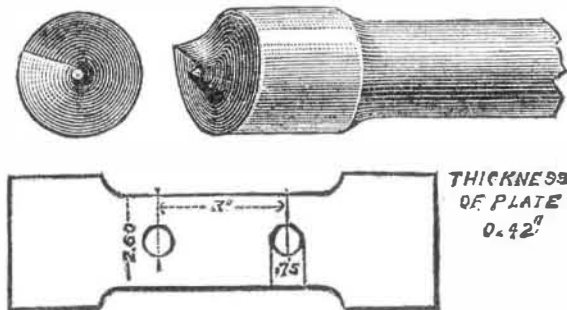
The molten metal can be made almost as cheaply as pig iron; in fact, there is no reason why it should not be made as cheaply. The first outlay in plant and the wear and tear are reduced to a minimum. To produce 100 tons of the metal per week, the cost of plant will be about £2,500—two reducing furnaces, two cupolas, fan or blower, small engine and boiler, hoist and ore breaker, being all that is required. There are many points not touched upon in this brief and somewhat imperfect description of the process and apparatus, but the question is one worthy the consideration of iron and steel makers.

With regard to the action of the lime in accelerating the reduction of the ore to a metallic state, it certainly is a great help forward in the manufacture of iron sponge. What its

chemical action is has not been clearly demonstrated; but it is remarkable that so small a quantity of it should produce such a great acceleration. Perhaps some of our chemists can explain the phenomenon?

IMPROVED SPIRAL PUNCH.

This punch is so formed as to cut its way through the iron with a shearing action, which, it is alleged, does not tear or injure the iron like the ordinary blunt punch. The results are very remarkable. For example, steel boiler plates of the form shown in the figure below but with only one hole in the center, punched with the common punch, had a



tensile strength of 38,579 lbs.; a similar plate, punched with the spiral punch, had a tensile strength of 63,929 lbs. When two holes were punched as above with the common punch, the plates broke at the holes in every case, but remained firm under the new punch, which also requires less power to make a hole of a given size. It was lately presented to the Iron and Steel Institute as the invention of Mr. Kennedy, by Thompson Sterne & Co., London.

THE INVENTION OF THE REAPING MACHINE.

It has always been a point not quite decided whether the Scotchman Bell or the American McCormick was the first to construct a practicable reaping machine. The evidence appears to be strongly in favor of Bell, whose apparatus was in use from about 1826 to about 1850, shortly after which time it was purchased by Mr. Woodcroft for the Patent Office Museum. Mr. McCormick, on the other hand, may fairly claim the credit of having been the first to bring a reaping machine into anything like general use, and there seems no doubt that the machines of our own time are the descendants, not of Bell's forgotten apparatus, but of the machine brought forward by McCormick at the 1851 Exhibition, and patented by him seventeen years before in the United States (1834).

It is, of course, well known that many other inventors had previously attempted to gain the desired object by means more or less effectual. Revolving cutters were tried as far back as 1799, while two inventors at least* (Salmon, 1807, and Ogle, 1822) had reciprocating knives, or frames fitted with knives, which resembled, to a certain extent, the cutters now used. These last had, however, no shearing action, and it is precisely this shearing or drawing cut that alone answers for cutting corn. Such an action is found in Bell's and in McCormick's machines, but there now seems some reason to believe that both these were anticipated by John Common, of Denwick, Northumberland. The following extract from the old MS. Committee Minutes of the Society of Arts does not appear to have been seen by writers on the subject, and it almost certainly has never been printed. The extract is from the minute-book for the Session 1811-12:

"Took into consideration a reference to this committee of April 15th, 1812, on a reaping machine. Read two letters from Earl Percy, dated 8th and 14th April, 1812, stating that he had sent to the Society the model of a machine for reaping corn, barley, oats, etc., made by John Common, of Denwick, Northumberland; that he is not quite certain whether a sufficient trial of the machine has been made to authorize its being laid before the Society, as the inventor, Mr. Common, partly from the fear of any person stealing his invention and partly from the want of more extensive means, did not cut more than ten or twelve sheaves, but in this experiment the machine acted with great precision; that the two persons who assisted Mr. Common are the only persons who have seen it act and have sent certificates respecting it.

"Read a certificate from John Thew and Thomas Appleby, dated Denwick, April 9th, 1812, stating that they accompanied John Common to a field at Denwick, to make trial of his newly-invented reaping machine, where they saw it cut down a small patch of ripe oats with ease and dispatch, and that they are of opinion it will answer the purposes intended, and be of general benefit to the country.

"Examined the model sent. The apparatus is to be drawn by one or more horses, and is of considerable length; it appears that the two large wheels, from whence motion is given to the machine, are to be made of wood and iron spikes fixed in their periphery; they are fixed upon an axle of iron which moves round with them, and which axle also turns round a brass wheel fixed upon it, the teeth of which work in a pinion placed on a longitudinal axle. On the other end of the spindle or axle near to the shafts is fitted another cog wheel, the teeth of which work in a pinion below supported by a small wheel to prevent this part of the machine from touching the ground. The pulley and pinion last mentioned give an alternate backward and forward motion to a set of angular knives, so as to enable them to act upon a principle similar to the action of a number of scissors upon the blades of corn, directed to them by angular spikes of iron projecting before them as it falls upon a set of rollers, from whence it is delivered in a line upon the earth, as described in an account sent with it.

