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THE GREAT TOWER OF THE FRENCH EXHIBITION.

AT the end of the month of June, almost at the hour fixed upon by Mr. Eiffel, the four masonry foundations for the great 984 foot tower were finished, and the erection of the metallic portion was at once begun, and is now pushing forward with an accuracy and rapidity that are astonishing. We shall enter into some detail concerning the mounting, an operation that is the more interesting in that the problem to be solved is almost entirely new in every respect, and that the engineers who are called upon to meet the exigencies of this quite peculiar work can find hints, rather than instruction truly sanctioned by practice, in the colossal structures that they have hitherto erected. It is well to note, however, that the construction of the Eiffel tower will there should be any deviation, these jacks will permit of re-establishing the absolute equilibrium of the structure. But, owing to the accuracy of the calculations made, and of the working drawings, such deviations are hardly to be feared. However, when we think of the wide spacing of the trusses and the necessity of a mathematical convergence of the elements of the base, we can see the importance that an error, even a minute one, at the start, would have in the final result. In order to prevent this, all the pieces of this enormous assemblage come from the works of Mr. Eiffel, at Levallois-Peret, cut to their exact dimensions according to the instructions of the bureau of studies, and marked and drilled, so that no modification has to be made at the place of operations. The workmen put them in place without any alteration, and we cannot help being struck by the accuracy of the work, which character- feet sweep and of 6,600 lb. power, will be mounted on these beams, which will serve them as slides, and against which, at every 13 feet, they will be fixed and temporarily bolted. The cranes will thus be able to distribute the necessary materials throughout their entire circle of action. When a new section has been constructed, the crane will be raised to the following story, and so on.

At the height of 140 feet, the uprights thus constructed, and forming the sides of four great inclined trapezoids, will be ready to receive the four horizontal trusses forming the first story of the tower. Then will come the question of putting these in place. As it will be impossible to mount them without a support at such a height and across such a space, the builders have decided to use a large wooden scaffolding, which will be erected according to the median vertical of each trape-

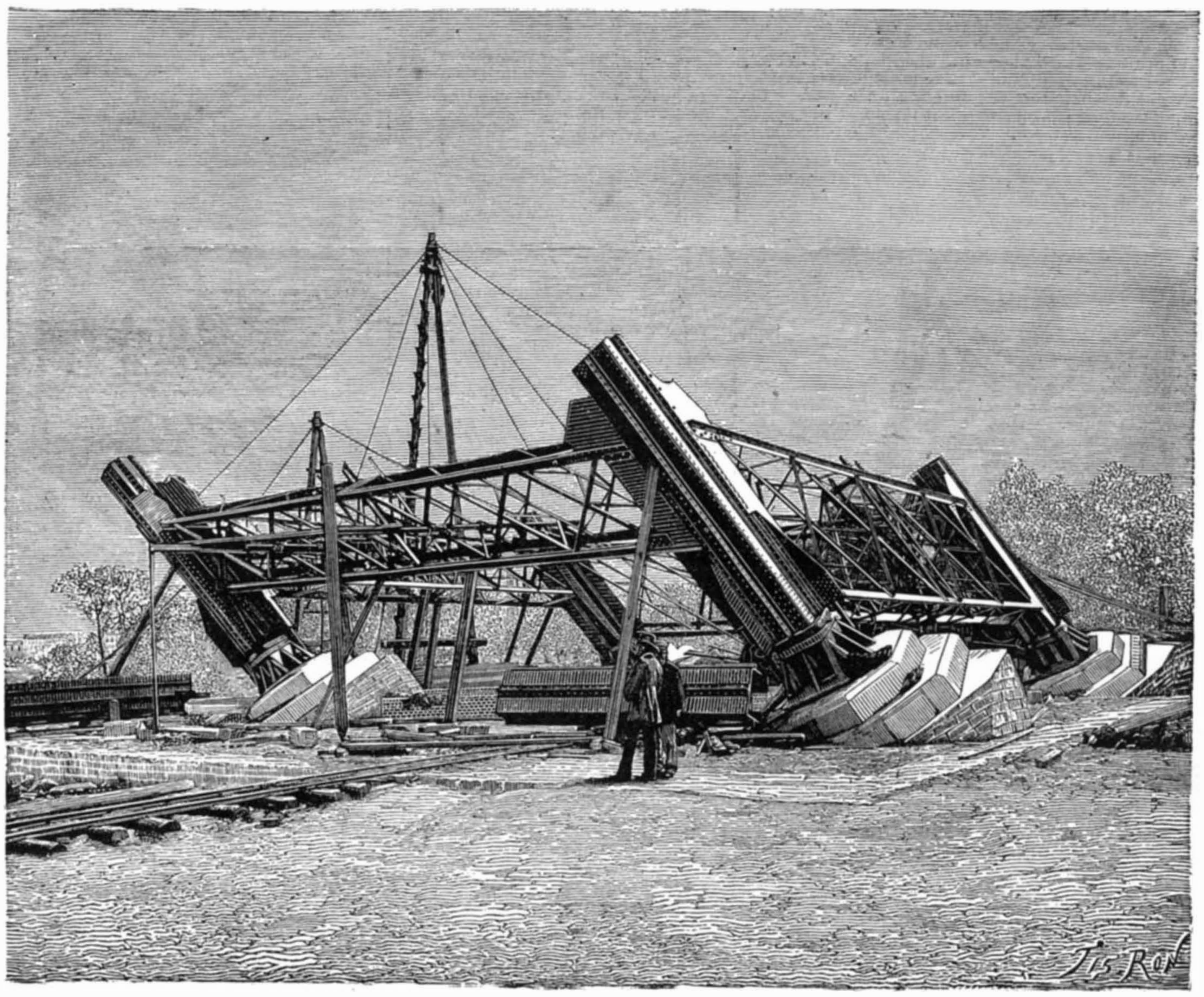


FIG. 1.—MOUNTING ONE OF THE TRUSSES OF THE 984 FOOT TOWER.

THE GREAT TOWER OF THE FRENCH EXHIBITION.

have had a way paved for it, after a manner, by the work on the Garabit viaduct and the Tardes bridge, and we can logically deduce therefrom that the instruction to be obtained will itself be put to profit later on, to a degree scarcely imaginable, in the carrying out of other great utilitarian operations of colossal order. Some of these are now under way, especially those on the Forth bridge in Scotland, which but a few years ago would have seemed to be impracticable. Now, such operations are entered upon with security, and, we may say, with simplicity in both conception and execution. The reason is that these great works form a continuous chain in progress. The operation on each of them reduces to naught difficulties that before had been considered insurmountable, and removes any doubt concerning resistance and stability. It is from this standpoint especially that the 984 foot tower merits the attention of the engineers and builders of the entire world. The history of its construction will prove fertile in revelations of every nature, and the useful consequences of it are certain.

The iron trusses that will form the main framework are beginning to rise on the foundations, and already reach a height of about fifty feet (Fig. 1). Their inclination is 54°. Each truss is fixed to the masonry through an iron shoe capped by a steel plate weighing 5,500 lb. In each shoe there is space provided for the reception of a 15,400 lb. hydraulic jack of a force of 800 tons. In case izes the perfect and necessary alliance of the technical study and of the construction properly so called.

The mounting will be divided into three periods, the first of which comprises the work now in progress, and the two others of which have already been perfectly studied.

The first period, as just intimated, comprises the mounting of the trusses on the shoes. These are put up in sections that are riveted to one another and cross braced, and that balance upon each other, and can thus be mounted without external help to a height of about 85 feet. Starting from this level, the vertical of each group of trusses will fall outside of the base, and, as the elements next put in place overhang, they would tend to overturn the portion already constructed. Then will come into play the frames shown in Fig. 4, which, abutting against the trusses, will constitute new bearing points. The distribution of the metallic sections over the piers, and their putting in place, will present peculiar difficulties as soon as the height reached exceeds what it is at present, that is to say, fifty feet. The operation will be performed as follows: In the interior of the uprights of the tower are arranged beams that have a plane surface and that will serve for the rising of the elevators. The builders of the tower have conceived the ingenious idea of using these, in measure as they are put in place, for the continuation of the work. To this effect, four cranes, of 38 zoid projected upon a vertical plane passing through the upper extremity of the inclined trusses at the level of 140 feet.

This scaffolding is shown in Fig. 4. The four great trusses established on each face, starting from the center of the scaffolding, will, on reaching the uprights, be connected with the latter just as the superstructure of a single span bridge is connected with the abutments. When this operation has been performed, the work on the tower will be greatly advanced. There will then be at the disposal of the builders a wide and rigid base, at 150 feet from the ground, that will allow them to proceed safely and progressively, and with so much the more ease, in that the weight of the pieces, their size, and distance apart will continue to diminish.

The builders seem to have given up the idea of making the great arches that are seen traced upon the plans of the tower serve to contribute to the rigidity of the work. These arches will be reduced mainly to a decorative role, and will be simply affixed to the rigid parts, whose contours they will round off without supporting any of their weight.

Toward the end of this year. the tower will have reached a height of 150 feet, the level of its first story, and 3,000 tons of iron will have been used to attain this result. Everything allows us to hope that the structure as a whole will be entirely finished in October or November, 1888, much before the opening of the exhi-

bition. Consequently, Mr. Eiffel is pushing to the front the studies on the architectural decoration, along with those on the construction properly so called. This task falls to Mr. Sauvestre, the skillful architect of the tower.—*Le Genie Civil.*

LEAVES FROM THE NOTE BOOK OF A MILLING ENGINEER.

WATER IN CHANNELS.

THE section of the channels in which the water is led to the water motor depends on the ground in which the channel is cut. Fig. 1 represents a section through a canal; h shows the depth of water in the canal, and the angle, x, shows the incline of the sides of the canal, which vary from 25° to 90°.

1. If the channel be made in brickwork or masonry, the angle of its sides would be 90°.
2. If in stone without mortar, the walls require to be built to an angle (x, Fig. 1) of 60°.
3. Should the channel be cut in a clay soil, an angle (x, Fig. 1) of 45° will suffice.
4. For coarse gravel and stones, 40°.
5. For finer gravel, 35°.
6. Thirty degrees will answer when sand is used; and—
7. For ordinary soil, 25°.

Regarding the speed of the water in channels for driving mills, it will be understood that it runs at its highest rate just below the water surface, decreasing toward both the bottom and the sides of the river. Fig. 2 shows a longitudinal section through the stream. The arrows of different lengths represent the speed of the water in different positions. The depth of the water in the trough (h, Fig. 1) should not exceed 3 to 4 ft.

The average speed at which the water can be run in a channel depends largely upon the nature of the material in which the channel is cut, as soft material will not admit of the water running over it so rapidly as hard material. The nature of the water must also be considered. Some water brings mud, and other carries sand in its course. In some instances the settling of this sand in the channel is a great hindrance, but if the water runs at a speed of 9 in. per second when muddy and twice as fast when carrying sand, no disadvantage by settling will be felt.

If the bed of the stream or canal consists of ordinary soil, the water should run at not more than 3 in. per second; for a bed of sand, not more than 1 ft. per second; fine gravel, not more than 2 ft. per second; coarse gravel, not more than 3 ft. per second; stony ground, not more than 4 ft. per second; rock, not more than 5 ft. per second; larger rock, not more than 6 ft. per second; solid rock, not more than 10 ft. per second.

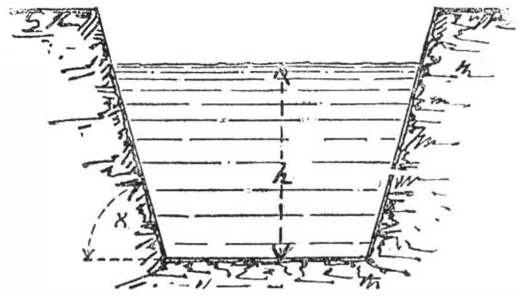


FIG. 1.—SECTION THROUGH CANAL.

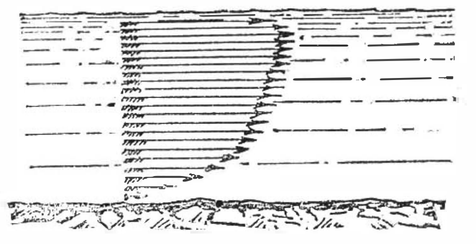


FIG. 2.—ILLUSTRATING BY ARROWS THE VELOCITY OF WATER AT VARIOUS DEPTHS.

WATER IN PIPES.

Should it be necessary to lead the water to the mill through pipes, as is generally the case for turbines, such pipes should not be longer than is absolutely necessary, owing to a loss of friction in the pipes; and as the friction also increases in the same proportion as the speed of the water in the pipes, the speed should not exceed 3 ft. per second, which has proved to be about the most advantageous rate. Of course the size of the pipes has to be chosen to secure such a speed. From end to end they should be equal in diameter. Any difference in the section, or a decrease of same, will cause friction and loss of efficiency, as every increase or decrease in the section alters the speed of the water, and consequently causes it to whirl at that particular part of the pipe which is not of uniform section. Sharp bends should be carefully avoided; but if some bends are necessary, they should be arranged on an easy curve, the radius of which should not be less than double the diameter of the pipe. It will be understood that sharp bends and other obstructions in the pipe have a similar effect to that caused by a decrease in fall.

WATER MOTORS.

Water motors are divided into two classes, vertical water wheels and turbines, which are mostly horizontal. The vertical water wheels are divided into three different classes, namely, undershot wheels, breast wheels, and overshot wheels. Their efficiency varies very much according to the circumstances under which they perform their work. The breast and overshot wheels are the most economical, as they give up to 75 per cent. of the theoretic power.

Ordinary Paddle Water Wheels are not much used in this country, but can be seen in large rivers on the Continent, where they float in the middle of the stream. Their diameter varies from twelve to twenty feet. The speed on the circumference is about half the speed of the stream. Their efficiency ranges from 25 per cent. to 30 per cent.

Undershot Wheels are mostly used for small falls, generally less than 3 ft. The diameters vary from 10 to 20 ft., the speed on circumference being about equal to half the speed of the stream, similar to the paddle water

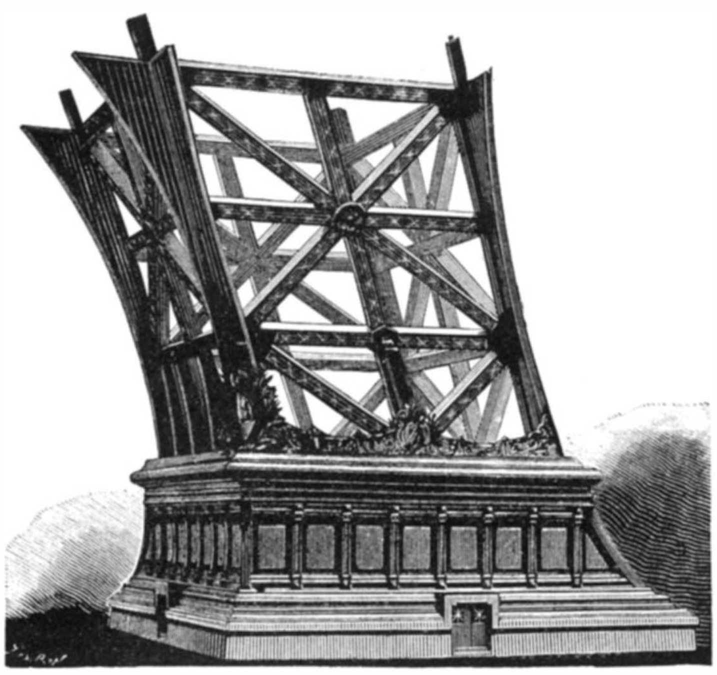


FIG. 2.—WORKING MODEL FOR THE DECORATION OF THE BASES OF THE UPRIGHTS.

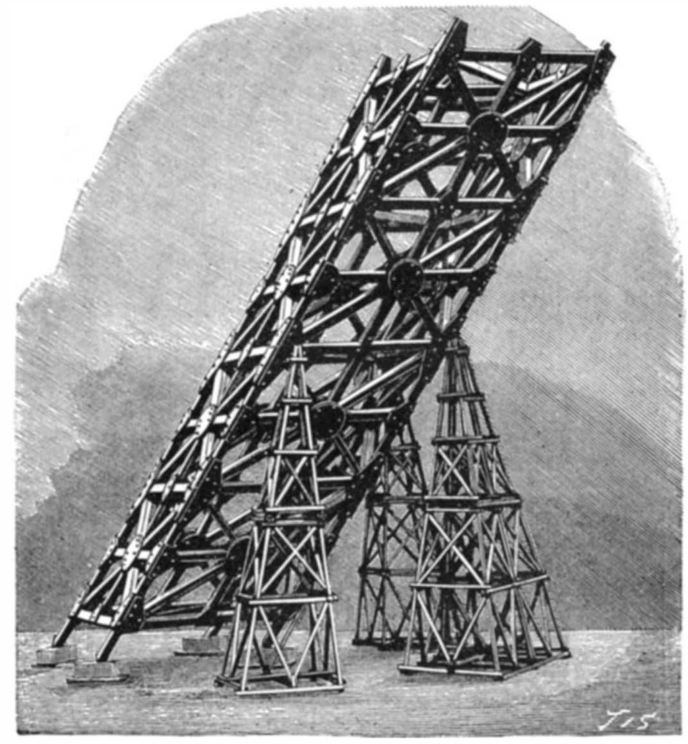


FIG. 3.—ROUGH MODEL OF THE SYSTEM OF MOUNTING THE TOWER.

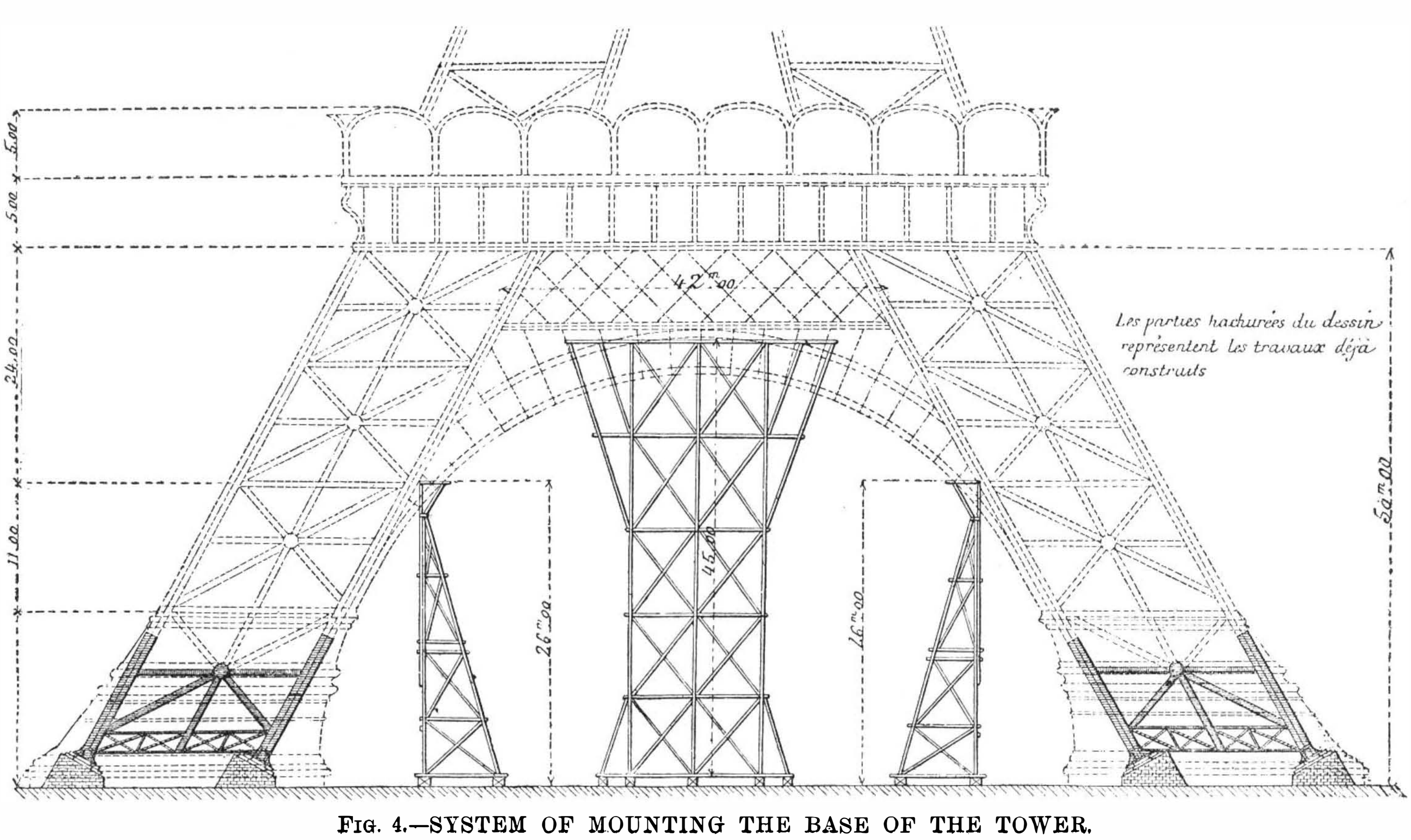


FIG. 4.—SYSTEM OF MOUNTING THE BASE OF THE TOWER.

wheel, and the efficiency is also the same, ranging from 25 to 30 per cent.

The "Poncelot" Wheel.—The diameter of this ranges from 10 to 20 ft., the speed on circumference varying from 10 to 12 ft. per second, efficiency being from 50 to 55 per cent. The fall is about 4 or 5 ft.

Breast Wheels.—There are two kinds of breast wheels, namely, the low and the high breast wheel. The diameters of these wheels vary from the fall of the water to double this measurement. The speed on circumference ranges from 5 to 6 ft., and the efficiency from 55 to 75 per cent. The water enters the low breast wheel slightly below its center, and in the case of the high breast wheel it enters above the center.

Overshot Wheels are generally used where high falls can be obtained, and but small water quantums. Their diameters are generally equal to the fall, or slightly higher, the speed on circumference being from 4 to 5 ft., and the efficiency from 65 to 70 per cent.

Below is given in Table No. 5 a series of water wheels with their usual diameters, and the head of water at which they work most satisfactorily.

TABLE NO. 5.

Giving Fall, Quantity of Water, and Efficiency of the Different Water Wheels.

Description of Water Wheel.	Suitable for Falls of Water in ft. and in.	Approximate Quantity of Water per second, galls.	Efficiency.
			Per cent.
Paddle Water Wheels......	3 in. to 1 ft.	50 to 200	25 to 30
Undershot "	6 in. to 3 ft.	20 to 1,000	25 to 30
Poncelot "	9 in. to 5 ft.	20 to 800	50 to 60
Low Breast "	2 ft. to 5 ft.	20 to 600	70 to 75
High Breast "	5 ft. to 10 ft.	20 to 600	70 to 75
Pitch Back "	10 ft. to 30 ft.	15 to 200	70 to 75
Overshot "	15 ft. to 40 ft.	10 to 100	65 to 70

From the above table will be found the approximate quantity of water required for driving the different water wheels. With paddle and undershot wheels, the quantity is of less importance, as in cases where such wheels are used there is generally more water available than is necessary to drive them. The pitch-back water wheel which I mention in the table is similar to an overshot wheel, but turns in the same direction as the breast wheel, that is, in the opposite direction to which the water is running. All paddle, undershot, and Poncelot wheels work in the same direction in which the stream is flowing, while the high and low breast and pitch-back wheel run in the opposite direction to the stream.

TO CALCULATE THE HORSE POWER GIVEN BY WATER WHEELS.

The driving power of the water is obtained by its weight, and not by its velocity, as is often erroneously imagined; in fact, with nearly all the water wheels the water should run in at a speed as low as possible.

The power developed by a certain weight of water falling a certain height is equal to the product of the water in pounds and the fall in feet. The theoretical power in a fall of the water is consequently equal to

$$\frac{62 \cdot 4 \text{ lb.} \times \text{cubic feet per second} \times \text{fall in feet}}{550}$$

62·4 being the weight of cubic feet of water, and 550 foot pounds per second being equal to one horse power. Some wheels, however, are driven by sea water, sewage, or small streams containing impurities from factories higher up the stream. In such cases the formula which I have given would be incorrect, as it is based on a cubic foot of water weighing 62·4 lb. Sea water, for instance, weighs 64·1 lb. per cubic foot, and sewage water will be found to weigh 63 lb. per cubic foot, which would, of course, give a larger result than that mentioned in formula.

