

ing will necessitate the right-eye picture being put into the lantern on the left hand, the left-eye one into that on the right, and the ground glass to be viewed from a fixed position in front, thus preventing the effect from being observed by many persons together.

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THE MANUFACTURE OF WOOD-WORKING MACHINERY.

Among the various mechanical industries of the world there is none—with perhaps the exception of iron—which is more widely spread or employs more capital and labor than the working of wood in the manifold uses to which it is applied. In the present advanced state of manufactures machinery is employed for nearly every process to which wood is subjected. From the wooden toothpick to the railway car or the palace of royalty, machinery is used for producing the required form. The manufacture of machinery for working wood has become, therefore, one of our most important industries, for only by securing the greatest perfection in the machinery employed, can the best results be obtained.

We have selected as the representative of this industry the house of C. B. Rogers & Co., at Norwich, Conn., the oldest as well as one of the largest engaged in this business. The house originated at Keene, N. H., in 1832, when Mr. J. A. Fay commenced the manufacture of mortising and tenoning machines for sash and door work. Previous to that time, with the exception of the Woodworth and Daniels planers, saws, and a few special tools, very little wood-working machinery was used. The new machines made by Mr. Fay met a ready sale and increased demand, and in 1848 Mr. C. B. Rogers engaged with Mr. Fay in the business, opening a factory at Norwich, Conn., for the purpose, and bringing out the sash sticking machine, which met with such an unprecedented demand that for over three years one machine per day was the average sale. A few years later a shop was started at Worcester, Mass., which was devoted to Woodworth and Daniels planers.

In 1861 the death of Mr. Fay, together with the need of condensation of the business at some central shipping point, made it advisable to remove the entire business to Norwich. The firm was made into a joint stock corporation, a large works erected to accommodate the whole business, and the name, which up to this time had been J. A. Fay & Co., was changed, and the present title, C. B. Rogers & Co., adopted. The history of the establishment from the start has been one of progress, and the inventive talent of the managers has been kept constantly employed to keep pace with the demand for improvement. Many of the most indispensable machines in use originated with this house—notably the power mortiser, tenoning machine, sash sticker, and four side moulding machine.

The works, of which the central cut of our first page illustration is a fine representation, are located in the city of Norwich, Conn., on the banks of the river Thames. The location is most excellent as regards freighting facilities—an important item with this class of goods—the city being midway between Boston and New York, with a daily line of steamers to the latter, and two railroads centering there, by which freights may be forwarded expeditiously to all points, and are by special arrangement to all Western points at the regular New York freight tariff. The works, including the foundry, cover nearly three acres of ground. The manufactory surrounds three sides of a quadrangle, and consists of the main building, 125x45 feet, four stories, with blacksmith shop, 30x25 feet, attached; a wing, 65x40 feet, four stories; and a second wing, 50x20 feet, three stories. The fourth side is occupied by a storehouse, 100x30 feet, three stories, for lumber and coal. The factory has about 40,000 feet of floor space.

Entering the works at the north end, ground floor, we come first to the motive power, steam, applied to an 80 horse power high pressure double engine, built by this company, running 125 revolutions, and so delicately adjusted in its valve motion that the stoppage of half the tools in the building can scarcely be detected in the speed. Passing the engine, we enter the "planer room," so-called from its being devoted exclusively to the manufacture of planing and matching machines. Our artist has sketched this room entire, with the various planers in process of construction. Of this class of tools this house make twenty different sizes and styles, from the diminutive "Pony," so-called, to the planer and matcher weighing from four and one half to five tons. The greatest care is used in the construction of these machines, and the latest improvements and processes are applied. A recent one is the use of cast steel for all cylinder heads, as well as for the smaller gearing where the wear is greatest. The severe tests to which these machines are put have always proved successful and eminently satisfactory to the user. In the center of the room, but upon the outside, is an elevator running to the fourth story, and sufficiently powerful to raise the heavy planers to the street level for shipment.

Leaving the planer room, we pass through a store room filled with bar iron, of all shapes and sizes, and enter the blacksmith shop, which has six forges, two trip hammers, power shears, and all facilities for the various forgings. From here we ascend to the second floor, machinist room. This floor is engaged on moulding machines, of which seven sizes are made; sash machines; mortisers, twelve sizes; tenoners, seven sizes; hand saws, three sizes; scroll saws, railway cutting off and splitting saw frames, resawing machines, and various other tools.

