Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for scanning. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of scanning are checked below.

L'Institut a numérisé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de numérisation sont indiqués ci-dessous.

- [ ] Coloured covers / Couverture de couleur
- [ ] Covers damaged / Couverture endommagée
- [ ] Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- [ ] Cover title missing / Le titre de couverture manque
- [ ] Coloured maps / Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- [x] Bound with other material / Relié avec d'autres documents
- [ ] Only edition available / Seule édition disponible
- [x] Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.

- [ ] Coloured pages / Pages de couleur
- [ ] Pages damaged / Pages endommagées
- [ ] Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached / Pages détachées
- [x] Showthrough / Transparence
- [x] Quality of print varies / Qualité inégale de l'impression
- [ ] Includes supplementary materials / Comprend du matériel supplémentaire
- [ ] Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from scanning / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été numérisées.

- [x] Additional comments / Commentaires supplémentaires: Continuous pagination.

THE

CANADIAN MAGAZINE

OF

SCIENCE AND THE INDUSTRIAL ARTS.

Patent Office Record.

Vol. XVII. NOVEMBER, 1889. No. 11.

BUILDERS' WORKSHOPS AND WORKMEN AND THEIR MANAGEMENT.

BY A BUILDER.

In this paper I propose to treat on various subjects, which may occasionally be unpalatable to those whom the cap fits; but, nevertheless, I hope of interest and use alike to builders, foremen, and workmen. As I have occupied the three positions, I have had opportunities of noting some of the most necessary points in the successful carrying out of work without the necessity of making the master a tyrant, the foreman a bully, and the workmen slaves. I will first give my views on Joiners' Workshops. In the majority of instances workshops are built simply with a view to first cost, or, if built for other purposes, and afterwards adapted to the use of joiners, cheapness of first cost is the rule without regard to comfort or arrangements, without heating apparatus, without ventilation, except where the hurried building allows ventilation in summer or winter alike. If machinery is employed it is badly arranged. The shops are filled as closely as possible with benches of all sorts and sizes, fitted with the cheapest of wood screws. Then it is stocked with an insufficient supply of cramps, glue pots, and other necessary accessories. The workmen are half-roasted in summer, and half-frozen in winter, and yet a foreman is expected to get together a body of good workmen, and to turn out the work as cheaply and as well as if he had every convenience to aid him. A workshop should be carefully, thoughtfully, and systematically arranged by a practical man, with the one aim in view, of lessening labour to a minimum, and of providing every convenience and aid to that end. In this time of keen competition, work is required to be done as cheaply as possible; and if it is to be done cheaply and well, a workshop must be comfortable. In the first place a workshop should be properly ventilated; no man can do as much in a close, humid atmosphere in summer as he can in a cool, well-ventilated workshop. Then, again, it should be fitted with heating apparatus for cold weather. It is a mistake to think that if a shop is cold, a man will work all the harder to keep himself warm. A man standing shivering with the cold beside his bench, with cold hands and cold feet, cannot do half as much work as a man who can pull off his coat and feel comfortable. Besides that, a good workman values a good workshop, and will do his utmost to keep in it. Then, again, as regards the work, a man not only cannot do as much work, but he cannot do it as well. His glue is cold before he can rub a joint, or cramp up a shoulder, with the result that he might almost as well have kept the glue away from it altogether. Then there is the huddling of men together, with from 18 inch to 21 inch bench-room, on benches of various heights; no man has sufficient room to put together a door or a sash, without to some extent hindering his benchmate; if it is a large piece of work requiring the space of two or three benches, then those two or three men are running about to find pieces to pack up level, and spend as much time in preparing a place to put the work together, out of wind, as is required to do the work; after all this fuss and unnecessary waste of time, the probability is that they have to run about for cramps, or they cannot get glue, or perhaps there is no lengthening-bar to the cramp, and they have to lengthen out with a piece of wood, which, by the time it is done with, will have cost more than a proper lengthening-bar, besides probably being of no use afterwards. And yet those men are expected to do the work as cheaply and as well as if every appliance were at hand. Again, the benches are old, shaky, with tops hollow and twisted—a man cannot try-up a piece of stuff true without packing it, and if he wants to clean up a panel he has to use a panel-board, and perhaps spends as much time in looking for one as would suffice to do the work. The bench-screw is of wood, of a value of 1s. 3d., and if he has anything to hold firmly in the vice, he has to strain, until occasionally he breaks the handle, and wastes a half-hour to make another. Give me a shop with good benches, all uniform in height, fitted with good iron square-thread screws, good, clean, true bench tops, a good supply of light T-iron cramps, with proper socketed lengthening bars, a glue-pot to about every four men; give each man 2 ft. 6 in. bench-room, and I will guarantee to turn out more work than if the same shop was filled till each man had only 18 in. bench-room, and the order of things as in a large percentage of workshops. This means a saving of 20 per cent., and employers can reckon up for themselves how much they would save in wages, according to their shop-room. If you have comfortable shop-room for fifty men, and you place one hundred in it, you will only get a very small amount of extra work done. If I had 150 benches in a shop I would have them good, and I would have them so that if I had a piece of work big enough to cover the lot the men would simply have to lay it on the benches and put it together, with a certainty of it coming off true.

About Machinery. A builder will sometimes put down a lot of machinery; it may have all the latest improvements, but again cheapness and hurry come in, and it is badly arranged in a make-shift sort of way. He wonders why the work costs so much, and does not see that the men are in each other's way, and have to wait for each other; it suits the men, but does not suit the employer. If machinery is to be put down, it is necessary to consider its efficient arrangement. I should first consider the door or opening through which the material was to come in from the yard, and from that I should lay my plans, so that the stuff would pass from one machine to another without carrying backwards and forwards, and without getting the work in various states of conversion mixed. I have seen stuff just from the saw, some from the planing-machine, some set out, some not set out, some partly worked, all belonging to various jobs, all mixed up together, tumbled about and trodden under foot, on account of the bad arrangement of the machinery. And then men are expected to finish it off as quickly, and in as good a style, as if it were kept right. A great mistake is to get as much machinery as possible crammed into a small place. If you have not plenty of space you are better without the machinery. If you have not sufficient space for one man to work each machine without in any way inconveniencing another, and sufficient work to keep each man and each machine fully employed, you are better without it. Then, again, the economic use of machinery should be considered; in some workshops, no matter how trifling a thing is required to be done, if it can be done by machinery it must, when perhaps a man could do it by hand in less time than it would take to set the machine, and probably he would be standing idle whilst the work was being done by machine. I once saw as glaring a waste of time as is possible to conceive at a machine shop, where the proprietor boasts of being able to do anything by machinery. He had four large oak gateposts to work, and rather than have them done by hand, he had half a dozen men to get them up into the mill, then stopped a tenoning machine in order to take the slide bed and fit to recessing machine for the purpose of working the posts. Special cutters had to be made, each pair of posts was of different pattern, and when everything was ready it took four or five men to lift the posts about. It occupied two machinists, and kept idle two machines for two days, besides taking the time of three or four labourers; and then it took two joiners a day to finish them, when the whol of the work might have been done by them in three days. With good machinery, well arranged and fully employed, and good men to work it, a practical foreman to control the lot, joinery can be turned out in good shops by good full-priced joiners, in a thoroughly workmanlike manner, as cheaply as any jerry builder can turn it out with bad materials and underpaid pieceworkers. It is not the quantity of machinery which pays, but the choice of machinery, adapted to the requirements of the class of work, and the way in which it is handled; if you have little room, get a general joiner and band-saw. With these to aid the joiners, if there is plenty of space to work them, the work will be done cheaper than if you have every machine invented crammed into an insufficient space. The difference between cost, with or without machinery, is not very much in ordinary builders' work, and it will balance on the wrong side if you have more machinery than you have use for, or if it is not properly handled. If an employer provides clean, comfortable workshops, good work-benches, and other necessary appliances—a sufficiency of everything—and if he has machinery, gets what is adapted to his business, and arranges it properly, with plenty of power and proper speed, he is simply saving 50 per cent on the extra amount of money it cost him in the first instance, beyond what it would cost in fitting up in a makeshift manner. Then he requires to provide good materials. Joinery made from good timber is cheapest, when material and labour are added together. Deals at £14 per standard, which can be cut up right away without picking, with a certainty of none being unfit for use, are much cheaper than deals at £9 per standard, when it will take £4 worth of time to sort out and cut up a standard to best advantage, and then perhaps have to cast out a lot after it is partly worked, and a lot of time thrown completely away. Good materials save more than their extra cost in labour alone, besides giving credit and satisfaction. I myself have had to use up cheap stuff which, with interest of money added, would cost more than best stuff by the time we could get rid of it, besides giving the employer a name for using bad materials. If an employer provides good shops, appliances, machinery, and materials, he does his share towards cutting down cost, and he has to look to his *employés* to do their share.

Now about Foremen. Employers who are thoroughly acquainted with the working part of the business are the exception rather than the rule, and do not know when they have a really good foreman or not. First of all, what is the shop-foreman's position? Well, if the master is not practical, or the manager, as is often the case, the shop-foreman is the principal man in the establishment, and should be paid and treated accordingly. In small businesses, where the employer is not practical, the shop-foreman should be manager as well, as far as the work is concerned; his is the principal part, and requires most thought. A shop-foreman should have the original plans and specifications (tracings and copies only being sent to buildings), so that his work may be before him for some time before it is required; he then has a chance to be always prepared, and to use up materials to best advantage, and if he is a good man, it is best for him to give drawings and bevels, etc., for roofs for the buildings. If he is trustworthy, it is good policy to let him know the price the work has to be turned out for, and he will then use his best endeavours to economise for his own sake.

In large establishments a manager is usually necessary. I am afraid there are a great many managers about who do not reach my ideal, the tendency being to place surveyors, or surveyors' assistants, as managers. It may be policy in some cases to do so; but I would prefer to employ a manager who had worked his way up from the bench or the trowel. A manager should be up to all the tricks of trade—*i.e.*, he should have had practical experience as workman, shop, and general foreman, so that he may be fully acquainted with the faults and failing of each class. With a good practical manager to give orders and particulars, then devolves upon the shop-foreman the duty of systematically carrying out the work. Without system, all the hurry and push he may have only ends in muddle; time is wasted, and it is a matter of impossibility to obtain the exact cost of anything. It depends on the foreman whether there is system or only a makeshift. I can give, as an instance, a shop at the present time in which cheapness is considered the most essential point. In addition to the foreman, who simply superintends, a man is employed to set out rods. So far so good; but, in order to save time in setting out, he puts three or four jobs on one rod. A joiner requiring work to go on with, does not ask the foreman or the man who sets out the rods; but his stuff and job are given to him by the cutter-out, who perhaps knows nothing about the rod or what the work is. The stuff is given to the joiner a little at a time. He has no list of it, no rod, and knows nothing about it until he can find a number on the stuff. That is his first thread. He then has to wait until he can see a labourer to look about the shop for the rod, which perhaps someone else is using. After an hour or two waiting he gets the rod, and then he has to begin to puzzle out what the stuff he has is intended for, as probably it is neither marked nor cut to size. Then, just as he is beginning to see his way a little, a setter-out will take away the rod to set out a part of the work in the mill. The joiner sees no more of rod or materials for a day or two, but has to commence two or three more jobs in the same manner. In the mean time, the stuff is being dogged about in the mill, worked a bit at a time, and when it eventually reaches the joiner again it is knocked about and bruised; some grooved, rebated, or moulded to one setting, some to another, and he has to ease and fit and waste time to make the work fit together. And yet, forsooth, all this muddle under what is called a good sharp foreman, who considers he has a perfect system, and who fully satifies his employer. I could give many similar instances—in fact, I know of few shops where a saving of 15 to 20 per cent could not easily be saved. If a foreman has more than thirty men he should have a working assistant, and he requires an additional one to every twenty or twenty-five men beyond that number. The principal foreman should have specification drawings and full particulars, give particulars and drawings to his assistants, set out all the most particular work, superintend shop, mill, and yard generally, always knowing what materials are in stock, etc. If he does all this practically he has enough to do, and should be well paid for it. Each assistant should set out for his own men one job only on each rod, then take off his materials. I will here give the system I have found to answer well. Get material books, ruled as follows, or sheets will do, but I find books best:—

ORDER NO. 20,—NAME OF JOB.——DATE.

Number.	Description.	Material.	Length.	Wide.	Thick.	Finished width.	Do. thickness.	Remarks.
			ft. in.	in.	in.	in.	in.	
12	Styles	Oak..	6 9	5½	2¼	5¼	2¼	All good stuff polished.
12	Rails	"	3 0	5½	"	"	"	
12	"	"	"	11	"	10¾	"	
6	Muntins..	"	1 6	5½	"	5¼	"	
6	"	"	1 4	"	"	"	"	
6	"	"	2 6	"	"	"	"	

And so on the whole of the materials required. After the list is written out, it should be pasted on a board, together with a time-sheet, as example below:—

TIME-SHEET.—ORDER NO. 20.—NAME OF JOB.——DATE.——

Number or Name.	Time first week.	Second week.	Third week.
20	10	—	—
15	30	—	—
21	9	—	—
40	20	52½	40

A paper is then given to cutter-out, as follows:—

ORDER NO. 20.—MATERIALS.—NAME OF JOB.——

Feet run.	Material.	Width.	Thickness.	Quality.
150	Riga oak.	5½ in.	2¼ in.	Brand.
36	"	11 in.	2¼ in.	"

After booking his material, which must include waste, this list is sent to stores, and other materials added, such as glue, screws, nails, etc., and when job is completed, list and time-sheet are at once sent in, and exact prime cost can be obtained at once. It can be seen, by comparing list on board and materials list, what stuff has been wasted, thus having an effectual check on cutter-out, and, at the same time, it is an easy method of keeping stock of all materials. It is necessary to give finished sizes of panels, etc., to be jointed up, and also of stair-treads and risers, sash-frame casings and pulley stiles, etc., so that the stuff may be planed up in long lengths and cross-cut to exact length, to save a lot of squaring and cutting off afterwards, as well as being quicker for setting out. The rule—one job at a time—should be strictly adhered to. The materials, after cutting-out, are sent to the planing machine, together with list and time-sheet. The list explains finished sizes and number of pieces, and the whole of the stuff is kept together, as each man can see whether he has the lot or not. The joiner, who is to do the work should set it out, what is necessary; but with good machinery and good machinists it is not necessary to set out the whole. It is much better to give a rod or odd strip, the length from shoulder to shoulder, for work for tenoning machine, with number to each length written on rod, and an odd piece of stuff to set to should be included in list, especially when rails, etc., are scribed. All rails should be tenoned before setting-out for mortising, as it insures greater accuracy. It is only necessary to gauge one mortise for a good machine, and on no account should a job be done at two or three sittings. If this system is carried out all through, the stuff is kept together, the tenoning, grooving, moulding, etc., are all the same throughout, and the work is bound to come together accurately, and should require no fitting. If the work is sashes, with a lot of bars to scribe, it is best to get sufficient stuff in 9 in. or 11 in. widths, tenoned and scribed to length, then cut down to thickness of bars and moulded, as the lengths are more accurate and the scribings cleaner. If machinery is used to best advantage, and the foreman works to this system, and keeps rods and plane material well forward, there is no need for waste, either in time or material; the mill and shop are kept in order, so they may be swept out daily as every shop should be. To employ machinists, at times it is good policy when they are not pushed to get a good stock of wedges to each size chisel, also glue-blocks, buttons, cross-tongues, etc., also beads and mouldings in general use, the cost of which should be kept for charging to the various jobs. This saves running about and waiting, as joiners very often have to wait for a few wedges and glue-blocks while they might use them. By this system of keeping time the time is accurately kept, as each man has to book his time as soon as he has finished his part and pass on the sheet to next man, so there is no chance to cook the time, as is often the case. Let each joiner set out his own work—it is cheaper than having setters-out (unless the work can be turned out of the mill so as to only require wedging-up and cleaning-off), as it often takes as long for a man to look over and sort out his stuff and examine the setting-out as it would take to set it out, besides which a man can always do more work from his own lines than from those of another. Of course, everything depends upon what the foreman is. In the first place, he should be a first-class joiner, able to hold his own as a workman with any man he has under his control. In the second place, he should be a first-class draughtsman, and able to set-out any difficult work in such a manner as to be beyond the criticism of any of his men. (I can safely say that 40 per cent of the many foremen I have met, and had dealings with, cannot lay claim to either of these qualifications). In addition, he should have an even temper, and keep a firm command over his men without being a tyrant. His conduct towards them should be such as will not make them afraid to speak to him or ask a question. (I once worked under a foreman who if asked anything about the work, would snarl out, "Look at your rod!" when the rod was so badly set-out that neither he nor I could tell what it was intended for). At the same time, he should be sufficiently firm to deter any familiarity. If a foreman has these qualities, he gains respect from his men; he gets good men, who try their best to satisfy him, and will do more work for him than for a bully. I never yet met a bully who was either a good workman or a good setter-out. As a rule, he makes a bluster to hide his want of knowledge; a good workman will soon detect his incompetency, and take advantage of it, in retaliation for the bullying he has to put up with. A man who is bullied, never works with a good will; if he is a good workman, he takes it as an insult, and will move elsewhere when a chance occurs. I could give instances of foremen whose only recommendation to the employer is that they are bullies, who are constantly spoiling materials and wasting time by their ignorance, which they expose every minute by trivial interference with men in their work, and who have to discharge workmen, sometimes better than themselves, in order to shift the blame from their own shoulders. Foremen should not keep constantly interfering with men in every little detail; if a man can't do the work without it, discharge him, and not waste time finding fault with him. Then there are foremen who let apartments, and take good care of those who lodge with them, whether they are good workmen or not, and of course the master is the sufferer. Again, some foremen take drinks or bribes from workmen, and the man who oftenest greases the foreman's palm keeps his place longest. Again, there are society foremen who give their jobs to their most intimate friends at the branch they belong to, whether good or indifferent workmen. All these men exist. I have worked under them, with them, and employed them, and if any attempt to contradict me, it will be a good proof that the cap fits. They place themselves under an obligation to the men, the men take advantage of it, and employers are the sufferers. My opinion is, however, that the worst of all is the incompetent, underpaid foreman (and there are many), whose weekly wage, taken at per hour for the time he makes at shop and at home, is less than journeyman's wages. He takes the situation on account of the honour (?) of his position, or because he is too idle, or too incompetent to get on as a journeyman. He gets testimonials or recommendations of some description, and the employer, thinking of cheapness, gives him employment because his wage is the lowest. Employers should understand enough of human nature to know that very few men underrate their value, and depend upon it if a foreman offers his services at journeyman's wages, he is worth no more. He gets the appointment and trusts to luck and the help of the workmen more able than himself to help him through. If he has a job he does not understand (and he does not understand much, as a rule), he has to give it to a workman who does. Of course the workman takes advantage of it, and says to himself, "The foreman knows nothing about it; he has to give me what he can't do himself, and yet he has a good, easy job. I don't see why I shouldn't take it easy!" And so the employer is robbed. He (the employer) is fairly satisfied; the work gets done some way or other, more by luck than judgment. He does not see that his cheap foreman is not earning him one-third the profits a fully-qualified man at £1 per week more would earn him, which would perhaps mean £10 to £20 per week. And yet he will keep the foreman, and when he does not require his services will give him a testimonial that will insure the imposter a chance to rob someone else. But is this low rate all the cheap foreman gets? In very many cases it is not. He is inclined to air his position, and it takes money; so he has to put dead men in occasionally, and very often one or two inferior men worth not half the standard rate of wages, pick up weekly the full price, and hand back 2d. or 3d. per hour to the foreman. This is all true; scores of men have seen it. Every employer has to pay in some way or other, and it is best to get good, straight men, pay them a price which will place them in a position beyond the approach of a workman's bribery. If you do not do this, you will have to pay all the more, for an underpaid man will not stand much temptation; his palm will not itch long before he receives something to relieve it in some way or other. In nine shops out of ten there are men more capable than their foremen. And why? Well, a man who is fully qualified will place a fair value upon his abilities, as by them alone he would expect to hold his own. He looks at a foreman's post in its proper light, as entailing a lot of thought, worry, anxiety, and responsibility worthy of fair remuneration, and prefers rather to remain as he is than to give his energies and abilities without proper pay. That is the kind of man to have. Some time ago I wanted a shop foreman. I advertised and was inundated with applications. Some of the applicants gave a lot of references; said what good jobs they had occupied, and then asked very little more than journeyman's wages. One sent a short note without fuss, and wished to know what his responsibilities would be, as he should expect proper remuneration accordingly. I sent for him, found him thoroughly practical, and very independent. I engaged him, and he turned out better even than I anticipated. A good man at £4 per week is far more profitable to an employer than an incompetent one, who will take the post at £2 per week. If an employer advertised for a foreman at 45s. per week, he would have scores of applicants; but make the figures £4 5s., and I doubt if he would get half-a-dozen. A man who demands a good wage is, nine times out of ten, better worth his money than one who asks half as much. Now about workmen. Sometimes we hear old men say, "Ah, men don't know how to work nowadays." Well, I can agree with them in that in their generation they could do the work well; but the pace would not suit the present time. It is quite certain, that, taking quantity and quality together, we have better men (some) now than we have ever had. I might say 10 per cent of the men are good workmen in every sense of the term; but we find some of all sorts among the 90 per cent remaining, who nearly all claim to be average men. First, there is the man who can do more work, with a cup before him in a public-house than in the workshop; he is always more clever in talking about work than in doing it. Then there is the man who can do an enormous amount of work, but none well; and, as a rule, spoils all he does. Then there is the man who always jumps about, and looks his very best when the foreman is about, and who is always so embarrassingly respectful, pulls his forelock, and says Sir every time he speaks; you generally find *him* making up for all that when the foreman's back is turned. He is not half the man as one who looks you straight in the face, gives you a curt Yes or No, who troubles himself no more when you are watching him than when you are away, and who has pluck enough to give a suggestion about the manner of doing the work, whether it differs from your way or not. Then there is another class, which includes about one-third of the men—namely, what I call faddists, who have to go through certain formalities over every little thing.