As can be seen from above table, the theoretical power cannot by any means be said to be the power available from the mill wheel shaft, as, in the first place, there is a leakage of water to be deducted from the efficiency, and in addition to this much power is lost by the friction caused in overcoming the resistance of the water wheel, and in this fact will be found the reason for the low percentage of power given by some water wheels.

From the last column of the table it will be seen that there is a loss of from 25 per cent. to 75 per cent., according to the type of water wheel selected. To calculate the actual power which may be expected from a water wheel, the formula I have given will be found sufficient, but deduction must be made in accordance with the efficiency of the wheel. For instance, if the wheel is of the pitch-back type, and of good construction, it may be expected to produce 75 per cent. of the useful effect or efficiency, consequently, from the result obtained by the table, 25 per cent. has to be deducted.

By some makers of turbines an efficiency of 80 per cent. is guaranteed, only showing a loss of 20 per cent. from the theoretical power, which is very small indeed. Turbines, however, in addition to generally giving a larger efficiency, may be said to possess still another advantage over water wheels, owing to the fact that they run at a higher speed, which can be directly transmitted into the mill as first motion shaft, while the action of the water wheel is so slow that it generally necessitates several pairs of geared wheels in order to obtain the desired speed, thus causing a further outlay of power.—*The Miller.*

METHOD OF COALING SHIPS AT SEA.

By Lieut. REGINALD G. O. TUPPER, R.N.

THE man-of-war requiring coals is, if larger than the collier, to take the collier in tow. My diagram supposes this to be the case.

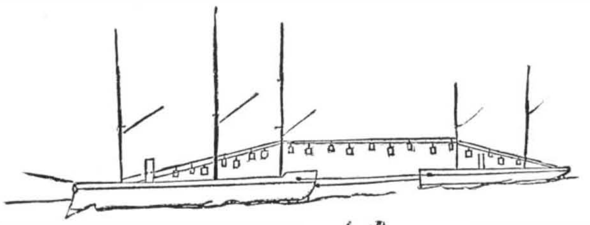
The vessel to be coaled lowers her crossjack or, if not strong enough, her mainyard to within about 30 feet of the netting, and secures it there squared and as rigid as possible.

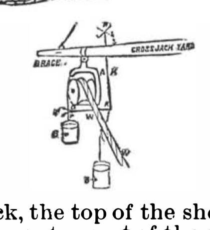
The collier performs the same evolution with a special yard on her foremast.

At each of the four yardarms, a strong iron snatch block is secured, and there is also a special fitting to enable the pendants carrying the bags or buckets of coal to pass over the sheave properly.

A steel wire hawser is then taken round the steam capstan of the man-of-war, the ends are rove through the yardarm blocks, and then through special iron rollers on the deck of the collier. The ends, which are fitted into eyes, are to be either lashed together or shackled. The collier supplies iron coal buckets or bags, to contain about 2 cwt. of coal, and fills them from her hold, and these are hooked to wire pendants spliced into the steel wire hawser at regular intervals.

The man-of-war then heaves round her capstan, and as the hawser is thus hove in, the coal is carried in the buckets or bags across the intervening space, full buckets passing in, say on the port side, and the empties returning to the colliers on the starboard side; a continual flow of coal is thus passed into the vessel requiring it as long as the weather will admit of the collier remaining in tow.





A, special iron snatch block, the top of the sheave flush with the shell, and the outer part of the shell, *a*, is curved outward.

BB, coal buckets or bags.

WW, the wire hawser.

PP, the wire pendants spliced to hawser and having a hook at other end.

KK, an iron spindle, having a handle at upper extremity, a shoulder at S, which supports the spindle, it being rove through the yard. The lower extremity is bent at right angles and carries a fork, F. The handle, H, is worked by a man sitting on the yard, who catches the pendant in the fork and then swings it round as the splice travels over the sheave of the block.

N. B.—The dotted line with handle shows the position of the spindle when catching the pendant.

At first it may seem that the blocks at the yardarms will stop the transit of the pendants carrying the buckets, but I propose to overcome this difficulty by the fitting shown in Diagram II., viz., a vertical spindle through the yardarm, having a handle within easy reach of a man or two men sitting across the yard, its underneath part being fitted into a horizontal arm, at the extremity of which is a wide-pronged fork.

As the pendant approaches the snatch block, the men stationed on the yardarm will turn the fork so as to catch it, and will then turn the handle and lock it, so as to bear the pendant out in line with the yard, releasing it again as the pendant falls over the block, and turning it then forward (or aft), so that the pendant will be released from the fork.

Another efficient method of overcoming this difficulty may be by having a wide spreading semicircular rail projecting a few inches beneath the snatch block, of sufficient size to prevent the pendant swinging inside it as the ship rolls. If this plan be practicable, being automatic, it possesses a decided advantage, and I see no reason why it should not answer in allowing the pendant to slide round it, but it certainly has the disadvantage of probably causing the bucket to swing violently on leaving it, and thus some coals might be lost.

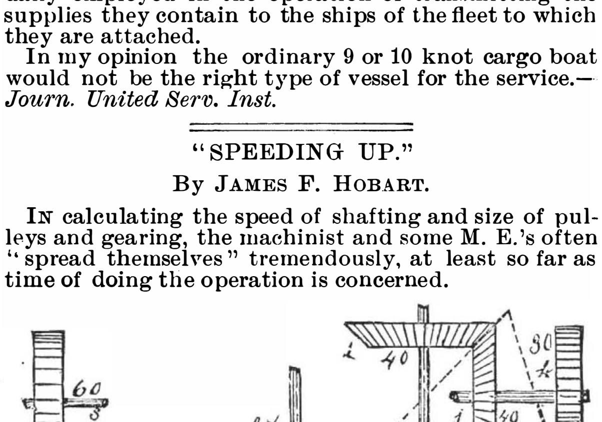
I will conclude by saying that I think vessels performing the duties of colliers, storeships, and transports to a fleet should be large and of the highest speed, and armed with quick-firing and machine guns, so that they might be utilized as scouts for the fleet, and in the capture of enemy's commercial fleets when not actually employed in the operation of transmitting the supplies they contain to the ships of the fleet to which they are attached.

In my opinion the ordinary 9 or 10 knot cargo boat would not be the right type of vessel for the service.—*Journ. United Serv. Inst.*

"SPEEDING UP."

By JAMES F. HOBART.

IN calculating the speed of shafting and size of pulleys and gearing, the machinist and some M. E.'s often "spread themselves" tremendously, at least so far as time of doing the operation is concerned.



If a pulley thirty inches in diameter makes sixty revolutions per minute, a man will say without hesitation that a belt from that pulley will drive a six inch pulley 300 times per minute, but if you ask him "how he knows," then that man will stop to think, and, perhaps, have to cipher it out before he can give a satisfactory reply.

If a bevel gear of forty-five teeth be driven by a gear of twenty teeth, on the shaft carrying the six inch pulley, then the ordinary mechanic will require a sheet of paper and several minutes' time before he gets the speed of the large gear at 133⅓ revolutions per minute.

Every time a change of speed occurs, the operation is made more complex. In the engraving, a train of belts and gearing is shown. *a* is the thirty inch pulley, running sixty revolutions per minute, *b* is the six inch pulley, *c* the twenty tooth bevel gear, and *d* the forty-five tooth gear, which, by following the speed from shaft to shaft, we find to run 133⅓ times per minute. A six inch pulley driven by a thirty inch will run 30÷6=5 times as fast, or 300. Now, a twenty tooth gear will reduce the speed of a larger gear 45÷20=2¼ times; 2¼=4×2=8-4+¼, or 9·4; therefore, gear *d* will run 4·9 as fast as gear *c*, and 300×4·9=133⅓.

Now, to use the graphical method, draw the dotted line between every driver and its driven pulley, keeping the drivers all on one side of the line, whether pulleys, gears, worm wheel and screw, or friction devices. Diameters of gears may be used, or the number of teeth in each, which will give the same result.

Put the speed of the driving shaft on the driven side of the dotted line also. Now multiply together all the figures on the driven side and also those on the driven side of the line, and divide one amount by the other. This result will be the speed of gear *d* as required.

If the problem is from machinery in a mill, we can dispense with the drawing and the dotted line and proceed as follows: Draw a line on a piece of board and set the size of driven pulley and its speed thereon; go to the next pulley, *b*, and place its size upon the other side of the line. Now count the teeth in the gears, and set the number thereof upon their respective sides of the line, which will appear thus:

	60
6	30
45	20

Now, instead of multiplying and dividing, let us cancel as much as possible and obtain an answer which equals 10×20×2÷3; or, 400÷3=133⅓, the speed of gear *d*.

If a whole train of belting and gearing is to be calculated, proceed exactly as before. In this example the statement would be:

	60
6	30
45	20
20	9
8	28
40	40
18	30
X	

The statement will resolve itself into 10×7×5=X; or X=350, the speed of pulley *l*.

If now the speed of *l* was to be so changed that X=500, and the change is to be made in pulley *e*, the solution of the problem is obtained in precisely the same manner, and the statement is:

6	60
45	30
20	20
8	
40	28
18	40
500	30

It is precisely the same, except that nine, the size of *e*, is omitted, and 500, the desired speed, is placed where X formerly stood. The solution is, after cancelation =45×2=90÷7=12 6-7, the size pulley *e* must be to drive *l* 500 revolutions per minute.

This method is so simple and easily applied that the mechanic has no excuse for long computations in calculating speed and the size of pulleys.—*Manufacturers' Gazette.*

FLEXIBLE CRANK AND PROPELLER SHAFTING FOR MARINE PROPULSION.*

By J. F. HALL.

THE object of this paper is to direct the attention of members of this institution to an improved method of constructing the crank and screw shafting of steam vessels, so as to enable them to escape the multitude of strains and contortions that such shafting has to undergo.

Both crank and propeller shafts, quite as often as through defective material, fail through being unduly bent or strained in an irregular line of bearings, which get out of line with each other when unequal wear takes place and when the hull of the vessel slightly alters its shape through the action of the sea, climate, temperature, or unequal distribution of cargo. These evils are often intensified by the natural flexibility and springy nature of the hulls themselves, which the tendency of the age is to build too light.

It is no uncommon event for some vessels to require a new shaft every one or two years, and in the majority of vessels seven years is considered a good life for the shaft. In very few vessels is the fear of breakage in the shaft minimized to the extent that the fear of a boiler explosion is.

It is obvious that when, for instance, in a two-throw shaft, as illustrated on Fig. 16, the bearings of the after crank have fallen (be it ever so slightly) below those of the crank on the forward side, and the tunnel bearings on the after side, the crank with the propeller shaft at that unsupported or partially unsupported point is liable or actually is bent by the efforts of the piston centered in that locality.

As a consequence, multiple, tensile, and compressive strains of great intensity will be localized in the crank pin and across the webs, in the after crank, where the bending efforts of the piston are centered, and where, owing to its peculiar symmetry of form, the shaft naturally seeks relief when being overcome in its struggles to retain its true shape.

On a single voyage across the Atlantic, a shaft, ever so little out of line, will be bent and unbent over one million times. Is it remarkable that it should give way, or, rather, is it not wonderful that any shaft should last as long as it does?

Of course, the degree of bending to which the shaft is subjected varies continually, as the ship strains, and as the bearings wear more or less. Let alone the risk of fracture engendered by these undue strains, they

* Read at the twenty-seventh session of the Institution of Naval Architects, April 16, 1886.—*Marine Engineer.*

cannot be ignored without curtailing the efficiency and durability of the propelling apparatus generally.

No small extra power has to be expended in rotating the shafts when bent, and in overcoming the extra friction set up in the bearings.

Some five or six years ago, my firm, Messrs. William Jessop & Sons, Limited, of Sheffield, took up the manufacture of Thomas Turton's patent built-up crank shaft, as illustrated on Fig. 21, and have, since that time, made a considerable number of them.

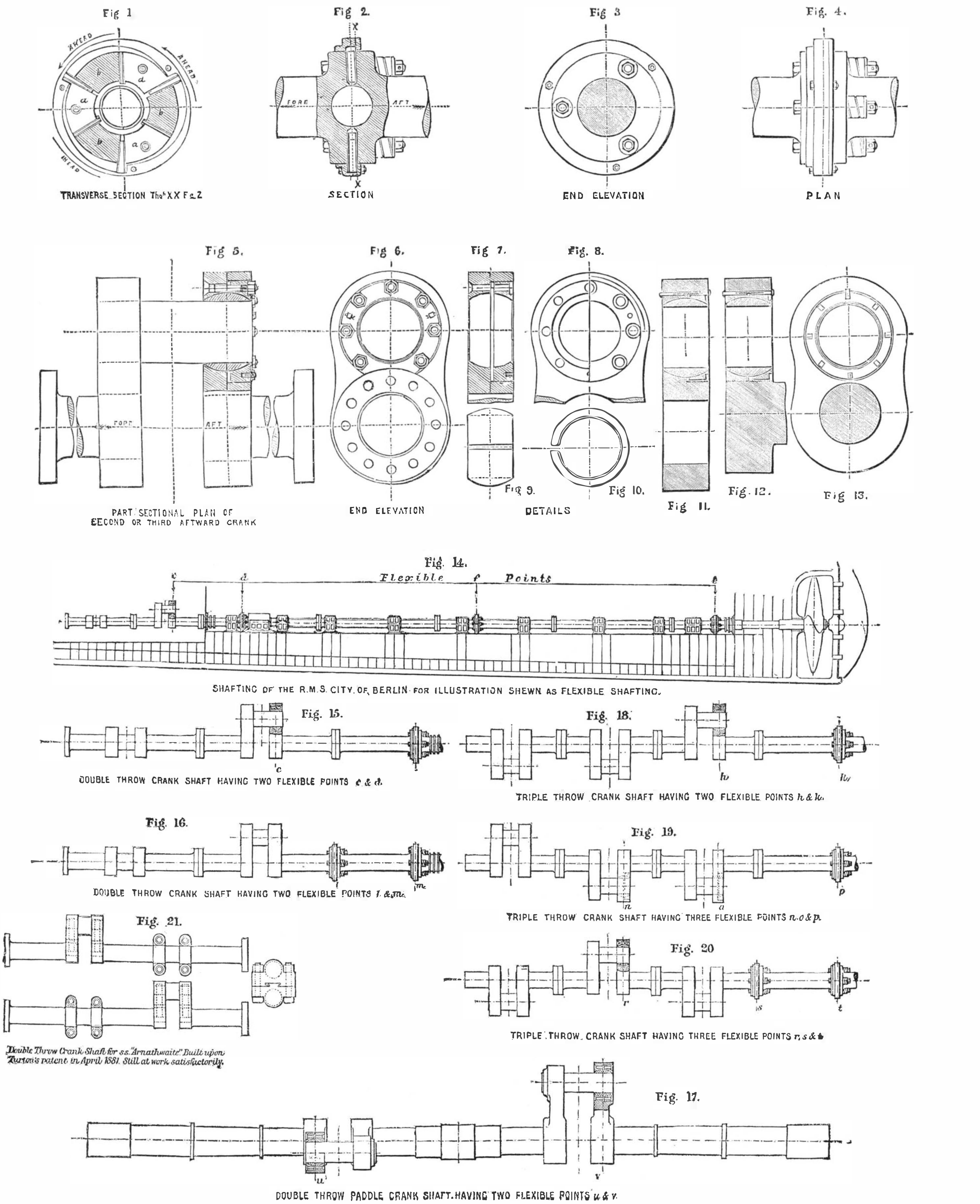
The chief feature of this crank, as originally claimed by the patentee, was the facility with which the crank pin part could be replaced, and he hoped to have been able to do it even at sea.

Although this desirable faculty has not been realized to the extent wished for, it has in its very failure developed a virtue in the shaft that was not in the first instance claimed for it, viz., to allow itself to slightly bend, unbend, and even slightly to twist in an irregular line of bearings without a tendency to break or do more than elongate or distort the bolts passing through the webs and holding the shaft together. It will readily be understood that this very action, although preventing the shaft itself from breaking, increases the difficulties of taking the bolts out and the shaft to pieces, but the loss of this advantage is more than recompensed for by the other.

It was this extraordinary development in the working of Turton's shaft that led me to investigate the causes thereof, and subsequently to take up the flexible ball coupling patented by Mr. Verity, although the same was at the time somewhat complicated and cumbersome. However, as two heads are better than one, we have, together, since then considerably simplified and reduced the coupling to what we think is a practical success.

It was during the study of this ball coupling or universal joint that it occurred to my mind that the proper place for at least a part of the flexibility was at the end of the crank pin in the after web. This idea was no sooner thought of than it was rapidly developed, and so admirably worked out by Mr. Verity that I have no hesitation in now submitting it, viz., the flexible crank shaft, together with the flexible ball coupling, and how we propose to apply the same for the consideration of the members of this Institution.

Before proceeding, I may mention that we have had one of the ball couplings purposely thrown a quarter



FLEXIBLE CRANK AND PROPELLER SHAFTING IN LIEU OF RIGID SHAFTING FOR MARINE PROPULSION.

of an inch out of line, at work for over two years, and that it continues to work perfectly satisfactory.

We have also since Christmas had a flexible crank shaft ten inches diameter working in a steamer that had previously given great trouble with her crank shafting, and the same is giving every satisfaction.

Fig. 1 shows transverse section; Fig. 2, section; Fig. 3, end elevation; and Fig. 4 plan of the flexible ball coupling, which may be either a part of each shaft to be coupled, or shrunk or keyed on to plain shafts. The end center of each half coupling is cupped out to receive a ball which is inserted between them. On this ball, which retains the axis of each shaft end, oscillate the two shaft ends when they are revolving with any angular movement. For the purpose of transmitting the rotary motion of one shaft to the other, a disk is formed on each shaft end. Upon the face of each disk are three projecting jaws, A and B, corresponding and engaging with each other. In order to keep the shaft ends in contact with the ball, suitable bolts are passed through both disks, fitting loosely in their bolt holes, and under each nut or bolt head is placed a spring washer. Not only by this arrangement are the parts kept in close contact, but the spring washers admit of the disks simultaneously opening and closing upon each other, and necessarily of the jaws moving deeper into and out of gear with each other alternately at every revolution, when the shafts are rotating with any angular movement. In order to reduce friction to a minimum, a parallel piece made of suitable material is placed between the driving ahead faces of the jaws, A, on the driving shaft and the driven ahead faces of the jaws, B, on the driven shaft. These pieces are lipped under the jaws at the bottom or inner end to prevent them flying out while in motion. For the purpose of taking up the backlash and compensating for any wear that might occur on the driving ahead faces of the jaws, adjustable pieces made in wedge form are fitted between the driving astern faces of the jaws, A, on the driving shaft and the driven astern faces of the jaws, B, on the driven shaft, or between the other faces of the respective jaws if preferred, when parallel face pieces are not used between them.

Each of the adjustable and also the parallel pieces are slightly rounded on both sides, so that they may roll between the jaws in place of sliding when the jaws are accommodating themselves to any angular movement of the shafts.

Each of the wedge pieces is secured and may be adjusted by means of an adjustable ring.

On the inner surface or circumference of this adjustable ring are formed internal cams corresponding with the number of wedge-shaped pieces. These internal cams are in close contact with the outer ends thereof, and by turning the ring round, the cams act upon such outer ends of the wedges, and adjust them between the jaws. After the adjustment has been made, the adjustable ring is retained in its position by inserting blocks of wood or other suitable material between the before mentioned wedge-shaped pieces and the heels or ends of the internal cams. Then after the blocks or packing have been inserted, they are covered by a metal plate, whereby they are held in position; and the whole presents a neat and compact flexible coupling, comparatively inexpensive, but certain in its action.

With this description of the flexible ball coupling, I will now proceed to that of the flexible crank shaft, or more properly speaking the accommodating web at the end of the crank pin.

Fig. 5 shows sectional plan, Fig. 6 end elevation, and Figs. 7, 8, 9, and 10 details. In this crank the pin is fitted or carried rigidly with its forward web. The pin eye of the aftward web is bored out to receive a circular bush, such bush being made convex on its periphery, and through which the outer end part of the crank pin is passed. The eye into which the bush is received is bored out to a suitable depth and of sufficient diameter to admit of an adjustable ring plate, which is made concave on its inner face to fit upon the outer side of the periphery of the convex bush. A corresponding concave place is formed in the other portion of the eye, which in conjunction with the before mentioned ring plate forms a seating to receive the convex bush and allows it to adjust itself as required. This bush is split to allow of its being compressed upon the crank pin by the adjustment of the movable ring plate, should the parts become worn or slack. The adjustment is accomplished by suitable bolts, the screw nuts of which bolts are subsequently secured by a lock plate.

If preferable, the adjustable ring plate may be screwed into the eye of the web, as shown in Fig. 11.

A square or round headed key placed through the web and secured by a split pin, fitting partly in a groove cut across the screw thread on the periphery of the adjustable ring plate, and partly in the threaded portion of the eye of the web, prevents the ring plate from unscrewing.

To readjust the ring plate, should any wear take place, the key is withdrawn and the ring plate screwed further in as required, and round to a point where one of the grooves on the ring plate (there being several cut across its periphery) comes opposite the key way in the eye of the web, when the key may be replaced and subsequently secured by the split pin.

This arrangement would not only dispense with the retaining bolts, but would encroach less upon the metal between the two eyes of the web, as the ring plate could then be made less in diameter.

It need hardly be stated that in cases where the sufficiency of metal between the eyes of the web is a consideration, this latter arrangement would have the preference, inasmuch as it leaves the web stronger; and if shortness of stroke is an object, this may be further done by making the web solid with the shaft. See Figs. 12 and 13. In this latter case it might be advisable on the score of economy of workmanship, instead of forming part of the spherical seating of the bush in the solid web, to permanently fit in the eye of the web a concave ring plate, which may be secured by the same key that holds the adjustable ring plate.

The after crank in a two or three throw shaft constructed on this principle, by any one of the above methods, is flexible, inasmuch as it will permit of the propeller shaft in rigid continuity with the after journal length of the crank shaft revolving at an angle to the crank section itself.

This flexibility, it will be easily understood from the foregoing description, is attained by allowing the after crank pin with the convex bush freedom to oscillate in the after accommodating web, as well as being capable of a to and fro movement in the bush, so as to adapt itself to any bending and unbending or opening and closing action of the crank, which takes place alternately in every revolution, if the respective journal lengths are revolving at an angle to each other. This would be the case when the propeller shaft was thrown out of line with the crank section through the straining of the hull of the vessel, or again when the forward or after end of the crank shaft fell out of line, or when it fell bodily out of line through unequal wear having taken place in the line of bearings.

This crank will also admit of any lateral movement of the propeller shaft when wear has occurred in the thrust block, or when it has not been properly adjusted, as the crank pin is capable of moving to and fro in the convex bush.

In a double or triple throw crank shaft a flexible after crank would freely allow of the crank and propeller shaft revolving at an angle to each other when either the forward end of the former shaft had fallen out of line through unequal wear in its bearings, or when the latter shaft had been carried out of line aftward by the straining of the hull of the vessel. When, however, the after end of the crank shaft or the shaft bodily falls out of line, circumstances arise which this flexible crank by itself cannot entirely obviate.

For in bending down the end of the propeller shaft to bring its axis in continuity with the axis of the crank shaft, one of two evils will be experienced.

Either the crank pin will be submitted to a bending strain in having to bend down the end of the propeller shaft, or the end of the propeller shaft will have to be held down by the after bearing cap of the crank shaft. This bending strain, if taken wholly on the crank pin, would not, of course, be anything like as distressing as it would in an ordinary built-up or solid crank, but would still exist in a degree greater than is desirable, and the intensity of it would depend on what resistance the propeller shaft offered against being bent. This resistance of the propeller shaft would be the less, the farther aft was the first point where the shaft was supported in line and where the shaft would be bent from. As such shaft would not only be bent through a smaller angle, but would be more easily bent as the forces tending to bend it would have a greater leverage, consequently a less bending strain would be put on the crank pin, and the propeller shaft itself would suffer less, inasmuch as it would not be bent so severely. (It may here be remarked that when speaking of a shaft being bent, I do not always mean that it literally is bent, but that it has a tendency to bend.)

