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SCIENTIFIC CANADIAN
MECHANICS' MAGAZINE
AND
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Vol. 9. MAY, 1881. No. 5.

THERE is much talk in London of a central Railway Station to supply the Metropolis with an arrangement by which all the lines might be united to reach a common destination. To those who can remember a first visit to London, and the vexation of spirit which supervened upon the discovery of the interminable distance of any one terminus from any other, thé prospect will open up visions of a hardly to be hoped for Utopia. There can be no doubt that such a plan would have immense advantages, especially to traffic passing through London, as a large proportion of the foreign traffic does, and vice-versa, and the project has been discussed at some length in a paper read by Mr. Arthur Ellis before the Institute of Bankers on a collateral subject, the advantages of centralization as applied to the clearing system in trade. Meanwhile as is natural, men's minds are moved to consider the shortcomings of the existing railroad stations, more particularly in point of architecture, and a comparison is instituted with the *termini* of continental lines. There is nothing which makes us feel so small, or at least should do so, hearing another reproached for a fault which we ourselves exhibit in even a greater degree, and surely to a Montrealer the much abused Victoria Station would seem a perfect gem of architectural beauty. There are rumors in the air that our disgrace is not to be long lived, and that the chief city of Canada is no longer to welcome its visitors in an ugly dilapidated barn to which courtesy allows the title of a Railroad Station. At all events we live in hope.

THE usefulness of glass is becoming daily more fully recognized. Already for some time glass roofs have been gaining in popularity, and deservedly so. Now that it has been demonstrated that the expense of a glass and iron roof is little if at all greater than that of a wooden or wood and iron one, the imperishable nature of the material, and the great boon of transparency are bringing it into very general use for store sheds and lean-tos, where light is difficult to obtain, and its introduction through the roof of great value. In this country there has been a proposal to introduce glass into stove-lights in the place of mica, which will, if successful, introduce a revolution in the trade. But the last novelty in the use of glass is its substitution for wood in the manufacture of brewers' vats. The wooden vats have long been giving trouble by their absorption of liquor, and the consequent impossibility of keeping them properly clean, especially in summer. Slate has been tried, but is too perishable, and iron conducts heat too freely. The new material is said to be a pronounced success in Germany, where it has just been tried. The glass vats are a little more expensive, but they are correspondingly durable, and by saving of labour in the cleaning, soon make up the difference of first cost.

LONDON is exercised, and not without reason, over the recently discovered dangers of gas baths. The introduction of these into the homes of the middle classes has been no doubt productive of great convenience, and where they are properly fitted under competent direction they may be a great addition to the comforts of a home. But builders are too apt to act in these matters without proper architects supervision, and where they do so should be warned of the consequences which may be incurred by neglect of proper precautions. Mr. Charles Frederick Deacon, a solicitor, living at Anerley, went into his bath room for the purpose of taking a warm bath, the water being heated by an atmospheric burner. After the lapse of an hour and a half, his wife, becoming alarmed, called a friend who forced the door, when Mr. Deacon was found leaning against the wall quite dead. The surgeon, who made a *post mortem* examination, found all the organs of the body healthy; but from the appearance of the intestines and the organs, he was led to the conclusion that death resulted from inhaling carbonic acid gas and carbonic oxide. He considered that the atmospheric burners used for heating the baths were extremely dangerous. They threw off a considerable quantity of poisonous fumes. There was, too, no ventilation in the bath room where Mr. Deacon met his death. The most remarkable part of the case is the statement of Mr. Turner that during the previous fortnight he had attended six persons who had been similarly attacked after using the bath, and yet apparently had not thought it his duty to recommend the taking of any steps to remedy the evil. It should be remembered that ventilation is not all that is necessary in these cases, as carbonic acid gas and carbonic oxide are distinct poisons affecting the brain much as chloroform does, and not merely killing by suffocation. It is, however, quite possible to fit a gas bath so as to reduce the risk of the escape of the poisonous gas to a minimum, and no one should attempt to fit such a bath without a proper knowledge of the method.

APPRENTICESHIPS—II.

It is generally supposed that Trades Unions still have restrictive rules with regard to apprenticeships which operate to the disadvantage both of employers and the public; and that these rules are enforced both in the limitation of the number which an employer may take, and as to the term for which they shall serve. In a very few trades, some half a dozen perhaps, such restrictions are nominally retained, but even in those the disadvantages are more felt by the workmen than by the employers, except in isolated cases.

We are, however, more immediately concerned with the building trades. These trades comprise six distinct branches, and employ probably 750,000 adult males. The operatives connected with those trades are located in every town and village of the kingdom, proportionately to the size and requirements of the several districts. In point of numbers and skill they stand second to none in our national industries; and hence their rules and modes of action affect more or less the whole of the trades of the country; the importance attaching thereto cannot consequently be overrated.

1. The masons for a great number of years took the lead in all matters affecting wages and conditions of work, and they endeavored to limit the number of apprentices to the smallest possible compass. From twenty-five to thirty years ago they even went so far as to prohibit their own members from teaching the trade to more than one of their own children; and even the one put to the trade was supposed to be regularly apprenticed. Of course the rule was evaded, nor was it possible to carry it out had it been right in principle. But it was not, and it failed in consequence. At the present time no actual apprenticeship is, or can be, enforced, the only conditions exacted for admission to the Mason's Society are: competency as a workman and the ability to command the current wages of the town or district where he is employed as a journeyman; these qualifications acquired, no matter how obtained, he is, if duly proposed and seconded and is willing to comply with the Society's rules, admitted as a member, and recognized as a journeyman stonemason. In some towns efforts have been made of late years to impose certain restrictions, more particularly in some parts of Yorkshire, but they have mostly if not altogether failed. These attempts have arisen out of local circumstances and customs, each branch being responsible for its own action in dealing with questions affecting the trade usages of the district. The Society as a whole does not, however, now attempt to enforce limitations as to the number, or to define the period which apprentices shall serve. The Scottish Union has long abandoned all interference in these matters, so that throughout Scotland the trade is virtually open to all comers without let or hindrance of any kind, either as to numbers or term of service.

2. The bricklayers have long since been compelled to abandon any pretence of limitation or restriction. What is known as the "Manchester Unity"—a society embracing most of the northern and midland towns—tried hard for many years to continue a restrictive policy but failed. Regulations were constantly inserted in their schedules, apportioning the number of apprentices or boys to the number of journeymen, and strikes in support of such schedules sometimes took place; but even then the number and conditions varied according to local circumstances and usages; uniformity being quite impossible, modifications were continually taking place, and it was at last apparent, to even the most obtuse, that the regulations could not be maintained. In the London district, and throughout the southern, eastern, and western counties the trade has for years been practically open without limitation or restriction. In the towns the trade has been recruited from country districts, the "wallers," as they are called, becoming bricklayers when they migrated to districts where bricks were used instead of stone.

3. The carpenters and joiners have three separate unions—the Amalgamated Society, the General Union, and the Scottish Association, in neither of which are there any rules or regulations as to the number of apprentices or as to the term of service. Singularly enough the societies in this branch of the building trades were the first to relax their rules in this respect, notwithstanding the fact that not only is great skill required of the workers, but they have to find a considerable chest of expensive tools before they can take a position as a shop joiner. At the present time they not only do not attempt to interfere but they discountenance all regulations as to limitation of number or as to period of service. In some places there may be a kind of mutual understanding between the employer and those employed as to the proportion between apprentices and journeymen, but not as the result of coercive action. If a youth can "pick up" his trade, and he offers himself as a candidate for admission into the society, he has only to prove that he is able to earn the current wages and he is admitted.

4. The Plasterer's Society makes no attempt to limit the number of apprentices, nor does it seek to enforce a specific term of service. This branch of trade was at one time mainly recruited from Irish "hawk boys," but of late years these wondrous specimens of humanity have been to a great extent dispensed with. And no one in the building trade will much regret it, for they were the most mischievous vulgar-tongued set of young scapegraces that one could meet with in a day's march. Now the plasterers serve themselves for the most part, the laborers furnishing them with the materials. These laborers now, more than ever, are Englishmen; some may in time become plasterers. But there is an increased tendency in this trade to take learners for terms of from two to three years. The sons of plasterers seem to fill up the vacancies in this branch of the trade to a greater extent than in some other branches of the building trade.

5. The plumbers have been, and still are, more restrictive in their action than any other branch of the building trades. The reason for this has been that the master plumbers were anxious for their journeymen to keep plumbing as a close trade, and to a certain extent they have succeeded; but whether to the advantage or disadvantage of the public it is not for us to determine. Certain it is that a number of men call themselves plumbers who are not, in the best sense of the term, craftsmen; but these no doubt, have first of all learned a smattering of the trade as "plumbers' laborers," then started as handy jobbing men, and then have set up in the plumbing line on their own account. In so far as rules and regulations are concerned, the trade cannot be much influenced either way at the present time; and if we may trust to the complaints one often hears about the work done by plumbers, they have not improved in the quality or quantity of their work.

6. The last branch comprises painters, decorators, and glaziers, and to some extent upholsterers also; for the latter are called into requisition in connection with a portion of the builders' work in recent times. With regard to painters, paper-hangers, and glaziers, certainly little or no system of apprenticeship is in vogue; in the better class of houses some degree of preliminary engagement is no doubt enforced in the shape of improvers, but apprenticeship proper is not general. It would be far better for the public if it were; for the painter and decorator is, of all men, the most trusted, and every care should be taken to make him worthy of that trust. He has oftentimes the entire run of a mansion filled with valuables, so that his moral character as well as his abilities as a workman, is of importance when so much is at stake. By all the higher class firms these qualities are, doubtless, taken into account; but a system of regular apprenticeship would be a far better guarantee than any test as at present applied.

How far this loose system, or want of system, is conducive to the development of skill in the several handicrafts named is a question of much importance, and one that cannot long remain without an answer based upon ascertained facts. The continual complaints which one hears on every hand of bad workmanship in all departments of industrial life will force the hands of employers and compel them to take some action in the matter. Should this emergency arise, it is to be hoped that both parties—employers and employed—will co-operate to bring about a healthier condition of things. There is a growing disposition to seek and strive to obtain superior workmanship wherever possible; this feeling should be encouraged by masters and men, both of whom should combine in promoting a mutual understanding upon this subject.

Engineering, Civil & Mechanical.

ECONOMY IN STEAM BOILER PRACTICE.

Our attention was lately called to some simple and novel appliances employed at the Brooklyn Oil Works, Hunter's Point, which are worthy of special notice from the convenience and the notable economy which they realize in practice. We refer specially to the tar burners used in connection with the Babcock & Wilcox boilers for burning the refuse tar of the stills, of which an abundance is made at the refinery in question, in place of coal. The attempt has frequently been made to devise a practical method of utilizing residual products of this kind at gas works, refineries of petroleum, and other industrial establishments; but thus far no remarkable success has attended these efforts. The method here referred to, however, gleaned from personal inspection, and from facts pertaining to the present cost of operating the boilers, appear to be convincing in establishing the practical success of the method of tar-burning there in operation.

The apparatus is the invention of Mr. H. E. Parson, Superintendent, and Mr. Geo. V. Northey, Engineer, of the Watertown Steam Blower Co., of Watertown, N. Y., (whose offices are at 42 Pine street, New York). This company make a speciality of various devices for utilizing waste products in all kinds of factories. They have a steam blower for burning the different varieties of slack coal, spent tan-bark, sawdust, screenings, peat, or any kind of tarry matter. This blower is used for forcing a blast under and through the grate bars, and as such has wonderful capacity. It is a power within itself, having no shafting, gearing or machinery, giving a blast sufficient for boilers varying from 3 to 200 horse-power, and being under perfect control.

The high heating power of some of the waste materials mentioned, and their low cost as compared with coal, makes the question of their employment as a substitute for the latter, one of special importance on economical grounds where circumstances place the material in quantity at disposition. As we have already stated, our comments in the present article will be confined to the tar burners, at the Brooklyn refinery, where they have been in use for the past 18 months for firing a set of four Babcock & Wilcox boilers, of 100 horse-power each, and with the result of having given complete satisfaction as to ease and reliability of operation, and of having demonstrated a notable economy. This make of boiler is peculiarly adapted to this fuel, by reason of the thin heating surface and absence of all joints in the fire, enabling it to withstand the very intense heat generated, under which ordinary shell boilers are rapidly destroyed.

Referring to the arrangement of the burners, the tar, which is sufficiently fluid for the purpose, is allowed to run down through a pipe provided for the purpose, from an elevated reservoir. At the proper point, the tar is met by a steam jet, by which it is atomized and carried with great energy into what corresponds to the ordinary fire space of the boiler. The energy of the impelling steam jet induces simultaneously the entrance of sufficient volumes of air through openings provided for the purpose, to allow for the combustion of the tar and the thorough intermixture of the combustible with the oxygen of the entering air, while the method secures a very perfect and intense combustion. Grate bars are, of course, unnecessary, and are dispensed with. The operation, as witnessed by us, was perfectly automatic, and appeared to require no special supervision, the supply of steam and the flow of tar simply requiring regulation from time to time, as more or less steam was needed, which was effected by the turning on or off a stop-cock controlling the supply of the one or the other. The action of the arrangement under the proper adjustment of parts is, therefore, perfectly regular and automatic. The tar is burned without a particle of smoke and with a very intense heat. No dust is produced—in fact, it is a perfect fire.