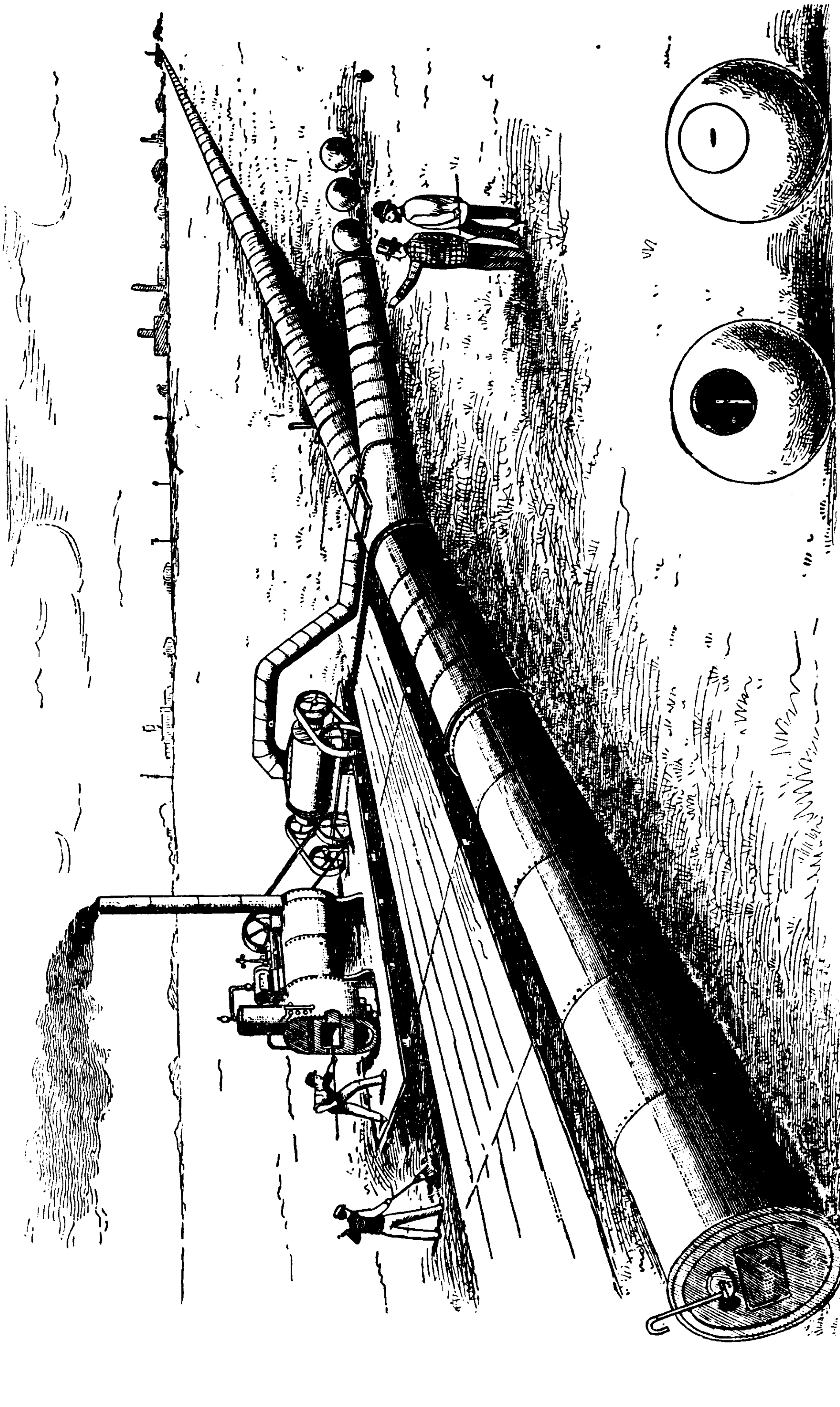
They think themselves fancy men, and have such a lot of fancy tools that they have to do an unnecessary lot of fadding in order to find a use for them. They are fairly good workmen, but they want breaking of their fads. Two-thirds of our joiners cannot shute a joint 3 ft. long without the formality of trying it with a straight-edge; and after a joint is made they do not consider it complete unless a dog is driven in each end, and a cleat, or cramp, placed across the centre. Such nonsense is only ridiculous waste of time. Throw away dogs and cleats (unless in long winding stuff), dispense with the straight-edge, make a proper joint, rub just enough to get out the glue, and the man will do half as much more work; and yet there is hardly a shop in London (and the practice is getting into provincial towns as well) where a joint is made without all this fuss. I saw, only a day or two ago, a man shuteing drawer bottoms preparatory to cutting off to length; they were 2 ft. 9 in. long, and he, a man with, I should say, at least fifteen years' experience in joiners' shops, *was actually using a straight-edge to see when they were straight.* There are scores of similar tricks these faddists perform that a foreman who is a practical man will detect and stop at once; but a foreman under some of the circumstances I have mentioned is too much under an obligation to his men to say anything to them, even if he has sense enough to see it. If a foreman is practical, has his eyes open, and his men in hand, he will soon either show them better or show them ticket-of-leave. Another class is that of the majority of young men growing up among us now. They can clean up a moulding, put together a piece of joinery, clean it off, and turn it out creditably; in fact, so far as use of tools is concerned, they can compete with anyone; but give them a rod for a fair piece of work, and their stuff not set-out, and they would be floored at once. These cannot be called joiners; they are simply human machines for finishing the work. Then, as a rule, they take faddists as their ideal, and follow them as nearly as possible, simply because they have no practical knowledge of construction of joinery. This is one outcome of employing one man to set-out the whole of the work; another is that practical men have no interest in their work, they don't care whether it is wrong or right—it is not their setting-out, so does not matter to them. Let each man set-out his own work; it is cheapest, the man takes more interest in it, and he can work better to his own lines than he can to those of another. A foreman can also see what a man's abilities are, and at what work he can best earn his wages, and if mistakes are made the right man gets the blame. Then there is the man who owns his incompetency by working at a lower rate of wages. I once employed one for three weeks, and found him the dearest man I had on my premises. I have always found a man at 6d. per hour worth not quite half as much as one at 9d. per hour. They must be employed somewhere, but I for one would prefer to do without them. Pay all your men the standard rate of wages, don't keep them if they cannot earn it, treat those who do earn it as men, and you will get men who will do their duty. There are always some who don't do this, and if you do you will find plenty of men. Give the man his hire, but see that he earns it first. In conclusion, I will say to employers: Get practical foremen, who can not only show a workman how to do a difficult piece of work, but can do it themselves if necessary; treat them as foremen, pay them as foremen, and see that they do their duty as foremen. Foremen, treat your men properly; if a man Sir's you too much, watch him. If you find a better man than yourself among your workmen, don't play coward and discharge him at first opportunity, and do not expose your ignorance to him by petty interference, or he will take advantage of you. Do not presume to undertake anything beyond your abilities, and, above all, don't get the idea into your head that you can do more than anybody else, and that your way of doing everything is the only way. Every man has different methods, and can work his own way best. Look at the results, and then if a man does not suit you, or is incompetent, give him the opportunity of trying his hand elsewhere. Don't treat men like dogs; if a man wishes you good-morning when he comes in, don't glare at him for his presumption. A foreman can be kind and affable, and pass time-o'-day with his men, and still keep them under firm control. You need not exalt yourself so very high above them in order to make them know you are foreman; it is a firm, steady, none-of-your-foolery manner that gets the work done. To workmen: Don't neglect the smallest opportunity for improving your knowledge of everything in connection with your trade. If Tom-So-and-So is no better off with all his knowledge, you may be, and don't be too clever to learn from your mates; if one gives you a hint, don't take it as an offence; see what you can learn from it. Do your best to become worth your money, so that you may be independent, and don't bribe foremen. You need all the money you can get for yourselves, and you are defrauding your employer in so doing, besides acknowledging you are not worth your money. If you are not a competent man, don't go and pose yourself as a man at a low price of wages; go as an improver, admit you are such, and strive your best to improve as quickly as possible to a full-fledged workman. If you have a kind, lenient master and foreman, do your best to keep them as such; don't take the least advantage. It is taking advantage by men that makes masters and foremen mistrust them and treat them as sharply as possible. Men always cry down a sharp master when it is their conduct that has made him so, and they that have made the rod for their own backs.—*Building News.*

AN IMPROVED PNEUMATIC DISPATCH SYSTEM FOR MAIL AND EXPRESS SERVICE.

The modern railway service for the rapid transmission of mail and high-class freight, in the estimation of most persons, is assumed to be quite adequate to the requirements; but, if asked for a reason for the assumption, the answer would most probably be because human ingenuity has devised nothing more speedy and efficient. If it could be shown to the satisfaction of those who rest content with present methods, through ignorance of the possible existence of better ones, that substantial improvements in respect of speed of transmission, security against loss and accident, and economy of operation, have actually been demonstrated to be quite practicable, the desirability of the adoption of such improvements would need no argument.

There are several methods of rapid transmission, adapted to a limit of weight of perhaps 500 pounds, that, in respect of speed and economy, give promise of accomplishing results greatly superior to what is now being accomplished by the railway service. These are the electric and pneumatic systems. The first of these it is not our intention to consider at length at this time. It is attracting the attention of some of the highest inventive minds of the day, and doubtless at no distant period will realize the high hopes that are entertained respecting it. Thus far, however, the problem still awaits a practical solution.

Whatever may be the outcome of the electric method, it is safe to say, that, until cheaper means of generating electric



EXPERIMENTAL SECTION OF TUBE OF THE JOHNSON PNEUMATIC TUBE SYSTEM.

currents shall have been discovered, no system of this nature can hope to compete in economy of operation with the pneumatic method, which with respect to cheapness of construction of plant and accessories, combines a means of operation in which simplicity is reduced to its lowest terms.

The efficiency of the pneumatic dispatch system, as applied at home and abroad in all the large cities in the transport of mail and other light parcels in numberless situations, is a matter of general knowledge ; and in view of this, it is a surprising circumstance that more serious efforts have not been made to adapt so promising a system to the same uses on a more extensive scale. That this will be accomplished successfully sooner or later, we feel quite well assured. There is little to be hoped for in the future development of the railway service, and it is generally admitted by those expert in this branch, that the highest attainable speed compatible with safety and the permanence of the roadway, has practically been reached by the best railway service of to-day. The pneumatic system, if we may judge from what has been accomplished with the toys now in use, is capable of developing unequalled speed —far in advance of the possibilities of the railway, and with a practical immunity from all danger of disasters. With the present tubes—a few inches in diameter—cylinders are dispatched over considerable distances at a rate of speed equal to 30 or 40 miles per hour, and with the expenditure of very little power for producing a very trifling air pressure of vacuum.

Why not construct tubes of steel of large diameter—5, or even 10 feet—and with the expenditure of proportionately little power compared with the increased capacity of such a line, employ such a system for the delivery of mail and light freight parcels between our principal business cities? There is nothing chimerical, or even impracticable, in the scheme. On the contrary, it is quite feasible, and unquestionably will be sooner or later put in practice as the cheapest system to build and operate for such service, and as affording a vastly more rapid and a surer method of transportation than the existing railway service.

A long step in the direction of practically realizing the requirements of such a pneumatic system has actually been made by the Johnson Pneumatic Tube Co., of New York. This system embraces a pneumatic tube, with rolling sphere carriers, air cushions, switches, compartment valves, automatic signals of passing carriers, etc., constituting a new system of rapid and cheap transportation through tubes of any length and of any size, from 3 inches to six feet in diameter.

An experimental section of this pneumatic tube, 1,200 feet in length, has been constructed and experimentally tested, with every indication of giving satisfactory results on the large scale, if we may judge from its performance, which we have witnessed with much interest. The company aim high in their claims, as may be inferred from the declaration they make that they are now prepared to demonstrate that their system will carry the United States mail and valuable freight at 150 miles, and upward, per hour, under perfect control, with equal safety, and as cheaply as any existing system of transportation, for similar bulk and distance, and that it can be operated with equal facility, where a railroad cannot be operated, regardless of ascending or decending grades, under or above ground, and on curvatures impossible to any existing system of rapid transit.

We have had a picture made of the experimental line above referred to, with the aid of which our readers will be able better to understand the following description of its mode of operation :

In general principles this tube is operated the same as any other pneumatic tube, the projectile being sent forward by creating a vacuum before it and a pressure behind it ; but it is the shape of the projectile, it is claimed, that makes it the only tube line practicable for long distances. In all operating tube lines, big and little, the projectile is of clyindrical form. In the Johnson system it is a perfectly round ball, looking like a huge cannon ball.

On the meadow at Marion, on the line of the Pennsylvania Railroad, near Jersey City, N. J., there is an exhibition line 1,200 feet long. This serves to illustrate the working of a line of any length. This line is constructed of No. 18 sheet steel, in sections 25 feet long, with cast-iron rings to strengthen and preserve the form of the tube, which is 30 inches in diameter ; a horizontal steel bed plate three-eighths of an inch thick, four inches wide, riveted to the bottom of the tube, forms a track for the balls to roll on. The balls to be used as carriers of mails and freight matter will be of *papier maché* or wood, with tightly fitting covers.

A ball which will run in a thirty-inch tube will be 29 inches in diameter, and when loaded with mails or ordinary freight will weigh from 350 to 500 pounds. The balls used at the exhibition line are of iron and weigh 750 pounds.

They are rolled on a track up to the mouth of the feeder tube and the moment the door is opened they are drawn through the feeder tube into an air chamber on the main line, which takes the place of a switch on a railroad. Then a pressure of air is created behind them, and they start for their destination and proceed with ever-increasing velocity, themselves giving warning of their approach to a station by a system of automatic signals.

Upon reaching the terminal the ball encounters an air cushion, and is stopped within a few feet. The compressed air chamber is forty feet long, and one of these 750 pound balls going 300 miles an hour will stop within half the length of the chamber. In an exhibition which we witnessed the ball was blown up to the upper end of the 1,200 foot line and drawn back. It made the return trip in eleven seconds with 18 horse power and a pressure of 70 pounds to the square inch of surface of the ball.

On a long line 400 horse-power engines would be located every 20 miles to pump and blow at the same time, and it is affirmed that there would be no trouble in maintaining an average speed of 200 miles an hour. The pipes can be made and operated in any size up to 6 feet in diameter, and the ball for that sized tube would carry any kind of freight.

Mail and express matter, it is affirmed, can be landed in Chicago from this city in about five hours, and in San Francisco in 34 hours.

The system of switching and signaling is ingenious and operates aparently very satisfactorily, and there may be any number of branch lines into which the balls are shot by means of the air chamber valves. As it approaches the station, each ball announces its destination by means of the automatic signal, and there is sufficient distance between two destined for different points to give the switch-tender time to separate them.

A dozen balls may come in a string when destined for the same point.

From the foregoing account, it may be inferred that the introduction of the pneumatic system of transportation on the large scale is in a fair way to be successfully realized by the ingenious system here described. We shall note the future development of this promising invention with interest.

THE DRAGON-TREE OF TENERIFE.

BY. R. CAMPER DAY.

The belief of the Greeks and Romans that somewhere beyond the Straits of Gibraltar, in the perilous and mysterious Atlantic, lay the beautiful islands of the Hesperides, where a dragon kept watch over a tree bearing apples of gold, was to some extent justified by a slender substratum of truth. For in the Atlantic, not so very far from Gibraltar, is to be found the little cluster of the Canary Islands, containing no dragon indeed, but a very wonderful tree, whose fruit is the size of a dwarf apple, and resembles red gold in colour. This tree is known as the dragon-tree, or *Dracœna draco*, and it lives to a greater age than any other plant.