From the foregoing remarks, it is obvious that to save the propeller shaft from all undue strains, when the crank shaft falls in its bearings below the propeller shaft, and to obtain in all other respects save torsionally perfect independence and freedom of the crank shaft in its relation with the propeller shaft, it would be necessary to use a flexible ball coupling between the first and second lengths of the propeller shaft as shown at C and D, Figs. 14 and 15, and at H and K, Fig. 18.

It has been suggested that two flexible ball couplings, one replacing the flexible after crank, and used between the crank and propeller shaft, while the other, as before proposed, between the first and second lengths of the propeller shaft, would give all the necessary flexibility. See L and M, Fig. 16, and S and T, Fig. 20.

No doubt it would, but the fact that this arrangement would not allow of lateral movement (to the same extent) of the propeller shaft through wear in the thrust block, etc., places it at a disadvantage with the former arrangement, which admits of such movement in the flexible after crank.

With regard to triple-throw crank shafts, they may be rendered flexible not only in their relation with the propeller shaft, but in their own length, by the use of two flexible after cranks and a flexible coupling between the first and second lengths of the propeller shaft, as shown at N, O, and P, Fig. 19, or another arrangement would accomplish the same end, though with not the same efficiency, viz., by the use of a flexible middle crank and two couplings, R, S, and T, Fig. 20.

It need hardly be said that flexible cranks can be used with advantage in a paddle shaft as shown at U and V, Fig. 17, which is an adaptation of the paddle shafting of the royal mail steamer Ireland.

Fig. 14 shows for the sake of illustration the crank and propeller shafting of the royal mail steamer City of Berlin, made completely flexible by the aid of an accommodating after web, C, and three flexible couplings. One, D, between the first and second lengths of the propeller shaft; another, E, between the latter and the tail end shaft; and the third, F, half way between the two, to save the propeller shaft from bending by its own weight, if one or more of its bearings failed to thoroughly support it. The coupling, E, would permit of the outer end of the tail shaft falling freely when excessive wear had taken place in the stern bush.

Such an arrangement of those couplings, D, E, and F, in combination with the after flexible crank, C, would give complete and perfect flexibility to the whole of the shafting, in such a manner that it could adapt itself freely and mechanically to any irregularities that might occur in its line of bearings.

The fact that such has the ability to revolve freely in its bearings under any circumstances should, in itself, be a recommendation for its general adoption. For not only is a minimum of power required to rotate the shafting in its bearings, but vibration, friction, deterioration in the brasses, and, above all, the danger of a shaft breaking is reduced to a minimum.

In conclusion, it goes without saying that a crank and propeller shaft must be one of two things, either completely rigid or completely flexible.

So long as half-hearted shafts are used, which are neither one thing nor the other, so long will they continue to wriggle against the inevitable in the vain attempt to retain their true form at the expense of their vitality, decay, and final collapse. All that was feasible and practicable without regard to cost has been done to make the rigid shaft a success in some of the finest vessels recently floated.

But the fact that they have constantly to be lined up in their bearings is evidence that the shafts run the risk of giving way, or have actually been bent at some point or other. Hence it is certain that rigid shafts will still continue to fail so long as bearings wear unequally and hulls strain. Also, as bearings that will not wear and hulls that will not strain are unobtainable, the only way of consigning broken shafts to things of the past is to elude the evils by using flexible shafting.

FIFTY OF THE BEST POINTS IN THE MANUFACTURE OF FLOUR BY THE MILLSTONE SYSTEM.

By "EXCELSIOR No. 1."

1. Good stones and good wheat.
2. It is essential for good work that they be of uniform quality throughout; neither porous nor close, but free cutting.
3. For ordinary flat, or finishing grinding, there is nothing much better than the common ten four dress.
4. For the production of middlings, or high grinding, a greater number of furrows of less width are better.
5. Face.—The face of a millstone is by far the most important "point" in a stone mill. Without a true face it is utterly impossible to do good work.
6. To obtain a good face, a thoroughly correct and reliable staff is necessary. There is nothing equal to the circular staff for correctness.
7. Where the ordinary staff is used, great care should be exercised, as it may prove misleading. Keep it true.
8. Never, in staffing a stone, let the staff cross the eye. It should cover only about a fourth of the stone, or just up to the eye burrs.
9. The grinding face of a stone should never exceed nine inches, and this should be perfectly flat and smooth (not glazed).
10. Let the bed stone be really flat; but the runner should taper from the grinding face to the eye, for which use a short prepared staff.
11. Do not overdress your stones, but get them true and smooth by all means. Many a stone is spoiled by too much cracking. Be discreet.
12. Be particular about your furrows. Avoid sharp, rough fore edges. Inattention to this causes irremediable mischief.
13. It is most essential that stones be kept sharp and in good face; for this reason they should be dressed at frequent intervals.
14. Running stones too long without dressing is a fruitful cause of bad face and unsatisfactory work.
15. Stones will preserve their work much longer where the driving irons are rigid.
16. Balance.—A correct running balance preserves the faces of stones, as an incorrect one certainly destroys them.
17. They should be balanced first standing, then running; for this purpose there is nothing like the well-known patent balance boxes.
18. Have the diameter of all driving wheels and pulleys as large as possible, and belts to correspond. This saves power and prevents excessive strain on shafts and bearings.
19. Next to a true stone face, the most important "point" is wheat—that is, wheat which will suit the stones and yield a strong white flour.
20. In blending wheats for a standard mixture bear in mind the following qualities—strength, color, and flavor.
21. A washer and whizzer for dirty wheat of the Indian type, and a damping worm for dry, brittle wheat, are great acquisitions and profitable investments.
22. The conditions and adaptability of wheat for stones is an important matter. Allowing the mixture to lie in a bin for a time will greatly improve it.
23. For suitability there is nothing equal to winter wheat or our own native wheat when in good condition. The milder Russian wheat will supply strength.
24. Aim at a good standard of flour, and, when satisfactory, maintain it. This can be done only by great attention to wheat.
25. Clean your wheat thoroughly of all extraneous matter by a proper arrangement of machines. Too much attention cannot be paid to this "point."
26. Let there be no waste in any part of the mill. "Do for your master as you would for yourself."
27. It is well to have some simple machine for the treatment of screenings, for the removal of any good wheat which may have got in accidentally. It pays.
28. A separate pair of stones for grinding screenings, etc., and a simple machine for dressing will pay. Their (the screenings') value is enhanced in the offals.
29. Grinding.—A well-dressed, true-faced, and correctly balanced stone will grind cool and free.
30. Cool meal dresses freely; hence true stones require less silk surface than untrue ones.
31. A regular, even flow of meal indicates a true stone, and an uneven, intermittent flow an untrue one. The latter is generally hot.
32. A correctly dressed stone will produce broad bran—the miller's desideratum. Broad bran and white flour go in unison.
33. However, if white, fine flour is desired, it must be finely dressed; and, if fine, a large silk surface is necessary.
34. Remember that length of silk means "length" of flour; and the finer the silk, the greater the surface required.
35. Observe, good, properly milled flour has a uniform appearance. Hard and soft flour mixed indicates bad milling and uneven stones.
36. Observe, also, that the finer flour is ground, the whiter it becomes; and if killed by too much pressure, becomes blue white and worthless.
37. Have no returns of any kind in your mill. Always work forward.
38. If you cannot finish in one operation, grind the unfinished stuff separately, and mix the flour; or, buy more machinery to treat it continuously.
39. Let everything be as automatic as possible. Hand labor produces irregular work.
40. Handle your products only twice, as wheat and flour (and offals).
41. No good stone mill is complete without one or more purifiers.
42. For purification, grade your middlings and arrange the clothing of your purifiers so that the tail

sheet is one number coarser than its respective grader number.

43. Dust your middlings well, and properly ventilate your purifier fans. The outlet of stive chamber should be twice as large as inlet from fans. This will prevent waste.

44. If you have sufficient stones or rolls, grind each size of middlings separately, and, for convenience, dress together.

45. A second or greater number of purifications is advisable; and grinding the middlings with rolls is an advantage.

46. If your rolls are belt-driven, see that the differential speed is maintained. Too much pressure will result in more power being required and less work done.

47. Make a practice of examining and testing all the products in the mill at least twice a day. The oftener the better, as trouble, regret, and loss will thereby be avoided.

48. Have no unfinished products about the mill. These have a tendency to increase unaccountably, and are great nuisances. "A place for everything, and everything in its place."

49. Redressing all the flour will greatly improve its color. Wipers, or sweepers, hung on reels, will keep them clean; they can be lifted off or placed on at will.

50. Bear in mind always that a good article sells itself. Endeavor to give your customers a little more than money's worth, and you will find it worth the money.—*The Miller.*

[Continued from Supplement, No. 614, page 9807.]

TEXTILE MACHINERY AT THE MANCHESTER ROYAL JUBILEE EXHIBITION.

After being formed into a lap the cotton is treated in the carding machine or "engine" as it is more generally called. This process is intended to clean the material from the husks or motes that remain, and at the same time to straighten the fibers so as to fit them for the subsequent spinning. In carrying out this treatment the short fibers are removed, only those remaining which it is essential to retain; the resultant "sliver" is thus rendered much stronger than it would otherwise have been. During the last few years there has been a complete change in the type of machine used, a change which is fully illustrated by the various exhibits. There are in the exhibition specimens of the three principal classes of machines employed by spinners during the past half century. This does not, however, mean that all the modifications are shown, but only that the chief forms are represented. The roller and clearer card, which for many years was almost the only machine used, is found in one exhibit—that of Mr. Samuel Walker. For the information of those of our readers who are not practically acquainted with the details of this class of machinery, it will perhaps be advisable to give some explanation of the method of

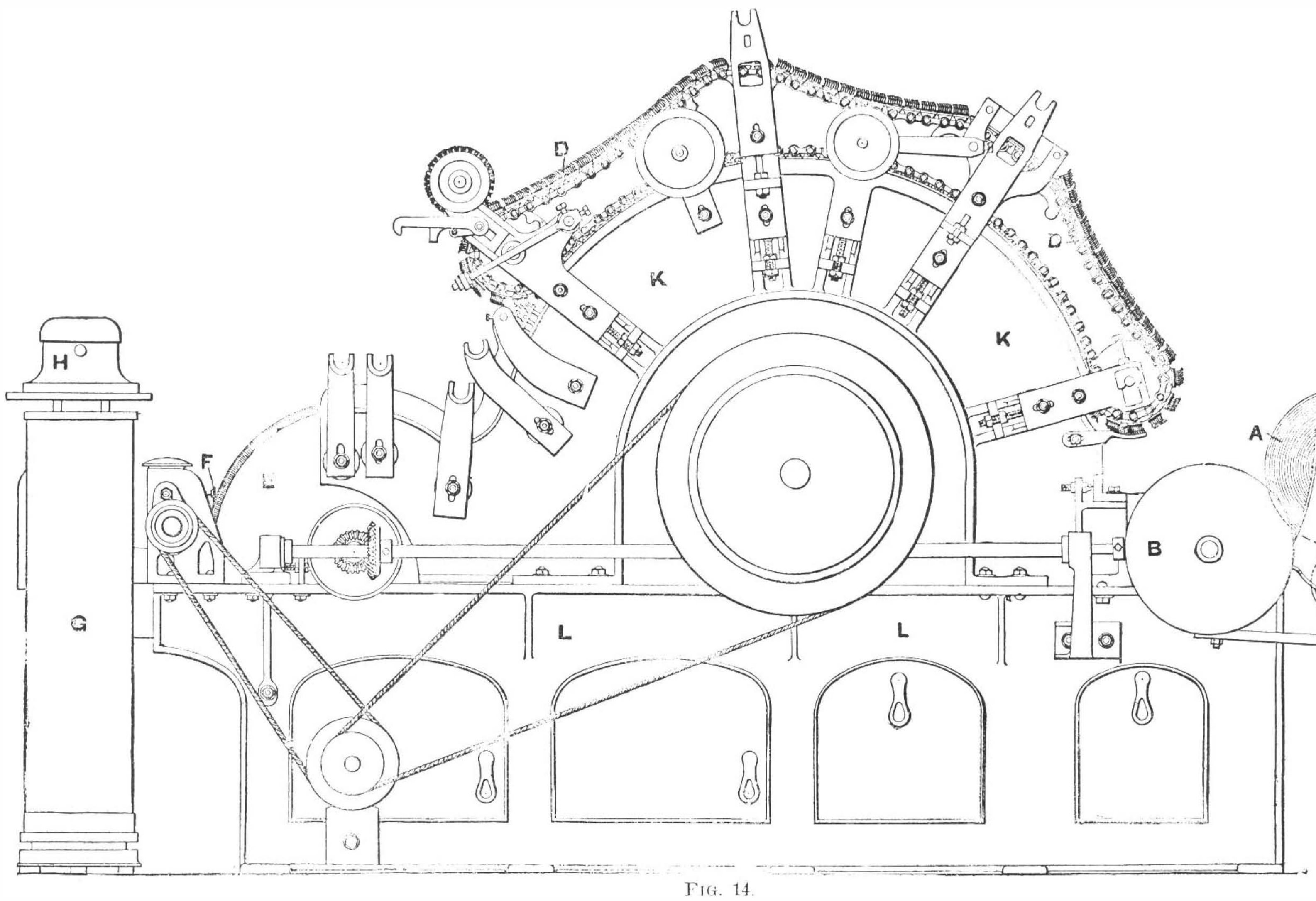


Fig. 14.

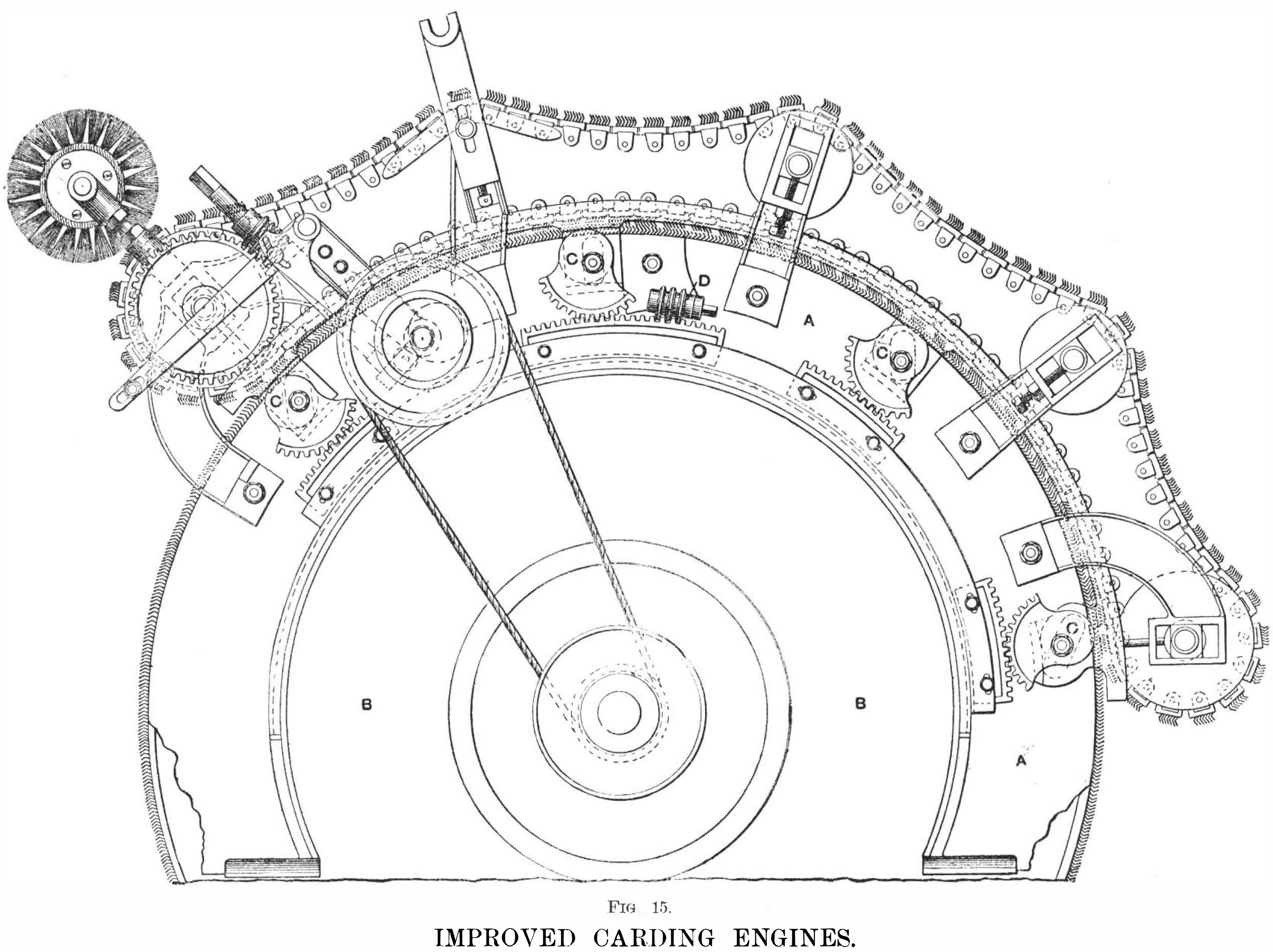


Fig. 15.

IMPROVED CARDING ENGINES.

construction. The actual carding is done by a modern substitute for the ancient card, which consisted of a number of spikes mounted on a flat board, these being drawn through the material by hand. The card clothing material used at present is constructed of a number of bent wires or staples, made of hardened and tempered steel wire, which are fixed in a suitable medium (usually felt or leather) in such a manner that the points of the wires project beyond the surface of the bed at the requisite distance apart. It will be clear that if the cotton is pushed up to the surface of this wire cloth and the latter caused to move, the fibers will be straightened out and thoroughly combed.

The general arrangement of revolving flat engines is illustrated in Fig. 14. The machine consists of a cylinder which revolves with its shaft in bearings carried by the frame. The lower part of the framing, L, is formed as shown with a flat upper surface, on which rests a semicircular frame, K, known as the "bend." The outer edge of the bend is usually formed so as to be concentric with the center of the cylinder, for reasons which will be apparent hereafter. The cylinder is covered over its whole surface with the wire clothing, as are also the two rollers, B and E, termed respectively the "take" or "licker-in" and the "doffer." The function of the former is to take the cotton from the end of the lap, A, which is placed as shown, and convey the fiber so extracted to the cylinder. The surfaces of the licker-in and cylinder are brought sufficiently near to allow of the cotton being easily taken from the former. The cotton is then carried round by the cylinder, being treated on its passage by means which will be hereafter described, and is removed by the doffer, the surface of which approaches that of the cylinder enough to permit of this taking place. The fleece so obtained is stripped from the doffer by a comb, F, having a rapidly reciprocating movement, and is taken through calender rollers. After passing the latter, the sheet of fiber is gathered together into the form of an untwisted rope, and is passed through the coiler, H, which consists of a disk carrying a short tube, through which the fiber passes. The collected sheet of fiber, called the "sliver," is by this means coiled in circular layers in a can, G. As the calender rollers do not deliver quite so quickly as the coiler rollers, a slight draw is put on the sliver, and by the revolution of the coiler disk a small amount of twist is set up as the delivery into the can takes place. All forms of carding engines have the whole of the parts so described, the differences consisting in the means adopted to remove the "motes," "neps," and short fibers. In the roller and clearer type of card, a number of rollers are placed surrounding and concentric with the cylinder. These rollers are clothed with similar filleting, and are fixed at such a distance that their wire-covered surface is able to take the cotton from the cylinder and treat it effectually. They are set up in pairs, and their surface movement is slower than that of the cylinder. The first of each pair (called the "worker") strips the cotton from the cylinder, being in turn stripped by its companion or clearer roll. The latter again gives the fiber to the cylinder, and this treatment is continued through the whole of the course of the material until it reaches the last of the series, the fleece being finally removed from the cylinder by the doffer. The teeth of the workers are set in the reverse direction to those of the cylinder, while those of the clearers are set in the same way. The fibers are thoroughly combed out and laid parallel to each other, the dirt being removed by a dirt roller, placed immediately above the licker-in, and stripped by a special roller or comb. The fleece so formed is taken from the doffer in the manner previously described, and is formed into a sliver in the usual way. In the machine exhibited by Mr. Walker, there are six worker rollers and five clearers, in addition to two dirt rollers. It is a good sample of a past favorite, which, being now to a large extent superseded, hardly merits a longer description.

Messrs. Curtis, Sons & Co. exhibit the only machine on the self-stripping flat system. In this, instead of the cylinder being surrounded by a number of rollers, as in that just described, a number of flat bars, with their under side covered with card filleting, and going across the top of the cylinder, are used. The flats, as they are termed, are, as a rule, stationary, resting upon the bend and being set sufficiently near the main wire surface on the cylinder to remove any dirt, "nep," or short broken fiber. As the wires of the flats would of course in time become filled with refuse, it is necessary to clean them. This is effected by an arm centered on the shaft, its outer end being thus concentric with the cylinder. At the end is fitted an appliance which, when it is over a flat, picks the latter up and lifts it clear of the adjoining flats and the cylinder. As this operation is performed the flat comes against a stop on the arm, which causes it to be turned over, and in this position it is held until a traversing stripper passes over and effectually cleans it. After cleaning, the flat is returned to its place and the arm travels forward to deal with another. The machine shown by Messrs. Curtis is fitted with one worker, one clearer, and one dirt roller, in addition to twenty-eight flats. By an ingenious device the same pinion which operates the flat is employed to move the arm into position for stripping the next flat. Like the previously described machine, this is now falling into disuse, and is only interesting as an example of a class which at one time was well thought of and which has undoubtedly done good service.

The engine which is now being most extensively used is that known as the revolving flat card. The idea of this type is not a new one, machines on this principle having been devised and tried many years ago, but without success. Of all the various classes, this needs the greatest care and accuracy in making, and it is perhaps not too much to say that, but for the enormous advance made in the construction of machine tools, the efforts made would not have resulted in such a satisfactory and economical production. The mode of construction necessitates the greatest care being taken that the whole of the different parts shall be turned out with the utmost exactness. The "flats" which are used in this machine are usually about 1$\frac{3}{16}$ in. wide, and are of metal. Holes are drilled along each edge of the flat, into which wooden pegs are driven, the same course being taken with the cylinders in all machines. Strips of wire clothing or "fillets" are nailed on the flats, so that they are quite tight and firm. The machine side framing is constructed in some cases to form a course for the flats, its upper edge being accurately turned so as to be perfectly concentric with the cylinder. The most usual plan is to fasten to the side of the machine a flat segment of a ring of such strength that it can easily be bent to the required shape. This is called a flexible bend, and in connection with its employment a most interesting mechanical problem arises. A little reflection will establish the fact that, while it is quite easy to create a perfect flat course at any particular vertical position of the bend, the alteration of that position will completely destroy it. This can be readily demonstrated. The cylinders as a rule are 50 in. diam. and 37 in. to 40 in. wide. Assuming, therefore, that the flats are, when the wire is new, an inch above the surface of the cylinder, the circle around which they move will be 52 in. diameter.

The top of the bend having been turned to this circle and fastened to the engine side, the space between the wire surfaces on the cylinder and flat respectively will be uniform over the whole distance that the flats travel. But assuming that the wire surface has to be ground in consequence of the dulling of the points by wear, it will be at once perceived that it is necessary to lower the flats in order to bring the points of the wires sufficiently near to card efficiently. This is effected by lowering the bend, and of course the concentricity of the flat course is thereby destroyed. The circle described is of a shorter radius, and is consequently relatively altered. The difficulty which thus arises may not appear to be of great moment, but in practice it is found to be highly important. How to provide a means of setting the bend and maintain the requisite concentric position is the question which machinists have had to solve, and their replies are found in the machines exhibited, as many as five different contrivances being on view in the section. Before proceeding to describe these in detail, it is necessary to point out the manner in which the flats are operated. A reference to Figs. 14 and 15 will show that they are formed into an endless chain, part of which is always over the cylinder top with the wire face down, while the remainder is passing over the guide rollers. The number of flats usually employed is 104, of which about 43 are always working; but this number is by no means an essential one, either as to the idle or working flats. The latter are constantly moving over the cylinder surface at a slow rate, and after leaving it are turned and subjected to the action of the revolving brush. The brush is constructed with teeth, as illustrated, in addition to the bristles, being thus enabled to clean the wire of the flats more efficiently. The necessary motion of the flats is obtained by means of a band from the cylinder shaft, the intermediate motion consisting of two worms and worm wheels. The setting of the teeth in the clothing is clearly shown in Fig. 15.