In considering the question of the economy of this arrangement, a notable element, aside from the prime question of the relative cost of coal and tar consumed per pound of water evaporated, is the material saving of labor in being able to dispense with the attendance to fires, removal of ashes, and other items of this kind which firing with coal demands, and which, where a number of large boilers are in constant operation day and night, as in the case here alluded to, is no inconsiderable one.

The best evidence of the economy of this method of firing, is afforded by the performance of the boilers. Fortunately for the correct estimate of this factor the superintendent of Brooklyn refinery, Mr. Haldebrandt, has kept an accurate register day by day of the amount of water evaporated and of the number of gallons of tar consumed, from which we are able to make a direct comparison with their performance with coal.

We give below the log of the attendant in charge of the boilers, for twenty-four hours, which we are informed represents an average daily performance: Tar consumed in 24 hours, 75 barrels, at $1 per bbl. = $75; water evaporated, 358,400 pounds. To estimate the evaporative value per pound of combustible, we may take 75 barrels of tar of 40 gallons each, equal to 3,000 gallons, which, at 7 pounds per gallon, would give the number of pounds of tar consumed, 21,000. The evaporation would therefore be

$$\left\{\frac{358400}{21000}\right\} = 17 \text{ pounds of water per pound of tar.}$$

This evaporative effect greatly exceeds that obtainable with coal, in addition to the very perfect combination which the blower insures, as before explained, the heating power of the tar is considerably greater than that of coal. A comparison of the above results with those obtainable with the use of coal as fuel, will be highly instructive, and is given in the following tabulation:

75 barrels tar, at $1 per bbl......................$75
To do the same work, would require on an average
20 tons of coal, at $4.50.................... 90

20 tons of coal, at 2,240 lbs. = 44,800 lbs.) and the evaporation per pound of coal would be

$$\left\{\frac{358400}{44800}\right\} = 8 \text{ pounds.}$$

Evaporation per pound of tar = 17 pounds.

The effectiveness and economy of this method of firing seems, therefore to be fully demonstrated.

It may not be out of place to make an allusion to the boilers in connection with which the above described tar-burners have been so successfully applied. Many of our mechanical readers will recognize the Babcock & Wilcox boiler at once in the accompanying engravings; and the only essential modification adopted in employing the tar burners, consists in dispensing with the grate bars, and in providing suitable openings for the free entrance of air into the fire-space.

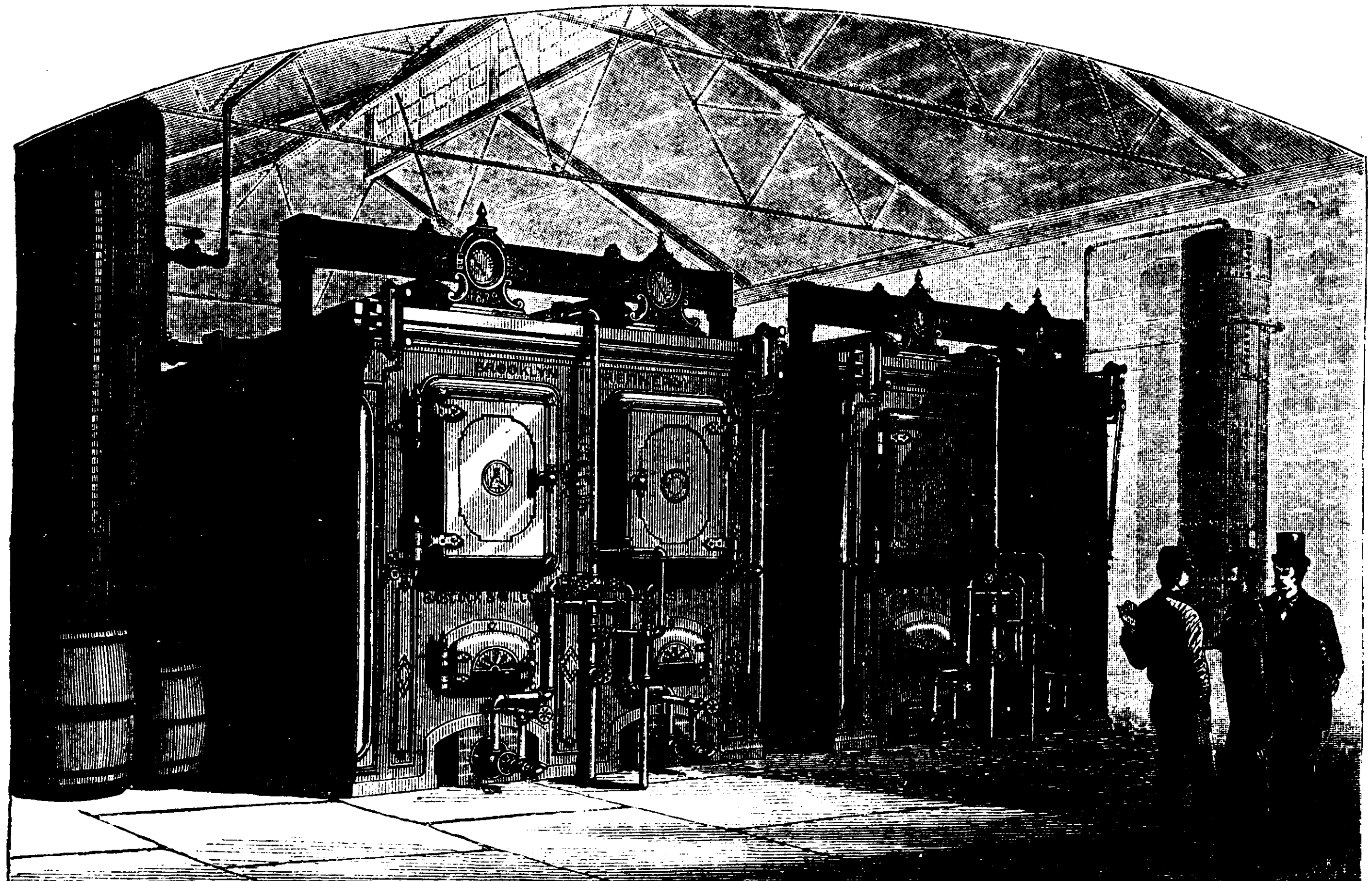
It will be unnecessary for us to dwell in this place upon the special peculiarities that have gained for this style of boiler a high reputation in respect to great economy and practical immunity against the danger of destructive explosion, since we have repeatedly presented these facts in detail. We will only add, in order to bring out in stronger contrast, the very high evaporative power developed by the use of tar in the Parson tar-burners at the Brooklyn refinery, the following records of the performance of the Babcock & Wilcox boiler, under strict test conditions. The evaporative duty shown in the following table will be at once recognized by steam users as being exceptionally good.

TESTS OF BABCOCK & WILCOX BOILERS.

—Water evaporated in lbs. from and at 212° Fah.—

	Per lb. of coal.	Per lb. of combustible.
At Centennial Exhibition	10.75	12.131
" Raritan Woolen Mills	9.798	11.227
" Harrison, Havemeyer & Co.	9.712	11.601
" T. A. Edison	9.4	11.365

The works for the proposed tunnel from Dover to Calais have made such satisfactory progress, that its promotors—Colonel Beaumont, R.E., and Captain English R.E.—are now able to employ three shifts of men constantly throughout the twenty-four hours, and are sanguine of being able to bore about 30 ft. per day when all the machinery is perfected. At present two drills worked by engines driven by compressed air are at work, and about thirty laborers are employed. The bore is 7 ft. in diameter, and the soil chalk. It is so firm that the engineers are of opinion that no brick or cement work will be required to shore it up. Hitherto the difficulty they have had to contend with has arisen from the quantity of water which has found its way into the cutting, and which has been pumped up by means of a powerful engine placed at the mouth of the shaft leading into the tunnel. This shaft is about 300 ft. long, and the boring already accomplished upwards of 500 ft. A new shaft is being driven through Shakespeare's Cliff, which, when completed, will be about 200 ft. in depth, and this will enable several additional hands to be employed, and the work to progress much more rapidly than at present.



METHOD OF BURNING PETROLEUM, REFUSE, TAR, ETC., AS USED WITH THE BABCOCK & WILCOX BOILERS AT THE STANDARD OIL CO.'S WORKS, BROOKLYN, E. D.

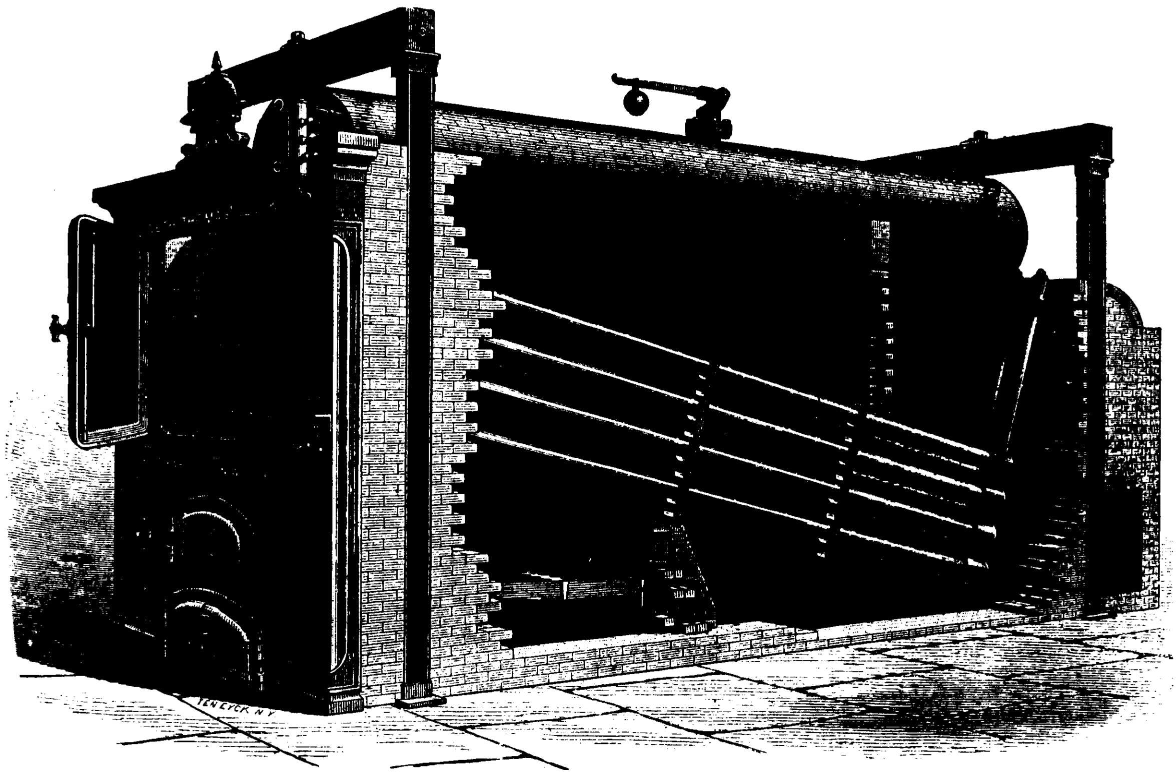


Fig. 2.—SECTIONAL PERSPECTIVE VIEW OF A BABCOCK & WILCOX BOILER.

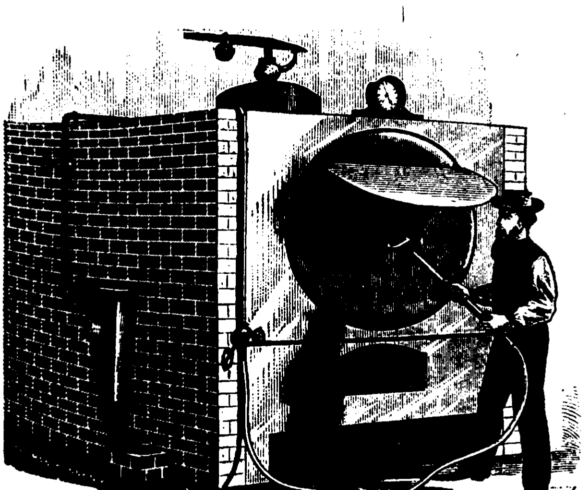


Fig. 2.
Air-Jet Tube-Cleaner and Steam Blower Attachment.

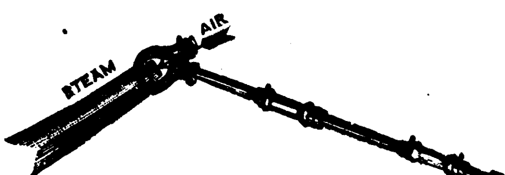


Fig. 1.—Parson's Air-Jet Tube-Cleaner.

PARSON'S AIR-JET TUBE CLEANER.