The Canaries have often been called the Pleiades of the Atlantic, a constellation of seven small islands. It is perhaps more appropriate to compare them to a planet attended by six satellites, one of them, the island of Tenerife, being considerably more massive than the rest, as well as more interesting. The wonders that meet the eye of a visitor to this island are innumerable. The greatest and most overpowering is of course the huge quiescent volcano, crowned by the well-known peak, and covering with its irregular base the whole area of the island. The outline of the island is not unlike the side view of a boot, with the toe pointing north-east and the sole turned towards the north-west; and the Peak of Tenerife is situated exactly at the ankle. The total length of the island is sixty miles, and from every part of the coast-line the ground rises steadily, though with many ups and downs in some places, to the summit of the cone. The cone itself, a comparatively recent formation, stands in the middle of an ancient crater no less than eight miles in diameter. In ascending the volcano the visitor finds that the average slope of the sides upwards from the sea to the edge of this crater is by no means steep. The angle is not more, on the whole, than 12 degrees from the horizontal; but on reaching the edge he comes upon an almost precipitous descent of 1,800 feet into the great basin. As he traverses the basin towards the central cone, high above the level of the clouds, exposed to sunshine of tropical intensity, and winds of piercing chilliness, he passes the ice-cavern which so enchanted Humboldt, and although the volcano is classed as inactive, he comes to many a vent puffing out whiffs of volcanic breath, and many a place where the ground is almost too hot for his feet. If, then, the visitor to Tenerife is a geologist, he will find in the volcano itself enough to occupy his whole attention. If he is a botanist, he will have ample employment in studying the five distinct zones of vegetation that clothe the sides of the mountain; and if an anthropologist, in hunting for traces of that curious extinct nation, the Guanches, who embalmed their dead like the Egyptians. But whatever may be his particular hobby, or even if he has none, he can hardly fail to be interested in the singular natural product, indigenous to the seaboard of the island, known as the dragon-tree.

This extraordinary creature, which has been the theme of so many enthusiastic writers from the days of Captain Glas, is distinguished by a host of interesting characteristics. In the first place, there exudes from the crevices of the stem an astringent resin of a deep red colour, formerly used as a medicine and a dye, and called "dragon's blood" by the mediæval alchemists. Magic properties have been attributed to this substance. As recently as the last century, it is said, the Devonshire girls, on being crossed in love, would cast on the fire a little packet of the red powder, and repeat the words—

> "May he no pleasure or profit see,
> Till he again comes back to me."

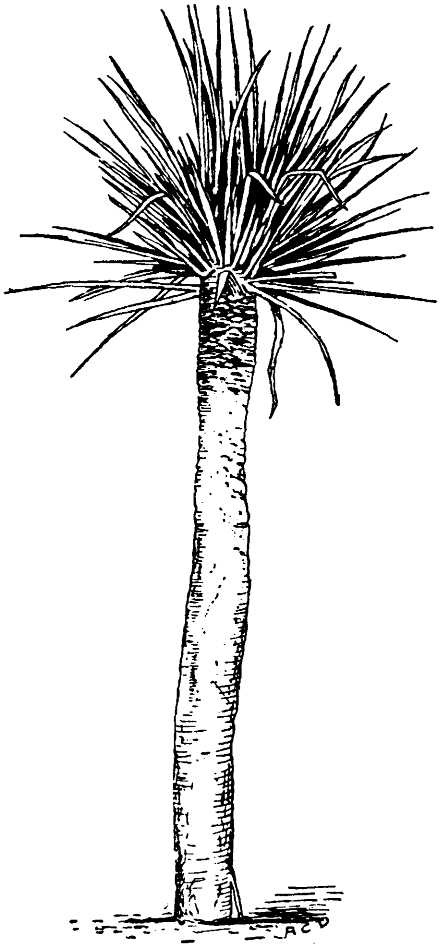
But the resin is yielded in such small quantities that the supply for commercial purposes was unequal to the demand. As a dye it has consequently been superseded by the cochineal insect and the coal-tar colours, and as a drug by the produce of the rattan palm. A second peculiarity of the dragon-tree is the extreme slowness of its growth; a third is the fact mentioned above that it attains to a greater age than any other known plant. Before the year 1867 there existed in the island of Tenerife a specimen (to be presently described) which is estimated to have been at least 6,000 years old. But perhaps the most noteworthy point about the plant is that, notwithstanding its size, it cannot strictly be deemed a tree at all, but only a monstrous vegetable. While the botanists agree in classing it among the *Liliaceœ* or lily-like plants, their opinions are divided as to whether it should be called a lily proper or an asparagus, or whether it should be relegated to a separate family with the title *Dracœneœ*. On the whole, it is probable that if a census could be taken of the views of botanists a majority would be in favour of calling it a stick of asparagus.

What, then, is the dragon-tree like? Our first illustration is a portrait of an infant specimen now growing in the temperate house of the Botanical Gardens at Kew. It consists of straight, smooth, and fleshy stem, about 7½ feet in height, variegated towards the top with scars, where old leaves have dropped off. The stem is crowned by a bunch of long and stiff leaves shaped like sword-blades, the total height from the top of the pot being 12 feet. The plant has not yet flowered, and will probably not do so for another twenty years.

After its first flowering the beginnings of branches may be expected to appear, and the tree will then enter upon the long period of middle age. In the mature tree the branches rise up like the arms of a candelabrum, and as there are no leaves except at the tips of the branches, the foliage is usually massed into a flat slab at the summit of the tree.

Any one desiring to see the dragon-tree in its old age can still find splendid specimens in the Canary Islands. There is one, for example, at Icod Alto, and another at Icod de los Viños, both of which were in existence at the time of the subjugation of the islands by the Spaniards in 1493, and one of which is mentioned in the history of the Conquest. The large illustration is a portrait of one of them. But the traveller will look in vain to-day for the great, the ancient, the phenomenal dragon-tree which, prior to 1867, was to be seen at Villa de Orotava. When Tenerife was conquered, and the primitive inhabitants exterminated, this tree was already old. At the close of the fifteenth century the great stem was a landmark in the delimitation of two estates, and as such it is mentioned in ancient documents which are still preserved. The Spanish general, Alonzo del Lugo, shocked to find that the hollow trunk had been used by the aborigines for Druidical rites, converted it into a chapel for the celebration of the mass. Situated in sight of the cone of Tenerife, and possibly a witness of its formation, the primordial Dracæna was still healthy and vigorous at the opening of the present century. In 1819 a large limb (according to one account a third of the spreading top) was lopped off and other damage done by a tempest, and a huge portion of the stem was afterwards hacked away by a botanical vandal; but the tree was mended with masonry, and still there seemed to be no reason why it should not endure for many centuries more. But in 1867 there came an exceptional storm, which broke off the tree just at the point where the branches begin. Efforts were made to preserve the old dead trunk, but without success, and now not a vestige of it remains on the spot where it stood. The proprietor of the ground, however, had raised some seedlings from the old tree, and one of these, an infant of some twenty years, serves to mark the site of its venerable predecessor.

Many pictures of the tree are in existence, but with a single exception they are caricatures such as give no true idea of its habit and appearance. I have not seen the picture given in the "Atlas Pittoresque" of Baron Humboldt, but it is said to be so singularly incorrect as to represent an elm rather than a dragon-tree. His sketch, it seems, was not taken on the spot, but was copied from a drawing by M. Marchais, and



Drawing of a Young Dragon-Tree at Kew.

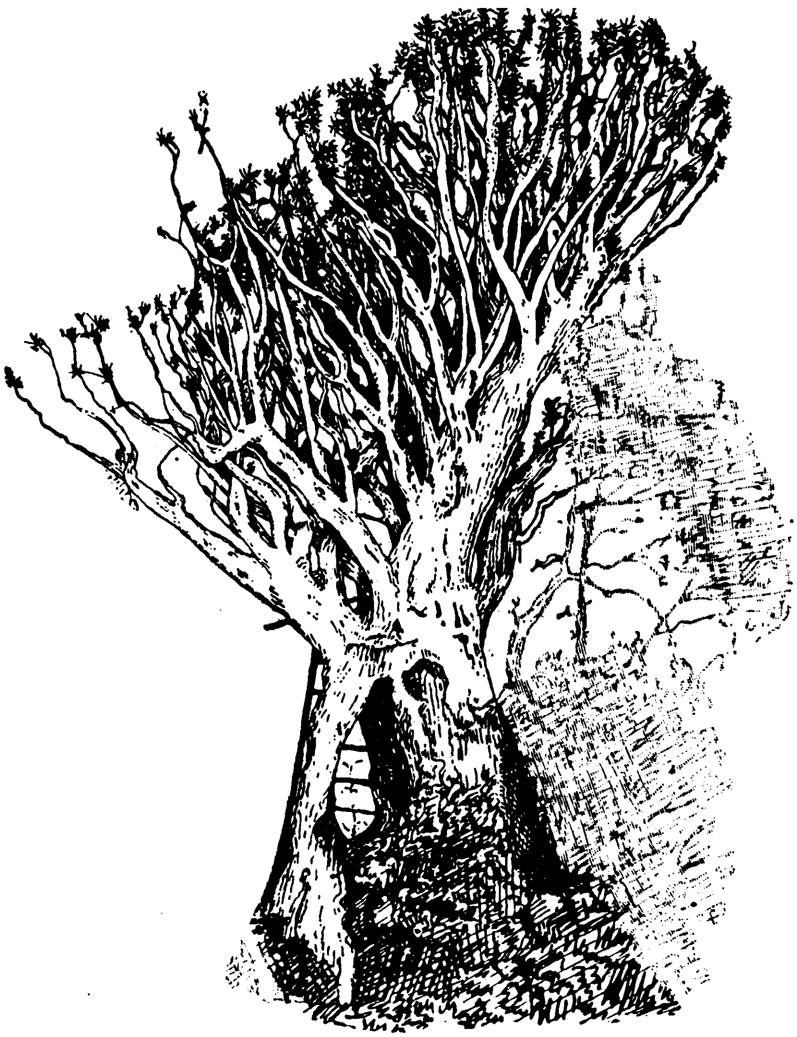
that from an unsatisfactory sketch by M. Ozone, which is still preserved in the hydrographical department of France, and each stage of copying seems to have been attended by a further departure from the truth. Fortunately, before the final catastrophe took place, the tree was visited by Professor C. Piazzi Smyth, Astronomer Royal for Scotland, who not only wrote an interesting and accurate account of it in his charming book about Tenerife, but earned the gratitude of all botanists by taking its photograph. It is through his courtesy that a drawing of this unique sun-picture of the oldest tree ever known is included among the illustrations to this article. The tree was certainly in luck, for in the early days of photography it was hardly to be expected that the observant eye of the camera would be opened in so remote a place.

"Sixty feet high above the ground at its southern foot," says the Professor, "forty-eight and a half in circumference at its base, 35·6 at six feet above, and 23·8 at 14·5 feet above, or the place where the branches spring out from the rapidly narrowing conical trunk—this Dracæna cannot compare with the real monarchs of the forest for size." High up on the Sierra Nevada of California, in the county of Calaveras, there is a grove of Wellingtonias (*Sequoia gigantea*), four of which are over 300 feet in height, and our Australian colonies can show still more enormous individuals among the gum trees. But these monarchs of the forest, mighty as are their dimensions, are centuries younger than the dragon-tree of Orotava. In short, it was its wonderful vitality and its no less eminent slowness of growth rather than its pre-eminent size that made this dragon-tree the wonder of the vegetable world.

"Let us take note," says Professor Piazzi Smyth, "of its characteristics. First, the immense uprearing of long naked root-like branches, and the pyramidal outline of the trunk. The leafage makes no very sensible appearance; there is the typical tuft at the end of each branch or rather stem; but the miniature palm-trees have been growing for ages without bifurcation, extending only in length, nothing in breadth. At the point of junction of two or more a thickening of the lower branch begins, and occasionally may be seen one or two withered radicles hanging loose, for they have failed to enter the bark, and work their way down to the ground."

When the stem of a young oak-tree is sawn across, the interior is seen to consist of a number of concentric rings and it is well-known that the number of these rings indicates the age of the tree in years, for a new ring of wood is formed every year outside the old ones. Hence it was found possible to estimate accurately the age of the mammoth Sequoias of Calaveras; for shortly after the discovery of the grove one of the largest trees, the "father of the forest," was cut down, and a clean section made through the trunk at the height of forty feet from the ground. The number of rings, on being carefully counted by experts, was found to amount to 1,255, and to this number we must add about fifty for the time occupied by the plant in reaching the height of forty feet. The age of the tree was therefore somewhere about 1,300 years. But if the trunk of a young Dracæna be sawn across, the interior will be found to present an entirely different appearance. No concentric rings will be observed, but a uniform woody or fleshy substance, diversified (like the end of a piece of cane) by numerous little dots. For flowering plants are divided into two classes, formerly distinguished by the names Exogens and Endogens, or "outward growers" and "inward growers." These names were given because it was known that the growth of Exogens was caused by the formation of layers or rings of new wood *outside* the old wood; and it was supposed that the growth of Endogens was due to the formation of new wood in the *middle* of the trunk. This latter view has turned out to be not quite accurate, and it is now the fashion to call the two classes Monocotyledons and Dicotyledons (hard words, but necessary) instead of Endogens and Exogens. The oak and all other British trees belong to the latter; the former, to which the Dracæna and the palm-trees belong, has no larger British representative than the Butcher's Broom.

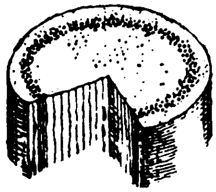
Now when the little dots with which the cross-section of the stem of an endogen is speckled are examined under the microscope, each of them is found to consist of a bundle of minute fibres encased in a sheath. The bundle runs up through the trunk like the wick through a wax-candle; and just as the wick of the candle terminates in the flame, so the bundle of fibres terminates in a leaf. The purpose of the



THE OLD OROTAVA DRAGON-TREE DESTROYED BY A STORM IN 1867.

bundle is to convey nutriment, chiefly water, from the roots of the tree to its own particular leaf. While the tree is still young the dots will be found distributed equally over the cross-section; but as it grows older the new dots seem to be produced near the bark, as shown in the following sketch. In fact it is in the zone between the bark and the interior wood (and not in the centre) that the new bundles are formed that cause the trunk to swell in size; and it is to the inextinguishable vitality of this zone that the dragon-tree owes its longevity.

We have seen that after a certain period in the growth of the tree no new fibres make their appearance in the middle portion of the trunk, but it does not follow that this middle portion remains altogether unaltered. It usually undergoes a very important change; in point of fact, it dies. Hence it is that the trunk of a large dragon-tree, like the patriarch of Orotava, is hollow; and hence arose the ingenious theory that an old dragon-tree ought not properly to be called a single tree, but rather a community of many trees. Each of the branches is really a separate individual. The original tree is dead and gone; the only living portions of the huge fabric are the topmost branches and their fibres in the circumference of the slowly expanding hollow trunk. An old dragon-tree, then, is an aggregate of individuals, each of which in some measure contributes to the support and aids the existence of the rest, just as the bees in a hive are separate individuals, all of which contribute to the support and continuance of the whole. In fact, as Professor Asa Gray has remarked, an old

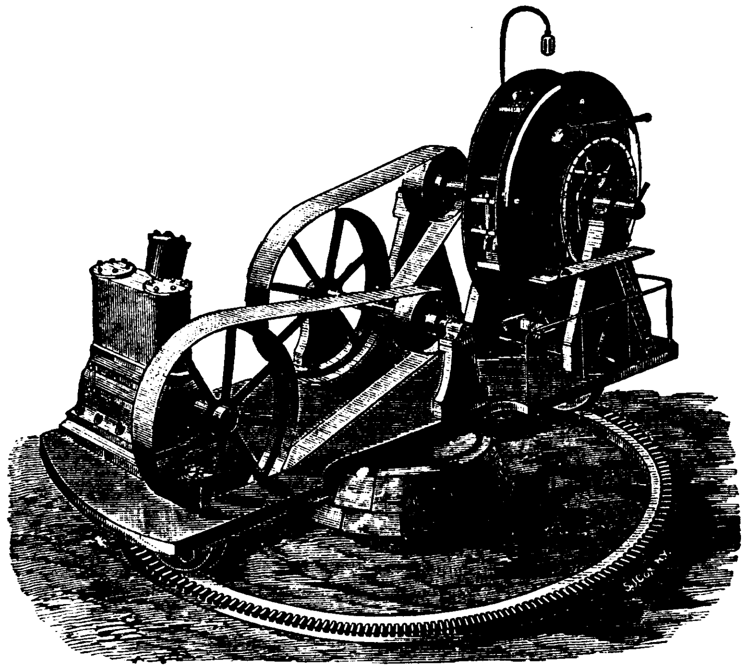


SECTION THROUGH THE STEM OF A MONOCOTYLEDON.

Dracæna is like nothing so much as a genealogical tree, the later ramifications of which alone are living.

Professor Gray, it may be mentioned, who formerly calculated the age of the Orotava tree at "perhaps hundreds of centuries," has since altered his estimate, and reduced the total to "something more than two thousand years." This estimate is certainly too low, but in the absence of concentric rings it is, of course, quite impossible to fix the age of a monocotyledon with precision. The only method open is to observe the rate at which the tree grows for a given period, and compute the age by rule of three.

It is usual for beginners in botany to learn their first lessons from our common flowers, such as the wild rose, the buttercup, and the daisy, and it cannot be doubted that this is on the whole the best course. But still there is something to be said in favour of "beginning at the other end" when an opportunity offers itself for the study of some of the stranger and rarer vegetables, such as the banyan, the bamboo, the baobab, the Rafflesia, or the Victoria regia. And it is partly with the hope of inspiring some of my readers with a liking for botany that I have ventured upon so long a description of the habit and method of growth of the dragon-tree.—*Knowledge.*



HICKS' CENTRIFUGAL GUN.

THE CENTRIFUGAL GUN.

The impression is very generally entertained among the best military authorities, that great advances in the science of gunnery are impending, which will have for their foundation the adaptation of mechanical devices for employing the destructive force of the modern high explosives—nitro-gelatine, gun cotton, the fulminates, etc., which, if it could be safely controlled, would add immensely to the efficiency of modern ordnance.

Such tremendous explosives, as is well known, cannot be discharged with safety from ordnance of the type at present made and used, for it has been proven that the rapidity of the expansive force of the slowest burning gunpowder will produce a percussion many times above the point at which the above-named explosive will detonate. It was to meet this grave difficulty that Capt. Zalinski constructed a gun in which the firing of the charge of dynamite is affected by subjecting the charge to a gradually increasing pressure of compressed air. The projectile in this gun leaves the muzzle at a high rate of speed, while the initial shock is comparatively slight—at least so slight as not to imperil those in charge of it; and scientific artillerists entertain high hopes of the future of this type of gun.

W. E. Hicks, of 17 Broadway, New York, in the solution of this problem, has devised a gun for discharging shells carrying the high explosives, in which the actuating agent is centrifugal force. There is no limit to the quantity of this force that we can command by extremely simple mechanical devices, save and except the limit imposed by the tensile strength of the materials of which the discharging mechanism is constructed.

Mr. Hicks has applied this principle in a very simple and ingenious manner, as will be perceived from an inspection of the accompanying picture, in connection with the following description :

It consists of two steel disk wheels, placed concentrically side by side upon a shaft, to which is attached a pulley wheel for revolving the disks. It is necessary that these disks shall be rotated at very high velocity, as the acceleration imparted to the projectiles depends on this element. To enable the disks to resist the tendency to bursting, due to the very high speed of rotation, they are made thick at their centers and gradually taper toward their peripheries. Between the disks, and near their peripheries, are, at equal distances apart, four projectile carriers, which retain the projectiles when the gun is charged. These carriers are provided with automatic locking and unlocking doors, which firmly clasp the projectiles. These may be released at any pre-determined point in the rotation of the wheel. In practice the officer in charge gives the signal for pulling a lanyard. This unlocks an automatic apparatus holding the projectiles, and releases them at any given point in the revolution of the wheel, so that they can be thrown at any angle desired between the horizon and the zenith. The details of the carriers cannot be entered into further, since they are not exhibited in our picture.