The machine exhibited by Messrs. Platt Brothers & Co. is fitted with a flexible bend, which is adjustable by hand only, being sprung into position and screwed tightly against the frame. There are serious objections to this method, but it is fair to say that very many of these machines are working satisfactorily. The strain put upon the metal and the setting up of tension in the bend would theoretically militate against the success of this plan; but it is stated by practical carders that in actual working they meet with no inconvenience. In Fig. 15 the mode of construction used by Messrs. Curtis, Sons & Co. is illustrated. The bend is, of course, flexible, with radial brackets formed on it at the four points, C C C C. On the inside of these are ribs, in the space between which eccentrics are fitted. The latter work on pins provided with nuts at their outer ends, and have also toothed sectors attached, the latter being placed outside the brackets. The sectors gear into racks formed on the upper edge of a ring with a circumferential movement obtained from the worm, D. It will be seen that by operating the worm, the eccentrics are revolved, and since these fit in the recesses made in the brackets on the bend, the latter is drawn down or pushed up as desired. Any adjustment which is required can thus be obtained from one point, and after it is made the nuts shown at C are tightened up, and the bend thereby locked against the engine frame, B, being rigidly held. As the bend is drawn down at the four points named, it is claimed that an accurate adjustment is made, and that by reason of the construction adopted, the flat course is always kept firm. Fig. 16 represents the arrangement of the bend

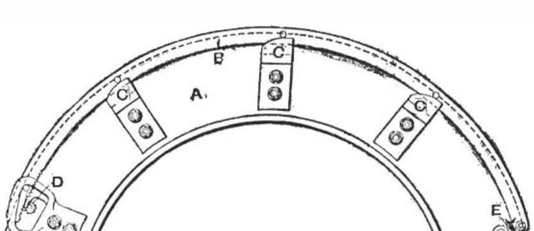
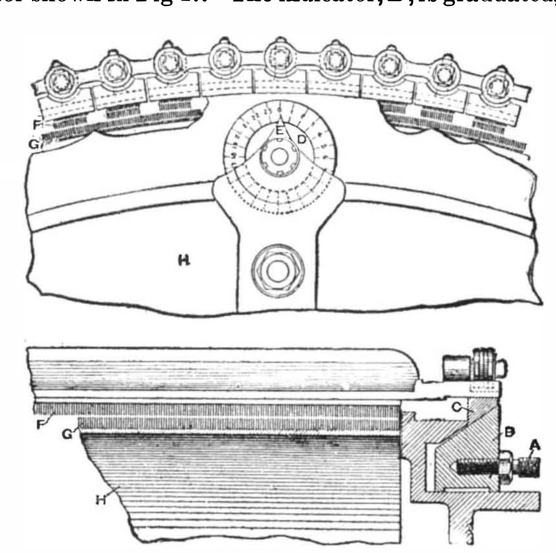


FIG. 16.

adopted by Messrs. Dobson & Barlow. On the engine side, A, are fixed three brackets, C, which are made with their top edges inclined as shown. Another bracket, D, is placed at the end of the bend, being formed with a space, the top of which is inclined at the same angle as are the brackets, C. Pins are fixed in the bend, B, carrying small runners which are kept pressed down on the inclined edges of C. At the point, D, is formed on the inner edge of the bend a toothed rack, into which gears a pinion. By revolving the pinion in either direction, it will be followed by the circumferential movement of the bend, which will at the points, C, rise or fall on the brackets, thus causing an alteration in the vertical position of the upper surface of the bend.

In order that the adjustment will be positive, and not merely caused by the weight of the flats and bend, the lever, E, is attached in the manner shown to the free end of the latter, its length being such that when the bend is moved it establishes in connection with the bracket at the other end a downward pressure on the bend. The latter is thus drawn closely to the brackets, C, and the flat course is altered exactly as desired.

Messrs. Howard & Bullough have an arrangement illustrated in front elevation in Fig. 17 and in section in Fig. 18. On the frame of the machine at each side is cast a projecting flat surface at right angles to the frame. This is turned concentric with the cylinder, and on it is placed the segment of a ring, B. As can be seen, the ring has a flat bottom and an inclined upper surface. Upon the latter rests a second segment of a thinner ring, C, the form of which is the reverse of the lower one, its inner edge being beveled to correspond with the outer surface of B, while its upper edge is flat. The flats rest upon and travel over the surface thus provided, and a ready means of adjustment is given. Fitting in the ring, B, is the screw, A, which passes through a bracket and terminates in the indicator shown in Fig 17. The indicator, D, is graduated,



FIGS. 17 AND 18.

and the finger, E, affords an easy method of making the adjustment accurately. This is also facilitated by the formation of the screw, A, with two threads similar to those on a micrometer. By revolving the screw to any desired amount the ring, B, is withdrawn or pushed in, to give the required setting to the flat course. The upper ring, C, is kept down on the lower one, B, by the weight of the superincumbent flats, its section being such as to permit this. It is stated that the arrangement so described permits of an extremely delicate adjustment being given to the flat, which can be set to the one-thousandth part of an inch if required.

Messrs. Lord Brothers use the mechanism illustrated in Figs. 19 and 20, in section and side elevation. This

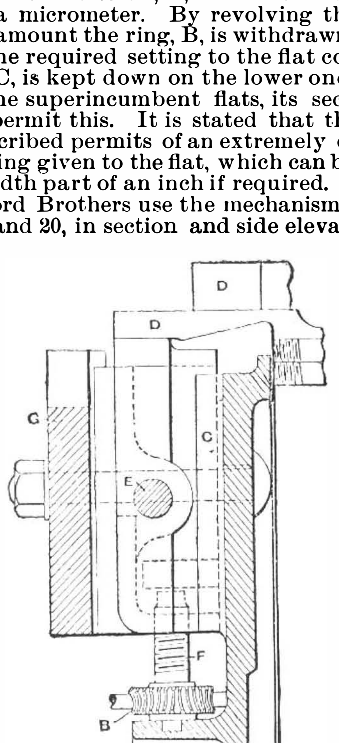


FIG. 19.

consists of the employment of a number of brackets, C, which have a radial movement in slides formed on the frame of the machine. These slides are made by ribs cast on the side, and afterward accurately planed, so as to be perfectly radial from the cylinder center. The upper edge of each bracket is turned so as to form a flat course, and each side of the bracket is angled with the front, so that the space between each pair overlaps. This point is important, as it enables a flat to fall on each bracket before leaving the previous one, and thus prevents any depression. There are nine brackets in all, three of which provide the setting points. Each of these is connected with the two adjoining brackets by a pin, E, which forms a kind of toggle joint. Over the brackets a plate, G, is placed as shown, fastened to the center bracket and held between bowls at each end, as will be seen by referring to Fig. 20. In each end also of G

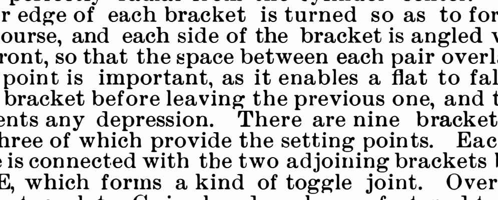


FIG. 20.

is a slot with a bolt passing through the center bracket and the plate as shown in Fig. 19. The screw, F, with the worm wheel, B, fixed on it is placed under the center bracket, and rests on the projection, A, formed on the bend. Into B gears a worm, by revolving which the whole of the brackets can be raised or lowered at will to the desired amount. The last of the series of devices to which allusion should be made is illustrated in Figs. 21 and 22. The frame of the machine is formed at its edge into a spiral shape, as shown diagrammatically in Fig. 21. Upon this frame, A, rests the flexible bend, B, which is made with its inner surface of the same curve as A, but with its outer edge concentric with the cylinder. It will be seen that by moving B along A, by means of the screws shown, the required vertical adjustment of B can be obtained. A glance at Fig. 22 will show that the bend is of such a construction that it will easily alter its form as desired, and that

resting as it does on the flat surface made on the machine side, it must of necessity be firm. This arrangement is exhibited by Mr. John Tatham.

As will have been gathered from our previous remarks, the construction of revolving flat cards is accompanied by the necessity for very much delicate and accurate work. The flats themselves are made in a most effective way, and as a mechanical process of some intricacy, the method pursued is worth a brief description. The initial point is the surface on which the wire filleting is fastened. This must be quite flat and free from twist.

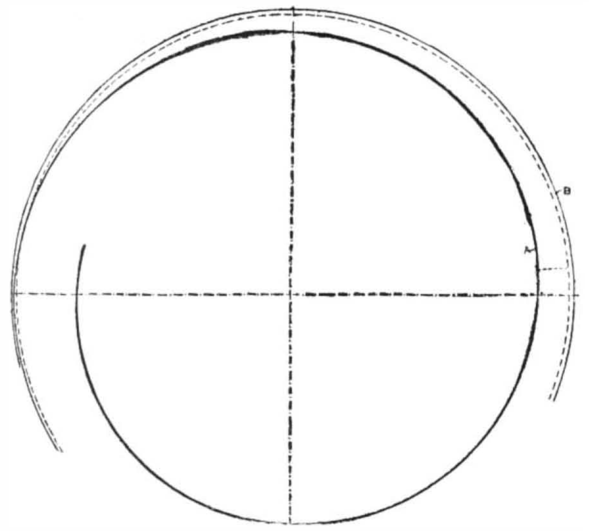


Fig. 21.

Having obtained this, the next step is to form the ends of the flat which rest on the bends so that each flat shall be quite parallel to the surface of the cylinder when working, this being a matter of supreme importance. When the flat is fastened or chucked from its face, the two ends are subjected to the action of milling cutters, which true up the end faces; and special machines are used for this purpose, by which the flat can be easily dealt with. Having obtained the flat in this condition, it becomes necessary to set it by hand, owing to the alteration of its shape arising from spring. In addition to this each flat must have a certain amount of what is called "heel;" in other words, one edge is thrown higher than the other, the wire surface being a little further away from the cylinder at the front side than it is at the back. The heel is given by hand, and each flat is tested, either by mechanical or electrical means, to insure its accuracy.

Not only is great care taken with each flat in preparing it for placing upon the machine, but equal care is observed in setting the bend. Messrs. Howard & Bullough test the concentricity of their bends by means of an electrical device fixed on the end of an arm placed upon the cylinder shaft. By revolving the arm over the course of the flats and setting the contact point accurately and delicately, it will be obvious that any part of the bend which is not concentric will come in contact with that point. In this way an indicating bell may be rung, and the necessary rectification made. If preferred, the apparatus can be attached to the cylinder. Other makers employ a series of compound levers by which any divergence in the height of the bend is multiplied and registered by a pointer on a graduated scale. Either method is productive of great accuracy, and efficient carding is facilitated.

The manufacture of the wire filleting with which the flats and cylinder are clothed is also shown in this section. The card clothing, as made at present, is the outcome of much thought and ingenuity. At the stand of Messrs. Walton & Sons, the development of this manufacture can be seen. The first stage in the older methods was to form a strip or fillet of leather 3 in. or 4 in. wide and pierce it by hand for the introduction of the wire staples, which had been previously prepared by hand. Following this came the piercing of the fillet by machine, and the production of the staples from a reel of wire by a second machine, the staples being pushed into the pierced fillet as they were produced. This formed a considerable advance, but the invention by Dyer of a machine to accomplish all the three operations of piercing the fillet, forming the staples, and fixing them, gave at once what was desired. The Dyer machines have of course been considerably improved, but all the essential parts remain the same. Briefly, it may be said that the machine is a vivid illustration of the power of the cam. It occupies a very small space, not more than 2 sq. ft., and the whole of the operations indicated are performed at a remarkable speed. The machine which is used to produce the fillets for use on the flats is wider than the ordinary cylinder clothing machine, as in this case it is necessary to produce a strip wide enough to cover the whole length of the flat. The difficulty here is that the wire points have to extend across the whole of the flat surface in parallel rows, and this it would be impracticable to obtain by fixing pieces of the narrow filleting. Accordingly, the wires are put into a broad sheet, and after the requisite number of rows to suit the width of the flat are inserted, the sheet is traversed forward over a space wide enough to permit of a margin of plain cloth being left to fasten the fillet upon the flat. Instead of putting each row of teeth immediately behind the preceding one, Messrs. Walton traverse the piercing head so that the former is a little to the left of the latter. In this way the gaps between the teeth are filled and a better carding surface obtained. Among the modern improvements in the construction of this article, the substitution of hardened and tempered steel wire for iron wire deserves to be noticed. Various sections are used, but oval and flat wire are most preferred. The hardening and tempering is conducted by special means, and a very efficient result is attained. The formation of a composite backing is also a special feature, although it is now no longer novel. The old backing or matrix was either leather or felt, both of which had certain disadvantages. Mr. Walton introduced, many years ago, a backing which consisted of cloth with a facing of a thin sheet of pure India-rubber, and this was at once recognized as an immense advance on the older types. The rubber facing enables the wires to recover their position rapidly when pressed forward during carding.

This branch of the subject requires careful attention from the student of textile mechanics. After the formation of the fillet, it is essential that it should be mounted on the cylinder and flats very tightly and evenly. To do this several appliances are utilized, one of which, shown by Messrs. Dronsfield Brothers, of Oldham, is noticeable. This we illustrate in Fig. 23, which represents the machine when employed in covering a doffer. The doffer or cylinder is mounted as shown and is revolved by the handle, R, and gearing, U, the chain pulley, O, actuating the slide shaft pulley, L, by means of a pitch chain. A differential speed can be given by the introduction of the necessary change wheels. The fillet is passed from the basket through the trough, D, the teeth being uppermost, and is guided upon a cone drum with three steps or divisions, A, B, C, the respective diameters of which are 6½ in., 7 in., and 7½ in. The fillet passes over these three surfaces in succession, and owing to the draw obtained by the increased diameter of C over A, and the frictional resistance of the smaller steps, a tension is put upon the card which causes it to be wound tightly upon the cylinder. To facilitate the application, a weighted lever, G, is employed to regulate the tension. The cone is mounted on a carriage moving along the slide, K. If necessary the carriage can be moved by hand, and in either case the fillet is wound on in a continuous spiral, and with unvarying accuracy and tension. To cover the flats with strips of clothing, the machine shown in Fig. 24 is used. Rests are provided for the flats, which are secured by thumbscrews. The strip of card is placed on the flat and nipped tightly, one rivet being put in at each end while it is so held. The nippers are then released, and the remaining rivets put in, after which the strip is held by the nippers shown mounted on the slide and operated by a ratchet. The fillet is thus drawn tight, and is riveted to the flat on the free side. In this way the strip of card is attached very effectively, and a rigid wire surface is provided. After the fillet is attached to the carding cylinder, doffer, or flats, it is necessary to grind up the points of the wire in order to provide a perfectly level surface, and to insure that the wire is quite sharp at the points. To do this various means are adopted, the most general being to apply an emery roller at some suitable point. This roller is driven from the loose pulley of the cylinder, and the cylinder itself is revolved in a reverse directon to that in which it usually travels, but at a much slower speed. The emery roller is built up with a light framing, and is arranged as shown in Fig. 25, with a lateral traverse. Sustained by two brackets fixed on the machine side, one end of the shaft has a space left between

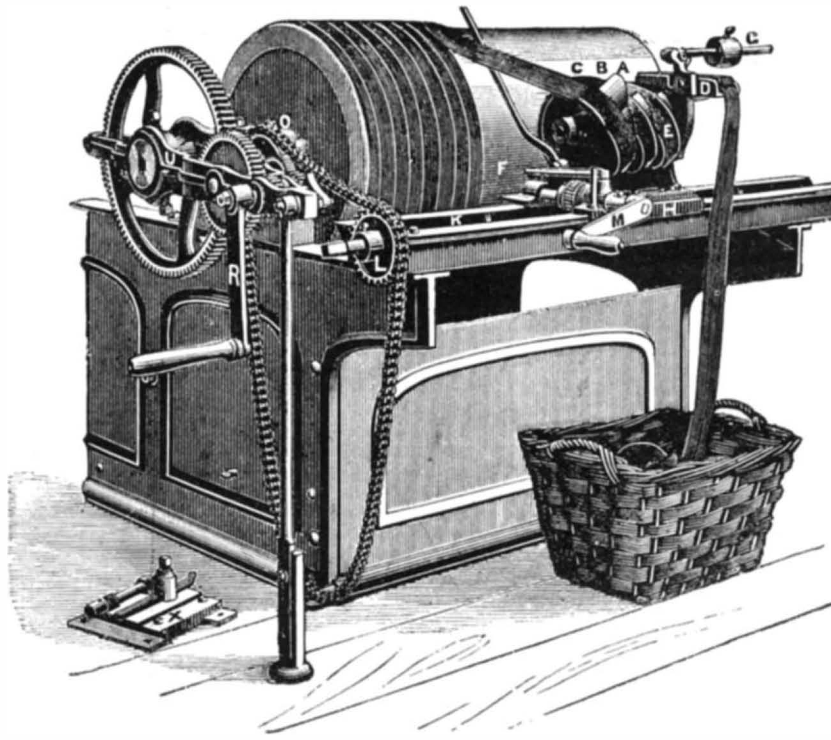


Fig. 23.—DOFFER COVERING MACHINE.

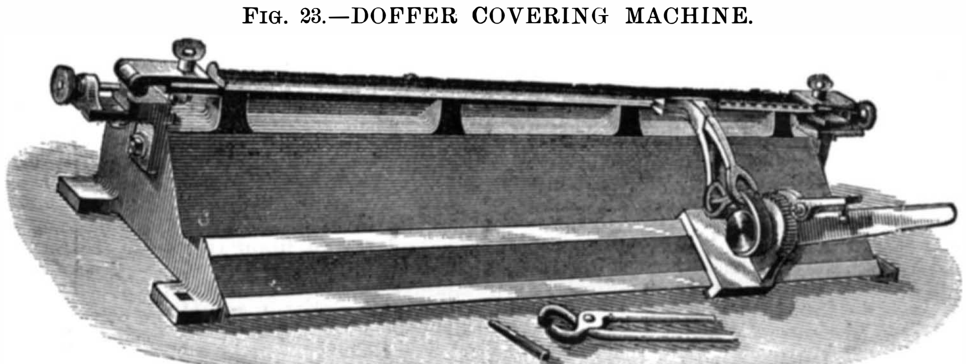


Fig. 24.—FLAT COVERING MACHINE.

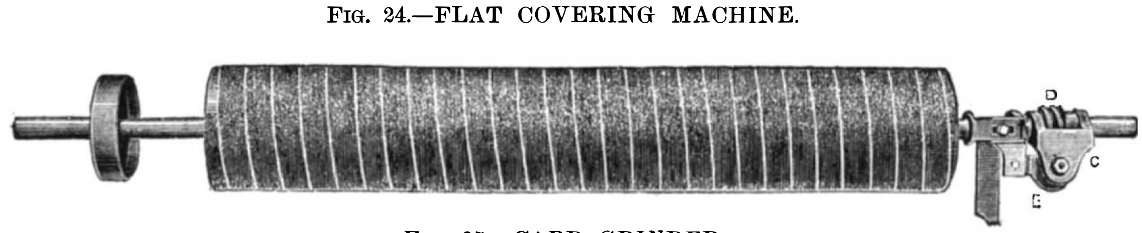


Fig. 25.—CARD GRINDER.

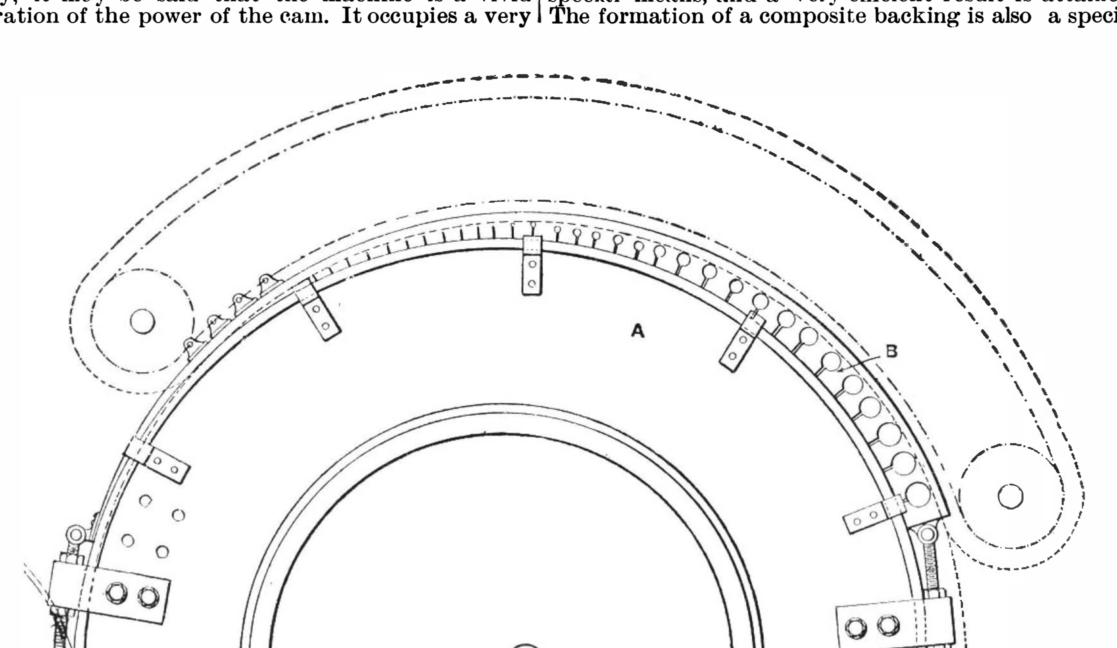


Fig. 22.—IMPROVED CARDING MACHINE.

the bearing and the end of the roller and the other end is fitted with the mechanism shown. The worm, D, gears into a wheel with an eccentric boss which operates the arm, E, which is fixed to the bearing as shown. The revolution of the shaft thus gives a lateral movement to the emery roller.

The machines for carding cotton, as illustrated by the preceding examples, are very effective in use. It is stated that by some of the machines produced, 1,100 lb. of ordinary quality American cotton can be carded per week, although it is probable that in actual practice this is not reached by 200 lb. or 300 lb. Still a card which produces an average of 800 lb. to 900 lb. per week is doing good work. The amount of waste made, including all incurred by stripping, is found to be from 4 to 5 per cent.—*Industries.*

TRANSMISSION OF POWER BY BELTING.

AT the recent National Electric Light Convention at Philadelphia, Mr. J. H. Shay read the following paper:

The transmission of power from its origin at the driving wheel to the receiving pulley or shaft originated, as nearly all mechanical appliances have had their birth, in a necessity, and in their first existence such creations have always been crude and imperfect. Thus we see in ancient pictures that strips of raw hide were used, more or less twisted, perhaps, but with huge and ungainly knots where the ends of the pieces are connected. From this an advance was made when cordage of imperfect construction became common, a lineal descendant of the twisted throng or a flat, untanned strip, or series of strips, of raw hide were connected by every conceivable form of knot or other awkward connection.

The time which elapsed before any reasonably fair belting made its appearance may be counted by scores of years, and during that long period, of all the various devices, the most satisfactory had proved to be a tanned leather belt.

Still the users of belts were not happy over the results obtained, and a radical innovation was made when an iron wire cable or rope made a stir for a comparatively short time. Yet except for special purposes it has found little favor. A few of the more serious objections to a wire rope are perhaps worth bare mention.

Constant use as a belt will, in a comparatively short time, crystallize and render the wire brittle, when it will of course refuse to bear the strain, and gradually give way.

The repairing of a broken wire cable belt is extremely difficult, and the mended portion is never of the same diameter as before; when it commences to fail, it is but a short time until its ruin is complete; and lastly, no round belt has bearing enough to do perfect work where solid hard labor is required of it, and the wire belting is no better than any other round belt on that account. Other methods of transmitting power by gearing, etc., had their day, but these have gone out of use, and there is nothing to be gained by discussing these noisy methods. For the past half century these have been gradually disappearing from view, until we have to search for an existing example outside the industrial centers of the world. The verdict of the mechanical engineer everywhere when called to sit in judgment on this question is the same: "There is nothing like leather."