We give here an illustration of Parson's air-jet tube-cleaner, manufactured by the Watertown Steam Blower Co., of 42 Pine street, New York, whose admirable arrangements for utilizing waste products as fuel we have described in a previous article. All users of steam boilers are aware of the difficulty of properly and speedily cleaning the tubes of boilers of soot, ashes, scale, etc., and many devices have been brought forward for the purpose. The Parsons air-jet tube cleaner is affirmed to be very effective for this and similar purposes. The apparatus is shown in Fig. 1, and the method of using it in Fig 2. The inventor, in this device, claims that its efficiency largely depends upon the manner in which he has succeeded in utilizing the expansive power of air, which is carried into and through the tubes. To this end he delivers from the orifice of the apparatus a thin ring of steam, in such a manner that the angles of delivery form a wedge or cone shaped surface, inducing and holding a strong central air current, which, being forced through the heated tubes, expands as it travels, and carries with it all the accumulations of soot, ashes, etc., that have found lodgment therein. In using the apparatus, it is recommended that the steam should be taken from as near the top of the dome as possible. A piece of strong flexible tubing, connecting the steam delivery pipe with the apparatus, is necessary, as shown in the cut, to enable the operator to move from tube to tube. With this apparatus, it is claimed, that ten tubes per minute can be cleaned, while the boiler is running.

This device, we are informed, has been extensively introduced into a number of large industrial works throughout the country, and in all cases has demonstrated its utility.

GAS ENGINES.

A paper on this subject was read by Mr. Charles Gandon at the meeting of the Society of Engineers. The author pointed out that the use of gas as a motive power was still in its infancy, which was not a matter for surprise, seeing that its introduction for lighting purposes dated only from the commencement of the present century. So early as the year 1794 a patent was taken out in England for producing an inflammable vapour force by exploding the spirits of tar or turpentine in closed vessels.

Between that date and the year 1860 various other inventions were patented for obtaining motive power by the explosion of various mixtures, gaseous and solid; but all the descriptions appeared to be somewhat obscure as to the nature of the explosive compounds to be used, and the means for obtaining them. Carburetted hydrogen, a constituent of coal gas, was mentioned by some; but it appeared that the idea of using coal gas, as manufactured for lighting purposes, for working engines, was first practically applied in the Lenoir gas engine, patented in 1860, and first introduced into this country at the Exhibition of 1862, where it attracted much attention. The general principles of the Lenoir engine were described, and it was pointed out that, among other defects of this engine, was the damage done to the working parts by the sudden and violent nature of the explosions, and also the necessity of the use of electricity for the explosion of the charges of gas and air with which it was worked. The latter objection had, however, now been overcome in more modern engines by the employment of gas jets for the same purpose. The author described the Otto and Langen gas engine, the chief improvement in which is, however, due to the compression before ignition of the charges of mixed gas and air, by means of which it is found that a much larger proportion of air can be employed than would form an explosive mixture at ordinary atmospheric pressures, and the force thus obtained is gradual and continuous, instead of sudden, resulting in an economy of gas and more regular working. Advantage has been taken of this discovery in several of the more recently designed gas engines. The general principles of the Otto were described, and its consumption of gas stated to be at the rate of about 21 cubic feet per horse-power per hour, as compared with from 40 to 70 cubic feet with engines of previous make. On account of the heat generated by the explosions in gas engines, it was found necessary to surround the cylinders with water, and that advantage had been taken of this in a gas engine called the Eclipse, in which the water, instead of being allowed to escape when heated, was stored in a separate chamber, where it generated steam, which was used together with the gas, to assist in working the engine. Attention was also drawn to the Bisschop gas engine, which is meritorious chiefly on account of the small sizes in which it is made, and which range from one half man or one-eighth horse-power upwards. This engine, although not comparatively economical in its consumption of gas, was recommended on account of its simplicity and small size, as available for purposes to which it would otherwise be impossible to apply mechanical power. As regards comparisons which have been made between the cost of working steam and gas engines, the author observed that the practice had generally been to take the total cost of working in each case, including labour, and that, when this was done, the comparisons were invariably in favour of gas engines; but he pointed out that such estimates were liable to be misleading. As a gas engine requires little or no attention, the results of the comparisons depend mainly upon the amount estimated for labour for the steam engine with which the comparison is made. With a small steam engine it would in most cases be unfair to estimate the whole time of one attendant, while, as the size increased, the proportionate cost of attendance would diminish. Instances were given where estimates had been made showing steam engines to be from twice to seven times more expensive in working than gas engines; but although such estimates had doubtless been made with every care, they only served to show that it was impossible to frame such comparisons so as to be generally true. By comparing the costs of the gaseous and solid fuels it was shown that gas must necessarily, both theoretically and practically, be more expensive than solid fuel When, however, the labour, wear and tear, and first cost were also considered, the conclusion arrived at by the author was, that for engines of small sizes, gas would always be the most economical. Even with larger engines, if the same economy could not always be maintained, circumstances would in many cases render gas engines the most advantageous and convenient, particularly when only the intermittent use of an engine was required.

THE MEKARSKI AIR ENGINE.

For about three months during the autumn of last year the traffic of the Wantage tramway was conducted temporarily by means of locomotives driven by compressed air, on the Mekarski principle. One of these engines is now in London. These locomotive weigh about 7½ tons each, and consist of cylindrical steel air reservoirs, a special regulating apparatus, and ordinary cylinders and driving gear. The locomotives are supplied before starting on a journey with air at a pressure of 450 lb. per square inch, the air being compressed by means of a stationary engine and plant. On starting the engines the air passes through a reservoir of hot water and steam to the regulator and thence to the working cylinders. The hot water raises the temperature of the air, and thus increases its volume, and economizes the store, while it has the further important effect of preventing the formation of ice in the exhaust passages of the cylinders, which would otherwise take place as the spent air escaped. The moisture with which the air becomes charged, moreover, assists the lubrication of the working parts of the engine. By means of the regulator the pressure of the air when passing to the cylinders can be reduced to any desired extent. In practice the working pressure is constantly maintained at 90 lb. per square inch. The exhaust air escapes quietly from the cylinders, thus rendering the locomotive noiseless in this respect, while there is, of course, a total absence of smoke or other products of combustion. Ample brake power is provided, and the general mechanical arrangements are such as to place the engine well under the control of the driver. The system is carried out in two different ways; in one the engine is separated from the tramcar, while in the other the engine and car are combined. The principle, however, is the same in both, and is one which commends itself to notice for tramway work. The system has been employed for nearly two years past with every success on the Nantes Tramways, which are about four miles in length, and it is now being introduced into England, the offices of the company being at 3, Westminster Chambers, Victoria Street, London.

BUILDING IN JAPAN.

It is now pretty well known that the ancient empire of Japan has recently divested herself of her old social and political vestments, and commenced to array herself in those of a more modern type. She has, in fact, decided to institute and organize Western technical processes and industries throughout the various islands which make up the empire, and to invite experts to assist in the work from Europe and America. There is certainly a vast field thus opening up for the operations of those who choose to venture so far in quest of active employment, and who can carry with them talent, energy and enterprise. This holds good of representatives of every art, science, and manufacture at present in existence in Great Britain, and of architects and builders in particular. The general construction of houses in Japan has hitherto been of so primitive a character as to resemble very much that style which prevailed at home some hundreds of years ago. Purely Japanese buildings are generally, and almost without exception indeed, built of wood. Even the chequered tile and plaster constructions with which artists have made us familiar are formed of timber as a base; and this, therefore, serves as a support merely to the ornamental tiles. The utterly unscientific disposition of materials observable in almost all native structures, and the total absence of braced and trussed framing, prove that their builders were utterly ignorant of the first principles necessary to ensure the maximum of strength with the minimum of material. They have also ignored the use of diagonal members in their framing, and preferred the rectangular to the triangular division into bays. Some have, it is true, attributed this latter peculiarity to considerations respecting the contingency of earthquakes; but it need hardly be mentioned to our readers that the rectangular is far inferior to the triangular division for ensuring rigidity and solidity.

The truth is, in respect of all Japanese edifices as they stand at present, that their designers were innocent of any knowledge of the scientific rules which should govern design and construction, and hence, like some of our own earlier mechanical engineers, they placed too much material in the wrong form.

Then, again, the almost universal employment of wood in the construction of buildings is a mistake, and one which would not long exist if British counsels prevailed in Japan. It is unnecessary to say that the most important conditions influencing the durability of wood in such cases is, its position in regard to atmospheric surroundings. If, for example, it is subjected to alternate moisture and dryness it will soon fall into decay, and no climate is more fickle in respect to rain and sunshine than that of Japan. The Japanese strangely enough appear to have paid no attention to processes intended for the preservation of timber, such as injecting into its pores antiseptic salts. Red stucco, or plaster is the only preservation employed, and as this is sometimes spread over wood perfectly unseasoned, and perhaps full of sap, the consequences may readily be imagined.

In brief, architecture and building in Japan are not only in their infancy, but scarcely out of their swaddling clothes, and yet the country is rich in every variety of material for adaptation and development in those decorations.

THE NEW TAY BRIDGE.

The report by the directors of the North British Railway Company just issued has the following in reference to the new Tay Bridge:—The question of the reconstruction of the Tay Bridge has continued to engage the anxious attention of our directors and they believe that the bridge finally decided upon is the best possible under all the circumstances. It provides for the navigation of the river with spans of a width of 245 feet, the greatest height being, from high water to the under side of the girders, 62 feet as against 88 feet in the old bridge. The line of the bridge will be a uniform gradient, varied considerably, being in one part as severe as one in 74 north of the four navigable spans. There were in the old bridge nine other large spans. In the new bridge these will be replaced by eighteen spans of half the old dimensions, the girders being placed below instead of above the rails as before. Each of the piers will be of brickwork and concrete up to eight and a half feet above high water, and of plated wrought iron from that level to the under side of the girders. The termination of the bridge at each end will be by brick arching, and a substantial parapet will be erected throughout its entire length. Many suggestions have been made for the utilising of the old foundations which in themselves are quite capable of sustaining the weight of the superstructure; but the insuperable objections to their use lies in the fact that they were liable to scour, and this, in the new bridge, would be prevented by making the foundations, except those in rock, 20 feet below the bottom of the river, where they will be beyond the reach of any possibility to scour. The report adds—It will be satisfactory to the shareholders to know that all the claims for compensation arising out of the deplorable loss of life in connection with the accident have been disposed of, and that without litigation.

THE MONOLITHIC SYSTEM OF BREAKWATER.

Mr. Kiniple, harbour engineer, of Westminster and Greenock, has patented his monolithic system of forming sea breakwaters and harbour walls. This invention, enables harbour works to be constructed in jointless masses of concrete *in situ* without the aid of divers, stagings, or overhead travellers; in fact, without the use of the ordinary costly plant. The system has been experimentally tried with success at New York, Quebec, and Greenock, and last year it was also experimentally used by the patentee at Wick in the reconstruction of the south pier-head upon its old, or rubble foundations. The Government Loan Commissioners granted a sum of from £10,000 to £12,000 for these repairs, and for the extension of the head this year for forty feet, so as to render last year's repairs safe against any seas which may enter the bay of Wick. The extension will be of the same monolithic construction, and founded deep into the hard clay of which the bottom of the bay is composed. At Wick any breakwater which is not of monolithic construction from foundation to parapet cannot be relied upon as safe against all contingencies of sudden and severe storms. There are numerous places, it is believed, where, had this system been used instead of the ordinary blocks or bags, the breakwaters would have been in existence at the present time, and at 40 per cent. less cost. One of its chief merits is its simplicity and reliability, for any breakwater in the most exposed localities can, it is asserted, now be constructed at about one-half the usual cost, and certainly within one-third of the time formerly occupied in executing these works, for there is nothing whatever to prevent a breakwater being commenced at its head, centre, or root, or being carried on simultaneously from end to end. No skilled workmen beyond ordinary labourers or fishermen are required, and, indeed, a present of a patch of Portland cement to some of the poorer fishermen is all that is necessary to enable them to repair or construct small breakwaters along the coast. The system is well adapted for founding on rocky or irregular bottoms, but in many cases trenches would have to be dredged by dipper or other dredges for the reception of the concrete. The concrete is mixed either in bulk or in blocks, and allowed to set or harden out of water, so that when thrown overboard into the foundations or works it is hard enough to prevent the cement from separating from the sand and shingle while passing through the water, and soft enough when in the work to fall together and to become one compact mass, equal in strength after a short time to the natural rocks. Where the walls are required to be vertical or battered, a few iron rods are used with sliding planks to retain the concrete in form for a few days until it is set. At Wick recently, masses of concrete cast in this manner resisted a heavy storm within twenty-four hours after they were put in, while stones of several tons weight were hurled in every direction by the same gale.—*Engineer & Building.*

Mechanics.

BURSTING OF FLY-WHEELS.

BY GEO. M. HOPKINS.

The theory of the bursting of fly-wheels, which has been accepted in the majority of cases, is that the centrifugal force due to a high velocity overcomes the cohesive force of the particles of the material of which the wheel is composed.

Of course this explanation is entirely inadequate when applied to a wheel whose strength is sufficient to resist any tendency to fly to pieces from purely centrifugal action under the conditions of its use; but of the fact that such wheels burst no evidence is needed, and some cause other than centrifugal force must be assigned for the bursting.