By this principle, it seems quite clear, Mr. Hicks has reduced the element of danger of self-destruction from accidental explosion of discharge to the lowest possible quantity.

There is absolutely no shock. The shell is projected by the rotary motion of a revolving carriage, which begins with a slow motion, gradually increasing in rapidity. There is, therefore, no shock or jar until after the projectile has left the gun and come in contact with some object. The four shells may be discharged in rapid succession, and the trajectory of each being practially identical, each successive shot will add to the destruction done by the preceding one. One peculiarity of the gun—or engine, as it might perhaps more properly be called—is its comparative noiselessness. There being no expansion of gases, and no vacuum, there is no report of any kind, the only sound being the whiz of the shell as it passes through the air. There is neither flash nor smoke, report nor recoil, and there is nothing to apprise an enemy of the whereabouts of the gun, and the destroyer might come in the midst of an enemy unseen and unheard.

The whole apparatus is set, as will be seen, upon a turntable, so that the gun can be trained in any desired direction.

The carriers are so arranged as to fly upwards at the instant of discharge, and thus counteract the centripetal tendency of the curvilinear trajectory. The initial velocity is, of course, limited by the tensile strength of the steel firing chambers. A simple calculation will show that to secure initial velocity of 2,000 feet a second, would require a wheel having a diameter at the point where the shells are placed, of 10 feet, and revolving 4,000 times in a minute.

There would seem to be no objections of a theoretical character to make a gun of this description, and it is to be hoped the inventor may have an early opportunity of making such practical trials of it as may furnish the necessary data to determine its efficiency.—*Manufacturer and Builder.*

EXTEMPORIZED SCAFFOLDING IN CANADA.

BY OWEN B. MAGINNIS.

Builders throughout the country in their daily practice, find it necessary to erect temporary scaffolding, and in doing so usually employ scrap-stuff or some of the material they intend using in the building. These scaffolds require to be handy, take little time in constructing, and must at the same time be strong and suitable for safely sustaining men and material. With a view to assist builders to a rapidly formed system of scaffolding the following is submitted :—

The handiest, though not always the most applicable form, is the bracket scaffold, which consists of a number of permanently framed timber brackets, placed on a line, at a convenient distance apart, on which to rest the planks. Each bracket measures about 4 ft. by 4 ft., and is framed together of 1½ in., or 2 in. by 3 in. sound spruce, for lightness and strength. It is held in its place on the frame wall by a ⅞ in. round iron bolt, which is forged long enough to pass through the boarding and studding, and a 2 in. block, which spans two studs inside. The end of the bolt is tapped and the bracket can be screwed tight against the boarding by a screw, key, and washer. The bolt is fastened to the bracket under the horizontal arm, after passing through a hole in the vertical arm, by being forged flat and bored and bolted to it with ¼ in. bolts which are countersunk on the upper side of the arm, to permit the planks to rest level on it.

All that is required to affix these brackets to the building is to bore a hole for the bolt, and they hang quite safe and will sustain the weight of any ordinary quantity of boards or siding. They can also be put up for boarding, and taken down as each strip of covering is finished.

In the absence of the above, a good safe scaffold can be quickly made of joists and ⅞ in. covering or roofing boards. Cleats gained out the thickness of the bracket board are first got out, and to the gain a bracket piece is well nailed; the outer end of the bracket piece is next nailed square to the side of a sound joist at the required height, and the three together are then nailed by the cleat through the wall boarding into a stud. If much weight is to be put on the scaffold, blocks should be nailed under the bracket piece on the vertical joist to take the strain off the nails, especially when hemlock joists are used for uprights.

A very simple way of gaining a strong scaffold is to lay joists on their edges across brackets no more than 10 ft. apart, with ledgers placed across their upper edges, on which the planks rest. It is also very convenient when the scaffolding planks are not forthcoming, and boards are substituted, and it saves a double thickness of boards. This scaffold is braced diagonally, and in order to increase its height, another joist can be placed on the top end of the bottom one, and the joist secured by nailing a ⅞ cleat across it.

A useful and easily removed scaffold for putting on roof boarding consists of simple brackets nailed through the roof boarding into the rafters beneath, with a plank laid across them to stand on.

When the boarding is all on, and the window frames and cornice set, one of the next accessories is a handy shingling stage. After the first courses have been laid, it is usual to form a scaffold out of joists laid against the roof on their edge, and fastened by shingles. The best way, however, is to shingle the joist in, by nailing the shingles to it, and fastening them in a course of shingles, keeping those nailed on the joist down, so that the joist will come below the butts of those in the course. These can be cut off when the scaffold is no longer needed, and the roof will not have been in any way injured.

The handiest scaffold which a carpenter and builder can adopt for setting cornices over store fronts, consists of a piece of 8 in. or 9 in. by 1 in. spruce board nailed square across near the ends of two joists at the desired height, far enough apart to permit each joist to stand respectively, allowing for the difference in their levels on the store floor and sidewalk. When the number of these frames needed is nailed together, they are placed in position, braced diagonally, and the plank laid across them. This method makes a very convenient, firm scaffold, and costs very little time.—*Builders' Reporter.*

FOR THE FIREMAN.

A man may become a good fireman without having any knowledge of the laws of nature which control combustion; but he attains his skill by long practice and groping in the dark for the right way.

The fireman who has learned his calling in this manner is not, however, perfect master of the art of firing, for any change of furnace arrangement is likely to bewilder him, and he finds himself compelled to repeat his first experience in experimenting until he *happens* to hit the best method. This entails a waste of fuel and repeated delays for want of steam.

The nature of fuel, the composition of the air that fans the fire, the character of the gases formed by the burning fuel, and *the proper proportions of air and fuel required to produce the greatest degree of heat,* are the principal points in the laws of combustion which should be studied in this connection. Oxygen and carbon are the two most important elements of combustion in the fire-box.

These elements unite freely and combine very rapidly, when heated to a high temperature, producing violent evolutions of light and heat. Oxygen is the vital part of the atmosphere, and carbon is the fundamental ingredient in all fuel used for making steam, anthracite containing the larger per cent. of pure carbon.

When the fireman has learned to combine these two elements in proportions which shall produce the greatest amount of heat, he will have solved the problem of making steam with the greatest economy of fuel and manual labor. Take a locomotive fire-box for example: a common form of locomotive fire-box is 72x35 inches, which gives about seventeen square feet of grate area with the only draught through the ash pan. If an engine of this kind is required to draw a fairly heavy train at a running speed of forty miles per hour, it will be necessary to burn sixty pounds of coal per mile, or 2,400 pounds per hour, to maintain steam for this work. This would require the burning of about 141 pounds of coal on each square foot of grate surface every hour. In this case the supply of air must be liberal and the oxygen will be separated from the air and combines with the carbon in the proportion of twelve parts of carbon by weight, to thirty-two parts of oxygen, by weight, which produces carbonic acid gas. If, however, the supply of air is restricted the carbon takes up a smaller proportion of oxygen, giving us carbonic *oxide* gas, which produces much less heat than carbonic acid gas.

One pound of carbon uniting with oxygen to form carbonic acid gas generates 14,500 units of heat; or, sufficient to raise eighty-five pounds of water from the tank temperature to the boiling point.

On the other hand, when one pound of carbon unites with oxygen to produce carbonic *oxide* gas, only 4,500 units of heat are generated; or, sufficient to raise twenty-six and a half pounds of water from the temperature of the tank to the boiling point. In both cases the same quantity of fuel being used, the difference being that less oxygen is in the mixture.

The combining proportions of carbon and oxygen to produce carbonic acid gas being twelve to thirty-two, the combustion of each pound of carbon requires two and two-thirds pounds of oxygen. It takes 4.35 pounds of air to supply one pound of oxygen, therefore it will require eleven and a half pounds of air to provide the gas essential to the economical combustion of one pound of coal.

So far the problem seems simple enough, the solution being to give the fire plenty of draft; but there are several practical objections to having the air blow through the grates like a hurricane.

The fuel should be kept saturated with the air containing oxygen, a large volume of air is required but it should not be forced through the furnace and tubes at too great a velocity, the result of which is to send the gases into the flues and through the stack without being ignited. Further, the heat in passing through too fast is not given time to impart itself to the water. From these statements it will be seen that loss of heat is threatened from two opposite directions. If there is not enough air admitted, a gas of inferior heating quality will be generated: if too much air is allowed, heat will be wasted.

It is a matter of common observation that fuel will not burn until it has attained a certain heat, and different materials require different degrees of heat to ignite them. Hence unless the fire in a fire-box be kept up to a condition to impart the necessary igniting temperature to its various parts as well to new fuel passed into it, a large amount of waste will occur in the distillation of the combustible gases and the passing away of these gases before ignition. This takes place proportionately to the power of the draught, both in the stationary and the locomotive fire-box, and requires constant watchfulness, so that sufficient intensity of heat be maintained at all points in the fire-box, and that, withal, the fire be not allowed to become so thin as to permit of the passage of a greater volume of cold air than the capacity of the fire to impart the required temperature.—*American Engineer.*

TANGENT GALVANOMETER.*

The tangent galvanometer is of great importance in electrical measurements, especially in the class relating to currents. The principal of the instrument is illustrated by Fig. 1. In a narrow coil of wire is suspended a short magnetized needle, whose length does not exceed one-twelfth the diameter of the coil. Two light pointers are connected with the needle at right angles thereto. When a current is sent through this coil, the needle is deflected to the right or left, according to the direction of the current, and the amount of deflection is dependent upon, but not proportional to, the strength of the current. It is, however, proportional to the tangent of the angle of deflection.

A practical tangent galvanometer is shown in Fig. 2. In this instrument the conductor is wound upon a grooved wooden ring 9 inches in diameter, the groove being $\frac{3}{8}$ inch wide and 1 inch deep. The wooden ring is mounted in a circular base piece, which is pivoted to the lower base to admit of adjustment. The lower base is provided with three leveling screws, which are bored longitudinally to receive pointed wires, which are driven into the table to prevent the instrument from sliding. The lower base is provided with an angled arm, which extends over the upper base piece, and is provided with a screw for clamping the latter when adjusted.

The winding of the ring is divided into five sections having different resistances, so that by means of a plug inserted in the switch on the base the resistance may be made 0, 1, 10, 50, or 150 ohms.

Fig. 3 is a diagram showing the coils and the switch connection stretched out. The first coil, *a*, is a band of copper $\frac{3}{4}$ inch wide and $\frac{1}{16}$ inch thick, with practically no resistance. The other coils are of iron. The coils, *b* and *a*, together, have a resistance of one ohm. The coils, *c*, *b*, *a*, have a combined resistance of 10 ohms. The coil, *d*, together with the preceding, offer a resistance of 50 ohms, and the combined resistance of all of the coils, *e*, *d*, *c*, *b*, *a*, is 150 ohms.

The conductors are connected with the binding posts, *f*, *g*, and the current flows through the coils in succession, until it reaches one of the smaller switch plates, which is connected with the plate, A, by the plug. In the present case the plug is inserted between the plate marked 1 and the plate, A, causing the current to flow from the binding post, *f*, through the coils, *a*, *b*, and plate A, to the binding post, *g*. The resistance of the galvanometer is obviously 1 ohm.

The magnetic needle, which is $\frac{3}{4}$ inch long, is located exactly at the centre of the ring, and delicately poised on a fine hard steel point. The needle should be jeweled to reduce the friction and wear to a minimum. To the sides of the needle are attached indexes of aluminum having flat ends, each of which is provided with a fine mark representing the centre line of the index. The box containing the scale and the needle is supported by a cross bar attached to the wooden ring. To the top of the wooden ring is attached a brass standard, which is axially in line with the compass needle.

Upon the standard is mounted a bar magnet, which may be

* From "Experimental Science," by Geo. M. Hopkins. In press. Munn & Co., publishers, New York.

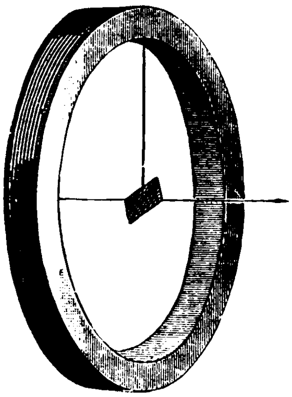


FIG. 1.—PRINCIPLE OF TANGENT GALVANOMETER.

adjusted at any angle or raised or lowered. This magnet serves as an artificial meridian when the galvanometer is used for ordinary work. When it is used as a tangent galvanometer the magnet is removed.

The tangent galvanometer must be arranged with the coil and the needle in the magnetic meridian, and its adjustment must be such that a current which produces a certain deflection of the needle in one direction will, when reversed, produce a like deflection in the opposite direction. The angle of maxi-

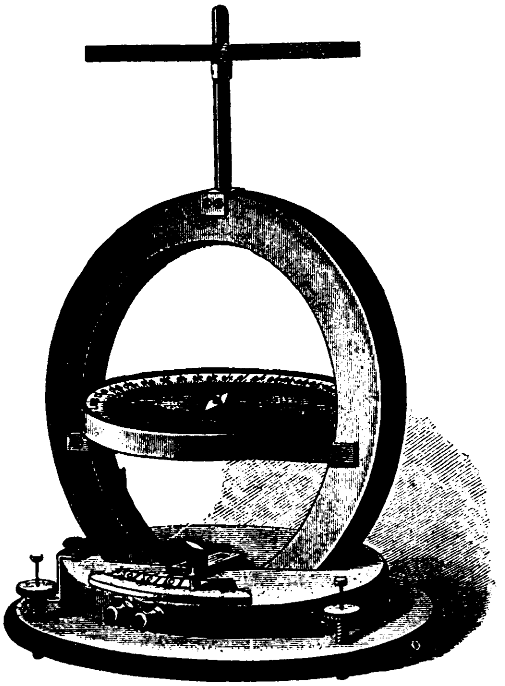


FIG. 2.—TANGENT GALVANOMETER.

mum sensitiveness in the tangent galvanometer is 45°; therefore, when it is possible to do so, the current should be arranged to produce a deflection approximating 45°.

The resistance of a battery may be ascertained by means of the tangent galvanometer as follows: The battery is connected with the galvanometer, and the deflection of the needle is noted; then a variable resistance is introduced and adjusted until there is a deflection, the tangent of the angle of which is equal to one-half the tangent of the angle of the first deflection. The resistance thus introduced is equal to that of the battery and galvanometer. Take from this quantity the resistance of the galvanometer and the remainder will be the resistance of the battery.

For example, when a battery placed in circuit with a tangent galvanometer produces a deflection of 48″, the tangent *

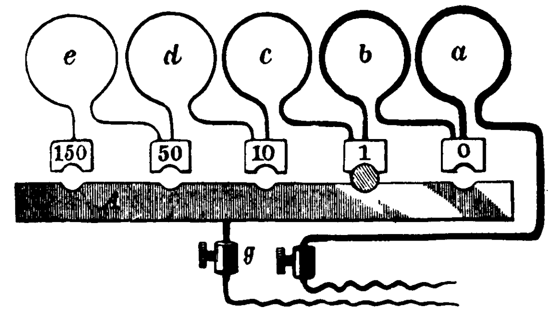


FIG. 3.—ARRANGEMENT OF SWITCH CONNECTIONS.

of that angle being 1·111, half of this quantity would be 0·555, which is very nearly the tangent of the angle of 29°; therefore, resistance is introduced until the needle falls back to 29°. Assuming this resistance to be 15 ohms, and the resistance of the galvanometer to be 10 ohms, the galvanometer resistance deducted from the resistance introduced leaves 5 ohms, which is the resistance of the battery.

To measure the electromotive force of a battery a standard cell is necessary. A Daniell or gravity cell, having an E. M. F. of 1·079 volts, is commonly used. This is connected with the tangent galvanometer, and the deflection and total resistance in the circuit, which must be high, is noted. The standard battery is then removed and the one to be measured is inserted in its place, and the resistance of the circuit is adjusted until the deflection of the galvanometer needle is the same as in the first case. It now becomes a matter of simple proportion, which is as follows:—

E. M. F. of standard battery.	:	F. M. F. of battery being measured.	: :	Total resistance in first case.	:	Total resistance in second case.

Assuming the resistance in the first case to have been 2,500 ohms, and that in the second case 2,000 ohms, the proportion would stand thus:—

1,079	:	Unknown E. M. F.	: :	2,500	:	2,000

or as 5 to 4. The E. M. F. of the battery measured is therefore 0·8632 volt.

A convenient arrangement of the tangent galvanometer scale is to have one side of the scale divided into degrees, the other side being arranged according to the tangent principle, so that the reading will be direct and reference to the table of tangents will be avoided.

The simplest method of measuring resistance is that known as the substitution method, in which the unknown resistance and a galvanometer are placed in the circuit of the battery; the deflection of the galvanometer needle is noted. A variable known resistance is then substituted for the unknown

* A table of natural tangents may be found in almost any engineer's hand book.

resistance, and adjusted until the deflection is the same as in the first case. The variable known resistance will then equal the unknown resistance. If the current is so great as to cause a deflection of the needle much exceeding 45°, it should be reduced either by removing some of the battery or by the introduction of extra resistance into the circuit. The same conditions must obtain throughout the measurement.—*Scientific American.*

VALUABLE INSTRUCTIONS FOR ENGINEERS.

The Eclipse Pump Manufacturing Co., Cincinnati, have published the following valuable instructions to engineers :

1. The first duty of an engineer, when he enters his boiler room in the morning, is to ascertain how many gauges of water there are in his boilers. Never unbank or replenish the fires until this is done. Accidents have occurred, and many boilers have been entirely ruined, from neglect of this precaution.

2. In case of low water, immediately cover the fire with ashes, or, if no ashes are at hand, use fresh coal. Do not turn on the feed under the circumstances, nor tamper with or open the safety valve. Let the steam outlets remain as they are.

3. In case of foaming, close the throttle and keep closed long enough to show true level of water. If that level is sufficiently high, feeding and blowing will usually suffice to correct the evil. In case of violent foaming, caused by dirty water, or change from salt to fresh, or vice versa, in addition to the action above stated, check draft and cover fires with fresh coal.

4. When leaks are discovered they should be repaired as soon as possible.

5. Blow down under a pressure not exceeding 20 pounds, at least once in two weeks—every Saturday night would be better. In case the feed becomes muddy, blow out six or eight inches every day. When surface blow cocks are used, they should be often opened for a few minutes at a time.

6. After blowing down, allow the boiler to become cool before filling again. Cold water pumped into hot boilers, is very injurious from sudden contraction.

7. Care should be taken that no water comes in contact with the exterior of the boiler, either from leaky joints or other causes.

8. In tubular boilers the hand-holes should be often opened, and all collections removed from over the fire. Also, when boilers are fed in front and blow off through the same pipe, the collection of mud or sediment in the rear end should be often removed.

9. Raise the safety valve cautiously and frequently, as they are liable to become fast in their seats and useless for the purpose intended.

10. Should the gauge at any time indicate the limit of pressure allowed by the inspector, see that the safety valves are blowing off. In case of difference notify the inspector.