Yet there are as many kinds and forms of leather as there are of nearly any other animal product; and while for some purposes we know other leathers are better suited, the fact is undeniable that for strength, durability, ease of repair, and adhesion oak-tanned leather captures the blue ribbon and stands superior to any others on all occasions. The first essential is found in the character of the hide. Due care must be exercised in the tannage, and a thorough and careful selection of hides must be made to insure evenness of stock. Without particular pains in this last requisite, uniformity in the belt is impossible. Or the stock must be reduced to a uniform thickness by splitting, which introduces another fault, weakness, and consequent want of durability.

Having now arrived at the point when the properly selected, tanned, and sorted stock is ready for cutting and splicing, we have to decide which of several methods is best for attaching the various lengths to form a continuous belt.

There are, as I have intimated, several methods of attaching these.

By thongs of lace leather.

By wire hooks.

By rivets and burrs.

And finally by scarfing and lapping—the two scarfed surfaces being cemented under pressure. This has been adopted quite generally by Western manufacturers, and any objection to such joints which may have formerly existed are now set at rest forever through the use of more recent methods and materials. There are objections to the three methods and materials. There are objections to the three methods first mentioned, which are at once simple and damaging, from a mechanical point of view. It goes without saying that a belt punched full of holes for either lacing, hooks, rivets, or any other appliances for fastening is weakest at those splices, instead of being strongest. And again, any inequality, such as must necessarily arise from any one of these fastenings, must result in undue strain on the belt, must give rise to a slapping motion, and thereby reduce the useful work of the power. We may find a still more serious objection further along.

When an important belt is properly constructed, properly proportioned and speeded, and receives the attention and care which it deserves, there is scarcely any limit to its durability. The cause of the failure of many large belts may too often be found in some one of the above particulars. Of course, there are other things to be considered. It is a mistake to figure too closely on the length or width of an important belt.

Do not risk a possibility of slipping, which means heat, and will ruin the best belt made, in an astonishingly short time. It was a few years since the rule among one class of belt customers to depend almost exclusively on rubber for the severe work required in saw mills. This has now fallen into disuse, and has been replaced by leather, this latter proving better adapted for this purpose.

Belting for electric light machinery, to be a success, must have characteristics not necessarily found in belting for other purposes. For ordinary machinery for sawing, turning, planing, etc., there is not the positive necessity for steady motion which must exist in an electric light belt to secure satisfactory results. It is my desire to point out a few of these peculiarities and at the same time particularize some methods of prevention. Perfectly uniform motion, other things being equal, means steady, even electrical force; and this, as I understand it, means uniform, steady light. One acknowledged advantage which pertains to the electric light, more especially the incandescent form, is its steadiness and freedom from flicker; and to obtain this a uniform belt must be used. This uniformity of belt must exist throughout its entire length, not only at the portion between laps, but in the laps themselves. The presence of anything which will increase the heft or thickness of the belt at the lap is no worse than at any other point, nor any less mischievous. No engineer would consider it an advantage to have the driving pulley out of true a quarter of an inch on one side, and yet this would have probably no worse effect upon the uniformity of the dynamo movement than additional thickness at the laps of the belt.

Another cause of irregular motion may be found in a slipping belt. A certain amount of suction (of the power known among engineers as vacuum pressure), which of course means atmospheric pressure, is a positive necessity to hold the belt in place, and so make its pull uniformly. The more closely the belt hugs the driving pulley, of course the more perfectly and quietly does it accomplish the end sought. Now, it takes but little thought to comprehend, in fact, it is apparent on sight, that a belt which is lifted from the pulley every 4 or 5 ft., allowing the air to enter the space between the belt and pulley, can only produce unsatisfactory results.

Experience has demonstrated that the most perfect remedy for all this irregular action, from any of the causes mentioned, is in such a union of the laps as is produced by a scarfed joint, simply relying upon the cement, discarding rivets, pegs, wire, or any other form of fastening. To accomplish these results, there is still one vital qualification necessary, which I have mentioned. Unless the belt has been properly stretched in the manufacture, the hard, rapid pull of the dynamo work will soon render it necessary to take out the slack. This should not be.

This proper form of belt is to be had, and the electric light fraternity of the West have quite generally indorsed its use.

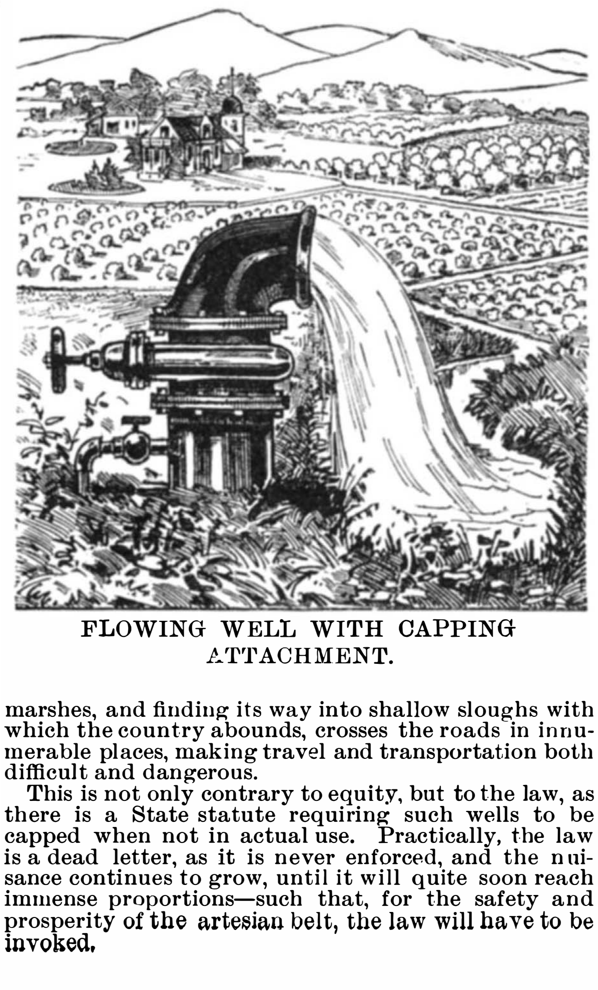
Of the care of belting in use, a few words may not be out of place. The saturating of belting by any kind of oil is destructive. Belting stock, properly prepared, needs occasionally simply a slight coating on the grain. The dressings ordinarily offered in the market for this purpose are destructive. They are mostly of the mineral oil variety, and contain more or less of those light products of distillation known as naphtha, benzine, etc., and combine readily with many vegetable and animal products, and tend to destroy their integrity. There are belt dressings produced which not only do not injure, but really add to the life and power of the belt.

Without making invidious comparisons, I may perhaps be permitted to say that especial study has been made by a Chicago establishment of the needs of the electric light fraternity, and we who are intimate with the processes of manufacture are convinced that success must everywhere result from the use of evenly matched, uniformly thick belting.

CAPPING FLOWING WELLS.

THERE are in California many hundred flowing artesian wells. From most of these the water, for the greater part of the year, runs utterly to waste. This is notably the case in the great artesian belt of Kern and Tulare counties. Some of these wells flow as high as two and a half million gallons a day, and it is safe to say that from them all there is an average waste of water per day of fully 100,000,000 gallons.

This water is not only unutilized, but is in its uncontrolled state a nuisance of great magnitude, as it covers large tracts of land, converting deserts into



FLOWING WELL WITH CAPPING ATTACHMENT.

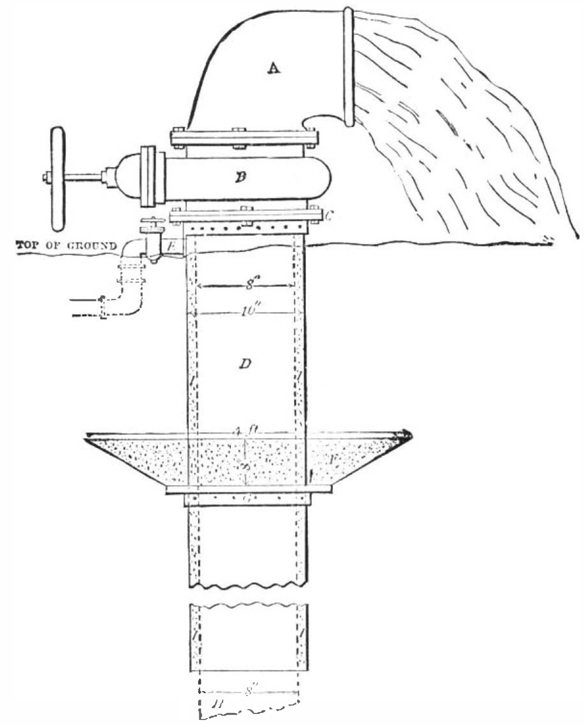
marshes, and finding its way into shallow sloughs with which the country abounds, crosses the roads in innumerable places, making travel and transportation both difficult and dangerous.

This is not only contrary to equity, but to the law, as there is a State statute requiring such wells to be capped when not in actual use. Practically, the law is a dead letter, as it is never enforced, and the nuisance continues to grow, until it will quite soon reach immense proportions—such that, for the safety and prosperity of the artesian belt, the law will have to be invoked.

The object of this communication is to direct the attention of such of your readers as may be interested to the prime importance of capping all flowing artesian wells. With this I send you an illustration of the manner in which this has been done on the great well recently sunk for the Miramonte colony in Kern county.

The illustration shows clearly what is above the ground. Below, it is arranged as shown in the diagram, as follows:

In beginning work on the well, a ten inch casing of galvanized iron, riveted and soldered at all joints so as to make it water tight, is put down into the ground forty feet. Nine feet underground is riveted to the outside of this casing a cast iron collar and flange. On top of this, and extending outward from the casing on all sides, forming a diameter of about four feet, is run



WELL SHOWING ANCHOR, CASING, AND CAP.

a block of concrete eight inches to a foot thick. This serves as an anchor to hold this casing in the ground against the pressure of the water when the well cap is closed. On the top of this ten inch casing is a flange and collar, to which is fastened a regular water valve gate, as shown in the illustration, and an elbow of cast iron on top of that to divert the water in any desired direction. Inside of this ten inch casing is started the regular eight inch well casing in two foot joints, and the well put down to its required depth, and the space between the eight inch and the ten inch casing filled in with sand and cement.

By the illustration it will be seen that in the side of the ten inch casing, and of course opening into the eight, is a smaller connection, which may be from one to three inches. A pipe connected with this and carried underground will lead the water in any direction and to any desired point or points, such as dwelling house, barn, corral, watering trough, etc.

As there is a heavy pressure of water in the well casing when the cap is closed, the water is carried in this pipe under that pressure.

I do not know that anything more can be added to the above description and illustration. It tells its own story, which would certainly be an eloquent one to any person who has had experience with flowing artesian wells.

In the outline engraving, A is the eight inch elbow of cast iron; B is the water cap or gate, also eight inch; C is the gate flange; D is the ten inch casing; E is the small connection and pipe; F is the anchor of concrete; G is the cast iron flange; H is the eight inch casing; and I is the sand and cement between the casings.—*Min. and Sci. Press.*

[Continued from SUPPLEMENT, No. 615, page 9823.]

[FROM THE AMERICAN JOURNAL OF SCIENCE. 1887.]

ON RED AND PURPLE CHLORIDE, BROMIDE, AND IODIDE OF SILVER; ON HELIOCHROMY AND ON THE LATENT PHOTOGRAPHIC IMAGE.

By M. CARY LEA, Philadelphia.

Action of Nitric Acid on Silver Subchloride.

WHEN freshly precipitated and still moist subchloride of silver is treated with nitric acid, a sharp effervescence, accompanied with a disengagement of red fumes, sets in; presently the strong red coloration of the photochloride appears and the action ceases. This production of the red and not the white chloride in the decomposition of Ag_2Cl is precisely what might have been expected, for when AgCl is formed in the presence of Ag_2Cl, more or less combination always takes place.

The action is interesting in this respect. The AgCl first formed is at the moment of formation in presence of all the yet undecomposed portion of Ag_2Cl, and whatever part it combines with is removed from the action of the acid. It would therefore seem probable that this method would be one of those that yielded a product having the largest proportion of Ag_2Cl, but analysis showed that different specimens were extremely variable; of those analyzed, one contained 8·62 per cent. of Ag_2Cl, another 6·56, and a third 1·96. All that analysis can do with such substances is to fix the limits within which they vary. The quantity of subchloride left after treatment with nitric acid depends partly on the strength of the acid and the time for which it is allowed to act, but also to some extent on variations in the resistance of the substance itself. These specimens were of shades between rose and purple.

The color of any particular specimen is always light-

ened in shade by abstracting Ag_2Cl from it by continued boiling with nitric acid. But as between different specimens, especially when formed by different reactions, it by no means follows that the darkest in color contains the most subchloride.

Argentous chloride when treated with sodium hypochlorite yields a purple form of photochloride. A specimen so treated contained 2·57 per cent. of Ag_2Cl.

Action of Cupric Chloride on Silver.

When metallic silver is submitted to the actions of either cupric chloride or, what gives the same result, a mixture of copper sulphate and ammonium chloride, an action takes place very similar to that of ferric chloride, but more energetic, and the resulting red chloride is apt to be lighter in shade, though in this respect it varies very much. As in the case of ferric chloride, this action of cupric chloride on silver is given in some text books as a means of obtaining argentous chloride, for which purpose it is as little suited as the iron salt.

As a mode of obtaining red chloride it is not to be recommended. It is troublesome to get the copper completely removed.

A specimen analyzed was found to consist of white chloride with 6·28 per cent. of subchloride.

Action of Protochlorides on Silver Solutions.

Cuprous Chloride.—When very dilute solution of silver nitrate is poured over cuprous chloride, a bulky black powder results, which, by boiling with dilute nitric acid, turns red, the acid extracting little or no silver.

Ferrous Chloride.—When silver nitrate is dissolved in a slight excess of ammonia, and this solution is poured into a strong one of ferrous chloride, there results a precipitate which is sometimes grayish, sometimes olive black. By washing with dilute sulphuric acid, this product becomes brownish purple, and brightens by boiling with dilute nitric acid. It was found to contain 4·26 per cent. of subchloride.

Photochloride by Action of Hydrogen.

When hydrogen is passed over argentic citrate at 212° F., as in Wöhler's process, there results a black or dark brown powder consisting of argentous citrate, metallic silver, and perhaps other substances. When this is treated with hydrochloric acid and subsequently with nitric, the resulting product is photochloride, the characteristic color of which sometimes appears as soon as the HCl is added. But more frequently the material after the action of HCl has precisely the appearance of silver reduced in the wet way, and the red color appears only after treatment with nitric acid. Even cold dilute acid (by some hours' contact) will isolate the red chloride; boiling acid does so at once.

Color, beautiful purple. A specimen analyzed was found to consist of normal chloride combined with 3·11 per cent. of subchloride.

Photochloride by Action of Potash with Oxidizable Organic Substances.

There is no better method of obtaining photochloride than by acting on a salt of silver with potash and certain organic substances. Milk sugar, dextrine, and aldehyde give particularly good results. Milk sugar acts rapidly, dextrine slowly. Other substances with which, combined with potash, I have obtained chloride, are: gum, tannin, gallotannic acid, manna, glycerine, alcohol, carbolic acid, etc. The number might doubtless be indefinitely multiplied. After the action has reached a proper stage, which with milk sugar is apt to be in less than a minute and with dextrine may take half an hour, HCl is added, whereupon the precipitate changes in appearance, but does not exhibit its characteristic color until after boiling with nitric acid. The best result is obtained when the precipitate, after addition of HCl, has a rich chestnut brown shade,* which by nitric acid changes to shades of purple and burnt carmine, when milk sugar, dextrine, or aldehyde has been the reducing agent. When the salt of silver employed has been the chloride, of course treatment with HCl is superfluous.

A specimen obtained by acting on silver nitrate with potash and dextrine was found to contain 2·26 per cent. of subchloride. Another obtained with silver nitrate, potash, and milk sugar contained only 0·34 per cent. As in former instances, these determinations are useful only in indicating the extreme variability of these substances and their approximate limits of composition.

Other Reactions Leading to the Formation of Photochloride.

A few more instances are here added, indicating the variety of ways in which this product may be obtained.

The following is an interesting reaction. If a solution of ferrous sulphate is made strongly acid with HCl and solution of silver nitrate added, the silver is thrown down as white chloride. But if to the silver solution is first added a little ammonia, enough to redissolve the oxide, but much less than enough to neutralize the acid added to the iron solution, then on pouring the silver solution into the iron, the silver falls as red chloride. So obtained, it has at first a dull purple or shade, but by purification, as before described, a good product is obtained. This method, however, scarcely tends to the production of the splendid copper red shades of color that are got by acting on silver chloride dissolved in ammonia with ferrous sulphate and then adding dilute sulphuric acid. The shade of color shown by any particular specimen is always of interest, because, as before mentioned, it modifies the effect exerted upon it by the spectrum.

Potassio-ferrous Oxalate.—The now well known "oxalate developer," which I described in this journal some years ago, throws down from silver nitrate a black powder. This precipitate treated with HCl scarcely alters in appearance, but washed and boiled with dilute nitric acid, changes to a deep purple.

Pyrogallol is capable of leading to the formation of photochloride. When ammoniacal solution of silver nitrate is poured into solution of pyrogallol in water made strongly acid with HCl, in such proportion that the mixed solutions remain strongly acid, there falls a grayish product which, by washing and treatment with hot dilute nitric acid, becomes bright pink.

* A specimen in this stage and before treatment with nitric acid was found to contain 92·68 per cent. of silver, showing it to be a mixture of metallic silver with chloride and subchloride.

Ferrous oxide differs essentially in its action on silver solutions from ferrous sulphate. A silver nitrate solution added to one of ferrous sulphate precipitates gray metallic silver. But if potash or soda is first added to the ferrous solution, and then silver nitrate followed by HCl, the red chloride is formed abundantly. This reaction is similar to that already described in which an ammoniacal solution of a silver is added to one of ferrous sulphate.

To the same class of reactions belongs the following: Silver carbonate with excess of sodium carbonate is thrown into solution of ferric sulphate, and after standing a few minutes, HCl in excess is added. The silver is converted into red chloride.

It seemed possible that silver itself might be made the means of reducing its chloride. The experiment was made in this way: Freshly precipitated and still moist chloride was intimately mixed with metallic silver in fine powder and a little water. This was heated till the water boiled and nitric acid was added. After the action was over, the chloride had assumed a deep pink color. A similar result is obtained without the aid of heat, but the resulting color is much paler.

Analogous to this is the following: When a cake of fused silver chloride in a crucible is reduced with dilute sulphuric acid and zinc, if the reduction is interrupted when not quite finished, and the metallic silver is dissolved out with hot nitric acid, the residue of silver chloride will be found to be pink.

When HCl is brought into contact with Ag together with an oxidizing agent such as a bichromate or permanganate, it gives rise to formation of colored chloride. These I have not specially examined, but there can be little doubt that they are identical in nature with the foregoing. So too when silver in contact with mixed potassium chloride and chlorate is cautiously treated with dilute sulphuric acid.

The reactions above described will serve to show under what a vast variety of conditions the photosalts are formed. Most of the methods here described represent each a whole class of reactions, all resulting in the same general way, and these classes might doubtless be largely added to. Almost any silver solution brought into contact with almost any reducing agent and then treated with HCl gives rise to the formation of photochloride. Almost any chlorizing influence brought to bear on metallic silver has the same result. Or when silver is brought into contact with almost any oxidizing agent and HCl. It may be said without exaggeration that the number of reactions that lead to the formation of photochloride is much larger than that of those leading to production of normal chloride.

Reactions of Photochloride.

Exposed to ordinary diffuse light, all the bright shades of silver photochloride quickly change to purple and purple black. The darker shades are more slowly influenced.

Mercuric chloride gradually changes it to a dirty white.

Mercuric nitrate dissolves it easily and completely, but apparently with decomposition, as it can only be recovered as white chloride.

Potassic chloride seems to be without effect.

Potassic bromide soon converts it to a dull lilac, which at the end of twelve hours showed no further change.

In contact with potassic iodide the color instantly changes to blue gray. This change is produced by a quantity of iodide too small to dissolve even a trace of silver. The filtrate is not darkened by ammonium sulphide. With a larger quantity, silver is dissolved abundantly. By acting with renewed iodide solution, the substance continually darkens and diminishes until only a few black points, barely visible, are left.

Treated with dilute solution of potassium chlorate and HCl, the red substance gradually passes to pink, to flesh color, and finally to pure white.

The action of heat on the photochloride is very curious. Its tendency is generally toward redness. Specimens appearing quite black are rendered distinctly purple or chocolate by heating to 212° F. in a drying oven. Often when the substance first separates by addition of HCl, it is pure gray. This gray will often be changed to pink by simply heating to 212°. (This happens when a gray form is produced. If the grayness is due to admixed metallic silver, it is only removed by boiling with nitric acid.)

The somewhat surprising change of color which is often seen when the crude substance is boiled with nitric acid (sometimes from dull dark gray to crimson) is due to three concurrent actions—that of the mere heat, the removal of the silver, and the breaking up of uncombined subchloride.

It is not possible to dissolve out the normal chloride by a solvent like ammonium chloride from the photochlorides, leaving the subchloride behind. When red chloride is boiled with successive portions of strong solution of ammonium chloride in large excess, the material gradually diminishes until, if the operation is continued long enough, there remains a small residue of a warm gray color, which consists of metallic silver and dissolves without residue in nitric acid.

If sodic chloride is substituted for ammonium chloride, the same result follows, except that the operation is greatly more tedious. If persevered in until the hot solution no longer removes traces of silver chloride, the residue consists of nothing but metallic silver.

Action of Light on Normal Silver Chloride.

When silver chloride precipitated with excess of HCl is exposed to light, it becomes with time very dark. Cold strong nitric acid 1·36 sp. gr. extracts a trace only of silver.

The principal action of light on AgCl (precipitated in presence of excess HCl) consists in the formation of a small quantity of subchloride which enters into combination with the white chloride not acted upon, forming the photochloride, and thus is able to withstand the action of strong nitric acid. At the same time a trace is formed either of metallic silver or of uncombined subchloride. It is impossible to say which. After a certain very moderate quantity of photochloride is formed, the action of light seems to cease. This cessation has been noted by many observers, perhaps most exactly by Dr. Spencer Newbury.

The nature of the product formed by the continued action of light on silver chloride seems to support the conclusion that the subchloride is combined with the whole of the normal chloride after the manner of lakes, rather than in equivalent proportions. If the latter were the case, it seems probable that the continued action of light would extend to much greater decomposition than it is found to do.

The action of light in the formation of the so-called latent image will be examined in the second part of this paper.

PHOTOBROMIDE AND PHOTOIODIDE.

It has been already mentioned that bromine and iodine form with silver combinations in all respects analogous to those of chlorine. A more particular account of the bromine and iodine compounds must wait for the next succeeding number of this journal. Here it can only be mentioned that these substances are formed much in the same way as the chlorine compound. They are less stable than it, and consequently the number of reactions that lead to their production is somewhat more limited. Each, however, is formed in a great variety of ways, and with the same ease as the chloride. In color they are for the most part indistinguishable from it, but exhibit different reactions.

RELATIONS OF PHOTOCHLORIDE TO HELIOCHROMY.

The photochloride was examined both with the spectrum and under colored glass.

The rose-colored form of photochloride was that which gave the best effect. In the violet of the spectrum it assumed a pure violet color, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged. The maximum effect was about the line F, with another maximum at the end of the visible violet, less marked than the one at F.

Under colored glass the colors obtained were brighter; under two thicknesses of dark ruby glass, the red became brighter and richer. Under blue glass some specimens gave a fair blue, others merely gray. Under cobalt a deep blue was easily obtained, and under manganese violet, a fine violet, very distinct in shade from the cobalt. Green produced but little effect. Yellow was sometimes faintly reproduced, but rarely. But the yellow glass of commerce, even the dark yellow, lets through portions of nearly the whole spectrum, as can readily be seen by testing it with the spectroscope.

The dark purple forms of chloride do not give as good results as the rose and coppery shades. These last have many points of resemblance with the material of Becquerel's films—resemblance of color, probably of composition, as far as we can judge of the constitution of those films from their origin (they were far too attenuated to admit of analysis); and resemblance in the curious way in which their color is affected by heat, so that the conclusion seems inevitable that they are at least closely related.