Supposing the fly-wheel to be perfectly balanced and without defects in material or design, it may be driven without danger at any velocity usually considered within the limit of safety, so long as it continues to rotate in a plane at right angles to its geometrical axis. And it may be moved in the plane of its rotation or at right angles to it, that is, in the direction of the length of the shaft, without creating any more internal disturbance than would result from moving it in the same way while at rest. But when a force tending to produce rotation at right angles to the plane of the wheel's rotation is applied, the effect will be vastly different, and the result will be a tendency to rotate about a new axis between the other two, and the centrifugal strain upon the wheel is supplemented by a twisting strain, which is an important and generally unnoticed factor in the destructive action.

To bring this idea to a practical application, the shaft and fly-wheel of a high speed engine may be taken as an example. Let the wheel be correctly designed, well made, and well balanced, and if its shaft is properly lined and supported in rigid journal boxes, the wheel will perform its office without danger of bursting; but support the same wheel and shaft upon weak plummer blocks, and allow one or both of its journals to move laterally at every stroke of the engine, or even less frequently, and a disturbing element will have been introduced which will strain the wheel laterally, and which, together with centrifugal force, will effect molecular changes in the structure of the iron, and the result will be that if the wheel is not immediately broken it finally becomes weakened, so that it will yield to the forces that tend to destroy it.

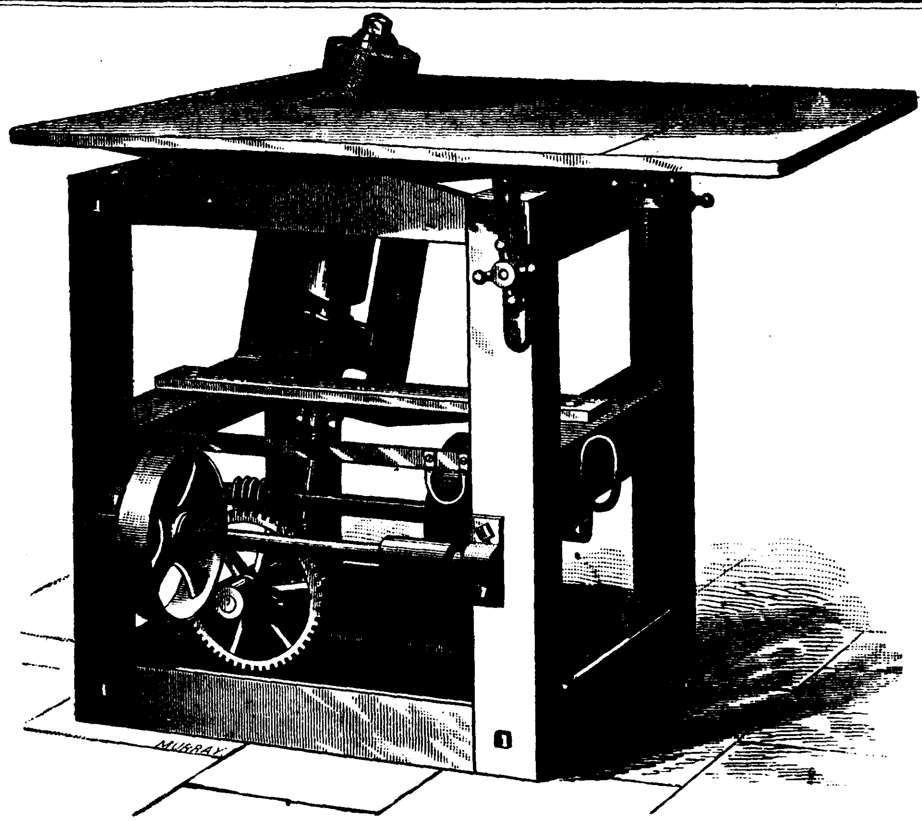
Any wheel whose axis is swung in a plane at right angles to its plane of rotation, either occasionally and irregularly or frequently and regularly, tends to turn laterally on an axis between that of the normal rotation and that of the extraneous disturbing force. This tendency exists in ordinary wheels, although not visible. The engraving shows a flexible wheel, which clearly exhibits the effects of the disturbing forces. The rim is of rubber, the spokes of spring wire, and when the wheel is revolved very rapidly and moved in a plane parallel with its plane of rotation, no disturbance results, and no effect is produced by moving it at right angles to its plane of rotation; but when the wheel is turned even slightly on an axis at right angles to its geometrical axis by swinging the shaft laterally, the rim, while preserving its circular form, inclines to the plane of the rotation of its shaft, bending the spokes into a concave form on one side of the hub and convex on the other, showing the effects of the disturbing force on the figure of the wheel, as in Fig. 2.

When the disturbing force is rhythmical the wheel sets up lateral vibrations and wave motions in the rim, which are out of all proportion to the extraneous force applied.

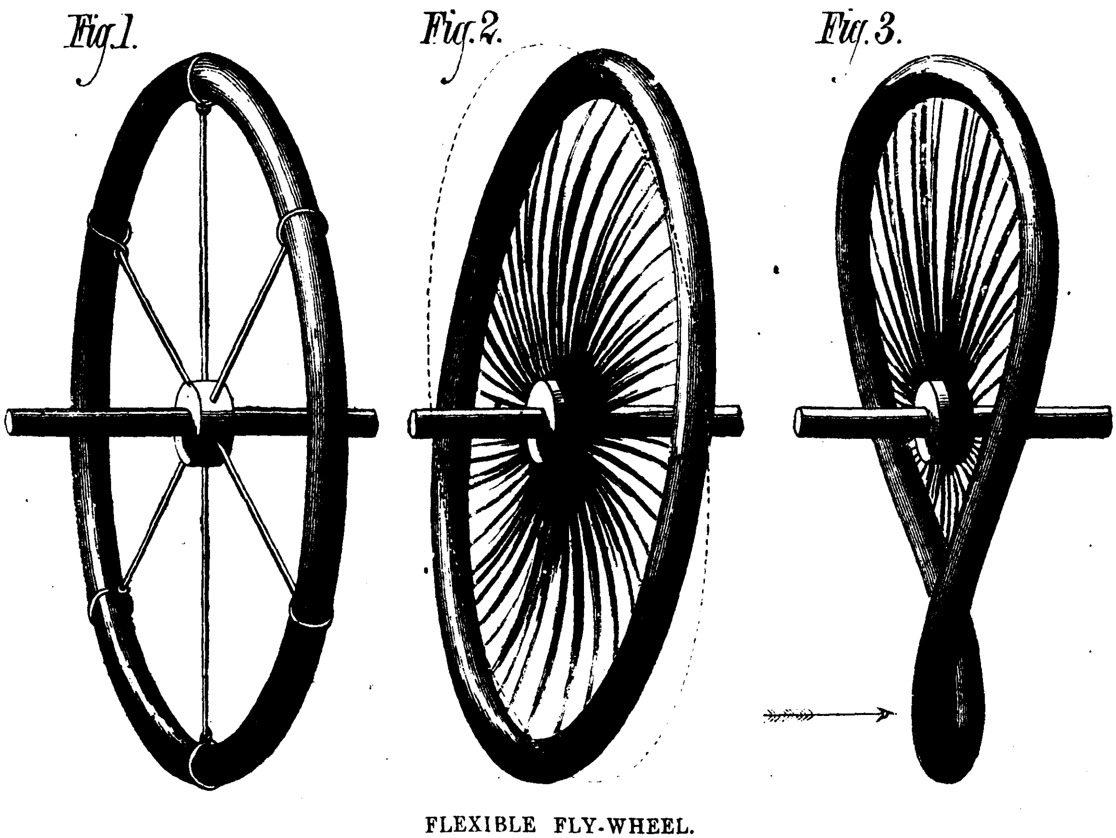
From the experiment it is evident that the lateral swinging of the shaft of a fly-wheel (for instance when its journal boxes are loose, or when the frame of the machine of which the fly-wheel forms a part is yielding) tends to weaken the wheel even when the lateral movement is slight; and where it is great, as when the shaft is broken, the twisting effect is correspondingly great, and the wheel or its support must yield.

No rotating machines are more subject to bursting than grindstones, and generally no rotating bodies of equal weight are mounted upon such small shafts or on such weak supports. The suspended ones are especially liable to the destructive action above described, as their frames are generally far too weak.

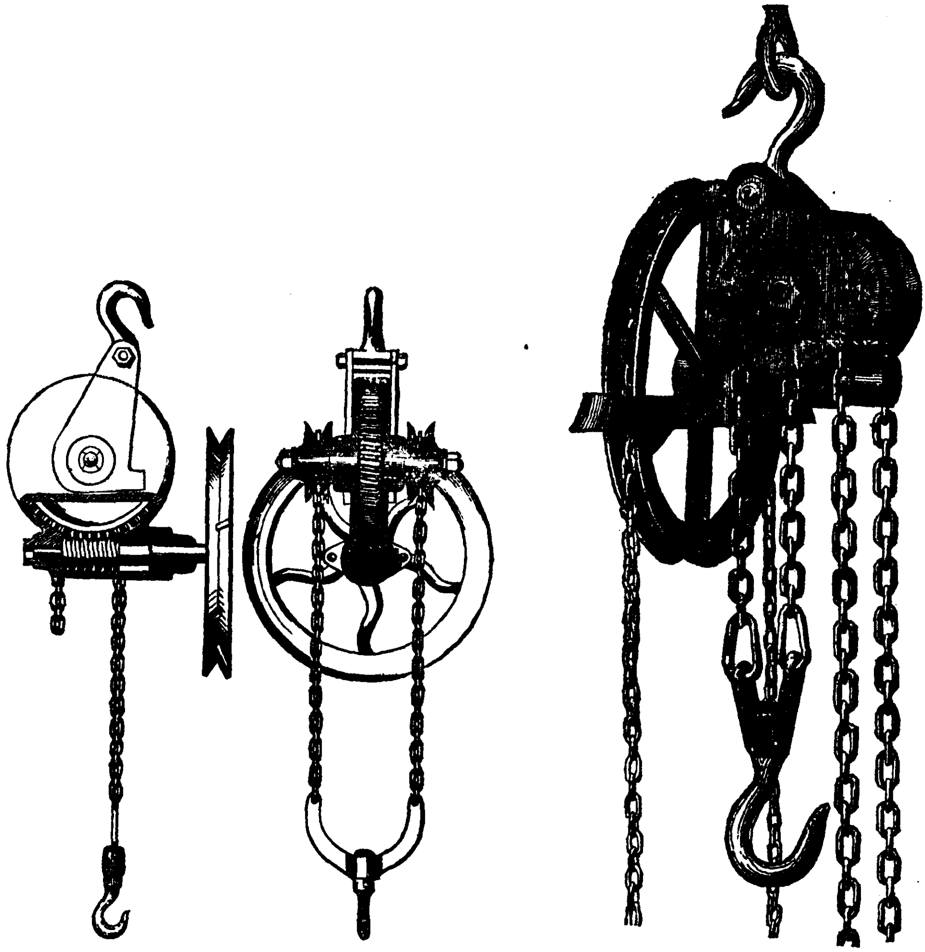
Fig. 3 illustrates the effect of a lateral blow on the rim of a fly-wheel. Of course the effect is much exaggerated in the flexible wheel, but it shows the form taken by the rim under a blow, the blow producing a much greater effect on the wheel while in motion than when at rest.



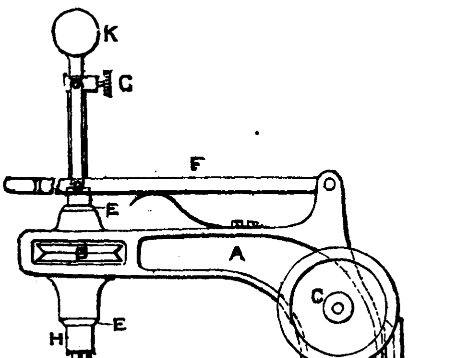
IMPROVED EMERY GRINDER FOR STOVE PLATES, &c.



FLEXIBLE FLY-WHEEL.



HARRINGTON'S PORTABLE DOUBLE CHAIN SCREW-HOISTING MACHINES.



DRILLING APPARATUS.

SCREW-HOISTING MACHINE.

We illustrate herewith a patent portable double chain screw hoisting works, now being introduced for the first time on this coast by Parke & Lacy. The larger cut is a perspective view, and the smaller ones show sections from which the working parts will be understood. With this machine one man can lift from 250 to 15,000 lbs., according to size of machine. The peculiarity of this appliance is that the chains work at any angle with less friction and more speed, and with very much less power than is usually required. With the medium sizes, 35 lbs. will raise 1,000; and 15 lbs. will lower 1,000.

The load being received on two chains instead of one, it is doubly secure, and the possibility of slipping is prevented. All the pulleys being at the top of the machine, there is no danger of accident to the workmen, and the load can be raised high. The chains are never under the feet, and as the hoisting chain can be readily removed from the pulleys, the machine is more easily put in place. It works with perfect smoothness under all circumstances. The load cannot rise or fall a hair-breath, except at the will of the workman; and an exact adjustment of the load is secured.

The working chain is independent of the hoisting chain, and the stretching of the chain does not prevent the proper working of the machine. These hoists are so arranged that they can be run at a rapid rate, either in hoisting or lowering any distance required. They are supplied with an efficient brake, for ease and safety in lowering the load. While the load is being raised with one end of the chain, the other end is descending for a fresh load. With the 1,500 hoist, one man can lift 600 lbs. 10 ft. a minute; with the 1,000 lbs. hoist, 300 lbs. 20 ft. in a minute.