11. Keep gauge cocks clear and in constant use. Glass gauges should not be relied on altogether.

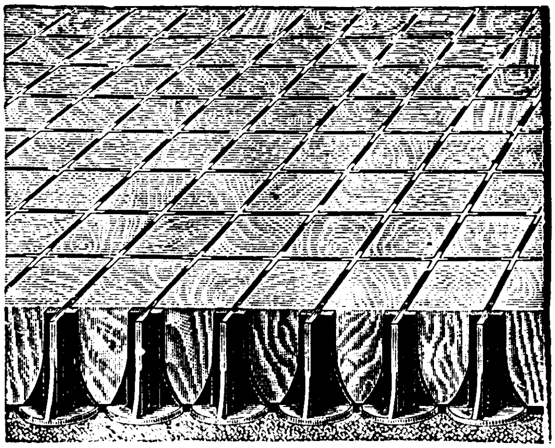
12. When a blister appears, there must be no delay in having it carefully examined and trimmed, or patched as the case may require.

13. Particular care should be taken to keep sheets and parts of boilers exposed to the fire perfectly clean, also all tubes, flues and connections well swept. This is particularly necessary where wood or soft coal is used as fuel.

14. Under all circumstances keep the gauges, cocks, etc., clean and in good order, and things generally in and about the engine and boiler room in a neat condition.

IRON PAVING IN SHEFFIELD.

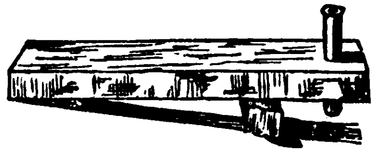
There is now being tried at Sheffield an interesting experiment in the adaptation of iron for street-paving. A year and a half ago a small piece was laid down privately at the entrance to a manufactory. As that proved serviceable, the consent of the Sheffield Corporation was obtained for a trial of the system in one of the streets where it would be subject to the heaviest traffic in the town.



As shown in the accompanying engraving, the iron is used in the form of upright studs, each one having an independent base. The horizontal section of the stud is cruciform, the angles of which carry the corners of the four adjacent blocks of wood; thus each stud carries four blocks, and each block is carried by four studs. Upon a concrete foundation there is a thin layer of asphalte, upon which the studs bed themselves ; these being slightly taper, the wood blocks are wedged slightly in, the interstices of which being filled with pitch, the whole is firmly bound together. The ends of the studs projecting slightly above the wood, not only carry the weight of vehicular traffic, but give a foothold to horses which is lacking in ordinary wood-paving, and dispenses with the usual gravel sprinkling. The experimental piece was laid down in Saville-street about two months ago. The work was done by Mr. G. Carr, contractor, of Carlisle-street, and consists of thirty-eight superficial yards.—*Building News.*

A COUNTRY BOY'S HOME-MADE MICROSCOPE.

The cut shows an effective form of microscope for beginner's use, and one that every boy can make who has a good spy-glass or telescope. The eye-piece, or joint nearest the eye, contains (in every good glass) four lenses arranged in two



groups, and serves directly as a compound microscope to enlarge the image which the object glass, or front lens, forms.

If this joint be unscrewed and held steadily at the proper distance from an object, it will serve as an ordinary microscope and of a very fair power. This may be accomplished in a simple manner, as follows : Take a nice piece of pine, about

18" x 2" x 2", and bore a hole near one end, slightly smaller than the tube of the eye-piece. Do not measure the tube by the rim of the lower lens for that is always larger than the tube. Fit the hole to the small brass slide which carries the screw, and then the main tube may be adjusted nicely through it. Be careful while handling the brass tubes not to bend them. Should the bit of the nearest size be slightly too large, wind the slide carefully with paper until it will make a snug fit.

The lower lens tube should be removed until the hole is finished and the tube inserted ; then screw it in, and rest the strip on a small block of wood as shown in the cut. Focus roughly by sliding the block back and forth, and finish by sliding the tube up and down, giving it at the same time a slight rotatory motion. Rest a flat-iron on the lower end of the strip if there is any unsteadiness.

This shows but one form of mounting the eye-piece of a telescope and the simplest, but such an instrument afforded the writer his first glimpses into the marvelous world of microscopy. It is a good instrument, and with it any young enthusiast will train his eye and hand so as to do fair work in preparing and mounting objects, and at little expense in ready money.—*Builder and Woodworker.*

FLORICULTURE.*

The cultivation of flowers is an occupation that improves alike the body, mind and heart. It is an almost certain indication of purity and refinement.

Floriculture, or the cultivation of flowers, is an art based upon the natural sciences—botany, chemistry, and entomology. Although a knowledge of these and kindred sciences will give much aid, it will not of itself make a good florist.

When a student has learned all that lectures and books can teach, he still needs observation, practice, and experience to make him master of floriculture. It is not a rude, simple matter, but requires and rewards the fullest command of science and the knowledge of nature's laws.

What is needed in the cultivation of flowers is more study, more thought, more enthusiasm, with less attachment to old ways, methods, and practices, which, if ever desirable or judicious, have long ceased to be so. If those who love flowers, will intelligently resolve that their cultivation shall and must improve, it will not be long before we have an art worthy of our country and the age in which we live.

We can afford to cultivate and study flowers if for no other reason than their cheerful surrounding. Many do without flowers because they think that they cost too much time and trouble, but one does not have to think long to be convinced that all things worth having cost considerable and that anything worth having is worth working for. Oftentimes the partial success or in many instances total failure in the cultivation of flowers is due to the fact that we try to do too much, that our gardens are too large and not sufficiently cared for. No one should have more ground devoted to a garden than can be kept in the highest state of cultivation. Excellence affords satisfaction and pleasure, while failure brings mortification and pain.

The same may be said of house plants or plants kept within doors during the winter. Too often do we see many plants crowded together in a poorly lighted window, compelling each plant to take on a form never intended by nature and foliage quite different from that desired by the owner.

* A paper read by George C. Watson before the Clyde Grange Natural History Society.

One of the chief requisites in management of house plants is plenty of sunshine.

Next is an atmosphere neither too dry nor too close and a uniform temperature (lower at night than during day).

Some practical hints as to watering may be summed as follows :—Rain water is better than spring or well water. Hard water may be greatly improved by adding a drop or two of ammonia or a little soda, a small nugget about the size of a pea to every gallon of water used. As to time of day, morning is the best, and next is the evening. Never water house plants when the sun is shining brightly upon them ; the supply of water must be regulated according to the demands of the plant ; the condition of the plant and of the soil is the best guide. Never give water when the soil is moist to the touch. Nearly all plants require more water when in bloom than at any other time, more in a warm temperature than in a cold, and more when in a state of active growth than when at rest. Plants in open rooms usually require water once a day and some demand it twice, at any rate all should be examined with interest to water at least every day.

Cleanliness is essential. The leaves of plants should be kept free from dust, hence frequent washings are absolutely essential, although when watering never wet the flowers of a plant nor allow drops of water to stand on the leaves in the sunshine. Never allow water to stand in the saucers of the pots unless the plants are semi-aquatic. Watering is at least two-fold. It supplies plants food or elements of fertility contained in itself and converts the plant food or nourishment of the soil into a liquid form, so that it may be absorbed by the roots. The roots of a plant must be kept moist, not wet.

When the drainage is the most perfect, plants will generally be the healthiest and will need watering the oftenest.

Give house plants as much light as possible during the day, and darkness with a lower temperature at night.

Plants require rest ; a uniform temperature of 60 or 70 degrees in the daytime and 40 to 45 degrees at night will give the best results.

Turning the plants toward the light should not be done, unless done regularly. Besides light, house plants require a good supply of fresh air. Ventilation is absolutely necessary.

A word as to the restoration of cut flowers that have become wilted ; the question is often asked, "How can I restore or refresh this flower?" It may be a rare flower, or one that is prized highly as the gift of a friend—in either case joy will follow its restoration. Cut flowers have frequently been restored to freshness, even when every petal is drooping, by placing the stems in a cup of boiling hot water and leave them until the petals have become quite smooth, then cut off the cooked ends and place in lukewarm water, and for this purpose pure rain water is thought to be preferable. The freshness of cut flowers is due wholly to two conditions, either evaporation from the flowers must be prevented by inclosing in a case containing a saturated atmosphere or the evaporation must be supplied by moisture at the cut end or stem. This stem is composed mostly of woody fibre or cellulose, whose power to absorb water soon diminishes, hence to enable the stem to absorb the most water, the end must be frequently cut off.—*Scientific American.*

A system of building houses entirely of sheet iron has been communicated to the Society of Architecture in Paris. The walls, partitions, roofs, and wainscoating are composed of double metallic sheets, separated by an air mattress, which is surrounded by different non-conductors of heat.

CELLULOID.

Now there seems to be every probability of glass being, at least partially, superseded by celluloid in negative work, especially out of doors, we may expect soon to find a new subject for discussion in the question as to whether the substance referred to is altogether free from faults in its new application. It may be said, indeed, that the question has already been raised.

If it should be proved that these doubts are well founded, the question suggests itself as to whether the beautiful substance cannot in some way be freed from its baneful ingredients. In other words, whether it cannot be *decamphorated* and *denitrated* without destroying its advantageous features, especially its transparency and flexibility.

With a view of testing the possibility of this we have made a few rough experiments, but not with any very decisive result, at any rate so far as success is concerned, but rather the opposite. With a view of removing, if possible, the camphor, a sheet of celluloid was digested with ordinary methylated alcohol, which, though at first producing no apparent result, was found in the course of a few hours to have *completely* dissolved it. Here, then, there is no possibility of dissolving out the camphor, since the latter lends its aid to the alcohol in dissolving the pyroxyline.

Another sheet accurately weighed (like the last) was submitted to the heat of about 180° Fahr. in a gas oven for a period of twelve hours; at the end of that time it was physically changed to the extent of being badly curled and crumpled by the heat, though that might possibly be remedied by proper precautions. But the loss in weight after twelve hours "stoving" did not amount to *one-tenth of one per cent* on the total weight. So here, again, there does not appear much hope of driving off the camphor in vapor without hopelessly spoiling the material.

Of a number of experiments in denitrating, one may be specially mentioned. If the celluloid be immersed in strong concentrated sulphuric acid, no apparent action takes place; but if an equal volume of water be added, the sudden and intense heat evolved causes a deep yellow coloration of both celluloid and liquid, and the evolution of a powerful empyreumatic, mixed up with which camphor is plainly recognizable. After a very short time the action ceases and the color leaves the solution.

If the celluloid be now taken out, washed, and dried, it will be found to have lost considerably in weight and to have had its surface eaten away irregularly, or corroded in much the same way as glass when treated with dilute hydrofluoric acid. Returned to the dilute sulphuric acid and boiled, no further action takes place until ebullition has gone on for some time, when the liquid commences to turn yellow, but the color at first quickly disappears on stirring. Gradually, however, it becomes stronger and more persistent, and at the same time strong nitrous fumes are given off, these being apparently the cause of the yellowing. Finally, the color becomes brown, and the celluloid dissolves entirely, forming a deep brown solution.

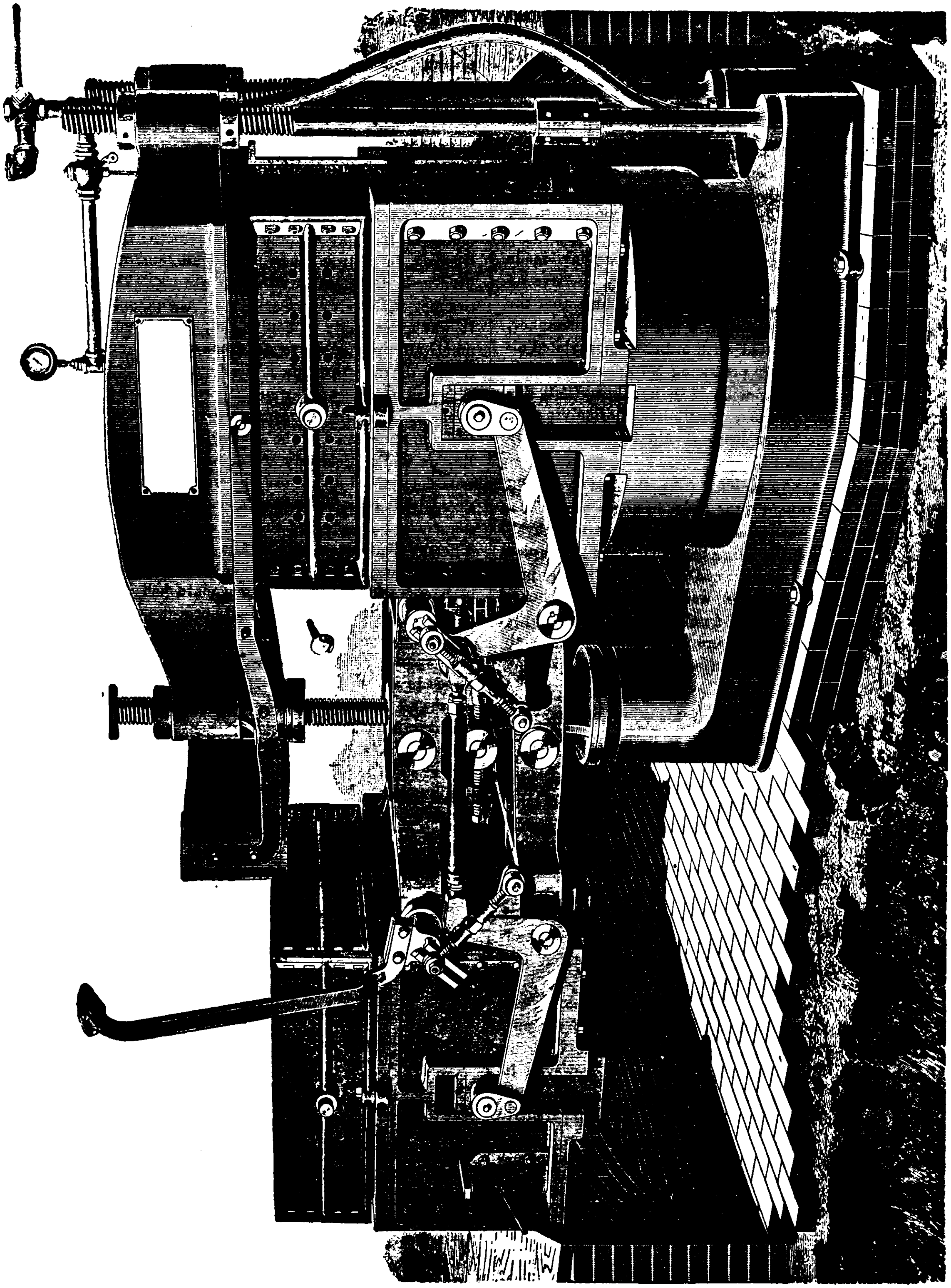
Now this seems to prove that *as celluloid* the substance for a long time resists even boiling sulphuric acid, but gradually it is denitrated, and then *as cellulose* is carbonized and destroyed by the acid. Thus the possibility of denitration is proved, but whether it can be done practically without destruction is a question.

If this can be accomplished, one at least of the possible weak points in celluloid will be removed.—*Br. Jour.*

PNEUMATIC MOULDING MACHINE.*

The author began by explaining the general principle of moulding machines which had preceded the one he was about to describe. The system of moulding by machinery commenced by machines in which the sand was rammed or pressed by a flat plate. The next step was taken when the pattern was mechanically withdrawn after the mould was made. Subsequently the two systems were united, and many machines were made in which there was combined a flat presser and a withdrawable pattern. These were by far the more numerous class in the market, but there were other systems designed to expedite the removal and casting of the boxes, which had been largely adopted. Instances of these were found in the plan adopted by Messrs. Alley & McLellan, of Glasgow, in casting fence post spikes, and at Goudienne, in France, in dealing with stove grate work. The chief difficulties met with were those arising in the ramming of the sand. It was exceedingly difficult, and, as the author contended, practically impossible, to get a box properly rammed by hand so that the sand throughout the mould was of uniform density. This was a matter of prime importance, as he believed most of the evils existing in connection with castings were due to faults or variations in the density of the mould. The Atlas Engine Works Company of Indianapolis for commercial reasons determined to reduce the engines made by them to five sizes, and it therefore became a matter of importance to devise some means of reducing the cost of moulding. Owing to the different depths necessary in the box, the proper pressing of the sand was a difficult matter, and, after a number of experiments with a divided presser plate had been made, india-rubber bags, into which air under pressure could be admitted, were tried. These succeeded admirably, and the machine was rapidly developed. At first the moulding boxes were placed in a fixed box, but eventually the rotary head machine, which we illustrate on the next page, was adopted. This machine is constructed, as shown, with two heads, which are swivelled on a centre rod, forming one of the pillars of the machine. The pattern is raised or lowered by means of the levers shown, which can be locked so that it is impossible for them to be moved at the wrong time. When the boxes are in the position shown, one is ready for being rammed up, while the other is ready for the removal of the box, both operations taking place simultaneously. The pressing head is constructed with the required number of bags, according to the size of the machine, the bags being held in the top box. When the box is brought into position under the presser, compressed air is admitted and first actuates a piston below the bottom plate, thus raising it and the box until the latter is brought in contact with the bags. The reason for this construction is that there must necessarily be a little space to allow of the free movement of the head, and it is necessary to fill this space before the bags are put under pressure. As soon as the box is sufficiently raised, a valve is automatically opened and the air admitted to the bags, thus ramming the box in a few seconds. The pressure of air used is 50 lb. per square inch, which is found enough for practical purposes. After ramming, the pressure is relieved, the head swung round, the pattern drawn downwards, and the box removed. The sand is supplied from a hopper placed above the outward head; the used sand, after being riddled and mixed, is brought back by a travelling band and elevator to

*Abstract of a paper read by Mr. George Richards before the Manchester Association of Engineers, on the 26th ult.



PNEUMATIC MOULDING MACHINE.—CONSTRUCTED BY THE PNEUMATIC COMPANY, INDIANAPOLIS, U.S.A.

the hopper. A special light frame or box swivels on a joint, and can be brought above the box during filling, to allow for a surplus of sand being filled in to ensure complete ramming. The extra quantity thus supplied can be easily removed when withdrawing the pattern.

The chief features of novelty and excellence claimed for this machine are those of simplicity of working and uniformity of the castings produced. The machine had been introduced into the works of Messrs. Marshall, Sons, & Co., of Gainsborough, with complete success, this firm now having three machines at work. It has been found that not only is the cost of moulding materially reduced, but uniformity in the size, weight, and density of the castings produced was obtained which could not be got either with hand or machine moulding as formerly tried. Further, no special provision had to be made for venting, as the gases easily found their way out of the sand. To show that a greater uniformity of castings were obtained, an elevator cover made by Messrs. Marshall was exhibited, the weight of which was under the old method of production from 14 lb. to 15 lb., but was made on this machine of a weight not exceeding 7½ lb., the variation being slight. The speed of the machine was demonstrated by reference to a sample mould exhibited, which was intended for small spur wheels about 12 in. diameter and 1 in. pitch. Of these from forty to fifty boxes per hour could be produced on the 16 in. machine. Loose patterns can be readily used on the machine without any difficulty, and Messrs. Marshall are making an extensive use of it in that way. A trial made in Indianapolis, by the Pneumatic Company, into whose hands the machine had passed, resulted in 196 boxes, each containing four wheels, being moulded in 190 minutes, and boxes 4 in. deep, moulding light bevels, were moulded at the rate of 219 in 180 minutes. A test had been also made at Messrs. Marshall's works, and the results would be given during the discussion. The sand used was just as it ordinarily existed in a foundry, no facing sand being usually needed. A further development made at Gainsborough was the use of a certain amount of water in the rubber plate, which had been attended with good results. In concluding, the author gave some particulars of the use of circular "gates," by which the metal was spun round before entering the mould. By the use of a plan of this sort it had been found possible to fuse cast iron rollers on to wrought iron shafts without preparatory turning.