There is certainly here a great and most interesting field for experiment. Hardly any two specimens of photochloride give exactly the same results with colored light, and this suggests great possibilities. There is the very great advantage in this method over any previous, that the material is easily obtained in any desired quantity and in a condition most favorable for experiment.

The action of light on photochloride can be a good deal affected by placing other substances in contact with it. Any substance capable of giving up chlorine seems to influence the action somewhat. Ferric chloride often acts favorably, also stannic and cupric chlorides.

Evidently an important point in all heliochromic processes is that as white light must be represented by white in the image, it is an essential condition that white light must exert a bleaching action on the sensitive substance employed. Red chloride does not bleach, but darkens in white light, but the property of bleaching, to a very considerable extent, may be conferred on it by certain other chlorides, and particularly by lead chloride and zinc chloride.

This I look upon as very important.

Another matter of interest is exaltation of sensitiveness, and this I find is accomplished in quite a remarkable way by sodium salicylate, the presence of which at least trebles the action of light on these substances. And probably on others.

I am persuaded that in the reactions which have been here described lies the future of heliochromy, and that in some form or other this beautiful red chloride is destined to lead eventually to the reproduction of natural colors.

(*To be continued.*)

THE PART ELECTRICITY PLAYS IN CRYSTALLIZATION.*

Ramifications and Dendrites by Electrolysis.—If, after spreading a thin layer of a solution of nitrate of silver over a strip of glass, we place therein two platinum electrodes communicating with a pile of a few elements, we shall obtain curious crystalline ramifications in the form of dendrites of very pure silver at the negative pole. These arborizations, in form, have a certain analogy with the positive ramifications produced by the discharges of a Leyden jar upon insulators, and, to a certain degree, even recall the arrangement of the lines of electric flux (Figs. 2, 3, and 4). When the electrodes are square, with the polar points turned toward each other, we observe, in addition to the ramifications of silver at the negative pole, a blackish deposit of peroxide of silver at the positive pole, formed of needles of shapes different from those of the negative pole (Fig. 3).

Relatively to this latter result, we shall remark that this form of deposit of peroxide of silver has been known for a long time. In fact, in Pelouse & Fremy's Treatise on Chemistry we find the following passage: "On decomposing by a pile a very dilute solution of nitrate of silver, peroxide of silver deposits upon the positive pole in the form of grayish needles of a metallic luster, whose length often reaches from 7 to 8 mm." Further along, we shall see that these needles may reach still greater lengths (2·5 cm.).

After repeating the principal experiments of Mr. Cardani, and after observing, with a slightly dilute solution, the simultaneous formation of arborizations of pure and brilliant nitrate of silver at the negative pole and of blackish needles of peroxide of silver at the posi-

* Continued from SUPPLEMENT, No. 613, page 9793.

tive pole, I carried the experiment farther than Cardani did, that is to say, to the moment of the junction of the two crystalline deposits.

The following is what I then observed: When the dendrites and needles came within a few millimeters of each other, there occurred here and there in the masses a motion that may be qualified as tumultuous. The arborescences or dendrites became covered, especially at the extremities, with a deposit of dull and even yellowish silver. They rapidly thickened and became woolly, so to speak. Black spots were observed at

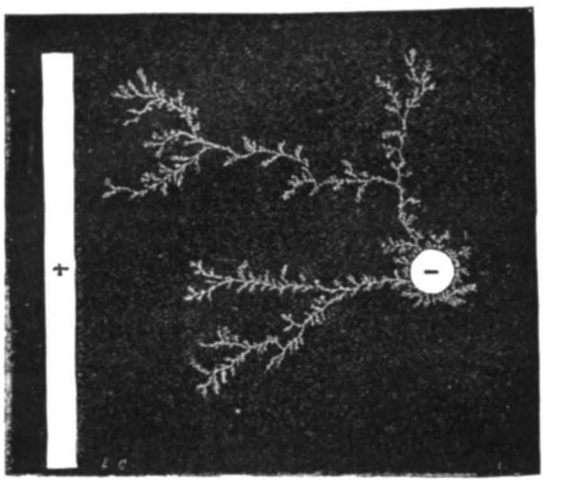


FIG. 2.

their extremities, and brilliant white dots were seen in the center of the black needles of peroxide of silver in the vicinity of the anode.

In another experiment, the electrodes being about two centimeters apart, the needles of peroxide of silver were as long as the arborescences of pure silver.

It is even possible at certain distances, with a properly diluted or concentrated solution, to obtain arborescences without needles, and *vice versa*. The following is an example of this class: With a slightly dilute solution, the distance of the polar points being 3 centimeters, at the end of ten minutes a single straight needle directed toward the negative pole was produced. Its length reached 2·5 cm. at the time of its total development. Later on it exhibited two parallel, lateral branches. Finally, when the point of the needle

FIG. 3.

had approached within 5 or 6 mm. of the negative pole, the arborescences began to appear, but not till then (Fig. 5).

I afterward gave my experiments other arrangements than those of Mr. Cardani. I shall cite the following: The anode was a platinum wire bent into the form of a ring 3·5 cm. in diameter. The negative electrode was another platinum wire of the same diameter, ending in the center of the preceding circumference (Fig. 6). The current was furnished by a pile of two elements united in tension.

The solution of nitrate of silver spread in a film over the glass, where it covered the electrode wires, was a concentrated one. As soon as the current was introduced, the arborizations at once developed at the negative pole, and in less than five minutes they had ex-

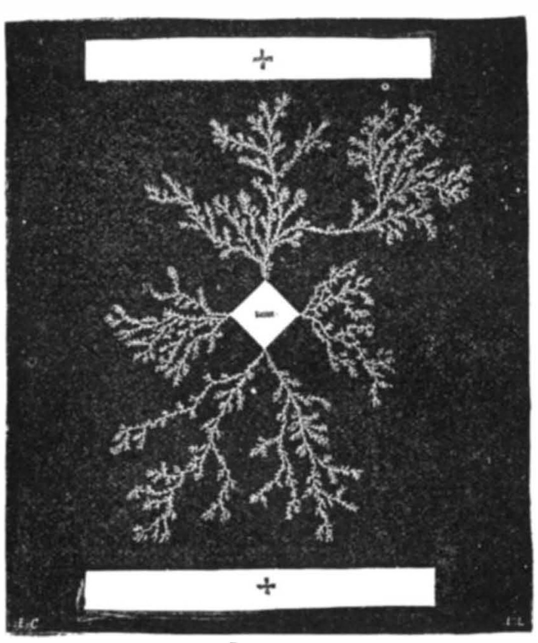


FIG. 4.

ceeded half the length of the radius of the circumference. Up to this point they remained brilliant and crystalline, but afterward they became dull, tufted, and yellowish. In six minutes they had reached the platinum wire ring, which was then covered within and without with amorphous points, but without any needles of peroxide. Scarcely had a contact taken place between the negative arborescences and the positive wire than the whole interior of the ring became filled with confused arborescences dotted here and there with black specks. As the electric current continued to act, the arborescences passed under the positive wire and spread beyond in confused masses of a woolly appearance.

In another experiment, with a more concentrated solution, the effects were more prompt. The needles made their appearance on the positive wire long before the arborescences had reached it.

In still another experiment, the negative pole of the pile was attached to the wire ring, and the positive

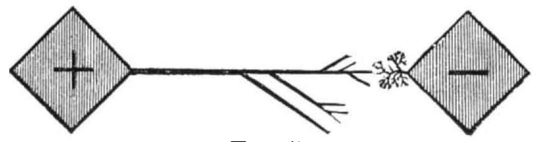


FIG. 5.

one with the vertical wire in the center (Fig. 7). Scarcely had the electric current passed than a black amorphous deposit was produced around the positive wire. This deposit rapidly increased in a few minutes and extended in a circle of 4 mm. diameter around the wire. Bubbles of oxygen gas continuously escaped from this same pole. A short, branching black needle was observed externally, but no arborizations appeared as yet upon the negative wire. Later on, a few made their appearance opposite the needle of peroxide, and, extending, soon reached the center. Then the combination occurred. The arborizations were absorbed in measure as they arrived.

The degree of concentration of the solution has a great influence under the form of electrolytic deposits.

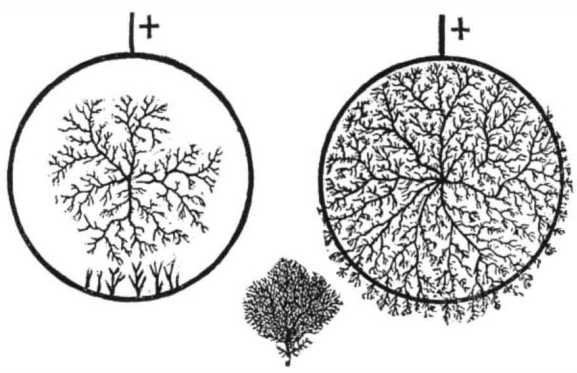


FIG. 6.

When it is very concentrated, and the interpolar distance is about 0·03 m. the needles of peroxide form at the positive pole at the same time that the dendrites do at the negative. But at an advanced phase of the phenomenon, when the deposits are no longer but 2 or 3 mm. from each other, the arborizations lose their luster, thicken, and become woolly. It is therefore advantageous to use dilute solutions if it be desired to have beautiful arborizations of pure, brilliant silver and to stop operations before the ramifications thicken.

It is possible, moreover, to obtain at will nothing but ramifications of brilliant silver by frequently breaking the communication of the peroxide needles with the positive pole, or, *vice versa*, we may obtain needles only by breaking the arborizations in measure as they are produced.

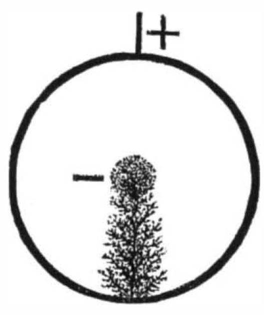


FIG. 7.

To obtain lengthy arborizations, the following method may be employed: The positive electrode may be brought within a short distance of the negative in order to cause the formation of the first crystallizations; and then, without the negative electrodes being touched, the positive is moved away in measure as the arborizations elongate. By this means, even with a feeble pile, it is possible to obtain arborescences that are relatively very long and that do not become woolly.

From the preceding experiments, it results that we can obtain at will: (1) Merely crystalline arborizations, of varying length, of brilliant silver; (2) merely brown needles of peroxide of silver; (3) arborizations and needles simultaneously; (4) a crystallization of dull or yellowish silver; (5) an amorphous deposit of spongy silver; (6) a confused black deposit of peroxide of silver.

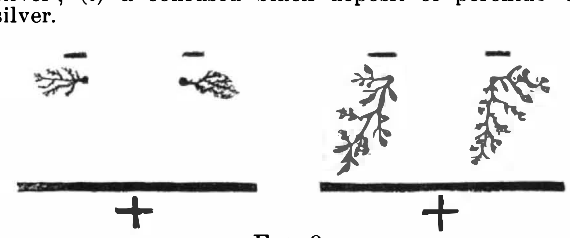


FIG. 8.

Taking up another line of thought, I became desirous of knowing whether the arborizations derived from two different centers, but from the same pole, would repel one another like lines of magnetic force. To this effect, I arranged the experiment as shown in horizontal projection in Fig. 8.

The ends of the same platinum wire, whose center was attached to the same negative pole, touched the glass plate, that is to say, the liquid film. The positive electrode was formed by the edge of a strip of platinum parallel with the straight line that would connect the two ends of the wire. The distance between these latter was 0·014 m., and the distance to the strips of platinum was 0·025 m.

The first effect produced is shown to the left in Fig. 8. The arborizations visibly repulsed each other, like two bodies charged with the same electricity or like the lines of force of two poles of the same name. Later on, the strip made itself felt, and predominated, as shown to the right in the same figure.

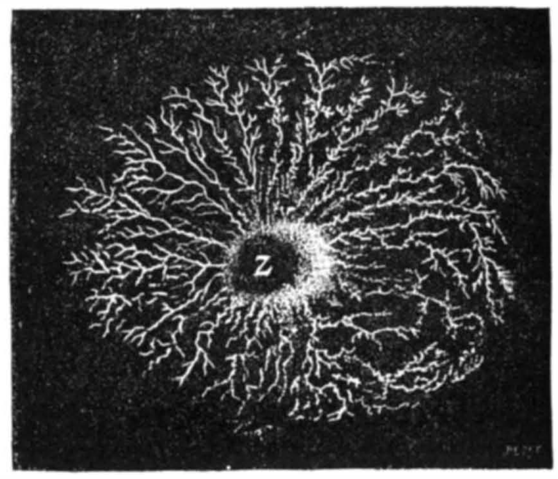


FIG. 9.

So, arborizations of the same name repel each other. Later on, we shall see another mode of experimentation in which these effects are rendered more apparent.

To photograph the electrolytic ramifications of which we have spoken, we begin, without disturbing the glass plate, by causing the remanent liquid to flow off through a piece of absorbent paper, for if, after the breaking of the electric current, this liquid was left to spontaneous crystallization, its crystals would clog up the arborizations and interfere with the sharpness of the photograph. Then the electrodes to which the fragile deposits are fixed are removed with great precaution.

When the whole is very dry, the plate can be used

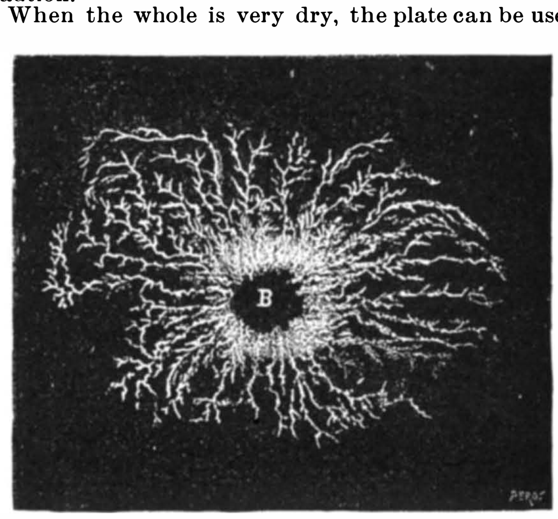


FIG. 10.

as a negative for obtaining prints on ferro-prussiate paper.

Metallic Vegetation.—In the interior of the earth we find metallic agglomerations having the form of plants—trunk, branches, branchlets, and sometimes an expansion of the extremities into the form of leaves. So these natural productions have long been called metallic vegetations. Others also are met with which are in nowise metallic, and which are like stones or crystals of diverse natures, saline or otherwise. Most of these have been imitated in chemistry.

We shall occupy ourselves especially with the metallic vegetations that are connected with electricity through one of the forces that the phenomenon puts in play. The metallic vegetations well known under the

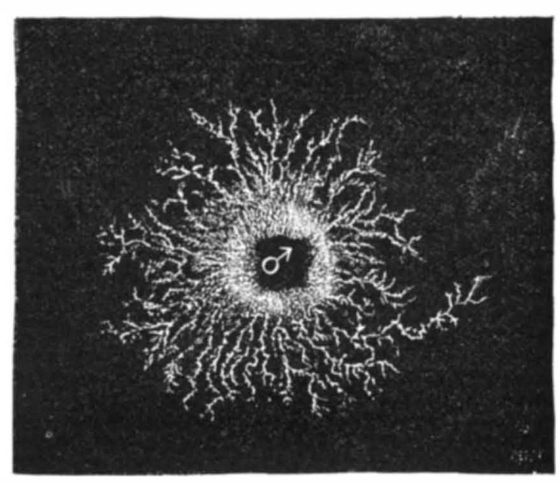


FIG. 11.

name of tree of Saturn, tree of Diana, and tree of Mars are, as well known, produced spontaneously without the direct intervention of electricity. But as a consequence of the experimental arrangements, electricity nevertheless presides over the phenomenon, for the latter results from the presence of heterogeneous metals in the solution that form voltaic currents which continue the crystallization caused by affinity.

Chemists of the last century as well as those of our

own have made many researches on this subject. Fischer De Breslau concludes thus: "It appears certain that although chemical affinity is the prime cause of the precipitation of the metal, the electric current tends in its turn to increase, and consequently concurs in its formation."

In a former article, we have given, after *La Condamine*, several figures obtained with a solution of nitrate of silver, in which the precipitant metals were chiefly zinc, bismuth, and iron. The analogy between these forms there is no doubt about.

The presence of a metal such as zinc in a silver solution causes affinity. The zinc substitutes itself for the silver, which is laid bare and forms from the beginning, and during the whole course of the phenomenon, a small voltaic couple which quickens the decomposition.

In order that the arborescences may push their branches to a distance they must not cease to be in contact, by their base, with the precipitant metal, and must form throughout their length a continuous metallic conductor through which is propagated the electricity derived from this voltaic couple of two metals in presence.—*C. Decharme in La Lumiere Electrique.*

COMBUSTION.

ALTHOUGH the spread of technical education and the multiplication of text books has extended the means of acquiring information concerning processes of nature which take place continually around us, there must remain a considerable percentage of our readers who have either not had a special training in physics or who are too much concerned with the practical affairs of everyday life to profit by the educational facilities available in all our great towns.

It happens, fortunately, however, that much information, useful and interesting, can be imparted to them in the pages of the technical press in such a form that but little time or labor need be expended by those who wish to acquire knowledge. We purpose in what follows to explain in simple language what takes place in a furnace—say that of a steam boiler—in a way that may be understood by those who possess little or no information on chemistry. In text books such a subject as combustion must of necessity be treated more or less thoroughly, because it covers a wide field; but by narrowing what has to be said to a single set of conditions, it becomes possible to clear out extraneous matter, and further condensation can be effected by asking the reader to take on trust statements the truth of which is demonstrated at greater or less length in more or less elaborate and complete treatises. We need hardly add that what we are about to say now will convey no new information to those who have had an adequate training in physics, and may accordingly be passed unread by them.

The combustion of coal is nothing more or less than its combination with oxygen gas. When a fuel of any kind combines with oxygen, heat is produced. Why fuel should combine with oxygen no one can tell. It is one of nature's secrets. The chemist tells us that the oxygen and the fuel have an "affinity" for each other. But when this statement has been made, we are no nearer to understanding why combination takes place than we were before. In text books nothing will be found as to why heat is produced by the combination. On this point an all but universal silence prevails. We are told, however, by a few writers of the old school, that heat energy was stored up in the coal millions of years ago by the sun, and that this heat energy is liberated when the coal combines with oxygen. This is absurd. It will not be out of place to give here an explanation which is consistent with facts, and therefore appears to be satisfactory.

All bodies, substances, gases, and liquids are supposed to be composed of multitudes of particles or molecules of almost inconceivable smallness, and these are all supposed to be in motion among themselves. This motion is heat; that is to say, heat is neither more nor less than a kind of motion, and this internal vibration can be transmuted into perceptible mechanical movement, or, on the other hand, mechanical movement can be converted into the invisible motion called heat. How the change takes place no one knows, but the change is none the less a fact. Now, the difference between a solid and a gas is that the motion of the particles or molecules of the gas is much greater in extent than is the motion of the particles of the solid. Also some gases have a greater range of motion than other gases.

If by any means we can take the motion out of gas, say by compressing it into a vessel the sides and ends of which reduce the range of movement, then, as nothing is lost in nature, the invisible and insensible motion of the gas, which it has lost, reappears as heat in a sensible form, and we find that the sides of the vessel become hot. Now, the oxygen which combines with coal has a very considerable range of internal motion; but when the oxygen has combined with the coal, another gas, known as carbonic acid gas,* is produced, as will be explained further on; and the particles of this gas having a much smaller range of motion than the particles of the oxygen have, the difference appears in the form of heat.

It is not necessary to tell readers of the *Engineer* at any length that coal is not always the same. It is composed of various substances and gases. The principal are carbon, hydrogen, oxygen, and certain impurities which make the ash with which we are so familiar. The carbon, hydrogen, and oxygen are "elements"—that is to say, they are not composed of separate substances combined together. They cannot be split up into anything else. In 1,000 lb. of anthracite coal there are about 915 lb. of carbon, 35 lb. of hydrogen, and 26 lb. of oxygen. In a good bituminous or North Country coal there will be 800 lb. of carbon, 54 lb. of hydrogen, and 16 lb. of oxygen. The difference between the sum of these quantities and 1,000 lb. is matter entirely non-combustible, which appears as ash. Of course there are an infinite number of variations in the proportions which the constituents of coal bear to each other, but the figures we have given fairly represent good Welsh and good North Country coals respectively.

The air we breathe is composed of two gases—oxygen and nitrogen. The latter appears to have no effect whatever on human life or combustion. It serves to dilute the oxygen. The two gases are mixed; they are not in chemical combination. By weight, approximately, 36 lb. of air contain 28 lb. of nitrogen and 8 lb. of oxygen. In bulk they are mixed in the proportion of, roughly, 4 to 1, four cubic feet of nitrogen and one of oxygen making five cubic feet of air. There are also present in air moisture in the shape of vapor, and a small quantity of carbonic acid gas. The accompanying table shows the composition of 100 lb. and 100 cubic feet of air accurately:

	In 100 lb.	In 100 cubic feet.
Nitrogen	75·55	77·50
Oxygen	23·32	21·00
Vapor	1·03	1·42
Carbonic acid	0·10	0·08

As has been explained, the nitrogen is of no use in a furnace, but it cannot be kept out. We may neglect it, however, as far as combustion is concerned. It goes into the furnace nitrogen and it comes out nitrogen, neither being acted on nor acting on anything else, except in so far as it carries away with it a good deal of heat, which is accordingly wasted.

The carbon and hydrogen in the coal combine with the oxygen of the air in definite proportions. The hydrogen is not free in bulk in the coal. On the contrary, it is probably condensed into a very solid condition. To explain its precise condition would lead into chemical questions, which it is not necessary to consider here. The only proportion in which hydrogen combines with oxygen in combustion is one to eight by weight—that is to say, 8 lb. of oxygen and 1 lb. of hydrogen combine and produce 9 lb. of water, which is instantly converted into steam by the heat of the furnace. Carbon combines with oxygen in two distinct proportions—one consists of $1\frac{1}{3}$ lb. of oxygen and 1 lb. of carbon, producing $2\frac{1}{3}$ lb. of the gas known as carbonic *oxide*; the other proportion is $2\frac{2}{3}$ lb. of oxygen and 1 lb. of carbon, producing $3\frac{2}{3}$ lb. of carbonic *acid* gas. The heat produced by the combination varies.

Here it will be well to explain that *quantity* of heat is a different thing from the *temperature* of heat, just as the *pressure* of steam in a boiler is a different thing from the *quantity* of steam in a boiler. In this country heat is measured by "units," the unit being that quantity of heat which could raise the temperature of 1 lb. of water 1° on the thermometer. This being understood, the following table, which we copy from Rankine's "Treatise on the Steam Engine," will also be understood:

Combustible.	Lb. of oxygen per lb. of combustible.	Lb. of air.	Total heat in units.	Evaporative power from 212 deg.
Hydrogen gas	8	36	62,032	64·2 lb.
Carbon imperfectly burned, so as to make carbonic oxide	$1\frac{1}{3}$	6	4,400	4·55
Carbon completely burned, so as to make carbonic acid	$2\frac{2}{3}$	12	14,500	15

The figures in the last column show the weight of water that would be converted into steam if all the heat produced by burning a pound of the combustible named could be used for that purpose, the feed water being heated to 212° before being pumped into the boiler. We see that at the utmost it cannot exceed 15 lb., so that when we hear of boilers evaporating 15 lb. or 16 lb. of water per pound of coal we know there must be an error somewhere.

We may now consider what a thousand pounds of bituminous coal would evaporate. We have, first, 800 lb. of carbon. This will require for its combustion, we see from the preceding table, 800×12=9,600 lb. of air, and the quantity of heat resulting will be 14,500×800=11,600,000 units. We have 54 lb. of hydrogen, which will require 54×36 lb.=1,944 lb. of air, and the resulting heat will be 54×62,032=3,349,728 units.* Summing up, we find that our 1,000 lb. of coal will require 9,600 lb.+1,944 lb.=11,544 lb. of air, and that it will produce 11,600,000+3,349,728=14,949,728 units. In practice no such quantity is ever utilized, and we shall now proceed to show how the facts we have stated apply in practice.