DRILLING APPARATUS.

A handy little drilling-machine, to screw to bench, is shown in sketch. It consists of a small cast-iron standard, of the shape shown at A and A; at the back is a grooved wheel B; carried on a pivot C is one of two smaller grooved wheels, over which the strap runs to D, which is fast on a sleeve H, which revolves in bearings at E and E, the lower one being of extra length to give steadiness. In this is the drill-spindle I, which passes nearly to the top of H, but turns with it, being held by a small set pin (not shown) taken into a groove L. The spindle, therefore, can rise or fall freely, but must turn with H. At the upper end it is connected to the spindle K; this does not turn round, but is connected to I, only to lift and depress it. At G is a small collar held by a set-screw, from which depend two links to the lever F, which is forged or cast with an oval slot, to allow K to pass through. A small rubber or leather round strap passes under B, over the two guide-pulleys at C, and round the smaller pulley D. On placing a drill in the spindle at I, the spindle is adjusted to the necessary height by the set screw G; on turning B the drill rapidly revolves, and the feed is given by depressing the lever F. For very small work it is best to feed with the knob at K, as giving a more sensitive action. All the wheels may be of box, or any hard wood, no expensive bevel-wheels being needed. By the spring under the lever F, the drill is withdrawn from the hole the moment the lever is let go.—*English Mechanic.*

COOKING WITH STEAM HEAT.

Steam has never been looked upon with special favor in the kitchen, and its use for cooking purposes has heretofore been rather limited. The prejudice against its use has doubtless been due in a great measure to the bungling devices employed in applying it, which generally resulted in producing sodden food, devoid of flavor. A new contrivance, the work of Mr. John Ashcraft, was successfully tested recently in the restaurant of Messrs. Nash & Crook in this city, when an entire dinner cooked with steam was served to a select company of the patrons of the establishment and a number of newspaper men. Soups, fish, roasts of beef and mutton and canvas-back duck, puddings, and other edibles were all cooked by the new process, and those who partook of the viands pronounced them excellently well cooked. The new process does away entirely with the use of stoves and ranges except for broiling purposes, and even broiling, it is believed, will be done much better by the steam oven than by an open fire. A device for so employing it has been put to some severe tests, and thus far has worked well, although it has not yet been put in general use. The steam ovens consist of vessels with double shells, one inside the other. The steam coming from a boiler is introduced by pipes into the space between the two shells. Radiation of the heat to the outside is prevented by a jacket of asbestos. The article to be baked is put in the vessel, where it is acted on by the heat derived from the steam, though the vapor nowhere touches the food. The quantity of the steam and the pressure are regulated by means of little wheels. There is no burning by the process, meats are not charred, their flavor does not pass off, the juices are preserved, and the kitchen is free from the usual disagreeable odors. Milk can be boiled without burning, and soups of delicate flavor can be prepared and kept better than with a stove or range. A great advantage of the new process is that no fires have to be kept lit as in a range, there is no dust or ashes flying about the kitchen, and the heat can be applied more speedily, and with less trouble than is the case with a range. The steam can be shut off or turned on at will, and after serving its purpose may be conveyed away for use in heating apartments. Wherever a steam boiler is used the ovens can be made available at a small expense. If the numerous steam heating companies, which have obtained permission to rip up the streets, ever get at work and supply steam heat to houses, the Ashcroft ovens will very likely come into general use in private houses, as they deservedly should, in view of the many advantages they possess over the cooking appliances in ordinary use.
—*Manufacturer and Builder.*

A detonating compound, invented by M. Petry, and termed *dynamage*, was lately tried by the Austrian military authorities. The initial velocity obtained with it in rifles was 323 to 356m., as against 295 to 302m. with powder. The firing proved, somewhat less exact than with powder (thought to be partly due to vibration of the rifle, partly to want of confidence). On the other hand, there was no deformation of cartridges, much less heating than with powder, and less need of cleaning afterwards.

Scientific.

SIMPLIFIED HOLTZ ELECTRICAL MACHINE.

BY GEO. M. HOPKINS.

In the domain of physical science there is nothing capable of being illustrated by more brilliant and pleasing experiments than frictional electricity; the means of studying it experimentally are in every one's hand, and if it were better known, doubtless many who are now comparatively uninformed on this subject would begin to make it a matter of study and experiment.

Many will recall the time in school days when the professor, with great exertion, trundled the ponderous frictional machine from behind the glass doors of the laboratory cabinet, and after no end of wipings, adjustments, and applications of amalgam, and after exerting an enormous amount of muscular force, succeeded in discovering that the atmopheric conditions were unfavorable to the generation of electricity, and the students, after being shocked by a quarter inch spark, were further shocked, and in another way, when informed that the philosophical machine must be reconsigned to its glass housings until a more propitious day.

Such was the general experience of the student of science a few years since, and such it is to-day in some of our educational institutions; but many of of our schools—to their credit it may be said—have kept pace with the times and have provided modern apparatus capable of being used successfully under all conditions. The more recent forms of Holtz electrical machine are vastly better than the earlier ones, and the earlier ones were far superior to any of the forms of frictional machines. The makers of the improved Holtz machine in New York, Boston, and Philadelphia furnish them at reasonable prices, but there are numbers of our experimenters and students who would hadly feel warranted in purchasing one of them, who would construct one but for a few difficulties which at first sight seem almost insurmountable to the tyro. The questions that beset the inquirer are: (1) What kind of glass shall be used? (2) How shall the glasses be apertured? (3) How shall the parts be adjusted and manipulated to secure the wonderful results attained by this machine?

It is the object of this article to fully answer these queries and to give such details of construction as to enable anyone having even a moderate mechanical ability to make, in a very simple manner, a machine fully as efficient as the best in market; and that, too, without any considerable outlay for materials. Without describing in detail the principle upon which the machine operates—these matters being fully treated in all works on physics—I will describe a machine which was made in odd moments as a matter of recreation, and which is as efficient as could be desired, yielding a spark fully six inches in length, equivalent to one half of the diameter of the rotating disk. This machine is shown in perspective in Fig. 1, and in plan in Fig. 2. Different forms of apertured disk are shown in Figs. 3, 4, and 5. The glass for the disks is selected from common window glass. It should be as thin as possible, of uniform thickness, and flat. It is not essential that the glass be absolutely free from imperfections, although this is desirable. The rotating disk is twelve inches in diameter, the fixed disk is fourteen inches in diameter. I begin with the glass disks, as it is here that most of the difficulty in making the machine is supposed to lie; the especial trouble being in making the aperture in the revolving glass for receiving its hollow shaft, and in making the three large apertures in the fixed glass. I dispense with the hole in the revolving disk and secure it to a vulcanite collar by means of a cement composed of pitch, gutta percha, and shellac equal parts, melted together. The method of applying the cement for this purpose is to warm the vulcanite collar, then cover it with a thin layer of the cement; then, after making the glass rather warm, lay it on a paper on which are described two concentric circles, one the size of the glass disk, the other the size of the collar, and while the glass is still hot press the collar down upon it. The vulcanite collar is screwed on the end of a wooden sleeve, C (Fig. 2), having at one end a shoulder to receive the collar, and at the other end a small pulley to receive the driving belt. The sleeve, C, turns upon a piece of three-eighths inch brass tubing which extends through the vertical post, D, ten inches high and two inches in diameter. The end of the sleeve, C, next the glass disk, B, is countersunk to receive a screw which enters the end of the brass tube holding the sleeve in place. This screw is covered by the glass when the revolving disk is in its place in the machine. The glass for the stationary or apertured plate, A, is first cut in circular form and then divided diametrically, and the apertures are formed by cutting half from each plate, a very simple matter as compared with cutting the three holes from an entire disk. The lateral holes are two and three-quarter inches long, and one and three quarter inches wide at the larger end, and their sides are nearly on radial lines extending from the center of the disk. The central opening through which the sleeve, C, extends is approximately circular, but is slightly elongated at *e e*, to facilitate the removal of the portion cut out. Of course the simplest way to get the glass into the desired shape is to have a glazier cut it with his diamond, but any one may do it with one of the twenty-five cent steel roller glass cutters sold everywhere. The disks of the machine represented were cut in this way, and the notches in the semicircles of the fixed disk were cut with one of these inexpensive yet useful tools. The only precaution necessary in cutting the notches is to make them rather flaring to permit of the removal of the piece after it is cut.

The two halves of the fixed disk are fastened together by two elliptical pieces of glass cemented to the two halves, between the central and lateral openings. The cement used is the same as that above described, and it is applied in a similar manner. The cement known as "stratena" answers very well for this purpose, but it must have several days to dry before the machine can be used.

The edges of the glass around the apertures and along the seams should be varnished with the best quality of alcoholic shellac varnish to prevent the accumulation of moisture.

Paper inductors, *c*, are attached to opposite sides of the apertured glass by means of starch paste made by cooking starch until it begins to thicken, and cooling it before it becomes clear, *i. e.*, while it is still of milky whiteness. These inductors are made of filter paper or of single thick drawing paper, and extend from the lateral openings or windows about one third the distance between the two windows in a circular direction. The outer edges of the inductors are arranged on a circle a little smaller than the revolving disk. At the end of each inductor and upon the opposite sides of the glass are pasted pieces, *d*, of gilt paper, which project into the window, and when dry are serrated, the points of the teeth being on the center line of the windows.

In front of the revolving plate, B, two combs or collectors, E, are supported upon glass columns having wooden bases and tops. These combs are made of three-eighths inch brass tubing, the two pieces being fitted together and fastened with soft solder. The points, which are simply bank pins, are driven into holes in the brass tubes three-eighths inch apart. The inner ends of the tubes forming the combs are soldered to brass ball buttons ; the outer ends are inserted in wooden balls, from which wooden screws extend backward to receive the deeply grooved wooden nuts, F, which hold the edges of the apertured disk, A. The points of the combs each cover a space $2\frac{1}{2}$ inches long, or about equal to the width of the paper inductors. Care should be taken to avoid bringing the inner ends of the combs nearer together than is absolutely necessary, and the outer point should be at least one-eighth inch from the periphery of the revolving plate. The points should be as near the face of the revolving glass as possible without touching. The combs are clamped in place by wooden screws in the wooden tops of the glass standards.

The outer ends of the tubes supporting the combs are fitted to tubes soldered in the large hollow balls. Through these balls the discharging rods slide with a gentle friction. The inner ends of the discharging rods are provided with spherical knobs, and their outer ends are fitted with wooden handles well varnished.

The cross arm, G, instead of being supported from the center, as usual with the apertured revolving plate, is elongated and bent so as to enter the rear end of the tube which forms the bearing for the sleeve, C. It is split to create friction in the tubes to retain it in position, and in addition to this the screw which holds the tube in the post, D, passes through a hole in the tube and bears against the extension of the cross arm.

The free end of the cross arm is carefully rounded, and the pins correspond in number and position to those of the combs, E. The cross arm when the machine is in use, is placed opposite the ends of the paper inductors, as shown in the illustration.

The lower edge of the apertured plate, A, rests in an adjustable support on the table.

The base of the machine is 13 inches wide by 14 inches long, with an extension 9 inches long for receiving the standard of the driving pulley, which is made adjustable on the table to tighten the belt, the table being slotted to receive the screw projecting from the standard, and the foot of the table answering as a nut to clamp the standard in any desired position. The pulley on the sleeve is $1\frac{1}{2}$ inch in diameter, and the driving pulley is 6 inches in diameter. Almost any kind of belting will answer, but a gut string is preferable.

To complete the machine two condensers or small Leyden jars are required. These may vary in size; in the machine shown they are $2\frac{1}{2}$ inches in diameter and 6 inches high, and are covered on the inner and outer side with tin foil to within 3 inches of the top, the starch paste before mentioned being used to fasten the foil. The uncovered portion of the jar is varnished with shellac. If jars of the desired form and proportion are not obtainable, bottles may be readily cut by means of a hot curved rod of iron about one quarter inch in diameter.

The condensers are placed outside the glass coloumns under the tubes that support the combs, and a small chain hanging on each tube touches the tin foil lining of the jar.

The outer coatings of the jars are connected by a small brass chain lying on the table. The plate, A, should be placed about three-sixteenths of an inch from the plate, B, and it must be turned so that the edge of the windows to which the gilt paper is attached is exactly opposite the teeth of the combs, E.

To charge the machine the ends of the discharge rods are brought into actual contact, and a piece of vulcanite, a quarter of an inch thick, 4 inches wide, and 10 or 12 inches long, is rubbed with a catskin, a piece of flannel, or a piece of silk, and applied to one of the paper inductors. At the same moment the machine is turned toward the gilt paper points. A strong smell of ozone and an increased resistance to turning are the first indications of the successful charging of the machine. Now, by slowly separating the discharge rods the spark will pass over an increased distance until it is fully 6 inches long. To produce the silent discharge all that is required is to remove the chain on the table from one of the jars. No special directions are required as to the management of the machine. A dry atmosphere is favorable to its action, and it must be kept free from dust. Air currents interfere with its operation ; therefore it should be used in a room with the doors and windows shut.