Passing the casting room, where tons of castings are in process of cleaning, we ascend the main staircase to the third floor or "wood room." This floor is engaged upon woodwork; framing machines, making foundry flasks, pattern work, of which a large amount is required in the production of new machines and alteration of the old. Although iron frames are the rule for most machinery, some of the wood frames are still retained as being lighter and cheaper—as the sash machine, tenoner, saw tables, etc. The frames retain their position equally with iron, but to insure this a large stock of hard wood is kept in store and seasoned for years before using. On this floor is the paint room, where the finishing touches are applied and the gray iron rendered more agreeable to the eye. At the south end of the room—the foreground in the sketch—is one of the most important departments in the building, where every machine before being shipped is thoroughly tested on the work it is designed to perform, and any error or oversight in the construction corrected. This was for many years a system followed only by this house, and its value has been amply proven by the universal success of the machines sent out.

Many purchasers have but a limited knowledge of machinery, and it is a great assistance to them to receive their machines all set and with tools prepared ready to set at work. The machine shown as being tested is a vertical tenoning machine made for tenoning car sills and doing the heaviest work with great ease and rapidity. The company have recently completed a machine of this class for working oak timber 16 inches square, cutting a double tenon 8 inches deep at one cut. A companion machine to this is the rotary car mortising machine, which works mortises 12 inches deep, 15 wide, and any length required, the timber being moved by power, and the whole operation almost automatic.

Upon the fourth floor is the "machinist room." This is similar to the second, but engaged on a lighter class of tools, with one exception—the inside head moulder, which is one of the finest tools in use. It weighs 3,500 pounds, and works moulding up to 12 inches wide, and by special adjustments is capable of producing 50,000 feet of narrow mouldings per day, a feat said to be unequalled by any other machine. Among the other tools are: iron frame tenoning machines, whose advantages consist in great facility of adjustment and ease of operation; upright shaping machines, five sizes; boring machines, one ingenious two-bit machine for cabinet work, cabinet jointers for piano work, Reidy's patent ironing and mangling machine, a specialty recently introduced into this country by an English patentee, its peculiarity being the method of heating the roll by a combination of gas and air. Last, but not least, in one corner, occupying but little space, is the manufacture of Boardman's barbed blind staple, which was invented by an employé of the house, and has been made by them for over twenty years. Here several machines are running constantly, for some time past night and day, to produce these little articles, 2,200 of which weigh but a pound, and of which orders have been received within three months for upward of forty tons. It would seem the work of a lifetime to produce such an amount, but the machines are tireless, and, like "Oliver Twist calling for more"—wire—they consume it in their insatiate maws, and the finished staples drop from them like the rain drops.

The three upper floors of the main wing are filled with finished tools ready to be shipped out on order, and the long lines of machines in dozens or half dozens of a kind make a fine display. On the third floor of this wing, a light, pleasant room, with a fine view of the river, is used for draughting the many new designs and improvements required in the business. Something in this line is in process constantly. One of the most recent is the large hub mortising machine, shown in the right hand cut of our illustration. This was produced on a requirement for a machine to mortise a hub 16x18 inches, a task as yet unaccomplished. The machine shown does the work successfully, mortising 8 inches deep in solid hard wood, and although very heavy and powerful—weighing 3,500 pounds—with as much ease to the operator as one of the lighter door mortisers.

This house have always given special attention to perfecting machines for specially difficult classes of work. Complete sets of machinery for making lead pencil woods and finishing the pencils were perfected by this house and furnished to the Messrs. Faber and others. Machines for making meat skewers, turning them out by the million, and many other specialties have been produced, it being only necessary to state the work to be done and something will be invented to meet the emergency. This company work their iron from the pig, the castings being produced in their foundry, of which an interior view is given. It has about 15,000 feet of floor space, two cupolas—one of seven tons capacity, large core ovens, cranes, and every facility for doing a large quantity of work. The present production is from three to four tons on alternate days. The quality of iron is an important item in this class of tools, and the company are able, by making their own castings, to insure the best. Attached to the foundry is the pattern house, 30x15 feet, two stories, and packed to overflowing with the patterns used.