In the first place, it will be seen from what we have said that 12 lb. of air per pound of carbon, and 36 lb. of air per pound of hydrogen, are the smallest quantities that will suffice. If less air be admitted, the quantity of oxygen sent into the furnace will not be sufficient, and the carbon, instead of being burned into carbonic *acid*, and so giving out 14,500 units per pound, will only be burned into carbonic *oxide*, and give out only 4,400 units, or about one-third of the proper quantity. But, furthermore, it is too much to suppose that all the oxygen can be seized by all the carbon in the rapid passage of the air through the furnace; consequently, we must admit an excess of air to the furnace, because a great deal of oxygen always escapes uncombined. In practice the smallest quantity of air that will suffice is 18 lb. per pound of coal, and this quantity is often exceeded, 24 lb. being admitted. When too little air is sent in, carbonic oxide is produced, passes away up the chimney, and then getting plenty of air, takes fire at the top, and burns.

In old days, when locomotives were fired with coke, all the air was admitted through the fire bars, and none over them, as there was no smoke to be prevented. As soon as steam was shut off the draught was checked. Sufficient air did not get into the fire box, and carbonic oxide was produced, which subsequently caught fire when it got air at the top of the chimney, so that at night a locomotive might be seen coming into a station with a blue flame some 5 ft. or 6 ft. long from the chimney. This was put out at once by opening the fire door. In coal-burning locomotives a great deal of air is admitted above the coal, and a fire brick bridge or arch is placed in the fire box, which helps to mix the air with the carbonic oxide, and so it is burned in the right place, namely, the fire box.

The total quantity of air required for the combustion of 1,000 lb. of coal in the best constructed furnaces, worked with a proper draught and a high temperature, will be 1,000×18=18,000 lb., and with furnaces working more sluggishly and not so well constructed, 1,000×24=24,000 lb. The volume of air varies with the temperature, augmenting as its heat increases. For our present purpose it will be enough to say that one pound at the ordinary temperature of 60° occupies very nearly 13 cubic feet, so that for the combustion of 1,000 lb. of coal, 18,000×13=234,000 cubic ft. would be needed in the best furnaces. This would fill a chamber about 62 ft. long, high, and wide, and its weight would be a fraction over eight tons.

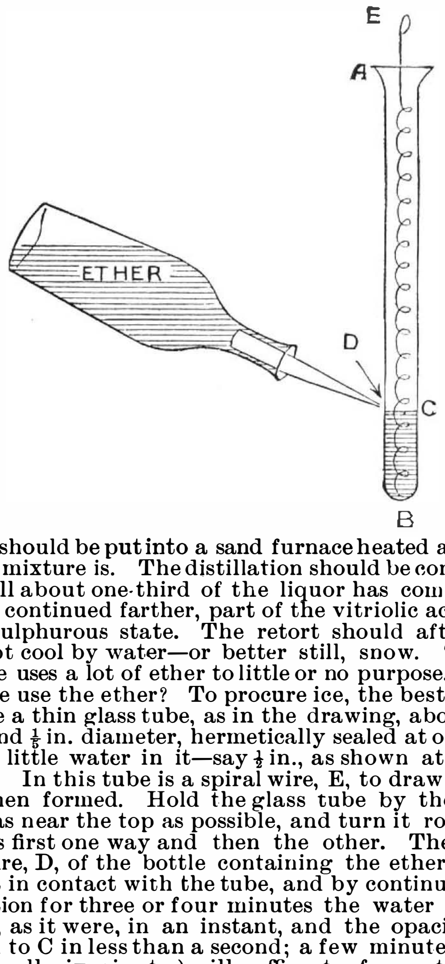
We have said nothing of what becomes of the heat generated in the furnace. To do that would unduly extend this article, and an explanation of the conditions which are most favorable to combustion we shall possibly give at another time. It will be enough to say now that much of the heat produced, instead of going to the water in the boiler, is expended in heating the air to a high temperature, and that the conditions most favorable to good combustion are those which most effectively mix the air and the hot fuel and gases.—*Q., The Engineer.*

* Called by modern chemists carbonic anhydride.

* It will be seen from the particulars of the composition of coal given above, that there is a percentage of oxygen in the coal already. There is some doubt as to the part played by this oxygen and the hydrogen, and some authorities have gone so far as to say that the hydrogen in coal should be neglected altogether as a heat producer. We have given the conclusions which seem more consistent with facts.

FREEZING WATER BY THE EVAPORATION OF ETHER.

FEW liquids are so volatile as ether, and the best way of making it is as follows: Mix together equal parts by weight of highly rectified spirits of wine and concentrated oil of vitriol (or sulphuric acid) or somewhat twice the measure of spirits of wine to one of the acid. This is to be done in a flint glass retort, the bottom and sides of which are very thin, that it may not break from the sudden heat that is generated by the union of these two substances. The spirits of wine is first put into the retort, and then the acid is poured in by a glass funnel, so that the stream may be directed against the sides of the glass, in which case it will not exert much of its force on the spirit, but will lie quietly below at the bottom. Then shake the retort very gently, that the two substances may mix very gradually. When this is completed, very little more heat will make the mixture boil. This mixture is to be distilled with as brisk and quick a heat as possible, for which reason, immediately after the acid and spirit are mixed, the



retort should be put into a sand furnace heated as much as the mixture is. The distillation should be continued only till about one-third of the liquor has come over. If it is continued farther, part of the vitriolic acid rises in a sulphurous state. The retort should afterward be kept cool by water—or better still, snow. "Zero" says he uses a lot of ether to little or no purpose. How does he use the ether? To procure ice, the best way is to take a thin glass tube, as in the drawing, about 4 in. long and ¼ in. diameter, hermetically sealed at one end, with a little water in it—say ½ in., as shown at C D in figure. In this tube is a spiral wire, E, to draw up any ice when formed. Hold the glass tube by the right hand as near the top as possible, and turn it round on its axis first one way and then the other. The small aperture, D, of the bottle containing the ether is kept almost in contact with the tube, and by continuing the operation for three or four minutes the water will be frozen, as it were, in an instant, and the opacity will ascend to C in less than a second; a few minutes more (say, in all, six minutes) will suffice to freeze the lot. In this manner, throwing the stream of ether upon the ball of a thermometer, so that a drop might every ten seconds fall from the bulb, M. Cavello brought the mercury down to 3°, or 29° below freezing point, with the atmosphere about temperate.—*B. R. Ikin, Eng. Mechanic.*

PHOSPHORIZED SILVER.

By H. N. WARREN, Research Analyst.

DURING the reduction of argentic phosphate by means of charcoal, and using calcium borate as a flux, on examination of the reduced metal it was observed to possess a decided yellow tint, resembling in every respect silver containing about 25 per cent. of gold, and at the same time retaining a perfect malleability similar to pure silver, although after fusion refusing to spit on cooling. On submitting the same to a careful gravimetric analysis, the mean of several estimations was as follows:

Silver	95·42
Sulphide of silver	4·30
Gold	0·38
Phosphorus	traces
	100·10

The sulphide of silver present apparently becoming introduced on account of the calcium borate used to flux the metal containing calcium sulphate, which on being subjected to a high temperature becomes partially reduced by means of the charcoal. The sulphide of silver existing in the regulus, however, apparently played no part in transmitting a yellow color to the silver, which was afterward confirmed by taking pure silver, and introducing phosphorus in small pieces when in a fluid state; the silver, on cooling, apparently throwing off the whole of the phosphorus in the form of small jets, which burnt lively on the surface of the

metal, the silver at the same time, however, retaining sufficient phosphorus to prevent its spitting on cooling and to produce a decided yellow tint, although the average result as regards the percentage of phosphorus in the same seldom exceeded 0·002 per cent. This quantity of phosphorus, although so minute, is exceedingly difficult to expel by means of cupellation, often requiring from three to four consecutive cupellations with lead before leaving the silver possessed of its natural properties.—*Chem. News.*

PLANT ANALYSIS AS AN APPLIED SCIENCE.*

By HELEN C. DE S. ABBOTT.

MISS ABBOTT was introduced by Prof. Persifor Frazer, and spoke as follows:

Schleiden,† in his principles of botany, states: "Botany is an indispensable branch of knowledge for the chemist and physiologist." I think he might have said, with equal truth, chemistry and physiology are indispensable branches of knowledge to the botanist. An acquaintance with these three branches of knowledge is indispensable to the plant chemist. If we consider that our food, fabrics, dye stuffs, perfumes, drugs, and beverages are all derived from plants, we can scarcely fail to inquire into the functions and intimate structure of vegetable life. The application of chemical knowledge to the study of plant life under all conditions is the first step toward a practical solution of the problems of agriculture, materia medica, and the industries derived from plant sources.

As long ago as 1795,‡ a learned Scotch nobleman said: "Indeed, there is no operation or process, in agriculture, not merely mechanical that does not depend on chemistry." Fifteen years later, after Earl Dundonald's treatise, the first vegetable substance was accurately analyzed. Another period passed before the analyses of Liebig. Since that day investigators have been busily engaged in plant analysis.

Plant analysis to-day rests on a sure foundation as a distinct subdivision of general chemistry. Chemistry teaches us what vegetation needs for its growth, and points out the sources whence the materials for crops can be derived. Intense cultivation of the plant is the agricultural motto. The contray is true for pharmacy. Plants which are to be used for medicinal purposes should grow under natural conditions. Cultivation of plants tends to diminish in quantity or to eradicate their noxious or medicinal principles. According to Prof. Vogel, hemlock does not yield coniine in Scotland, cinchona plants are nearly free from quinine when grown in hothouses, and tannin is also found in the greatest quantity in trees which have a direct supply of sunlight. Wild belladonna plants § contain more alkaloids than the cultivated.

Until within a comparatively very recent date, there were no schemes for vegetable analyses equivalent to *Fresenius' Manual for Inorganic Substances.* The irregularities of the methods of individual investigators in plant chemistry made it extremely difficult for students to follow this kind of analysis. The deficiency has been filled by the admirable book on *Plant Analysis*, by Prof. Dragendorff, of Dorpat, Russia. This book has appeared in a French translation, ‖ and the first edition of an English translation¶ was published a year before. Prof. Dragendorff does not claim to have written a perfect book. He offers a scheme, which, if followed, supplemented by well-known or original methods in the study of special or new compounds, will give the student a knowledge of the chemical constituents of a plant which he could not well obtain by a non-systematic scheme.

Dragendorff's scheme has been criticised as encouraging a mechanical method of work on the part of the analyst, but I think any student on working for the first time on a new drug by this method will find that he will be thrown very much on his own resources, and that the scheme serves him merely as a chain and anchor in a sea of novelty and uncertainty. It is indeed the most complete scheme for plant analysis which we have.

The scope of plant analysis is well outlined by Dragendorff in his introduction, and if my time permitted me, I could not do better than read it. The attention of the reader is directed to the great number of species of plants which occur in nature, to the great abundance and variety of their chemical constituents, and to the circumstances that almost every skillful analysis of a plant that has not been examined yields new hitherto unknown products. The difficulties of plant analysis are pointed out, but it should be the effort of future investigators to endeavor to overcome these difficulties, when the importance of plant chemistry is considered in relation to scientific botany and chemistry, medicine, pharmacy, dietetics, agriculture, etc. This author says that the analyses of plants in one respect possess an advantage over the analyses of minerals,** and in that respect can often be made more complete than that of a mineral.

It would not be possible within the space of an hour to give an accurate description of how to analyze a plant and the many methods which may be followed. I can give an idea of how to follow the scheme of which I have spoken as being the most complete, and the practical application of some facts derived from plant analysis.

The specimens which are presented for analysis should be in good condition and well selected as typical of the genus or species. In case of comparative studies, the time of year of the gathering should be noted. All foreign substances and dust should be removed, and care taken not to displace parts of the specimens.

All plants are chemically composed of two classes of substances, and on incineration one class is decomposed into gases and the other class forms the ash constituents. These two divisions of the plant's constituents are known as the volatile and fixed parts. The manner of proceeding with an analysis of a plant is somewhat different in the case of fresh plants and those which are air dried. Fruits and succulent plants and fleshy roots may sometimes be examined with advantage in the fresh condition, especially if they contain much saccharine material or volatile products. Generally the parts of plants to be used for analyses are dried at a temperature under 30° C., or air-dried until in a state to powder; for all vegetable substances must be brought into fine subdivision before extraction, in order that the solvents may penetrate the cells.

The fine powdering of the material is of the utmost importance. A drug mill is usually used for this purpose. An agate or iron mortar may be used sometimes to advantage, or the material may be grated upon a fine grater, and then submitted to the same process of powdering and sifting, until it can be passed through a No. 80 sieve.

The Mexican ocotilla bark* is resinous and contains a wax, and it is very difficult to powder. From this fine powder the analysis yielded by cold maceration thirteen per cent. of waxy substance. Hot maceration gave nine per cent. An analysis from portions less finely powdered gave three per cent. less of wax. To estimate the amount of moisture retained in the air-dried plant, a small quantity of the powder, from two to five grammes, may be weighed and dried until constant weight at a temperature from 100° C. to 105° C. By means of this determination, the results of all other estimations of the analysis can be calculated to the dry substance. Even in the case of fresh plants, it will be necessary for a quantitative examination of the entire plant at least to dry the portions which are to be treated with petroleum ether, ether, and alcohol.

The powder, which has served for the moisture determination, is carefully burned at a dull red heat, and the ash residue weighed. This gives the total ash constituents of the plant. In many cases it is desirable to estimate the amount of soluble and insoluble ash, and to determine quantitatively one or more of the ash constituents, especially sulphuric and phosphoric acids and potash. In the ash may be found phosphorus, sulphur, silicon, chlorine, potassium, sodium, calcium, magnesium, iron, and manganese, as well as oxygen, carbon, and nitrogen; rarely lithium, rubidium, iodine, bromine, fluorine, barium, copper, zinc, and titanium. The carbon, hydrogen, nitrogen, sulphur, and phosphorus are derived more especially from the organized parts of the plant, as the protoplasm and cell wall, and from carbonaceous substances, such as sugar, fats, and acids. It was stated that the volatile part of plants, on incineration, is gaseous, consisting principally of carbon dioxide, watery vapor, and nitrogen. The inference being that the combustible portion of the plant contains the elements carbon, hydrogen, and nitrogen.

The fact that various mineral constituents are essential to the growth and development of plants is of practical value in agriculture. The soil must contain the various constituents in such quantity and form as to be available to the plant. The ash analysis of any plant indicates in a great measure the character of its surrounding soil, though the chemical composition in which the ash is contained in the plant is not necessarily the same as in the soil.

In investigating a new plant for the first time, all rational means for discovering its component parts should be resorted to. Before beginning the systematic analytical scheme, a micro-chemical investigation of thin sections of the plant, and even of the powdered plant, may be followed. I have found it an excellent aid in the work, after knowing what constituents were present from chemical analysis, to determine in what tissues and cells these various substances are found. A drop of the extracts evaporated on a glass slide frequently indicates the character of the substances contained in them.

It is of importance to determine if volatile oils or acids, alkaloids and other substances, are present, which can be separated by distillation, and for this purpose a sufficient quantity of the powdered plant may be mixed in a convenient vessel with water, acidulated water, or milk of lime, and the mixture heated, preferably by steam. The distillate is condensed, and may be examined as to its reaction, odor, and physical appearance. If the aqueous distillate is agitated with a light petroleum ether,† volatile products may be readily obtained.

Many volatile oils diffuse in moist air and pass off with the petroleum ether, if precautions are not taken to prevent it, but a system by Osse‡ has been devised to evaporate the petroleum ether and save the volatile oil.

Distillation of volatile principles may be sometimes substituted by other methods, such as "infusion" and "enfleurage," of which I shall speak later.

The following is the general plan I usually follow, based upon Dragendorff's scheme, in order to determine the constituents of any plant. Twenty, fifty, or 100 grammes of the dried powdered plant are weighed and macerated with successive solvents. The solvent is added in the proportion of ten c. c. to one gramme of powder. This is allowed to stand, with frequent shaking, for eight days, when the liquid is removed with a pipette or filtered from the powder. The residual powder is then rinsed with more of the solvent, which, added to the extract first obtained, is made to a known volume. The powder is dried at the ordinary temperature, and is then ready for maceration with a second solvent, and so on, until the sequence of solvents has removed all soluble matter from the powder. The residual insoluble portions are cellulose, lignin, and other allied substances, which form the firm framework of the plant.

The solvents used must be chemically pure. The order of solvents recommended by Dragendorff, and the classes of compounds which may be extracted by them, are given in the table.

PETROLEUM ETHER EXTRACT.

Ethereal oils; volatile fat acids; glycerides; waxes; camphors; cholesterin or allied substances; chlorophyl and alkaloids with fixed oils; aldehydes; ethereal salts; alcohols; aromatic acids; resins.

ETHER EXTRACT.

Resins; waxes; fats; chlorophyl; coloring matters: organic acids; glucosides; alkaloids (caoutchouc, chloroform, or bisulphide extracts).

ALCOHOL EXTRACT.

Tannic acids; bitter principles; organic acids; alkaloids; glucosides; glucose; saccharose; coloring matters; resins.

WATER EXTRACT.

Mucilaginous and albuminous substances; dextrin and other carbohydrates; saponin and allied compounds; glucoses; saccharoses; organic and mineral acids.

DILUTE SODA EXTRACT.

Metarabic acid; albuminous substances; phlobaphenes, etc.

DILUTE HYDROCHLORIC ACID EXTRACT.

Parabin; oxalate of calcium, etc.; starch.

DETERMINATION OF LIGNIN AND ALLIED SUBSTANCES AND OF CELLULOSE.

Benzole, chloroform, amyl alcohol, and acetic ether are frequently valuable solvents for certain extractions, although they are not included in the general scheme.

Dragendorff recommends the maceration to be conducted at the ordinary temperature, but a fixed oil, if present, may be extracted more readily by exhaustion at an elevated temperature. Such substances as caoutchouc may be readily extracted by boiling chloroform or bisulphide of carbon. If a known volume of the extract is evaporated, the residue will yield an approximate result of the amount of definite substances contained in the plant.

In my own work, I have usually found it convenient to take about twenty grammes of the powdered plant and exhaust them in a displacement apparatus. There are some advantages for this method in a preliminary study of the plant. The time necessary for the exhaustion is very much lessened: from ten to twelve hours at the most is ample time to allow the apparatus to run with each solvent, if the solvents are kept at a boiling heat during this period. It is a rapid way to determine qualitatively what constituents are to be found in any plant, and this may be followed by a careful quantitative study on larger amounts. The general insight which can be obtained of the chemistry of a plant from this small quantity of material serves as a valuable guide for the future study on a larger scale.

The extracts obtained by heat show more proneness to oxidation than those from cold maceration, and there are some slight differences in the character of the extracts. The tendency of the higher temperature is to increase the number of constituents in the first extracts; *i. e.*, hot petroleum ether will remove a considerable quantity of chlorophyl, hot ether will extract tannin, and hot alcohol extracts contain sugar, saponin, etc. After the hot alcoholic maceration, the water, dilute soda, and acid extractions are conducted at the ordinary temperature.

It will depend somewhat upon the object in view on the part of the analyst what course to follow in the study of a plant. If only one compound is to be isolated and examined, disregarding the other constituents, suitable methods of study will be employed for this end. Even when Dragendorff's systematic scheme is followed, a fresh portion of powder should be extracted with water for an accurate estimation of soluble albuminoids, amides, and other classes of nitrogenous compounds. These subjects are very clearly stated in the volume of *Plant Analysis* to which I have referred.

I wish to bring forward some well-known statements, which may serve to illustrate the practical application of facts discovered by plant analysis. One of the more recent applications of new processes to industrial chemistry is the manufacture of hop resin extract * on a large scale. The use which is made of this extract is in the manufacture of beers, and it is being used to a large extent in Philadelphia and New York, fully supplying the place of the ordinary hop. The process is somewhat as follows: The hops are loosely placed in large wire cages, and then are run into an immense boiler or "extractor." A heavy door is shut securely, and about 300 barrels of light petroleum are pumped in by an engine, and heat is applied by means of a steam coil, until a pressure of 100 pounds to the square inch has been obtained.

The object of this high pressure is to break or crush the glands, called lupulin, which contain the valuable principle, this being taken up by the hot petroleum. The process is so managed that there is very little waste of menstruum, and the hop extract is readily separated; the petroleum ether being used over and over again. One pound of this extract represents about twelve pounds of choice hops, and it has a great advantage over the hop itself, as it will keep for an indefinite time; whereas at the end of two years the hop is useless.

Hop resin,† or bitter, was discovered from the chemical analysis of a plant, and it illustrates to what practical ends a fact derived from this source may be applied. The solubility of hop resin in petroleum ether is availed of also in the examination of beer.‡

(*To be continued.*)

OIL EMULSIONS.

E. KRAFT recommends a simple method for preparing the so-called *Emulsio* or *Emulsio oleosa*, which forms a frequent constituent of the prescriptions of Continental practitioners and is always prepared with oil of sweet almonds, unless another oil is expressly directed. These emulsions are always directed to be prepared in a mortar, which not only consumes some time, but is also accompanied by loss, as it is not practicable to transfer the whole of the contents of the mortar to the dispensing vial. The method recommended by Kraft consists in this, that the emulsion is prepared directly in the vial in which it is to be dispensed. For instance, if expressed oil of almonds, 10 parts, is to be made into 100 parts of emulsion, proceed as follows:

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* A lecture delivered before the Franklin Institute, January 17, 1887. From the *Journal of the Franklin Institute.*

† Principles of Scientific Botany. By Dr. J. M. Schleiden. London, 1849.

‡ How Crops Grow. By S. W. Johnson. London, 1869. P. 4.

§ "The Alkaloidal Value of Cultivated and Wild Belladonna." By Girrard, *Pharm. Jour. and Trans.*, vol. xv., p. 153.

‖ Encyclopedie Chimique. Tome X. "Analyse Chemique des Vegetaux." Traduit de l'allemand et annote. Par F. Schlagdenhauffen. Paris, 1885.

¶ Plant Analysis. By G. Dragendorff. Translated from the German by H. G. Greenish. London, 1884.

** Plant Analysis. English translation, p. 2.

* Preliminary Analysis of the Bark of Fonquieria Splendens. By Helen C. De S. Abbott. Proc. Amer. Ass. Adv. of Science, vol. xxxiii. *American Journal of Pharmacy*, February, 1885.

† Manufactured by Dr. H. W. Jayne, Frankford, Pa.

‡ Archiv. d. Pharm. (3), vii., 104 (1875). (Year Book Pharm., 1876, 362.)

* "Hop Extract." By W. B. Bissell. *Am. Jour. Pharm.*, April, 1885, p. 166.

† Lermer, *Vierteljahresschr. f. prakt. Pharm.*, xii., 504, 1863; Bissell, *Amer. Jour. Pharm.*, xlix., 582, 1877; Griessmayer, *Ber. d. d. Chem. Ges.*, xi., 292, 1878; Isleib, *Archiv. d. Pharm.* (3), xvi., 345, 1880; Cech., *Zeitschr. f. Anal. Chem.*, xx., 180, 1881.

‡ Griessmayer.

First pour 7·5 gm. of water into the vial; then the 10 gm. of oil of almonds, and next 5 gm. of best gum arabic in very fine powder, and shake energetically. After a while add gradually the remainder of the water. The resulting emulsion will be faultless.—*Pharm. Zeit.*

A HOME OF REST FOR HORSES.

THIS excellent institution has been established in England in order to enable the poorer classes, such as cabmen and small tradesmen, to procure on moderate terms rest and good treatment for horses which are failing, not from age, but from overwork or other accidental cause, and are likely to be benefited by a few weeks' rest and care. It also provides the owners with temporary substitutes during the time their horses are in the home, while another object is to afford an asylum for old favorites whose owners wish to avoid selling or destroying animals which have served them well, and have become superannuated. There are two homes—one at Sudbury, near Harrow, and a second at the Neasden Stud Farm, near Willesden.

1. Miss Lindo, the Founder of the Home, on Ken, the First Patient. 2. Procession of Patients. 3. Convalescents. 4. Visitors to an Old Friend. 5. Capt. Hayes on Horse Control for Shoeing and Veterinary Purposes without Cruelty. 6. First Lesson in Backing. 7. The Art of Riding by Balance (without Reins). 8. Learning to Jump. 9. Method of Catching a Horse.

HOME OF REST FOR HORSES, NEAR LONDON.