I have so far described only one form of apertured plate. In Fig. 3 is shown a form in which the disk has a central portion, $1\frac{5}{8}$ inches wide, removed and the two parts are connected by glass strips *a a* and *b b*, cemented in the manner already described When this form of plate is used the combs must be inclined to correspond to the direction of the edges to which the gilt paper is attached. Fig. 5 shows the usual form of plate which requires the aid of the glass cutter, as the holes cannot be readily made by one unused to operations of this kind.

THE EFFECT OF FREEZING ON PLANTS.

When frost attacks plants to such an extent that ice is formed in their tissues, says the *Gardiner's Chronicle*, it has been observed that the ice does not occur within the bags or cells of which the plant is made up, but outside or between them. The reason of this is probably because the contents of the cells are thicker and denser, and do not freeze so readily as do the thinner and more watery juices in the spaces between the cells. In this manner the essential part of the cell—so far as its life actions are concerned—the thick protoplasm, is less liable to injury. Moreover, as a consequence of the low temperature, the watery part of the cell-contents exudes from the interior through the cell-walls and there freezes. The expansion which takes place when water freexes, therefore, does not, at least in slight cases, take place within the cell, where it would do mischief by bursting the cell-walls, but outside them, where there is more room to expand and less risk of tearing the tissues. When the frost is more severe the tissues do become torn, cracks and fissuers occur, the protoplasm is killed, branches fall, leaves wither or rot, and death ensues. But where the injury is less, and especially where the protoplasm is uninjured, when the thaw comes the ice outside the cells becomes melted, and the water, by the power of diffusion, passes once more through the cell-wall into its cavity, there to mix again with the more dense protoplasm. It is clear, then, that the danger to plants from frost is proportionate to the water they contain. If they are in an unripe, sappy condition the danger is far greater than if they are comparatively dry and at rest. Tubers and seeds, for instance, are specially adapted to resist cold ; and how well they do so has been shown in the case of wheat which germinated at home after having remained throughout the winter in the Arctic regions.—*Mining and Scientific Press.*

THE correspondence between the distinguished astronomers, Bessel and Gauss, has been issued under the auspices of the Prussian Academy of Sciences. All but a few of the letters on scientific subjects which passed between the two astronomers during a period of forty years are included.

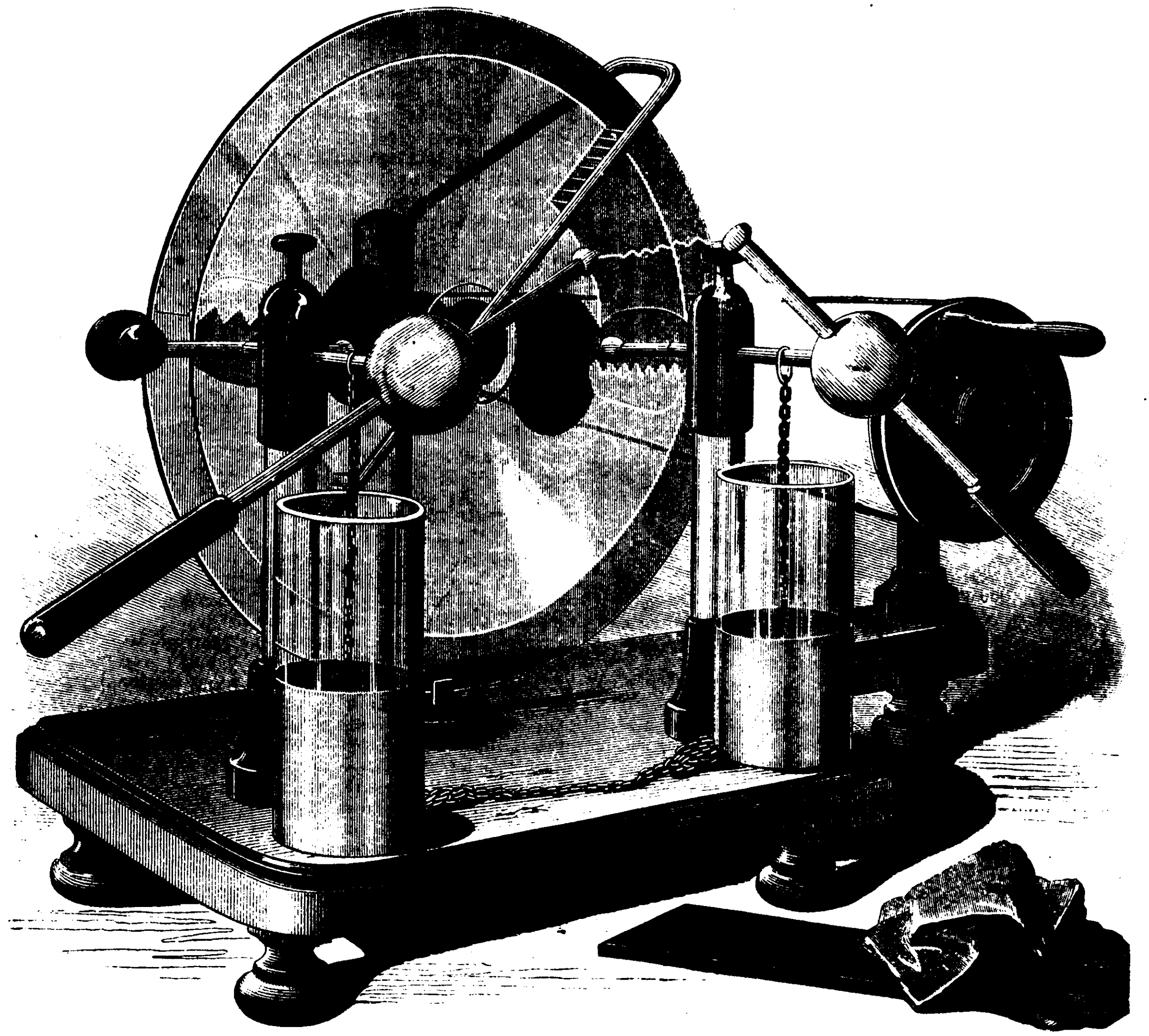


FIG. 1.—SIMPLIFIED HOLTZ ELECTRICAL MACHINE.

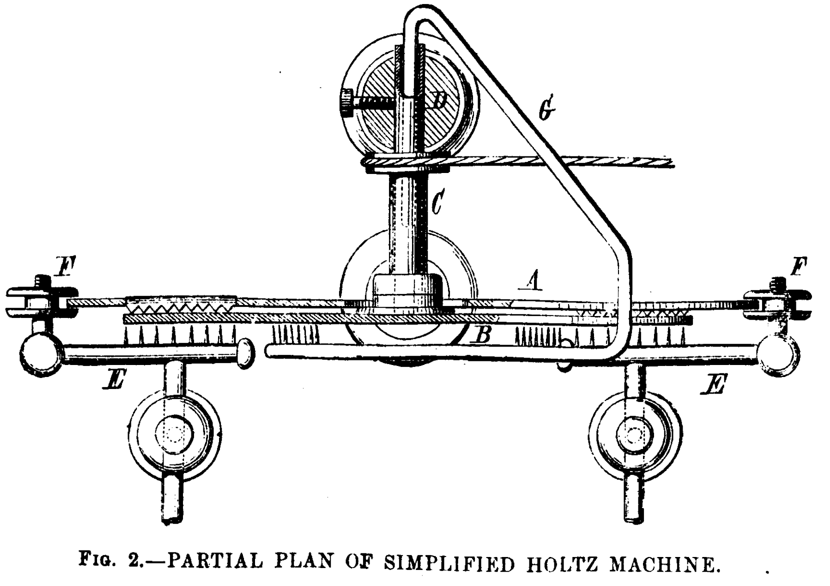


FIG. 2.—PARTIAL PLAN OF SIMPLIFIED HOLTZ MACHINE.

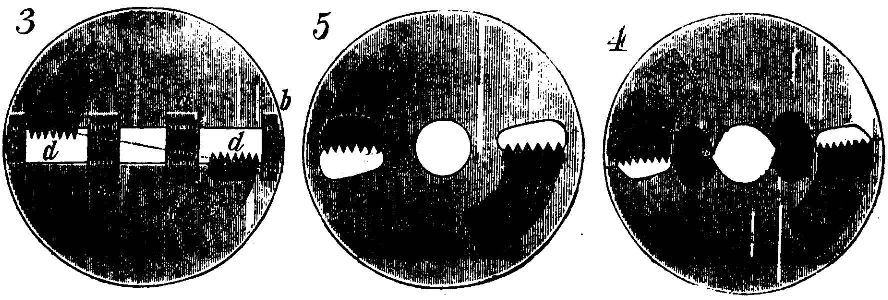
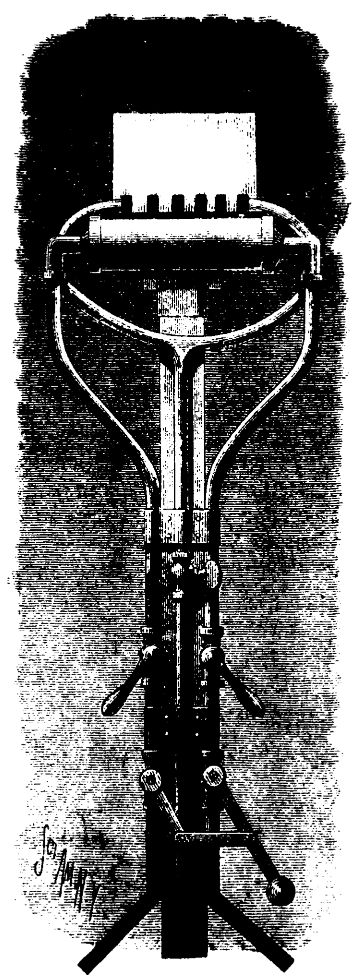


FIG. 3.—APERTURED DISKS.



NOVEL LIME LIGHT.

NEW LIME LIGHT.

The lime light illustrated herewith possesses a few novel features of considerable value, not the least among which are that it will take a block of common lime of any shape and of any reasonable size, instead of the expensive cylinder usually employed, and the light being once regulated, it may be turned up and down from a distance without the necessity of approaching the light for focusing and adjustment.

The particular form of apparatus illustrated is intended chiefly for theatres and other large inclosed areas. The chamber in which the combination of the gases takes place contains a series of perforated metal tubes, one within another, the function of which is to insure the complete admixture of the two gases before they arrive at and issue from the burners, which are fixed upon the upper part of the cylindrical chamber.

This feature of the invention is an important one, as it insures the perfect union of the gas without introducing an element of resistance to its flow as occurs when gauze, coils of wire, shot, and other obstructions are employed with the idea of deflecting the currents and so of securing combination.

For the purpose of regulating the light two levers are provided, one on each side of the apparatus. These levers have engraved upon them the names of the gases (oxygen and hydrogen) which ther respectively control by means of stop taps. These taps being once adjusted require no further attention, and the light may be turned up and down and regulated at will by means of the tap shown at the bottom of the apparatus, and which controls the supply of both oxygen and hydrogen. This tap may occupy any convenient position when the light is situated where it is not readily or conveniently accessible.

The pipe shown in the centre of the apparatus is connected with the ordinary gas service, and supplies gas for the purpose of warming the block of lime, igniting the mixed gases, and preventing explosions. It is stated that the apparatus is so simple that any one may work it with perfect safety, and that it gives ten to twelve times more light than an ordinary burner using the same amount and quality of gas.

The apparatus is being made and introduced by the inventors, Messrs. Allen & Co., of Cardiff, England.

RED SNOW.

On the 25th of last April there fell in the French departments, Basses-Alps and Isere, an abundant snow strongly tinged with red dust. The red matter was so abundant that from Barcelonette all the mountains looked ochery up to 2,800 to 3,000 meters. Above this the snow remained quite white. A notary of the place had a quantity of the snow collected, and, after fusion and filtration, sent some of the dust to M. Daubree, who found in it a large proportion of carbonate of lime, also mica and two felspars, one of them being orthoclase. The powder, then, had probably a terrestrial and not a cosmic origin; but it appears not to be volcanic, like the ash which has sometimes fallen in Scandinavia after Icelandic eruptions. It also differs from the sand of the Sahara, often carried great distances by winds. The point whence it came is still uncertain, but it is interesting to note that the same kind of substance had fallen in 1846, precisely in the same departments, and in 1863 in the Eastern Pyrenees. Showers of similar dust seem to have fallen in Saone-et-Loire on the 15th of April, and in certain parts of Algeria on the 24th.

THE FUTURE OF ELECTRICITY.