"Resolved, It appears to this committee, upon inspecting the model of Mr. Common's reaping machine, and reading the account thereof with the certificate produced, that this invention is incomplete, and at present they cannot fairly judge of it, and therefore cannot recommend it to the further attention of the Society."

The description is certainly somewhat meager, but as far as it goes it is sufficient to show that the main principle of the reaping machine was known and had been experimented with at least thirteen years previous to the date generally allotted to the invention.

Another machine brought before the Society of Arts, but

* See Appendix to Specifications of Reaping Machines. By B. Woodcroft, 1853.

apparently not elsewhere mentioned, is one by Amos, of Boston, Lincolnshire. In it "a number of scythes are caused to revolve rapidly by the usual adaptation of wheels and pinions." The committee had this brought before them in 1820, and decided that "the plan, however, was not new, and it has been found by experience that it is impossible to apply to this construction power enough to produce a sufficiently rapid motion of the scythes."

Bell's machine came before the Society in 1830, but was not rewarded, on the ground that the descriptions of the machine already extant had brought it sufficiently before the public, and that it did not therefore require the Society's aid in bringing it into notice.—*Journal of the Society of Arts.*

CORROSION OF IRON AND STEEL.

At a recent meeting of the Iron and Steel Institute, Mr. Henry Bessemer stated that he had prepared three bars of ordinary wrought iron, 2 inches square and 1 foot in length, and prepared three bars of cast steel of different makes of the same precise dimensions, and in order to have the precise amount of surface exposed they were carefully planed in the planing machine, and smooth-filed in every angle left square—the ends left bare—and then carefully weighed in an accurate weighing machine, which would determine to 1 or 1½ grain the weight of those large bars. Those bars—three of iron and three of steel—projected from a bar of wood 10 inches downward. A small trough was prepared in which water, with a small quantity—he thought about 6 per cent.—of sulphuric acid, as a corroding material, was placed. That bar of wood with its projecting pieces downward was immersed in that preparation, and taken out once in every ten hours for forty hours, to examine the state that each bar was in, and then replaced, so that one might see how much in weight was dissolved from each bar under operation. He might tell them that at the end of forty hours the steel bars had lost a notable portion of the metal, so much that they could feel the point between the water-line and the corroded part. Some of those bars of steel had suffered from here and there a bubble-hole in the surface; and those little black lines that they all knew so well and disliked so much appeared on the surface as little elongated slots, as showing the piercing of the fluid into the particular interstices of the steel, so far as the few cracks or elongated air-bubbles were concerned. The three iron bars were so corroded that on the flat side of the pile they exhibited a sort of slightly undulated surface. On the sides of the pile there were five separate welds shown, five grand separate weldings, and an infinite number of little weldings; but five main points were shown absolutely upon it, and the blade of a penknife would go in to the extent of ¼th of an inch all the way round. The most curious fact was seen on the end of the bar; the end of the bar looked, he should say, as much like an old clothes brush with black bristles as anything they ever saw. It was pierced endways, varying from ¼th to ½th of an inch, so that a needle or any other small point could be pushed up into it every way or any way, showing how corrosion varied in the pile, and exhibited a much larger surface, though the diminution of the bar of steel and iron was such that the iron gradually began to exhibit a greater surface, and therefore more rapid corrosion. His memory did not serve him, but he could supply the fact at another time; he believed the worst iron bar of the three had lost twice and a quarter of the amount of weight in the forty hours as that corroded in the steel bar in the same solution and for the same number of hours exposed; indeed, the way in which corrosion takes place in bar iron was exhibited in all those things that were constantly exposed to the action of corrosion and brightened. He should say that a very familiar object to many of them was a street pump handle. Every one who had taken hold of the iron handle which had been exposed for some ten or twelve years to the ordinary weather would know that the originally round piece of iron had got into a long reedy piece of iron—long lines that stuck up, and certain deep depressions worn away—that was evidently the corrosion taking place in certain lines much more rapidly than other parts. He thought there was no doubt that under the ordinary condition of acid or fluid, wrought iron would be found to be more corroded in a given length of time than a piece of steel.

THE MERCHANT FLEETS OF THE WORLD.

We learn from the *Bureau Veritas* that the total number of sailing ships in the civilized world at the end of 1877 was 51,912, divided as follows:

	Ships.	Tons.
England	17,765	5,526,930
United States	6,307	2,146,731
Norway	4,135	1,352,949
Italy	4,402	1,296,985
Germany	3,140	876,814
France	3,300	666,767
Spain	2,744	550,533
Greece	2,024	419,418
Russia	1,802	417,973
Sweden	1,941	402,248
Holland	1,268	366,284
Austria	652	253,730
Denmark	1,203	182,870
South America	355	129,901
Portugal	441	106,215
Turkey	300	50,101
Asia	51	21,079
Central America	57	18,546
Belgium	25	13,033

Of steamships the numbers are as follows:

	Steamers.	Tons.
England	3,133	3,283,911
United States	542	674,036
France	272	319,179
Germany	220	259,785
Spain	224	176,310
Holland	110	112,879
Russia	145	105,011
Italy	110	95,305
Sweden	210	87,280
Austria	74	83,540
Denmark	96	64,677
Norway	122	54,649
South America	82	58,649
Belgium	25	35,471
Turkey and Egypt	33	30,467
Asia	22	29,314
Portugal	26	22,580
Central America	13	10,152
Greece	12	7,621