WATER SOFTENING.

BY GEO. E. DAVIS.

Many steam users have at last commenced to discern that the steam boiler is not the proper place in which to deposit the mud and filth from the feed water employed in generating steam. To those of our readers who have discovered this fact for themselves no words or exhortations will be necessary, still there are many of the old school still existent, and who have yet to be won over to the new *régime*. The softening of water on the large scale presents itself to us as two problems—one mechanical, the other chemical—and it is only by a proper combination of the two that success can be insured. A water temporarily hard by reason of its containing carbonate of lime held in solution by carbonic acid requires a treatment differing from that of water permanently hard by sulphate of lime, to say nothing of other constituents present in the various waters employed in producing steam.

From "temporary" hard water the addition of lime water will cause the separation of the whole of the carbonate of lime held in solution by the carbonic acid, plus the carbonate of lime also formed by the union of this carbonic acid with the added lime. From permanently hard water, the addition of lime extracts nothing save the carbonic acid which all waters contain, and perhaps magnesia, if these salts are present; but the use of lime in every case requires the greatest care in manipulation, as it is easy to make the water worse than it was originally.

Many processes have been devised from time to time in order to make hard waters suitable for boiler feeding. Some of them have been a nine days' wonder, and on the 10th day the glory of their fame has vanished. Many are the nostrums now in use for "fetching off scale," the users not having yet learned the lesson that it is better to keep the scale forming substances out of the boiler in the first instance. Steam users should, however, know that without the active agents are used in definite proportion, easily ascertained by a chemical analysis of the water, the use of anti-incrustating agents is nearly useless. Of all the substances used as preventives of scale, the tribasic phosphate of soda is, no doubt, the best; but it is dear, comparatively speaking, and its combining weight is high. Next to this comes caustic soda, which forms the basis of most "boiler compositions," and it would be well if steam users bought and used the pure and undiluted article themselves, as all the other added materials are of but little moment. We have already mentioned that the anti-incrustating agent must be applied to the feed water in due proportion, and this quantity is far beyond what most steam users imagine. A few pints of a weak solution daily is of no more use than an expectoration. There is a certain minimum which must be applied. On the other hand, there must not be too much caustic alkali in excess, as in such a case the tendency to priming will be increased; and further, the caustic alkali will act upon and destroy the brass fittings upon the boiler in a very short space of time. Carbonate of soda, either in the shape of soda ash or as soda crystals, has often been recommended to prevent incrustations in steam boilers, but it is not nearly so efficacious as caustic soda or tribasic phosphate of soda, as a simple experiment will prove.

The softening of a water that has occupied my attention lately may well serve as an illustration of the foregoing remarks. I was asked to soften five millions of gallons per week of 144 hours. The water gave the following results upon analysis :—

GRAINS PER GALLON.

Total solids	63·50
Loss on ignition	13·00
Chlorine	3·23
Hardness	36·00

PARTS PER MILLION.

Ammonia	0·10
Albuminoid ammonia	0·06

A further investigation showed me that the hardening constituents existed in the following proportions in grains per gallon :—

Carbonate of lime (held in solution by carbonic acid)	5·20
Sulphate of lime	24·30
" " magnesia	0·15
Magnesium chloride	4·27
" nitrate	17·27

The foregoing quantities show to the trained mind the magnitude of the operations which have to be performed.

Five million gallons of water contain not less than *six tons* of magnesium nitrate, or three hundred tons per annum. We will, however, look at it from another standpoint. The carbonic acid holding the carbonate of lime in solution does not merely exist in the proportion of $CO_2 : CaCO_3$, it is much in excess of this; in some well waters twice or thrice CO_2 to $CaCO_3$—in such cases the carbonate of lime does not commence to precipitate until all the free carbonic acid in the water has been neutralised by a caustic alkali or alkaline earth. With some waters lime is a very useful purifying agent; but in this instance there would be no advantage in its employment. A very interesting series of experiments can be made with the foregoing water. Take three separate portions of one gallon each. To the first *(a)* add 36 grains of pure carbonate of soda, previously dissolved in a little of the water; to the second *(b)* add 27 grains of high strength caustic soda (Alhusen brand); and to the third *(c)* add 100 grains of tribasic phosphate of soda. If these additions be made in the cold, the different action of each will be remarkable; *a* may possibly become opalescent to a slight degree; but no appreciable deposit will occur even after twenty-four hours' settling. The portion *b* behaves very differently; first it turns opalescent, and then there slowly deposits a bulky precipitate, consisting of carbonate of lime, magnesia, and other impurities. The portion *c*, however, commences to precipitate the moment the phosphate is added, and in a very short time the deposit has settled to the bottom of the vessel in which it is contained, leaving, even with dirty water, the solution in the clearest possible condition.

We may now alter the physical conditions and observe the change. Place each vessel over a large Bunsen burner and heat to 70° C.; *a* throws down a small quantity of a sandy precipitate, *b* deposits a large quantity of a similar character, while *c* does not differ much from *b*. If we continue to heat the water, as the carbonic acid is expelled from *a* so we get a larger precipitate, but with *b* excessive boiling is not by any means necessary. We have thus arrived at several important conclusions: (1) Softening with carbonate of soda (soda ash) requires to be done at the boiling temperature, and, therefore, must be effected in the boiler. (2) Softening completely with caustic soda only requires the water undergoing treatment to be heated to 80° C.; this can be done in the boiler, and the insoluble matters easily filtered off in an apparatus such as that of the Pulsometer Engineering Co.

The water such as I have already given the analysis of would cost most probably about one halfpenny per thousand gallons for pumping. The softening would cost more. The quantity of high strength caustic required would be in grains per gallon:—

To decompose the sulphate of lime	14·4
" " " magnesia	0·1
" " magnesium chloride	3·6
" " " nitrate	9·4
	27·5

But some may say sulphate of lime is not decomposed by caustic soda—this is quite true—but the moiety of the caustic soda immediately becomes carbonate by combination with the excess of carbonic acid in the water, so that caustic soda may be said to be doubly effective—first it absorbs the carbonic acid, allowing the actual carbonate of lime to fall; and, secondly, the carbonate of soda so formed acts upon the sulphate of lime, producing carbonate of lime and sulphate of soda.

Caustic soda added to a boiler feed water will eliminate the lime salts, but I have not found it so easy to throw down the magnesia. Where a water contains much magnesia, I prefer a suitable mixture of caustic soda, carbonate of soda, and tribasic phosphate of soda, the quantities of which must be calculated from the results of the analysis of the water. To illustrate by an exact experiment, the water of which an analysis has already been given was treated with a mixture of—

Caustic soda (77 per cent.)	17 grains.
Carbonate of soda	17 "
Tribasic phosphate of soda	5 "

The water contained in grains per gallon—

	Before treatment.		After treatment.
Lime	12·9	..	0·78
Magnesia	6·6	..	3·78

Having deposited 28·3 grains of a precipitate consisting of—

	Per cent.
Lime	42·10
Magnesia	11·07
Carbonic acid	33·24
Peroxide of iron	4·00
Alumina	6·20
Phosphoric acid	3·45

On such a quantity as five million gallons per week 28 grains of dry solid matter per gallon would amount to no less than *nine tons*, or about 25 tons of semi-dry sludge. The quantity of high strength caustic soda required would be about nine tons weekly, so that the cost of purifying such a water as this would average 3½d. per thousand gallons. This of course is an exceptionally bad water to purify, but I hope I have sufficiently indicated that purification may be effected at a price, and also what that price is. Nearly every water can be successfully treated in one way or another, the exact process is a question for the chemical engineer. One word to the steam user: Do not use any of the secret nostrums, and do not endeavour to "fetch off scale," but rather devote your energies to its prevention; when scale is formed the mischief is done, it is too late then to apply the remedy.—*Chemical Trade Journal.*

THE DETERIORATION OF STEAM BOILERS.

Deterioration of steam boilers was the subject of a lecture recently in Sibley College, Cornell University, by Mr. J. M. Allen, of Hartford, Conn., an abstract from which is given below:—When a boiler is completed and set to work, destructive forces more or less severe become active, and they must be carefully watched, or the working age of the boiler will be materially shortened. The forces may be mechanical or chemical, or both. The mechanical forces are those usually arising from bad design or workmanship in construction, with the exercise of little judgment in the matter of setting. A boiler should be so designed, constructed and supported that under the conditions of use the strains will be as uniformly distributed as the conditions will allow. In externally fired boilers it is well known that the bottom or fire-sheets are more expanded than the top sheets. Hence it becomes necessary to have such arrangements made in the setting or support that the boiler shall rest easy and have opportunity to adjust itself to these conditions. In long cylinder boilers this strain often becomes quite severe, and if the boiler is tightly bound up in brick-work, fractures are very liable to occur. To compensate for this, various plans for supporting long boilers have been devised. In some cases the brackets or beams supporting the boilers have rested on volute springs, in other cases equalizing beams or bars are used. In some cases quite elaborate apparatus has been devised. The point to be attained is so to support the boiler that the load will be properly distributed under the changes of form to which the boiler may be liable under heat. Were it not for the elasticity of the metal, these long boilers could not adjust themselves to this severe strain, but when well constructed and properly set they have stood the test for many years. Usually these long boilers, from 40 to 60 feet in length, are used in iron-works and are heated by the waste gases from the smelting furnaces. The gas enters the boiler furnace under more or less pressure, and when ignited will present one continuous sheet of flame from the furnace to the rear end of the boiler. In order fully to utilize these gases, the long boilers are used. It is a question whether shorter boilers of a different type may not be used with safety and equal economy. Another form of cylinder boiler from 28 to 30 feet long is used in connection with reheating furnaces in iron-works, the gases being utilized for fuel. These boilers are often supported by resting simply on walls at each end. When the metal is being run off, the furnace doors are thrown wide open and a current of cold air is allowed to flow into the furnace and along the bottom of the boiler. The walls are very hot, and the temperature of the steam and water in the boiler is that due to the pressure. The sudden cooling of the fire-sheets causes contraction, and a severe strain is brought, especially on the girth seams. These not unfrequently crack from rivet-hole to rivet-hole, and in a number of cases I have known the boiler to break into two parts, each part flying off in opposite directions, Fig. 1.

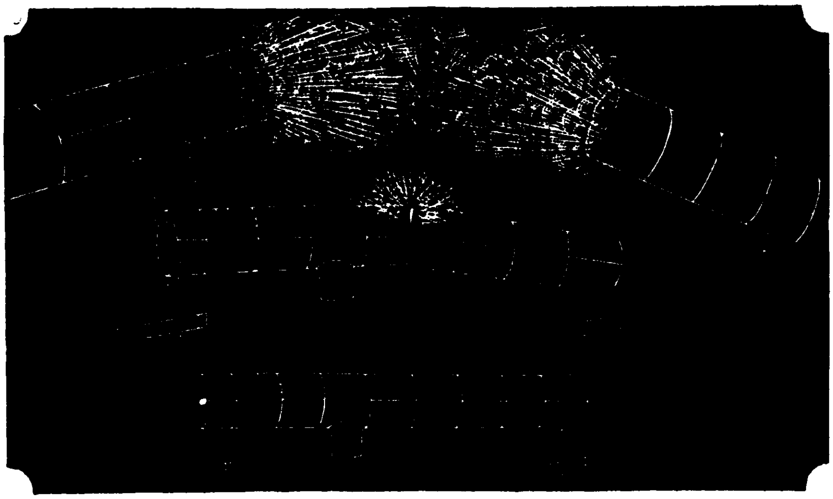


FIG. 1.

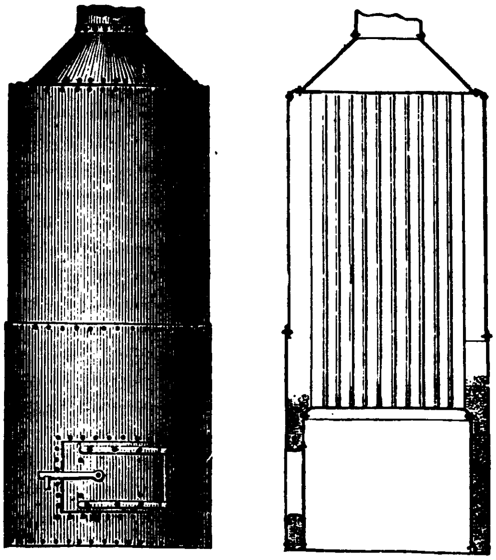


FIG. 2.—AS BOILERS ARE OFTEN BUILT.

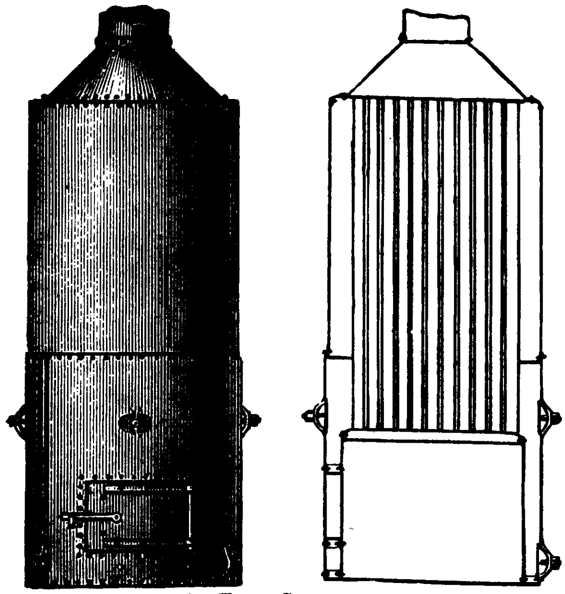


FIG. 3.—AS THEY SHOULD BE BUILT.

A current of cold air should never be allowed to strike for any length of time the fire-sheets of a hot boiler, and such boilers should always have rods, not less than one inch sectional area, running from head to head, sufficient in number to hold the boiler together under such circumstances. With this provision for safety, if a leak was noticed at any girth seam, the boiler could be put out of use and the extent of the fracture ascertained and suitable repairs made, thus preventing what otherwise might cause a serious accident. Internally fired and fire-box boilers have their weak points as well. There are narrow passages for the collection of sediment and formation of scale, and in these narrow passages the circulation is very imperfect, and wasting and corrosion are very liable to take place. I will say that this type of boiler is very much used, and with economical results. There is economy of space also, which is often an important consideration. But boilers with water-legs and narrow water passages should be frequently examined, so that the difficulty, if such exists, can be discovered and remedied before the progress of deterioration has gone to a dangerous extent. Boilers with narrow water passages, whether vertical or of the horizontal type, should be supplied with a sufficient number of hand-holes to make the work of cleaning out sediment comparatively easy. The following illustrations (Figs. 2 and 3) will show how vertical boilers are often constructed, also how they should be constructed to overcome the difficulties mentioned.

Another important matter is good workmanship in construction. If a boiler is bunglingly put together there will be several local strains that under the conditions of use will be greatly aggravated. If the parts of the boiler do not fit well and are brought into place by severe hammering and wrenching, what can we expect of such a boiler when put into use under a pressure of eighty or ninety pounds to the square inch? It will leak and give any amount of trouble to the user, and it will be fortunate if it does not burst or explode, carrying death and destruction in its flight. The "drift pin" seems to be one of the great evils in a boiler-shop, although few boiler-makers will admit that they use it, except to keep the plates in place while they are being riveted together.

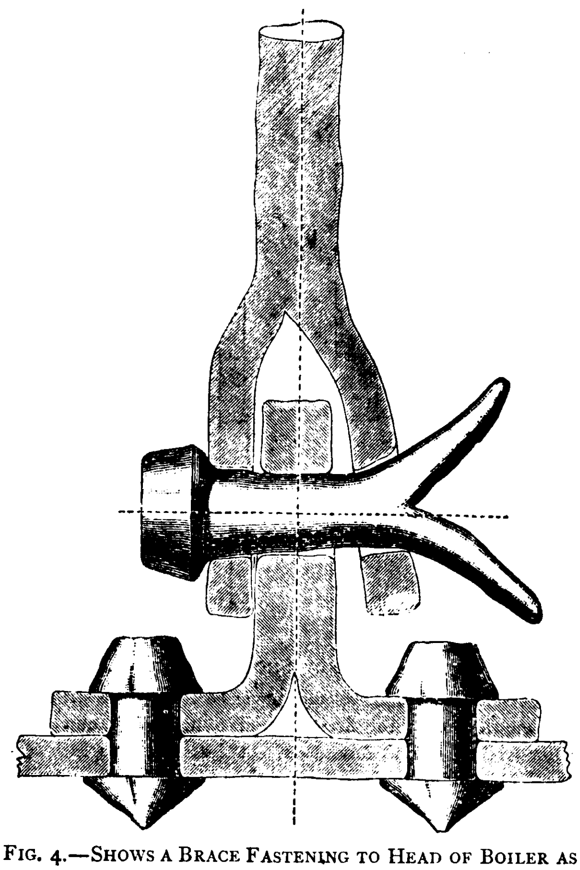


FIG. 4.—SHOWS A BRACE FASTENING TO HEAD OF BOILER AS THEY ARE SOMETIMES MADE. (This is no exaggeration.)

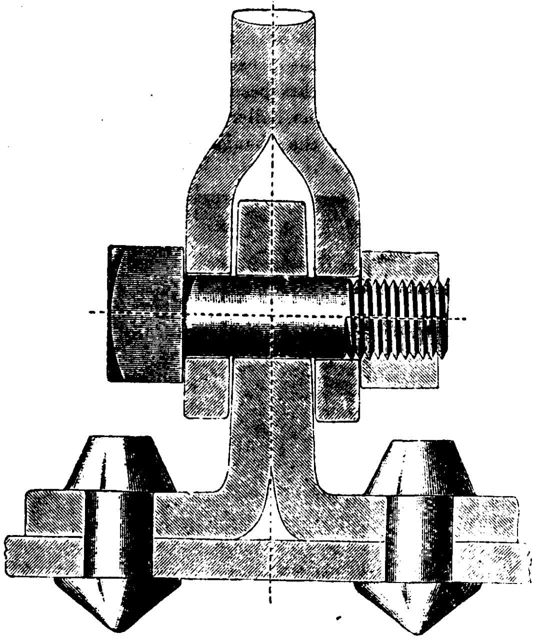


FIG. 5.—BRACE FASTENING AS IT SHOULD BE.

But I sometimes step into a boiler-shop, unknown and unannounced, and I have seen the cruel use of the drift pin. Another potent cause of the deterioration of boilers is the water which is used, causing deposits of sediment and formation of scale, and often having corrosive tendencies. We have a great variety of waters in this country, chemically speaking. In many sections of this country we find the underlying strata to be largely sulphate and carbonate of lime. This foundation is of wider extent than any other. Then there are also chalybeate waters, magnesia, alumina, silicate, and waters carrying more or less organic matter. All of these waters give more or less trouble. In carbonate waters, the carbonate of lime and magnesia are frequently thrown down in the form of a fine powder, which settles along the joints at the lap; this often causes leaks. Another practice which aggravates these cases is returning the exhaust from the engine to the boiler. The oil thus carried into the boiler in combination with the impurities in the water makes a pasty substance that adheres to the plate and keeps the water from contact, causing over-heating and often rupture. In fire-box boilers where there are water-legs and narrow water passages, this deposit often becomes a serious matter. Open heaters should not be used for collecting drips, if there is any oil used, but where the drips come from slashers or drying-rooms, there will be no trouble. To utilize the heat in the exhaust from the engine, a pipe or coil heater should always be used. By such an apparatus all danger is avoided.