At the weekly meeting of the Society of Arts, Professor John Perry read a paper, which was illustrated by many experiments, on "The Future development of Electrical Appliances." He said: electrical energy can be transmitted to a distance, and even to many thousands of miles, but can it be transformed at the distant place into mechanical or any other required form of energy nearly equal in amount to what was supplied? Unfortunately, hitherto the practical answer made by existing machines is "No." But, fortunately, Joule's experiments and other facts tell us that in electric machines of the future, and in their connecting wires, there will be little heating, and therefore little loss. We shall, at no distant date, have great central stations, possibly situated at the bottom of coal-pits, where enormous steam engines will drive enormous electric machines. We shall have wires laid along every street, lapped into every house, as gas-pipes are at present; we shall have the quantity of electricity used in each house registered, as gas is at present; and it will be passed through little electric machines to drive machinery, to produce ventilation, to replace stoves and fires, to work apple-parers and mangles, and barbers' brushes, among other things, as well as to give everybody an electric light. It had been supposed that to transmit the power of Niagara Falls to New York a copper cable of enormous thickness would be needed. Professor Ayrton showed that the whole power might be transmitted by a fine copper wire, if it could only be sufficiently well insulated. He also showed that the one thing preventing our receiving the whole of our power was the mechanical friction which occurs in the machines. He showed, in fact, how to get rid of electrical friction. Professor Ayrton and himself had come to the conclusion that very large continuous current machines, with separate exciters, or perhaps even magneto-electric machines, driven very fast by steam engines, will have an important place in the future transmission of energy by electrical methods. With such machines it would be possible to heat, light, and ventilate all the houses in New York, and to give to large and small workshops the power required to drive their machinery by means of an ordinary telegraph wire (but with some exceptionally good method of insulation), transmitting energy from as great a distance as the Falls of Niagara. The experiments of Dr. Siemens showed that there could be no doubt that the introduction of electric railways everywhere was merely a question of capital and the sacrifice of much existing plant. This kind of proof was very much needed by capitalists. But the electrician saw much further; he saw better insulation for the conductor, and application of the above principles to hundreds of miles of rail instead of a thousand yards; he saw, in fact, that the larger the experiment the greater must be its success. He looked forward to the absence of a vitiated atmosphere in our underground railways. He saw that the weight of rails (for there would be no heavy locomotive in the future, each carriage would have its own driving and breaking machinery) and the cost of bridges and wear and tear of permanent way might become less than one quarter of what they are at present; he saw, in fact, all the advantages that would arise, when instead of making a heavy steam engine travel backwards and forwards with carriages, the carriages alone travel, and the steam engine is not near the railway at all. After a number of interesting experiments bearing on the subject of the storage of energy, the lecturer concluded by exhibiting models to illustrate his belief that it will become possible by electricity to enable a man in London to see an occurrence going on in a distant town.

A Novel Invention.—We have examined a new and certainly valuable improvement in the way of an electric wire fence, patented by Dr. J. H. Connelly, of Pittsburgh. It is claimed that it will not tear or lacerate stock, as it does away with the barb or spur, and that it will repel the stock or other intruders promptly, as it gives a sharp stinging tremor or shock when touched. It is also more easily seen than other wire fences from the fact that the plain galvanized wires are not twisted together, but placed about one inch apart upon suitable insulated wooden posts, with as many such courses of wire as may be desired. It can be put up very cheaply, and there is nothing to get out of order. It is worthy of the attention of the public. It has been examined by a number of practical men and pronounced a success.

Cracks in Boilers.—A new method of repairing cracks in boilers, invented in Germany, consists in the use of a sort of wedge link—a pair of tapered pins connected with each other in one solid body by a flat wedge.

Cabinet Making.

STRAW LUMBER.

We have on several occasions referred to the straw lumber manufactured by S. H. Hamilton, of Lawrence, Kansas. The *Northwestern Lumberman* reports that the factory was recently destroyed by fire but that it will be immediately rebuilt. The same authority speaks of a specimen of this product shown in Chicago, twelve inches square and seven-eighths of an inch thick, one side of which is varnished, presenting a rich and highly finished appearance, and being presented under the designation of "Kansas walnut," puzzled some well-informed lumbermen to discover its true character.

There can be no question that the straw lumber is admirably adapted to many kinds of finishing work, barrels, table and counter tops, fine doors and ornamental work, and we are assured that it can be produced and sold in competition with the finer grades of pine, or in competition with wide walnut, at about one half the price of the latter. The standard manufacture is in widths of 32 inches, a length of 12 feet and a thickness corresponding to that of surfaced boards. These dimensions may be varied to suit such orders as may be given, and embrace any width, length or thickness. Unlike lumber, however, narrower widths are the most costly. The straw lumber may be ripped with the hand-saw or upon the buzz-saw; may be run through the sticker for the manufacture of moldings, and takes a nail or screw about as well as oak. It may be finished with varnish or with paint, and is susceptible to a high polish. It is water and practically fire proof, being manufactured under 500 degrees of heat, and we are assured has been boiled for some hours without any apparent change of structure. Its tensile strength is greater than that of walnut or oak, and its weight about one-fifth greater than the former when dry. It is made from any kind of straw including hemp and flax fiber—in fact, from any material that will make pulp—and a ton of straw will produce 1,000 feet of boards. The pulp is rolled into thin sheets, a number of which, corresponding with the thickness of the lumber desired, are placed together with a peculiar cement which is claimed to be water-proof, and are then rolled under a pressure sufficient to amalgamate them into a solid mass, which may be worked with the plane if desired.

When it is remembered that it takes 100 years to grow a tree to maturity suiting it for commercial purposes, and a tree producing 32 inch lumber will require fully twice that time, while 20,000 ft. per acre is a large yield under the most favorable circumstances, it will at once be realized that where 2,000 can be taken from an acre of ground, for an indefinite number of years, the process which enables such a result to be accomplished and which will yield a really valuable lumber, is one of vast importance. We look for valuable results in the future in the manufacture of lumber from what is practically a waste material, but which will be produced in endless quantities so long as the United States maintains its character as a grain producing country. The factory at the time of its destruction by fire was turning out 20,000 feet per day, and had orders on hand for 10,000,000 feet.—*American Cabinet Maker.*

CEMENTS AND GLUES.

At a recent meeting of the Polytechnic Club of the American Institute, Dr. John Phin read an interesting paper on cements and glues which we condense as follows:

Cements are to be divided into four classes, according as they dry, congeal by oxidation, harden by cooling, or "set" by other chemical changes. First are those which harden by evaporation. Under this head may be classed paste, mucillage and their varieties. Glues to a certain extent dry.

The second class includes the oils. These are said to dry, but it is not by evaporation. They lose nothing, but absorb oxygen from the air. The cement weighs more after hardening than when first applied. Cements which congeal by oxidation cannot be treated in the same way as those of the first class. They require a longer time to handle. The hardening goes on from the outside inward. For example, mend a piece of porcelain with one of these cements. Test it in a few days, and although the outside will be hard the inside will not appear to have dried in the least, and will have no tenacity. Leave it for six months, and it will be very strong.

Thirdly, we have those cements, which harden by cooling. These, instead of gaining their strength slowly, like those of class two, become hard at once. Shellac is a good example of a cement of this kind. China put together with melted shellac is extremely strong.

A fourth class of cements may be represented by plaster-of-Paris. This is the type of an extensive class, including the whole line of mortars and hydraulic cements, on which depend our great engineering works and even the houses in which we live. It forms a chemical compound combination with water first, and then more slowly hardens by drying, a part of the water evaporating.

In order to use a cement successfully we must know to what class it belongs and treat it accordingly. Next, we must know how to put it on. In no case should it be used in a large quantity. The less the better is a good rule to follow.

In mortar we mingle sand, which makes the actual thickness of the lime between the stony surfaces in all cases very slight, however much mortar we may employ. In the use of glue this is not practiced or necessary. The joints made by carpenters are good examples of the minute quantity of a cement which is necessary. Place a well-made glued joint on the edge, and it is almost impossible to find the lines of glue. Its position is mainly discovered by the direction of the grain of the wood.

Intimate contact between the cement and the edges is necessary. This is not easy, on account of the layer of air which adheres to all bodies. This layer of air is what causes needles to float when carefully placed upon the surface of water. When an object is warmed the film of air is easily moved. The hot needle sinks, and to the hot body the cement will adhere easily. It is partly for this reason, that in gluing it is needful to have the work warmed. The rubbing of the surfaces together gets rid of the air, and then not only with glue, but with all cements, the surfaces must be pressed closely together.

Common glue has enormous strength and adhesive powers if it is good. But to be good it must not have been injured in the making by decomposition ; not only is the glue itself liable to be injured in this way during the process of manufacture, but the animal matters such as skin, offal from the slaughter houses, hoofs, &c., are peculiarly liable to decomposition. When this happens the quality of the glue suffers in proportion. In the process of manufacture itself, which is a kind of jelly making on a large scale, there are numerous accidents which are liable to injure the quality. All of them seem to be forms of decomposition ; in fact, glue is not free from danger in this respect until it is entirely dry. The best glue will be pleasant to both taste and smell, and if it is not so its strength has been impaired. If in no way offensive either to taste or smell, it may be trusted to hold wood more firmly than its own fibers adhere to each other.

The strongest known glue is that made from the skins and sounds of fishes ; this is known under the name isinglass or fish glue, and the strongest glue of this kind is made by the Laplanders from the skin of a kind of perch. The Laplanders use it in making their bows, which are both strong and durable. In making it their cold climate is greatly in their favor ; here a fish skin will begin to undergo decomposition before it can be dried.

In making it the skins are put into a bladder, which answers for a water bath, and heated in water until a sort of glue results. This glue is, as may be imagined, very elastic. Isinglass is very liable to be spoiled in making by overheating.

The pastes are all made from starch in some of its forms. Gluten is also used for a paste, but starch is the best. All additions of rosin,&c., commonly recommended are a damage to paste.

Dextrine, or "British gum" is of immense value in the arts as a cement. It is derived from starch by roasting or by the action of nitric acid. It was discovered by accidental overheating of starch, and its process of manufacture was for a long time kept secret. Its chief use for some time was in the cotton manufacture. It is the standard gum for postage stamps, though it is said that gum-arabic and cheaper substitutes are used in this country. [Dextrine is one of the most valuable substances which we have for making pastes, &c., and deserves to be more generally known. Its usefulness as a material for sticking paper is much greater than gum arabic, being free from many of the objectionable features of the latter.]

No cement can be fire-proof which contains organic matter, since this is decomposed at a temperature about that of melting lead, or, 600° F. Cements containing oils will not be fire-proof.

Silicate of soda mixed with asbestos is the nearest to a fire-proof cement. It will stand a low, red heat. It is decomposed at a bright red.

Water-proof glues are made in two ways. Glue and linseed oil are recommended, but I have had little success with the mixture. The chromates may be used with glue. These, when exposed to the light, render the compound insoluble. Unfortunately, although water will not dissolve a glue thus treated, it still has an action upon it. The glue has in fact been, as it were, tanned by the combined action of the bichromate and the light. It will, like leather, swell up and soften when long exposed to water.

Aquarium cement is the best water-proof cement I know. The formula is :

Litharge	3
White sand	3
Plaster of Paris	3
Rosin	1
Boiled linseed oil	–

The solids are to be taken by measure in powder and mixed. As it sets rapidly, the set must not be added until it is wanted for use. It is better for being put into a mortar and pounded. It hardens in three days. It will hold glass firmly, and with it glass tanks may be made without frames, if the angles are well filled with cement. It is a kind of mastic, and could be used on brick.

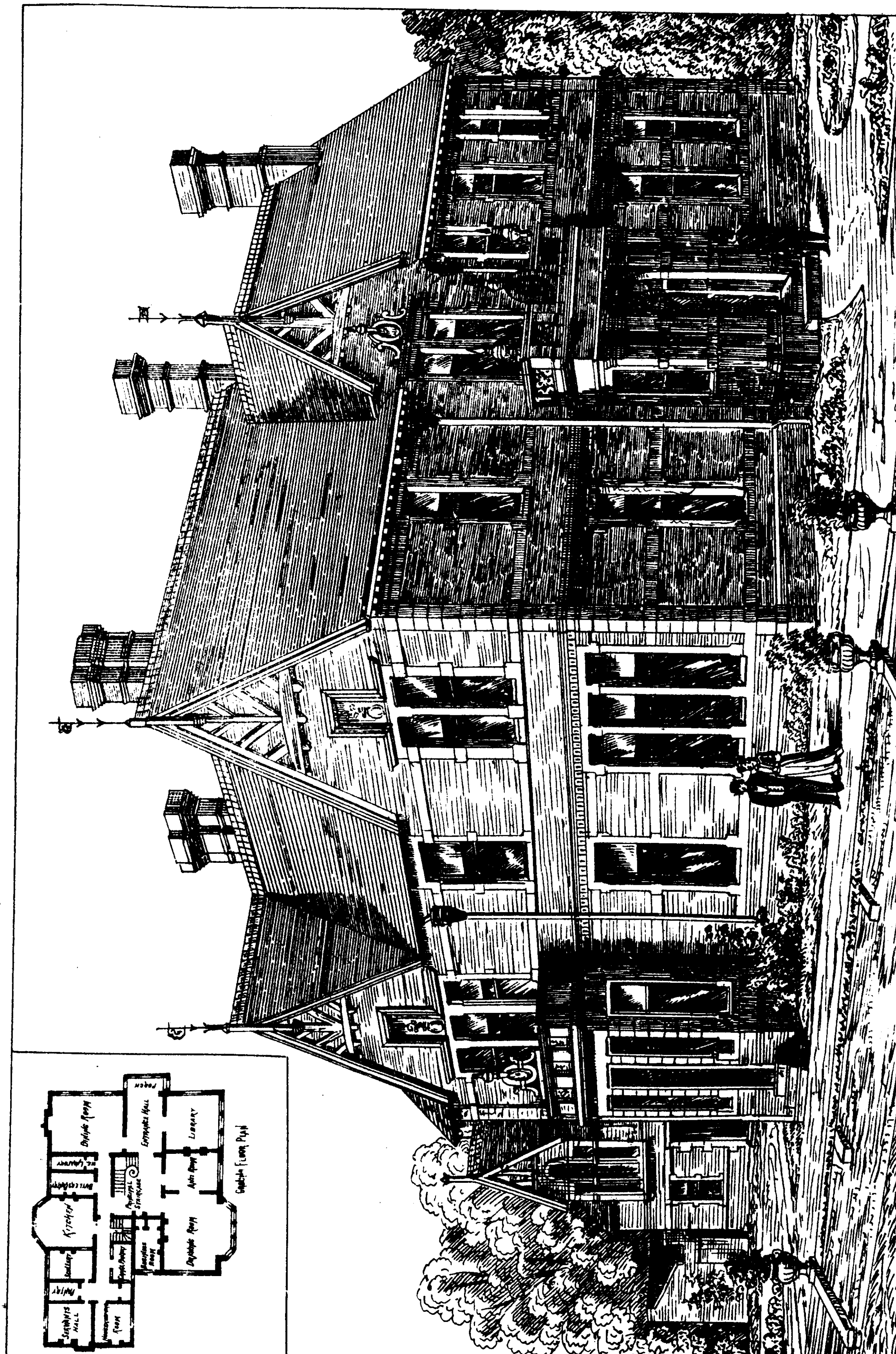
What is technically known as marine glue stands almost by itself. Where it can be put on hot it is admirable. It is composed of india rubber and shellac, dissolved in naptha. Some kinds are hard, some almost liquid. I have seen this glue adhere to glass so firmly as to tear the glass when plates were separated.