The offices of the house are in the second wing of the works, fronting the street. Here are the accounting department, the correspondence which is extensively carried on with all parts of the world, and in addition to these is a constant production of catalogues, cuts, and circulars descriptive of the various machines. A catalogue is issued frequently of 175 pages, giving full information relative to the

125 different machines made by the house, among which are tools embracing in their ranges of work house building, sash and door, furniture, cabinet and musical instruments, wheels and wagons, railway cars and coaches, to which class special attention is given, planing mills, lumber producers, mouldings and picture frames, brooms, curtain rolls, and in fact for nearly every purpose to which wood is applied. The house has a ware room at 109 Liberty street, New York, and their shipments extend to Great Britain, France, Germany, Sweden, Austria, Russia, Australia, New Zealand, South America, and every corner of North America, and in nearly every country named the house has a ware room with machinery in stock.

The machines have been exhibited at every exhibition of note from the Crystal Palace down to the present time, and over 100 medals in gold, silver, and bronze attest the competitive merit of the exhibits.

The present officers of the company are: Lyman Gould, President; R. M. Ladd, Treasurer; and B. H. Rogers, Secretary and Superintendent.

Correspondence.

Electrical Generators.

To the Editor of the Scientific American:

It would seem that the authors of books and chapters on electricity are largely culpable for the numerous discussions which have appeared of late in the SCIENTIFIC AMERICAN on electrical generators. The problem to find the maximum current with a given lot of battery cells and external resistance is well known; also the answer to it, viz., internal resistance equal external resistance. But the other problem, viz., to find, with given external resistance, the number and arrangement of cells, for procuring a given current with a minimum consumption of zinc, seems to be far less common in books, and perhaps generally, though the result may often be of far greater importance.

To illustrate, suppose that in some electro-plating establishment a plating bath is so run as to offer about constant resistance to current; and suppose a certain standard constant current is preferred. If these conditions can be realized by one arrangement requiring \$25 greater outlay in first cost for increasing the number of cells, whereby a saving of \$50 a year for zinc is realized; a party, expecting to run for years, would be quite likely to adopt the greater first cost.

What is true in consumption of zinc in batteries will be true, in some measure at least, in dynamo-electric machines, because the zinc consumed in one case represents energy, and so do the foot pounds consumed in the other. Hence, for simplicity, batteries are here considered instead of machines.

That for a given external resistance a given current strength may be maintained by different arrangements of cells in rows, the total number of cells varying as required, is evident from considerations of Ohm's law. For instance, if 100 cells in 5 rows satisfies a certain current and resistance, the same effect may be secured with 10 rows of batteries, though 40 or 60 cells may be necessary. It may happen, however, that a large percentage of zinc will be saved with the 60 cells and 10 rows.

The energy of a current is stated, on good authority, to be proportional to the zinc consumed in a well conditioned battery; also, it is proportional to the electro-motive force multiplied by the current strength. These facts applied so as to bring about the relation between the zinc consumed in different cases will show that for the same external resistance the weight of zinc consumed in a battery arranged for maximum current; divided by the weight of zinc consumed in a battery by like cells in greater number for an equal current, is simply equal to the number of cells in one row of the first battery, divided by the number of cells in one row of the second battery.

Also for the relation of numbers of cells, it will be found that the ratio of the number of cells in one row, 1st battery and 2d, added to the ratio of number of rows, 1st battery and 2d, is equal to 2; also, the maximum value of this 1st ratio can never be greater than 2.

An example will serve to fix the ideas: Let the cells of battery considered be all alike, with equal electro-motive forces, and the internal resistance of each equal 1 ohm; let the external resistance equal 4 ohms. If the number of cells be 144, arranged in 24 rows of 6 each, we have the maximum current for the cells of resistance named. Again, if 192 like cells be arranged in 12 rows of 16 each, we will have the same current strength, though the total internal resistance of the 2d will be only a third of the 1st.

According to the rule above, the consumption of zinc in the 1st battery will be 50 per cent greater than in the 2d.

Hence it appears that the best arrangement of a battery of several cells for maximum of current is one thing, while the best number and arrangement for securing a given current with a minimum of zinc is quite another. The quantity of zinc diminishes with internal resistance.

From the fact that zinc consumption in a battery stands for about the same thing as foot pound consumption in the dynamo-electric machine, it would seem that for the minimum of power the internal resistance of the machine should be reduced to as small a fraction of the whole as possible, the size of the machine and conditions of working being, of course, consistent with the given current required.

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