Our sketches represent some incidents at a *fete champetre* given on the occasion of the formal opening of the latter. The whole idea is mainly due to the exertions of Miss Lindo, who, as we represent, rode a gray horse, Ken, which she had purchased in a very poor condition, and which had so far recovered under her treatment that it had hunted for three seasons in Warwickshire. The programme of the day included a parade of the cab horses which are let out to cabmen having horses in the home, an inspection of the stables and the patients, and an address on horse training and management, delivered by Captain Horace Hayes, who gave practical illustrations of the art of giving horses good manners, and curing rearers and jibbers. Mr. Hayes also showed how it was possible to ride and jump without reins by simple balance, while there were various displays of hurdle and fence jumping. The patients mainly come from the shafts of London cabs, and poor persons are able to get their animals taken in free on presentation of letters from subscribers.—*Graphic.*

INFLUENCE OF SCIENTIFIC AND INDUSTRIAL PROGRESS.

By Dr. WERNER SIEMENS, of Berlin.

THE question is asked whether mankind is really being made better and happier by all the achievements of sciences and industrial arts; whether, on the contrary, these achievements do not lead to the destruction of all our ideals and to coarse sensualism; whether they do not simply tend to aggravate the injustice in the distribution of the goods and joys of this world; whether the improvements in machinery and the consequent division of labor do not diminish the individual laborer's opportunities of independent work, and bring the laboring man into a more dependent position than he has hitherto held; whether, in fact, the supremacy of birth and the sword is not about to be superseded by the still more oppressive reign of inherited or acquired property.

It cannot be denied that this dark view has, at the present day, a certain plausibility. The rapid and irresistible advance in the useful arts must, in its course, act destructively on many branches of industry. replace antiquated and untenable conditions and methods with better ones. We, therefore, hear increasing complaints of the general fall in prices and the decreased demand for labor; and as a means for lessening this evil it is proposed to shut one country against another and to impose forcible checks upon production. The advocates of these theories go so far as to deny the value to mankind of the advance in science and useful arts, and would even appear to desire a return to the methods of former and, in their eyes, happier times. They, however, fail to reflect that the population of the world would have first to be brought back to the former figures.

The number of happy shepherds and hunters which a country can support is very small, and, in estimating the comparative amount of happiness of any given period, the question of numbers must ever remain an important factor. It is a sad but, unfortunately, inevitable law in the life of society that all transitions, even those to a better stage, are accompanied with suffering. It is, therefore, a humane endeavor to attempt to alleviate these sufferings of the present generation by judiciously guiding and even partially checking the irresistible revolution in the conditions of social existence; but it were a hopeless undertaking to arrest or perhaps to force back this current of development. It is bound to continue on the prescribed path, and the countries and peoples which least of all will be visited by its devastations, and be the first to enjoy the benefits of the age of science, will be those which contribute most toward promoting its pacific course. But that this current is urging mankind forward toward a better state, and in its further progress will heal the wounds it has made, is already made manifest in various ways in spite of the unavoidable evils entailed by a transition to new conditions of life.

The improved methods of production frequently have the effect of causing the supply to outrun the demand, and of diminishing the opportunities for labor, inasmuch as the former methods of production, which gave employment to much larger numbers of hands, are forced to give way in the struggle with the newly invented machinery.

The same is the case with regard to the production of food. The cheapened means of transportation supply the older and more civilized countries with vast quantities of the products of distant and thinly peopled regions, whose virgin soil requires no artificial fertilizing, but whose paucity of cultivators has invited the co-operation of labor-saving machinery. The consequent fall in the prices of these products renders it impossible for our old methods of hand labor cultivation to compete successfully. It is true that improved scientific processes, the more thorough replacement of the constituents taken from the soil, more rational modes of cultivation, afford the means for counteracting these disadvantages; but it is extremely difficult to

Does not the mere fact of the general fall in the prices of the necessaries of life and other products of labor, combined with a simultaneous increased consumption and use of these commodities, afford a conclusive proof that the human labor required for their production is not only less arduous, but less in quantity? Does it not prove that the tendency of this progress will be to lessen the amount of time required

for earning one's livelihood? Does not the fact that the fall in the price of commodities is not accompanied by a corresponding decrease in the rate of wages indicate an improvement in the lot of the workingmen as science progresses? Greater ease in procuring the necessaries of life is equivalent to an increase in wages. "Higher wages and shorter hours," this ever-growing cry of the so-called working classes, is therefore but a manifest result of this progress. For inasmuch as, with the exception of times of financial panic and of transition periods, the quantity of commodities produced is no greater than what is consumed, it must be that the average hours of labor diminish with the increased rapidity and facility of production,

Another very general fact which presents itself is the decrease in the rate of the profits of capital, and to appreciate the importance of this circumstance we must remember that capital—that is, the savings of the wages of labor, as political economists correctly term it—is the gauge of all property. Capital, whether one's own or borrowed, enables a man to avail himself of the use of another man's labor. Were capital really abolished, as some fanatical and deluded people would have it, mankind would have to revert to an uncivilized state, as each individual would then have to rely upon the labor of his own hands for the satisfaction of his wants. But with the growth of capital, that is, the savings of labor, there is no corresponding increase in the demand for its use, inasmuch as the various kinds of apparatus employed for the creation of the products of labor are being constantly perfected, and made simpler and less costly. There is generally, therefore—leaving out of account fluctuations of transition and violent disturbances—more capital being accumulated than can be profitably invested; or, in other words, there is an "overproduction" of capital, which must show itself, and in fact *does* show itself, in the constant decline in the rate of interest. The savings of former labor—capital—will therefore constantly decline in value as compared with the labor of to-day.

And as for the other and apparently the weightier ground of complaint of the opponents of our present industrial revolution, which consists in the assertion that through this change the large majority of people are condemned to labor in large factories, and that through the constantly increased division of labor no field is left for the free labor of the individual—herein, too, the natural course of scientific development has its remedy.

The necessity for extensive workshops for the cheap production of commodities is at present still due, to a great extent, to the imperfect development of the art of practical mechanics. Till now large machines have worked more cheaply than small ones, besides which the putting up of the latter in the dwellings of laboring men is still attended with great difficulties. But mechanical skill will certainly succeed in removing this impediment to a return to the system of independent, self-sustaining, domiciliary labor, and this will be accomplished by the introduction of cheap labor-saving machinery—the foundation of all industry—into the smaller workshops and the homes of the workingmen. Large numbers of great factories in the hands of rich capitalists, in which the "slaves of labor" eke out their miserable existence—it is not toward this that the age of science is tending, but toward a return to individual labor, or toward the introduction, where circumstances require it, of co-operative workshops conducted by associations of workingmen. Such a system of co-operation, however, can be established on a sound basis only through a more general diffusion of knowledge and culture, and through greater facilities for accumulating capital.

Equally unfounded is the complaint that the pursuit of the natural sciences and the unceasing efforts to utilize the forces of nature impel man in the direction of materialism, foster his conceit with regard to his knowledge and powers, and divert him from ideal aspirations.

The more deeply we penetrate into the harmonious workings of nature, governed by eternal, unalterable laws, and yet so completely shrouded from our understanding, the more we are filled with a sense of our humbleness, the narrower appears the range of our knowledge, the more eager are we to extract what we can from this inexhaustible reservoir of knowledge, and the more do we wonder at the all-controlling wisdom which pervades creation. And our admiration and awe excite in us that spirit of investigation, that devoted, pure, and unselfish love of science, which have particularly distinguished the German scholar, and which, we trust, will continue to mark our future generations.

And so let us not permit ourselves to be shaken in our conviction that our activity in investigating and inventing tends to advance man toward a higher stage of civilization, that it ennobles him and fills him with ideal aspirations, that the dawn of the age of science will alleviate his wants and sufferings, increase his enjoyment of life, and make him better, happier, and more contented with his lot. And if we cannot always see clearly before us the path which leads to a better state of things, we shall still adhere to our firm belief that the light of that truth after which we are striving cannot mislead man, and that the power with which it invests him cannot debase him, but must elevate him to a higher level of existence.

LEAF PRINTS.

SEVERAL years ago I devised a method of taking leaf prints of marked beauty, and a specimen of the work recently sent to Dr. Gray elicited the reply: "Tis a new way. Better send account of it to *Botanical Gazette*," etc. I do so, prompted by the belief that the method may be of actual usefulness to the botanist as well as a refining recreation for those who love nature "on general principles." There will be needed for the work: 1. A small ink roller, such as printers use for inking type. 2. A quantity of green printer's ink. 3. A pane of stout window glass (the larger the better) fastened securely to an evenly planed board twice the size of the glass. A small quantity of the ink is put on the glass and spread with a table knife, after which it is distributed evenly by going over in all directions with the ink roller. When this has been carefully done, the leaf to be copied is laid on a piece of waste paper and inked by applying the roller once or twice with moderate pressure. This leaves a film of ink on the veins and network of the leaf, and by placing it on a piece of blank paper and applying considerable pressure for a few moments the work is done, and when the leaf is lifted from the paper the impress remains with all its delicate tracery, faithful in color and outline to the original.

To get the best results, however, several points must be carefully noted. Get a quarter or half pound of *dark* green ink, which is put up in collapsible tubes, costing from 50 cents to $2 a pound, according to quality. As sold, it is invariably too thick for this purpose, and should be thinned by adding several drops of balsam copaiba to as much ink as may be taken on a salt spoon.

Much depends on the proper consistency of the ink. In inking, the leaf is apt to curl on the roller, but it should part readily from it. In case it sticks tightly, *the ink is too thick*. Take care that the ink is evenly distributed on the glass and roller, as it is essential that each part of the leaf receives an equal coating of ink. If the leaf is large, ink it part by part, keeping the roller supplied frequently. A roller three inches long, costing 40 cents, will answer for all small leaves and branches of plants. (Clean the roller with benzine after using.) If the leaf is finely veined, the lower surface makes the better print; but if the veins are coarse and large, the upper surface may be used. If the specimen is fleshy or brittle, allow it to wilt until it becomes more pliable, or if necessary it may be pressed and dried first. In most cases the best copy is obtained after taking one or two impressions, as the leaf takes the ink better after several applications. A good quality of unsized paper that is made slightly damp by putting in a cellar several hours before using is best for general work, but in other cases well sized paper will take a copy that will allow a *foliotype* (may I coin the word?) to bear inspection side by side with a good lithograph.

I find a letter copying press very valuable in making the impression, especially if the leaf is at all coriaceous. If it be soft, it should be covered with a few thicknesses of newspaper. If it is irregular in thickness, paper may be laid over the thin parts, so that equal pressure is received. This is necessary with all leaves that have thick stems. If the leaf or branch is very irregular or delicate, or in the absence of a press of any kind, the specimen may be covered with several layers of paper and held in place with one hand while the pressure is applied with the thumb or palm of the other hand as required.

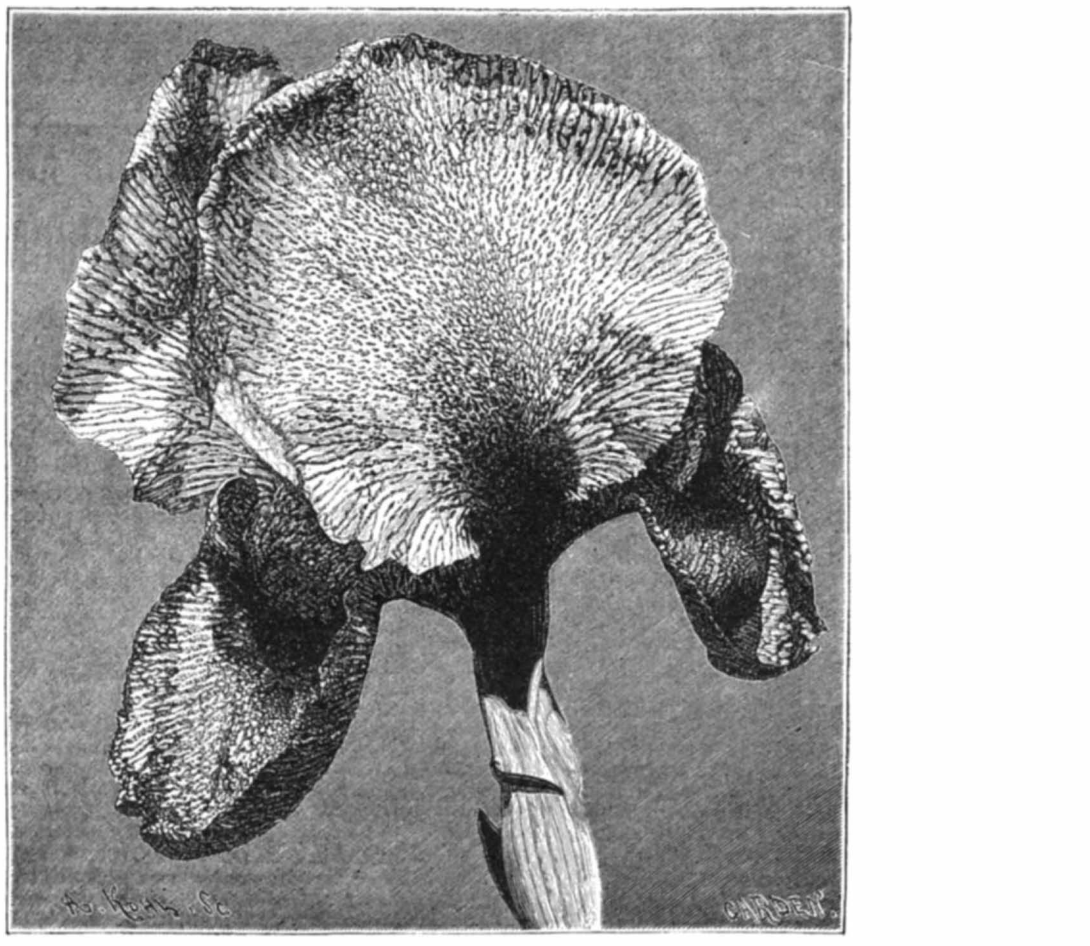
These particulars are as complete as practicable. Experiment will lead to many improvements in details. Employ tact and neatness, and you will be surprised at the result. For illustrating monographs and similar papers where the number is too limited to warrant an expensive lithograph, for identifying a rare specimen, or as an adjunct to an herbarium, combining portability, unalterability, and beauty withal, the method seems particularly fitted. But aside from this, others may find a delightful and instructive recreation in taking prints of the entire flora of the old farm, the trees of a certain grove, the native annuals of a county, the ferns of a State, or any other special field that seems most inviting. Such copies may be taken in a blank book suited to the purpose, or, better, take them on single sheets of uniform size, as in this way imperfect copies may be thrown out, and when the work is completed they may be named, classified, and bound, making a volume of real value and worthy of just pride. I would esteem it a favor as well as a pleasure to hear personally from any who may employ this method in any way the coming season, concerning the progress of their work, with its attendant imperfections and successes. HORACE M. ENGLE.

Marietta, Pa. —*Botanical Gazette.*

IRIS SUSIANA.

WE engrave a figure of this curious and beautiful iris, from a photograph by Mr. Greenwood Pim, in whose garden it blossomed this year, as well as in several other places about Dublin, no doubt fostered by the unusually dry and warm season. Mr. Pim writes that the individual was fully half as large again as the figure, although perhaps hardly up to average in size. It grew at the edge of a border of tea roses, which is kept up with two or three rows of bricks and facing almost due south; hence it is always warm and dry.

Ixias, sparaxis, and other like things flourish in the neighborhood. This most remarkable species is now so cheap (1s. 6d. per dozen) that, though not easy to bloom, every lover of choice things should get it.—*The Garden.*



THE GREAT SPOTTED IRIS (IRIS SUSIANA).

QUICK PROCESS OF CIDER VINEGAR MAKING.

ANY farmer can easily change all the cider he is likely to have into vinegar by the following quick process. The requirements are, first, a cask; second, a box made of four wide boards, fifteen to eighteen feet long, with a bottom board "full of holes;" this is to be placed upright, above, and leading into the cask; third, above and leading into this box there must be an automatic fountain. These provided, each person can determine where it will be most convenient to improvise the factory—whether in barn or woodhouse. If he has no better place, he can put the fountain in his house at a second story window, the box and cask being outside under the window. Instead of the box, I used (with first-rate success) two headless salt barrels, one above another, the lower one with one head full of holes. It may be possible that the barrels are better than the box, because air is admitted where they join, and they do not allow the porous contents to settle readily and pack as a straight box would. Cross pins through the box would be a remedy against the setting and packing. Next I put in a half bushel of cobs and filled to the top of the upper barrel with oak sawdust. Then from the fountain I turned on a stream of cider nearly or quite as large as a common pen holder, but reduced to a mere dripping through the night. The sawdust absorbed more than a barrel before any began to run into the lower cask. The fountain was kept running with cider till the lower cask was nearly full. Then the fountain was supplied from the contents of this cask till the liquid had made three or four circuits through the sawdust and corn cobs, and had become excellent vinegar.

Most of this was barreled, and the rest was used, alternately with new cider, to replenish the fountain. Sometimes I used twice as much of one as the other, but as fast as it became good vinegar I kept on barreling all except what was wanted to mix with new cider in continuation of the process. When there was no more cider to work up, the vinegar in the sawdust was got out by putting water in the fountain, and as it descended in the sawdust it "displaced" or pushed the vinegar downward. When the water began to come through tasting only a little of vinegar, it was turned off.

This last lot of vinegar may be mixed with that previously made, and the total measure will be fully equal to the original quantity of cider; and if the cider was pure and unwatered, the vinegar will be so intensely strong that it may be largely diluted.

During the process considerable heat is generated, the sawdust and liquor becoming quite warm. It may be that this heat may be increased or diminished to advantage by turning on a large amount of cold cider at once or by having the cider warm when it is turned on—more especially at the beginning, when everything is cold. However, without warming the cider, I suc-

ceeded as above. The original recipe prescribed mixing a small quantity of honey with the cider. This is not necessary. The recipe also called for beechwood shavings, as though nothing else would answer. The fact perhaps is that the shavings and sawdust of all kinds of wood that will not communicate taste or color are about equally good. Dead-ripe, cut straw washed free from rust and smut would probably answer. The theory of the quick process is based on the diffusion and exposure to the air of the cider (or of any other fluid that will make vinegar), so that all portions may absorb oxygen simultaneously. If the theory is correct, then it is almost a certain fact that crushed charcoal or coarse sand that will admit circulation of air would answer.

Some people object to the quick process cider; but there is no reason why the simultaneous absorption of oxygen by all parts of the cider from the pure external air should make a vinegar less wholesome than that which is one or two years in "making itself" by absorbing oxygen through a bung hole from the poor quality of air in a cellar where the cider is fermenting. Fresh made, quick process vinegar is free from animalcules, and will remain so for many years without "dying," becoming "mothery" or "ropy," if in full vessels tightly corked. S. D. H.

North Lansing, Mich.

As a free circulation of air in the barrel is of first importance, more air can get into it if within ten to fourteen inches of the bottom six or eight half-inch holes are bored at a slightly descending angle, so that the vinegar trickling down the sides may not escape through them. In order to thoroughly aerate the interior of the barrel, wooden or glass tubes may be inserted at a slight downward angle in downward inclined holes, bored so that the vinegar cannot escape through them. Experience seems to prove that beechwood shavings, rolled pretty closely, are the best filling for the barrels, while maple and basswood are valuable in the order named. Clean corn cobs will answer, and if they are thoroughly washed in warm water the second season, they are more effective than the first. Chips of beechwood, charcoal, and other porous bodies may also be used instead of shavings. Charcoal, broken in pieces the size of a walnut, sifted from dust, washed and dried, when saturated with vinegar, acts like beech shavings, but the pores of the coal absorb five to six times more of the fluid. If corn cobs are used, they should be put in layers, each layer crossing the other, to prevent their packing too closely. They should be first thoroughly soaked or washed in water, then dried, and boiled in strong vinegar. Shavings and other materials used for the same purpose should be treated in like manner to produce the best results. To acidify the material, hot and strong vinegar should be repeatedly poured into the top of the barrel or "generator," so as to be evenly distributed throughout its contents through the numerous small holes bored in the top. The vinegar thus extracts what soluble matter is left undissolved by the water. Unless removed, this matter tends to produce putrefaction in the vinegar. Next to an abundant supply of air in the generator, an equable temperature is most important. The limits of temperature should be 72° for the lowest and 100° Fahr. for the highest, and within these limits the higher the temperature the more rapid the fermentation and the transformation of the cider into vinegar. At a higher temperature than 100° some of the acetic acid decomposes, and there is likely to be a serious loss of alcohol, of which prime cider vinegar contains six per cent., pure cider containing ten per cent. The reduction is accomplished by the addition of *pure, soft* water, which is mixed with the cider before it enters the generator.—*Rural New-Yorker.*

HOW TO MAKE JELLY.

APPLE JELLY.

TAKE any good, juicy apples; cut them, skin, core and all, in slices into a preserving pan containing sufficient water to cover them; then put them on the fire and boil them until they are reduced to a mash. Then strain the water from them, through a hair sieve, into a basin or pan; then filter it through a flannel bag. Measure the liquid, and for every pint of it allow one pound of granulated sugar, of which make a sirup and boil it to the ball. Then mix the juice with it and boil until it jellies; stir it with a wooden spatula from the bottom, to prevent scorching; when it is boiled enough may be known by its adhering to the spatula, or a little may be dropped on a cold plate; if it soon sets, it is done. Take off the scum which rises on top. This jelly may be colored with vegetable colors—violet, green, orange, prepared cochineal or carmine.

QUINCE JELLY.

This is made in the same manner as apple jelly. The seed of the quince is very mucilaginous. An ounce of the bruised seed will make three pints of water as thick as the white of an egg.

RED CURRANT JELLY.

Take ripe red currants, and to every four quarts of them add one quart of ripe red raspberries; these are added in order to tone down the sharp acid of the currants. Put the mixed fruits into a bright and clean copper basin or, much better, a porcelain lined basin and mash them; put them on the fire and stir them until they are reduced to a mash; then strain and press the juice from them through a fine hair sieve into an earthen pan, after which filter the juice through a flannel bag.

Then, for each pint of the filtered juice you have, take one pound of refined sugar, make a sirup of it, and boil it to the "crack degree;" then mix the filtered juice to it, part at a time, and stir till well mixed. Continue to boil, removing the scum as it rises with a perforated skimmer, boil till it jellies, which will take about three or four minutes' time after the juice is added to the boiled sugar; then pour it immediately into your glasses or pots; when it becomes cold, lay a piece of paper, cut to fit and saturated with brandy, on the top of the jelly, after which tie up closely with stout paper or with wetted bladder. Keep in a cool, dry place. In this manner you will have a fine jelly, which will keep good for several years.

WHITE CURRANT JELLY.

This jelly is made entirely of white currants and precisely in the same manner as red currant.

BLACK CURRANT JELLY.

Make in the same way as red currant, using one-third red currants and two-thirds black ones.

A VIOLET COLORED CURRANT JELLY

Is made as red currant jelly, mixing two pounds of black currants with ten pounds of red.

CHERRY JELLY.

Pick off the stalks and take out the stones of some ripe, juicy cherries, and to every four pounds of cherries add one pound of red currants. Proceed as for currant jelly.

RASPBERRY JELLY.

Take six quarts of ripe raspberries and two quarts of ripe currants, press out the juice and filter it; to a pint of juice take one pound of sugar, and treat and finish as red currant.

GOOSEBERRY JELLY.

Make of ripe gooseberries in the same manner as currant jelly, or it may be made of green gooseberries in the same way as apple jelly.

BLACKBERRY JELLY.

Make as red currant jelly, using two quarts of raspberries to four quarts of blackberries. Finish as above directed for other jellies.—*Confectioners' Journal.*

MOUNTAIN ASH BERRIES.

THE juice of ripe mountain ash berries contains, besides sorbine and glucose, an astringent principle, having a very acid reaction. Caustic alkalies and ammonia turn it an intense gold yellow, which disappears on acidification. It does not precipitate solutions of alum; it reduces salts of silver in heat, precipitates copper acetate of an olive green, turns a very intense dark green with ferric salts, which the alkalies and ammonia alter to a reddish brown. With neutral lead acetate it gives a light yellow precipitate; with the subacetate a very pure lemon yellow. It does not precipitate gelatine. On distillation it gives a thick brown liquid, rich in pyrocatechine, and leaves a voluminous charcoal. This tannin approximates closely to morintannic acid, and especially to caffeotannic acid, but differs from them in several respects. The authors propose to name it sorbitannic acid.—*C. Vincent and M. Delachanal.*

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