In many cases the water is so bad that it is not fit to be used in boilers, and would not be used if a better supply could be found. Our rule is first to analyze the water and then, knowing what impurities are carried in solution, we are better able to decide what the remedy must be. If the impurity is mainly carbonate of lime or magnesia, it is usually thrown down in the form of small, fine powder. Frequent blowing is necessary, that is, blow down two gauges of water, two or three times a day. But in addition to this there should be a good pipe or a coil heater, and the sediment from that should be blown out often. It sometimes occurs that the impurities do not readily settle on the bottom of the boilers, especially if the boilers are hard worked and circulation is rapid. In such cases a surface-blow is desirable and important, the object being to remove as far as possible the impurities from the water. To give you a correct impression of the character of some water used in boilers, I copied the following from our laboratory records: In spring water from Nashville, Tenn., we found in 100,000 parts, insoluble and sparingly soluble solids 17·6 parts, readily soluble solid matter 35·2, or a total of 52·8 parts, or 30·82 grains to a United States gallon. In another case in water from a well at a chemical works we found in 100,000 parts, insoluble and sparingly soluble solids 25·6, readily soluble solids 71·2, total 96·8 parts, or 56·52 grains in a United States gallon.

You will very naturally inquire, "What do you advise to be done in these cases of bad water?" It is often a very puzzling question. If carbonate or sulphate of lime predominate, a very good antidote is carbonate of soda. Especially is this good in case of carbonate of lime. It prevents it from readily forming a scale, and if attention is given to blowing and cleaning, the difficulty can be easily overcome. We usually recommend from eight to ten pounds of soda-ash dissolved in warm water to be introduced into the boiler about once or twice a week. This can be done by putting a branch into the suction pipe of the pump and connecting this branch by a hose to the pail or vessel containing the solution. In some cases we use one part, by weight, of catechu to two parts of soda-ash. Tannin works wells in some cases, and a solution made from boiling the leaves of the eucalyptus tree has found much favor on the Pacific coast, and is being introduced in this part of the country. There is no grand panacea that will cure all these maladies. We must know something about the case before we can remove the disturbing cause. It will be readily seen that if attention is not given to these cases, the result will be not only annoying, but dangerous. Hard scale will accumulate on the fire-plates of the boiler, resulting in over-heating and greatly weakening the boiler. The question of the waste of fuel is also an important one, for steam can not be economically generated in a boiler where the plates are covered with scale. We all know that scale is a very slow conductor of heat, hence in addition to loss here the plates are worn away and become greatly weakened. The question of corrosion is a serious one in some cases and is difficult to manage. Water from swamp lands often has corrosive tendencies (Fig. 6), and on rivers and streams on which a number of manufactories are located, discharging their spent dyes and refuse, water becomes very much contaminated and gives serious trouble to the mills located down the stream. Our advice has always been for the parties to combine and lay a water main from the pond of the upper dam to the mill lowest down, sufficient capacity to supply them all with good water. Another difficulty which is often encountered and which at first seems paradoxical is corrosion or pitting from pure water. Corrosion in boilers in the absence of free mineral acids can proceed from three principal causes:

1. The purity of the water. Water is an almost universal solvent and dissolves most substances to some extent. In the absence of substances in solution to prevent that action, even pure water would attack iron and corrode it, but except in the case of distilled (condensed) water returned to a boiler with the return-pipe coming near the shell, this condition can hardly be said to exist, as even rain water contains from one to three parts per 100,000 of impurities.

2. The presence of air and dissolved gases in the water. This is in all probability the most fruitful source of corrosion, except the acid decomposition of grease, oil, etc. Water, unless recently boiled, contains varying amounts of dissolved gases, which are expelled at boiling temperatures. It has the peculiarity of holding a larger proportion of oxygen in solution than air has, usually about 33 per cent more in water free from oxidizable matter. This under proper conditions would combine with the iron, rusting it rapidly, and when oxidation had once begun, forming a rust spot, heat and moisture would rapidly continue the work. Water also contains varying and sometimes large amounts of carbonic acid gas. This by some authorities is equally injurious with the oxygen, but as when existing in large amounts it is almost invariably associated with lime and alkalies, which have been found to prevent corrosive action in practice, it is probably not especially harmful. Oxygen and nitric acid occur in rain water and newly fallen snow, and the purer and ærated a water is, as for example rain water, snow water, and water from uncultivated upland and quick slopes, the more dissolved oxygen it is likely to contain.

3. Substances in the water causing corrosion. A water containing more than ten parts per 100,000 of solid matter usually contains considerable lime as carbonates, some soda and potash salts, and is alkaline. Such a water is not likely to corrode a boiler. A water with only four or five parts of solid matter (though it may contain also considerable dissolved oxygen, etc.) may be almost if not quite neutral, or even

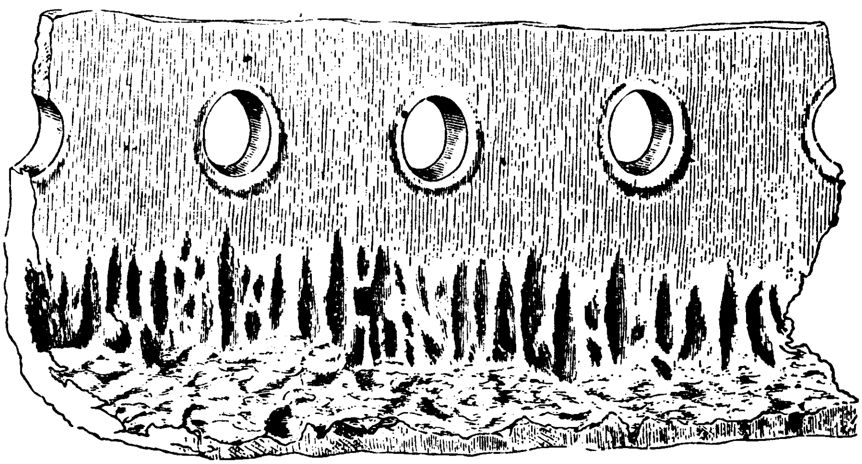


Fig. 9.—Part of a Head of a Boiler Badly Corrugated and Pitted by Water from a Swamp.

slightly acid. This acidity may come from dissolved organic matter, which, if from fields or woody districts, the water is likely to carry in considerable amount. This woody extractive matter is easily decomposable, and some of the complex acids, so-called humic, crenic, apoorenic, oxalic, etc., present or formed under the action of decomposition, act very unfavorably on the iron of the boiler. This woody or especially peaty matter also contains tannic acid and gums in many cases, and has been observed to varnish the inside of boilers, in some places, so as effectually to prevent corrosion where otherwise it would be expected. The presence of certain salts in solution has a very injurious effect on boilers, even in small amounts. Waters containing nitrates and especially ammonia salts, as ammonia chloride, seems to be especially bad. Water exposed to the leaching from vaults is especially undesirable, even though a water strong in salt and alkalies from a common sewer might not be harmful to the boiler. The action of oil and tallow decomposing to oleic and margaric acid in the boiler, in the absence of alkalies, and especially with a coating of sulphate scale to prevent free circulation of the water at the corroding points, is well established. It occurs that a water at some seasons of the year making quite a scale, is at others quite soft and charged with air and gases, and partly dissolves that scale. This may go on indefinitely, until an unusually wet season, or a very clean or new boiler with the water quite pure, may suddenly develop injurious pitting from the absence of matter to counteract the effect.—*Dominion Mechanical and Milling News.*

HINTS ON HAMMERING.

A correspondent of the *American Mechanic* furnishes that journal with some very interesting notes on the use of the hammer on shafts, rivets, etc. We collate as follows:

The particular manner in which a piece of metal yields to a blow depends upon the hardness, the weight, and the speed of the thing with which the blow is struck. A machinist straightens a shaft by striking the high side with a heavy soft hammer; he straightens the same shaft by striking the low side with a light, hard hammer. The heavy, soft hammer acts more as a slowly applied pressure, or like a screw press, and takes out a bend by bending in the opposite direction. The light, hard hammer dents or penes, and in consequence lengthens the low or short side, which straightens the shaft. Now a shaft can be straightened with a heavy, hard hammer, if it be heavy enough to bend the shaft more in the direction that it strikes than it tends to pene the shaft in the opposite direction. For any given shaft there is a size of hard hammer that will pene in one direction as fast as it will straighten in the other, and without a change in tendency, a man may hammer the shaft and his lifetime away and accomplish nothing.

HAMMER RIVETING

Is merely a series of dents. The particular manner in which pieces are riveted depends upon the weight or pressure, and the speed of the thing that does the riveting. Before riveting machines were made, hand-hammers were used, which were often more effective than the operatives were efficient. Two blows of a 4-ounce hammer would shorten a rivet so it would be nearly or quite even with the piece that it was supposed to hold, but it would not be right, because its body would be enlarged the whole length and be only slightly tapering, a little larger at the end, but not enough larger to hold. Some experiments were reported to the correspondent by Mr. C. H. Norton, the inventor of a riveting machine, in which the inventor tried light hammers, weighing about 1½ ounces each, which formed heads on rivets of some sizes without enlarging the bodies; but these hammers were still too heavy for the smallest rivets.

Some of the 1½-oz. hammers were cut off at each end, leaving them one ounce, which proved to be light enough; but the operatives did not like to have them so light, because so many blows had to be struck to form a rivet head. When Mr. Norton was not near, the heavier hammers would be used by some operatives and the riveting would be worthless. Such stimulants to morality as are kept in workshops for cases in which a lack affects the employer, were administered. Reward was offered to informers, discharge was threatened to bad riveters. Another trouble came, not so much through lack of morality as through lack of skill. Among the pieces to be riveted one to another were many eccentric washers, called glass clamps, for holding glass plates, the edges of which were placed under the clamps while riveting. A wild blow, uneven hammering, or too much hammering, would break a plate.

The riveting machines afforded relief from all these troubles so far as the employer thought that his interest was concerned, though they did not, essentially, advance the operatives either in skill or in morals.

Before a successful machine was made it was found that the helve must neither be too stiff nor too heavy, but that it must yield somewhat when the cam strikes the lift. If the lift does not yield enough, it will wear away the cam almost as quickly as if turned in a lathe. One cam was destroyed in less than ten minutes.

If the helve and the hammer are too heavy, and, in addition, the helve is too stiff, the hammer, by one stroke of the cam, will be thrown so high that it will not come down before the cam has made several turns. If the hammer is not light enough, it will not answer to the spring quick enough to strike a blow that will do the work. Mr. Norton learned the curious fact that, within certain limits, the lighter the hammer the more work it will do. It is the quick blow of the hammer pulled down by the spring that does the work; if the hammer be too heavy, its inertia will be too great to be overcome by the spring quick enough to do any work in the fortieth part of a second. It would appear that, though the hammer is heavier than a hand-hammer for doing the same work, the blow is largely taken by the cam, and in consequence the work done upon the rivet is like that of a small hammer. A solid metal helve that was stiff enough was too heavy. A wooden helve worked well while it lasted, but it soon splinted. The thing that finally answered every purpose was a piece of gas-pipe about seven-eighths of an inch in diameter. The length of the strike of the hammer should be from one-eighth to one-quarter of an inch.

MIXTURES FOR BRASS CASTINGS.

An English paper gives the following as the proportions of the different metals used for brass casting in a prominent English locomotive works:—

Brass for side rods—Six pounds of copper and one pound of tin; to 100 pounds of this mixture add one-half pound of zinc and one-half pound of lead.

Brasses for driving boxes—The same as for side rod brasses.

Some master mechanics prefer harder brasses, and call for five pounds of copper and one pound of tin, one-half pound of zinc and one-half pound of lead.

Bells—Four pounds of copper and one pound of tin; to every 100 pounds of this mixture add one-half pound of zinc and one-half pound of lead.

Castings subjected to steam pressure—Twenty pounds of copper, one and one-half pounds of tin, one pound of lead, and one pound of zinc.

Pumps and pump chambers—Eight pounds of copper and one pound of tin; to every 100 pounds of this mixture add one and one-half pounds of lead and one and one-half pounds of zinc.

Piston packing rings—Sixteen pounds of copper, two and one-quarter pounds of tin; to every 100 pounds of this mixture add one pound of zinc and one pound of lead.

THE NEW FRENCH TELEPHONE LEGISLATION.

The *Journal Officiel* has just published two decrees relative to telephonic communications. The first has for its object the fixing of the rate of payment for telephonic conversations on the urban and interurban lines, when they are not subject to the *régime* of subscription. The following is the text of the first decree:—Article 1.—The amount to be paid on entering a public telephone cabin to obtain communication with an urban line is fixed at 50 c. at Paris, and at 25 c. in all the other towns of France. Article 2.—The elementary amount to be paid for an interurban telephone conversation is fixed at 50 c. per 100 kilometres or fraction of 100 kilometres of distance between the points joined by the telephone line. The distance is calculated according to the real route of each line. Article 3.—For the application of the amounts above indicated the normal duration of the conversation is fixed at five minutes. This duration may be reduced to three minutes on lines, and under determined conditions by Ministerial warrant. If the needs of the service require it, a conversation may not be prolonged beyond the double duration of its normal duration. Article 4.—All dispositions contrary to the present decree are abrogated, save those of the decree of December 28th, 1886, fixing the amount to be collected for telephonic communications exchanged between Paris and Brussels. Article 5.—The amounts fixed above will be applicable on and from November 1st.

It may be mentioned that, according to anterior decrees, the amount to be paid was fixed at 1 franc between Paris and Reims, Paris and Havre, Paris and Rouen, and Paris and Lille, which are all more than 100 kilometres distant. The amount payable for communications exchanged over the Paris-Brussels line (340 kilometres) was fixed at three francs, that for communications between Paris and Lyons (531 kilometres) was fixed at 2 francs, and that for communications between Paris and Marseilles (880 kilometres) at three francs.

The object of the second decree is to authorize and regulate the telephonic translation of telegrams. It runs as follows: Article 1.—The subscribers to the urban telephone lines may send and receive telegrams by the line by which they are connected with those lines. The transmission of these telegrams is carried out gratuitously, with the exception hereafter noted; but it is subordinated to the prior deposit of a sum destined to guarantee the payment of the telegraphic amount. In towns having a subterranean line, the subscriber who proposes to make use of the foregoing disposition has to deposit annually, and in advance, a sum of 50 francs. Article 2.—Localities other than the principal places of a canton may be joined to a telegraph office by means of a telephone wire. This wire, and the telephone office which serve it, are established with the participation of the communes interested. The part to be contributed by these communes to the expenses of the first establishment is fixed at 100 francs per kilometre of new line to be constructed or at 50 francs per kilometre of wire to be established on already existing supports, and at 300 francs for the apparatus and installation of the telephone post. Article 3.—In localities possessing a postal receipt office, the telephone service is confided to the receiver. In all the others, the manager of the telephone offices and his deputy are nominated by the *maire* after having been agreed to by the departmental director. They may be replaced on the demand of the Administration. They benefit on the transmission of telegrams by the same allowances as the managers of municipal telegraph offices. They take the same professional oath. Article 4.—Every person may send and receive telegrams by a municipal telephone line. The transmission of these telegrams is carried out gratuitously, but it is subordinated to the payment of the telegraphic amount. The payment of this amount is affected by the manager of the telephone office. If this manager be not at the same time a postal receiver, his receipts and his expenses are included in the accounts of the telegraph office with which it communicates. Article 5.—Every telegram intended to be distributed by a municipal telephone office is subject of the expenses of special messenger, unless the municipality may have made arrangements for gratuitous distribution. Article 6.—A telegram may only be telephoned, either by an urban line or by a municipal line, if it be written in French, in clear language, and if its text does not exceed 50 words.

Hitherto, this distribution has been effected gratuitously on the State lines; but the General Telephone Company only authorised it on its lines on payment of a premium on the subscription of fifty francs. Now that the State works directly all the urban lines, it suppresses this duality of régime. Still, one exception has been admitted, as has been seen. It has reference to towns which have a subterranean line. Its object is to prevent crowding in places where the space reserved for the wires is limited by the canalisation, the line of which they must follow.

PAINS IN THE HEAD DURING THE GROWING PERIOD.

It is a matter of common occurrence that young people of both sexes are compelled to interrupt their attendance at school on account of a cephalopathy that the author terms *cephalalgia of the growing period.* It commonly occurs between the ages of twelve and eighteen years, is accompanied by dizziness and *malaise* and is excited by any intellectual effort, sometimes even by the reading of an entertaining book. Its location is mainly in the temples, but it also involves the hairy scalp from the orbits to the mastoid processes, or even the entire head.

The patient is at times irritable, easily excited, or inclined to sadness and to spells of weeping. They are wont to complain that they cannot do as their comrades do. It is a mistaken idea to treat such persons as malingerers, and to attempt compulsory means, which cannot possibly yield good results.

Together with the phenomena mentioned are also to be seen anomalies of refraction and accommodation, as myopia, hypermetropia, and astigmatism, and in fact, diseases of the eyes in general. Proper glasses or other appropriate treatment will often lead to a rapid recovery, but such is not always the case.

Additional means of treatment should be complete cessation from intellectual effort, change of air, and appropriate medication.—*Rev. mens. des Mal. de l'E.; Arch. of Ped.*

"EVERY MAN HIS OWN ASSAYER."

EDITORS PRESS:—At your request I have investigated the powder recently advertised by Prof. Herman, under the heading of "Every Man His Own Assayer," and the professor has kindly applied it to two samples of silver ore in my (and your) presence, as follows:—

Sample A, consisting of chalcopyrite, tetrahedrite, zinc blende and antimonial galena containing (by the assay previously made) 52 ounces of silver per ton, the gangue being quartz. Prof. Herman assigned a value of 100 ounces per ton by his test.

Sample B. The same mixed with one-half its weight of calcite, therefore containing 41·3 ounces of silver per ton. The professor's estimate of the value of this sample is 50 to 75 ounces per ton. The professor said these samples should be roasted.

The powder in question consists of a mixture of salt and bluestone, or some other soluble compound of copper producing cupric chloride when dissolved in water. A black substance, which seems to be manganese dioxide, is added, apparently for the purpose of disguising the nature of the mixture, as it is quite needless. The quantity of the powder sold at $2 is actually worth about 3 cents.

This method of testing silver ores is fully described in a little book, published by Messrs. Dewey & Co. in 1876, and still on sale under the title of "Testing and Working Silver Ores;" also in a pamphlet published some years earlier, and it is remarkable that the printed directions accompanying the professor's powder are couched in almost the precise language of those publications. The method is also mentioned in "Assaying Gold and Silver Ores," by C. H. Aaron.

The test is useful to prospectors, enabling them to ascertain whether the ore which they may find contains silver or not; but, in order that it may be effective, the powder must be added until the hot pulp gives a distinct coat of copper to a knife blade dipped in it and then washed without rubbing; after which the copper strip is used in the same way and receives a white coat of silver if any considerable proportion of silver is present.

My attention has been called to the fact that an ore containing arsenic may give a gray coating to the copper, which may be mistaken for silver.

The test is nothing more than a test; that is, it is not even an approximately quantitative assay, though it may enable very rich ore to be distinguished from poor ore by the character of the silvery deposit. The prospector who may wish to use it needs only to provide himself with a few ounces of powdered bluestone mixed with twice its weight of salt, a strip of sheet copper, and an enameled cup in which the powdered ore may be mixed with water and heated. I am not sure that it is in any case absolutely necessary to roast the powdered ore, with or without an addition of salt, but it is safer to do so if much sulphuret is present. The ore may be roasted on a piece of sheet iron smeared with moist clay and dried. It should be stirred during the operation, and the heat gradually increased to dull redness until no odor of sulphur is perceptible. Unroasted ore containing cinnabar will yield a deposit of quicksilver on the copper which becomes brilliant by rubbing and is driven off by moderate heating. When the test is applied to pan tailings, it is capable of showing whether or not the tailings still contain extractable silver; in this case the pulp should be thinned with water enough to enable any quicksilver it may contain to settle, and the copper strips must not be dipped too deeply.

The instructions state that this test is the invention of a practical man. This is true. I made it myself, and published it many years ago for the benefit of poor miners.—C. H. Aaron, in *Mining and Scientific Press.*

THE USE OF STIMULANTS BETWEEN MEALS.

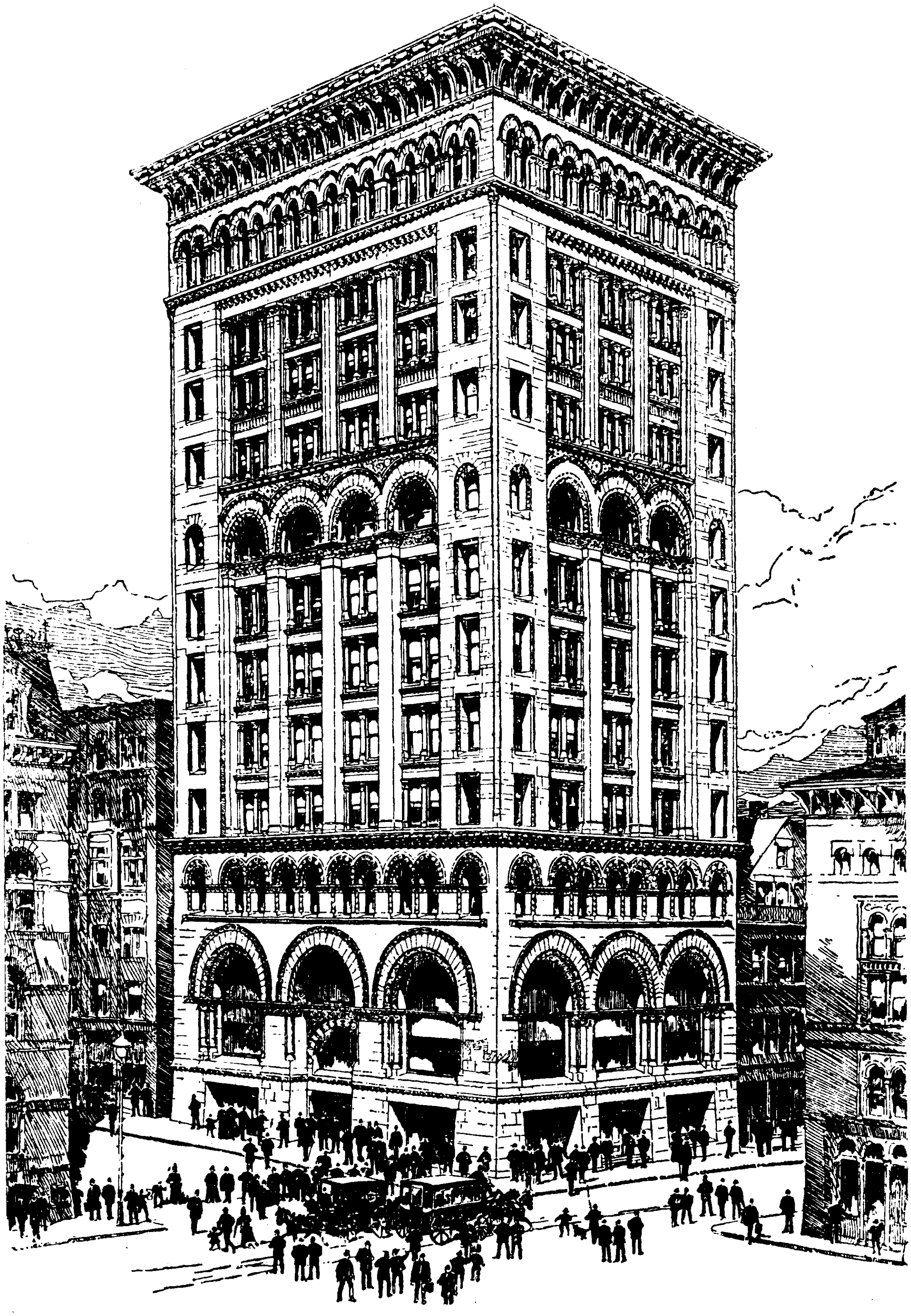
Although all persons who indulge in alcoholic stimulants, well within the margin of actual drunkenness, speak of themselves as "moderate drinkers," there are two special classes of them which bear no resemblance to each other, except in the one solitary circumstance that they never at any time take sufficient to intoxicate themselves. The one class is that which only partakes of stimulants while eating; the other indulges in them between meal-times. To the latter habit is applied in this country the title of "nipping," while in the East it is spoken of as "pegging." And this is the most pernicious of all forms of drinking, from the fact that stimulants taken without at the same time partaking of food, though only imbibed in small quantities at a time, have most deleterious effects on the internal organs. A man who habitually indulges in a single glass of sherry in the forenoon, a brandy-and-soda in the afternoon, and a glass of whisky-and-water in the course of the evening, does far more injury to his constitution than one who partakes of a larger quantity of alcoholic stimulants at meal-times.

OFFICE BUILDING, BOSTON, MASS.

The Worcester *Spy* says that Norcross Brothers have just signed a $625,000 contract to build a twelve-story building for F. L. Ames, at the corner of Washington and Court-streets, Boston. Messrs. Shepley, Rutan, and Coolidge, of Boston, Mass., are the architects. It will be not only the tallest business block in the city, but one of the most striking architectural features of the picturesque old town. No adjacent building is more than five or six stories high, and more than one-half of the altitude of the building (184 ft.) will tower with unobstructed view above everything else in the neighborhood. The Ames Block will have a frontage of 78 ft. on Washington-street, and 93 ft. on Court-street. The first three stories will be of Milford granite, and the remaining nine stories of grey Ohio sandstone. The basement, 10 ft. high, will have square windows; but the first story, directly above, will be 25 ft. high, and will be lighted on each side by three arched windows of generous dimensions. In the third story is a row of many arched windows of smaller size, and an elaborate cornice above completes the design of the granite section. In the fifth story above this there are large arched windows similar to those on the first floor. The windows of the topmost story are small arched windows, while those on all intervening stories are square. From foundation to roof the corner windows are set in continuous solid masonry that projects beyond the central portion of the structure and gives the effect of pilasters. Sculpture and mosaic will be used liberally on the exterior, and the interior finish will be worthy of marble and iron. The first floor is designed for banking-rooms, and there will be room for safe-deposit vaults in the basement.—*The American Architect.*

STEAM AND WATER JOINTS.

The following valuable article was awarded a prize by the *Mechanical World.* It is signed "J.H.R."—The question of how to make reliable steam and water joints and the materials to employ should, in the present days of extreme pressures, receive careful consideration in order to use the materials at command to the best advantage. The substances used must be able to endure high temperature, great pressure—accompanied sometimes by water—and the unavoidable contraction and expansion. The character of the joint will depend upon its situation, style of flanges and other circumstances. We will



OFFICE BUILDING, BOSTON, MASS.

first enumerate and explain the composition of the materials generally used for these joints, then point out their special advantages and the most advantageous situation to use each one.

Asbestos millboard, paper pulp and asbestos fibre, hard vulcanized rubber rings and soft sheet rubber, rubber "insertion," composed of alternate layers of vulcanized rubber and canvass; wire gauze "insertion," fine brass wire gauze, having a layer of vulcanized rubber on each side; wire gauze and "putty," fine brass wire gauze and red-lead putty—i. e., equal parts red and white lead; hard lamp-wick, same as that used for petroleum lamps; soft hempen "spun yarn" and "putty," soft lead wire, gutta percha rod and rings.

Now for the best places to use these materials, so as to take advantage of each one's special properties.

We will take the case of the high-pressure steam-cylinder cover joint. This requires a material that will stand great heat and pressure, yet it must leave the flange faces readily, so as to to lift the cover easily for inspection or repairs to piston, etc. The joint must last a fairly long period, as these large rings are expensive. Asbestos millboard is found to be the best substance to use for this class of joint, solid rings to cover the whole of the flange faces, said rings to be punched with holes for the studs, which hold cover in place. These asbestos rings, if carefully smeared with a mixture of plumbago and tallow or rubbed with plumbago alone, on each side to keep them from adhering to the joint faces, will last for a long time, during which the cover may be lifted many times if the joint is carefully removed and rubbed with the plumbago or plumbago and tallow before replacing. Solid rings of hard vulcanized rubber are sometimes used instead of the asbestos, but they do not last so long or answer so well. Hard lamp-wick may be used in an emergency if either of the above are not at hand. Red lead "putty" is sometimes used, but it is *very* difficult to remove the cover—the putty setting so hard, and there being such a thin layer of it. So that if great care is not used when driving the small steel wedges used to break the joint, the cover itself may be cracked.

Never make cylinder-cover joints with "putty" unless you have nothing else at hand. Slide valve cover joints are made in the same manner as those of cylinder covers. The joints may be cut out of the solid or composed of strips dove-tailed together at the corners. Asbestos is commonly used, but the remarks made *re* horse power cylinder covers apply to slide-valve covers as well.

Low pressure steam cylinder cover joints may be made with hard lamp wick soaked in paint or cylinder oil. Soft lead wire, turned into a ring and the ends soldered together, is sometimes used. Of course asbestos millboard can be used if the expense is not objected to, but it is quite unnecessary, as the heat and pressure in the low-pressure cylinder are very low.

The materials used for steam-pipe joints should vary according to the locality of the joint, style of flanges, etc. The best flanges for the smaller steam pipes are those known as "hydraulic" or "spigot" flanges. These have a recess in one face and a corresponding projection on the other to fit in the recess, but the projection must be longer than the recess is deep, so that when the jointing material is in place the outer faces of the flanges do not come in contact. Solid asbestos rings are generally used with these flanges if they are made of the same metal, both copper or both iron.

The plain flange as commonly met with is used for steam piping, both large and small. Greater care is required in making a joint with these flanges than with the "hydraulic" or "spigot" flanges as the walls of the recess in the latter keep the asbestos from being blown from between the flanges, if from any cause the tension on the bolts is slackened. Plain flanges having a large number of small bolts are preferable to those having a few large ones, as the pressure on the flanges is more equally divided, and they are not thrown out of shape so much as when the bolts are wider apart. In situations where very little water collects asbestos millboard can be used with advantage, if there is very little water present and both the flanges are of the same metal. Asbestos millboard should *never* be put between copper and iron—such as between flange of stop valve casting on boiler and main steam pipe to engines; the former is usually of cast iron and the latter of copper. I have known the cast-iron face of such a joint to be deeply pitted owing to the electrical action set up between the copper and iron, having a porous diaphragm of asbestos soaked with condensed water between them, thus forming a "constant battery."

Wire gauze and red-lead "putty" are materials to use in such a case. "Rubber insertion" is used where the joint is fairly easy of access, so as to screw up the nuts as the rubber becomes softened by the heat. This must be done until there is a good strain on the bolts and nuts. Of course the "insertion" is to be well greased with tallow and plumbago before using and the flange faces cleaned and filed flat where practicable.

Where a joint is in such a position that it can only be made when steam is down, the best plan is to use brass wire gauze and red lead "putty." All cocks on the boiler should have this joint. Having tried many substances I find none equal to the old plan—used many years on locomotive engines—of "gauze and putty" for all plain flange joints that do not require breaking frequently and have to endure high pressure and great heat in the presence of water. To make joint last the longest possible time two thicknesses of brass wire gauze should be used having the holes punched out for the bolts, the center hole for the steam to be cut with scissors. Each side of the pieces of gauze should be covered with a thin layer of stiff "red-lead putty," the faces of flanges being thoroughly cleaned, the "gauze and putty" placed in position and the nuts screwed hard down; if the joint is allowed to harden a little before the pressure comes on it, it will not require removing for years.

For pump cylinder covers, valve covers and all plain-flanged joints for water under pressure, wire gauze insertion, or failing that, ordinary "rubber insertion." All rubber and asbestos to be well rubbed with plumbago or plumbago and tallow before putting between the flanges to prevent it sticking to them. Joints in pipes conveying water under heavy pressure, say 600 or 700 lb. per sq. in., have the before mentioned "hydraulic" flanges having the recess and projection; in the recess is placed a ring of guttapercha about ¼ in. thick. These rings are very simply made from ¼ in. rod, long enough to form the sized ring required, and a little over for lap of the joint: if the ends are now heated in a lamp and pressed together, the ring is quickly made. In use the rings flattens out, owing to the pressure of one flange against the other by the pull of the bolts and coming against the outer rim of the recess is there stopped, thus making a capital joint for resisting cold water under heavy pressures. Manhole and mudhole joints on boilers should be made with oval rings of hard vulcanized rubber of the required dimensions; not having these at hand, rings formed of rubber—square in cross-section—can be used. The square rubber is cut to the length required, with sufficient over for making a scarfed joint of about 2 in. long the ends are scarfed, put together and tied with sewing twine temporarily, now tried on the door, and, if a good fit, then the scarf is "served" with sewing twine, wound closely together, and the ends fastened with a knot. This makes a good joint for pressures up to 100 lb. per sq. in. If required two rings can be used, placed one outside the other, with the joints on opposite sides of the door. Supposing we have no rubber at all then hempen "spun yarn" can be used, rubbed with stiff white lead. This makes a fairly efficient joint for pressures up to 60 lb. per sq. in. It may stand higher than this, but I have not tried it for above 60 lb.

NEW BOOKS.

HAND-BOOK OF CANADIAN GEOLOGY. By Sir William Dawson, F.R.S., Principal of McGill University. Montreal: Dawson Brothers.

This purports to be a complete manual of the geology of Canada, and, while valuable as a scientific work of reference, is of no little interest to the average reader of ordinary intelligence. No living writer is more competent than the author to deal with this subject, and there is no subject that the author himself is more competent to deal with than Canadian geology.

THE WORKING AND MANAGEMENT OF AN ENGLISH RAILWAY. By George Findlay, Assoc. Inst. C.E., General Manager London and North-Western Railway. London: Whittaker & Co., and George Bell & Sons.

The magnitude of the subject embraced in the title of this book has not prevented the writer entering into a thousand and one of the little details of railway management, which, while of special interest to railway men, are also of absorbing interest to the general reader. There is probably no railway in the world that cannot learn, that has not learnt, something from the London and North-Western. There is no living man more intimately acquainted with the working of that line and with railway matters generally than Mr. Findlay. Although the work originally took the form of a lecture delivered before the Royal Engineers at the School of Military Engineering, Brompton, and treats particularly of the use of railways for military purposes, there is hardly a branch of railway business ignored. The general public will find the book full of interesting revelations about railway organisation, and the training, discipline, and experiences of the various grades of railway employés. Railway officials in Canada will doubtless be much interested in comparing the methods in vogue on Canadian and American railways with those described by Mr. Findlay. Not the least surprising revelation in the book is the chapter which deals with railways from a military point of view, and which shows unexpected perfection in the preparations made under Government control for utilising the railways of the United Kingdom for defensive purposes in case of invasion. Bismarck is credited with a grim *bon mot* to the effect that he knew of five ways of an enemy getting into England, but not one of getting out again. The English railways will probably not be of much service to the enemy in either operation.

ENCYCLOPÆDIA BRITANNICA. Montreal: Canadian Subscription and Publishing Co., 647 Craig Street.

This is a cheap enough edition ($3 per volume) of the acknowledged first and greatest of encyclopædias; a reprint published by the Henry G. Allen Company, in twenty-four volumes. While the best possible edition of a work of this kind can be none too good, these cheap reprints bring the book within the reach of a very numerous class of students to whom the authorised English edition is unattainable. This reprint is a marvel of cheapness.

THE PATENTS, DESIGNS, AND TRADE MARKS ACTS, 1883 to 1888. By Wm. Norton Lawson, M.A., o Lincoln's Inn. 2nd Edition. Published by Butterworths.

This work does not claim to deal with the whole subject of the law of patents, but as an interpretation of the English Acts from 1883 to 1888, will be found exceedingly useful, and is not without practical interest and suggestiveness to patent experts in this country. The subjects specifically treated are:—(a) How to obtain Letters Patent; (b) Oppositions to the Grant; (c) Amendments of Specification; (d) Oppositions to Amendments; (e) Compulsory Licences; (f) Prolongations; (g) Actions for Infringement; (h) Action to restrain Threats; (i) Revocation proceedings.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS. Vol. XVII. Published by the Institute, New York.

This bulky volume covers the transactions of the Institute, and papers read before it, from May, 1888, to February, 1889, inclusive. It contains, besides a full report of the annual proceedings, a copy of the rules of the Institute, with a full list of the various orders of members, and other information of general interest to them. The papers included cover a vast mass of facts and a great variety of subjects of profound interest to practical scientists. The papers have the advantage of having been revised by their authors since they were first printed.

The volume is sent free to members of the Institute, and is also for sale. All communications should be addressed to—R. W. Raymond, Secretary, P.O. Box 223, New York City.

We also beg to acknowledge receipt of the following pamphlets, issued by the Institute, for November, 1889, some of which detailed reference will be made to later on:—

BLOW:	The Geology and Ore Deposits of Iron Hill, Leadville, Colorado.
CHAUVENET:	The Iron Resources of Colorado.
GOODALE:	Notes on the Additional Diaphragm in the Howell Roasting Furnace.
SCHWARZ:	The Ore Deposits of Red Mountain, Ouray County, Colorado.
ASHBURNER:	The Coal Trade and Miners' Wages in the United States for the year 1888.
OLMSTED:	The Distribution of Phosphorous in the Hudson River Carbonates.
FIRMSTONE:	Note on the Form of Crater Produced by Exploding Gunpowder in a Homogeneous Solid.
DUDLEY:	The Wear of Rails as Related to Their Section.
KEEP:	Aluminum in Cast-Iron.
PROCEEDINGS	of the Fifty-fifth Meeting, Ottawa, Ont., October, 1889.
GILPIN:	The Geological Relations of the Principal Nova Scotia Minerals.
RANDOLPH:	Notes on the Republic of Colombia, S.A.
RAYMOND:	Biographical Notice of Wm. H. Scranton.
NEWBERRY:	Notes on the Geology of the Aspen Mining District.