In answer to a question the speaker said that stratena, whose wonderful powers are so frequently exhibited upon the streets, is probably only the old Armenian cement. This is so strong that it will hold jewels in place, and is used for this purpose by the Armenian jewellers, who merely flatten the settings of their precious stones and then stick them in place upon the metal with this cement. It is made by dissolving isinglass in alcohol along with gum ammoniac. When well made it is perfectly transparent.

To Polish a Card-Case.—Instead of varnish, white polish should be applied, with a broad camel hair brush, passing it over once only in the same place, letting it remain a few minutes to dry. Then pass it over another part, and so repeated until all the painting is covered—taking care not to touch it with the brush while wet, or the colors will work up. By this method there will be no cloudiness, and after four coats so applied it will be fit to polish. Make a rubber of cotton wool very small ; the surface should not be larger than the tip of a finger ; slightly damp it with the white polish, place over it a fine piece of cotton rag, and apply just a touch of linseed oil to its surface, with this commence polishing one side at a time, holding it in the hand. Be careful not to have the rubber too wet, or it will work up the colors, and continue in this manner, rubber after rubber, until satisfactory. When a hard body of polish is worked upon it, if any unevenness appears on the surface it may be removed with No. 0 sand-paper, used cautiously, after which repeat the polishing as before. When one side is done, let it remain a day or two to harden before operating on the other.

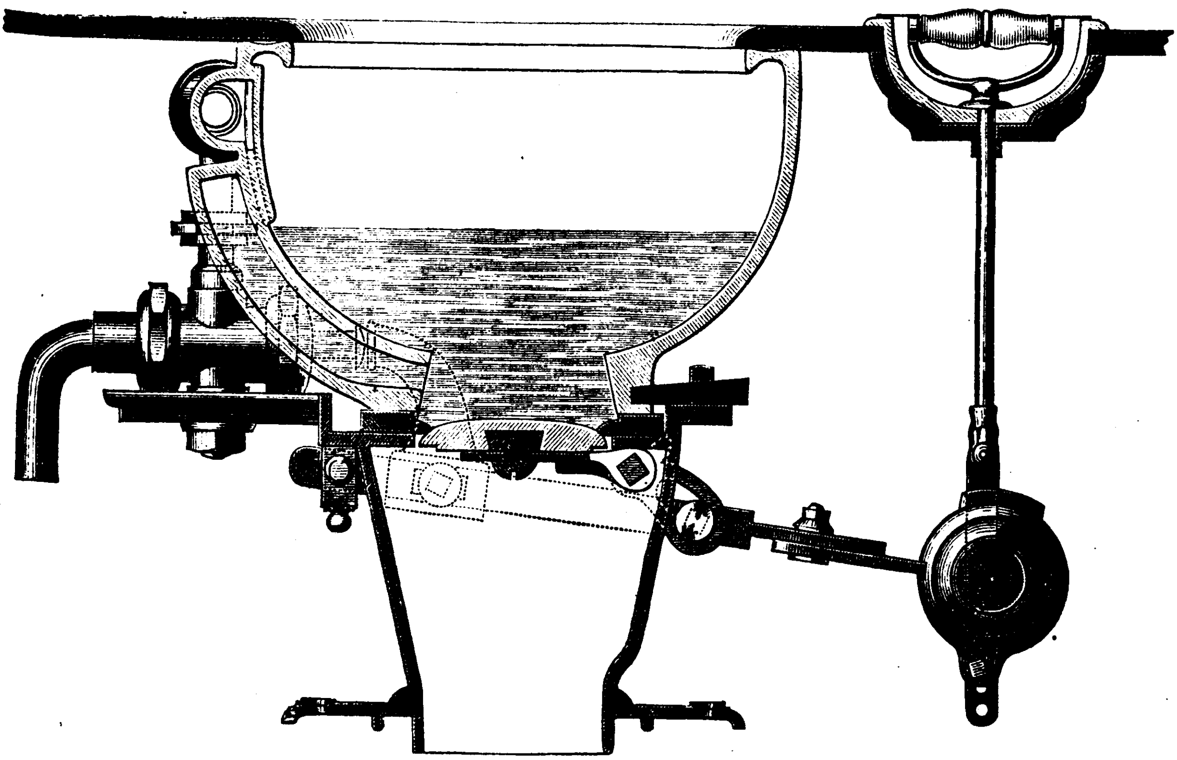
Walnut Coloring for Wood.—Dissolve equal parts of magnate of soda and crystallized epsom salts in twenty or thirty times the amount of water, at about 144°, and the planed wood is then brushed with the solution ; the less the water employed the darker the stain, and the hotter the solution the deeper it will penetrate. When thoroughly dry, and after the operation has been repeated, if necessary, the furniture is smoothed with oil and finally polished, the appearance being then really beautiful. Before smoothing, however, a careful washing with hot water will have the effect of preventing the efflorescence of the sulphate of soda formed. In the treatment of floors the solution may be employed boiling hot, and if the shade produced is not dark enough a second application of a less concentrated solution is made ; after it is quite dry, it is varnished with a perfectly colorless oil-varnish. On account of the depth to which the coloring solution penetrates, a fresh application is not soon required.

Black Surface for Box.—The peculiar glossy surface on the so called Japan trays can only be given by practice, but a near imitation may be effected as follows : Mix ivory black with melted size ; apply the mixture quite hot to the box ; when dry, sand paper the box, then give another coat of black ; when dry, paper smooth, at same time using care not to remove the stain, so the light wood under the stain is exposed. Now procure 1 lb. black Japan and one gill of turpentine ; mix enough black Japan for present use with turpentine ; only sufficient turpentine should be used to make the Japan fluid enough to run from the brush, and a fine-haired paint brush should be employed ; if properly done one coat will be sufficient. The box will look nearly equal to the Japan goods. Dry the varnished box in a warm room free from dust.

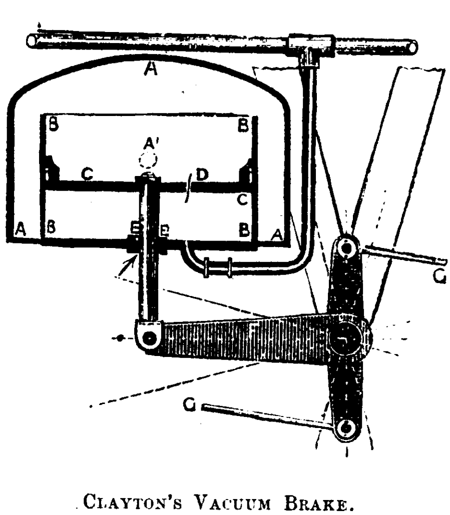


COLEHILL, WIMBORNE.—ERECTED FOR THOMAS RAWLINS, ESQ.

HENRY HALL, M.I.B.A., *Architect, Doughty Street, London.*



CARR'S WATER-CLOSET—SECTIONAL VIEW.



CLAYTON'S VACUUM BRAKE.

CLAYTON'S VACUUM BRAKE ON THE MIDLAND RAILWAY.

The great difficulty in the way of automatic vacuum brake inventers has been that, to obtain "automaticity," there must be a reservoir under each carriage. Now this is just the difficulty, because Westinghouse invented and patented auxiliary reservoirs in 1871.

The carriage superintendent of the Midland Railway, Mr. Clayton has, however, succeeded in obtaining all the advantages of a *reservoir*, without infringing any other patent of right, by placing the brake-cylinder inside the reservoir.

The following reference letters explain the diagram:—

A. Reservoir hung on trunnions A.
B. Brake-cylinder placed inside.
C. Brake-piston.
D. Small hole through piston.
E. Packing ring.
F. Lever.
G. Rods to brake gear.

The driver creates a vacuum with Du Tremblay's ejector in the main pipe and the lower side of the piston; the piston comes down to the bottom and makes a tight joint on the packing ring E, and the brake is off.

Then through the small hole, D (Clayton's patent), a vacuum is created in the upper side of the cylinder and in the reservoir. Now, to put on the brake, air is admitted to the main pipe and lower side of the cylinder, which, acting against a vacuum, forces the piston up, and, by means of lever and any arrangement of gear, applies the blocks to the wheels. To put the brake on quickly, as soon as the piston lifts off the ring, E, air passes into the cylinder round the rod.

In three or four minutes the brake leaks "off." This prevents any long delays to trains if it gets out of order. The brake is good, cheap, and simple, and much credit is due to the inventor Mr. T. G. Clayton.—*English Mechanic.*

Sanitary Matters.

CARR'S IMPROVED WATER-CLOSET.

The accompanying cut gives a sectional view of a water-closet, possessing a number of excellent features which have gained for it a wide reputation and a very general introduction. The manufacturer has spared nothing to enhance the serviceability and durability of this apparatus. The closets are made almost entirely of china, the use of putty and cement being entirely discarded. The distinguishing features of these closets are, the large quantity of water retained in the bowl, the perfect sealing of the overflow, and the use of an effective seal in the bottom of the basin, in place of the usual pan. These closets are somewhat larger than those in general use, on which account the surface of water retained in the bowl is larger than the opening in the seat, a feature that has obvious advantages on the score of cleanliness. The seal at the bottom of the bowl fits up tightly and solidly against a bearing, as seen in the cut, thus offering an effective barrier against the entrance of foul and unwholesome gases from the sewer end of the apparatus—a feature which is decidedly to be preferred, on the score of safety, to the loosely fitting pans commonly used, which, even with a water-seal, afford inadequate protection from this source of danger.

The operation of the apparatus will be readily comprehended from the following statements, reference being made to the engraving: The raising of the pull opens the seal at the bottom of the bowl and discharges its contents, and, at the same time, the water supply is turned on by the pressure of the lever, shown in dotted lines against the head of the water faucet. The water enters the overflow, and from this is discharged into the basin, copiously flushing it with clean water. When the pull is lowered, the seal at the bottom of the basin is brought to its seat, and the overflow pipe is effectually sealed with the water in the basin. By this simple arrangement of parts, without unnecessary complications in construction, a water-closet is provided that is at once convenient, durable in service, and safe against the insidious dangers of sewer gases. Should repairs become necessary at any time, a duplicate of any part of the apparatus may be obtained of the manufacturer, Henry Huber (successor to Wm. S. Carr & Co.), 106, 108 and 110 Center street, this city.

In addition to the above described apparatus, the merits of which we have briefly pointed out, Mr. Huber, who has succeeded to the extensive business in general plumbers' supplies and sanitary appliances built up by the late firm of Wm. S. Carr & Co., manufactures a number of other special appliances, of which we may select some for description in future issues. Of these we may enumerate the patent "Monitor" closets, hopper closets for factories, prisons and asylums, patent swinging urinals, Carr's self-closing faucets, Carr's patent reversible pumps, and patent basin and bath supplies and overflows.

Preparations for the Paris Electrical Exhibition are being made with energy. The general Commissioner proposes to have 600 electric light-centres for the Palace itself, and he calculates that a force of about 800 horse-power would be required. This matter has been much discussed, and a circular has been addressed to possessors of systems of electric lighting, and makers of steam-engines, with a view to securing the best distribution. No system will have monopoly, as the object is comparison. The exhibition is to have a department of electric toys. The various telephone systems will, further, be represented, and one interesting project is that of placing in the acoustic centre of the opera a transmitter, sending the music to the Palais de l'Industrie. It is also intended to have a very long telephone circuit, with powerful transmitter and the condenser for reception; the latter gives the speech a force and distinctness hitherto unknown. International Exhibitions have often given birth to permanent institutions in the cities where they have been held; witness our Crystal Palace and the Palais de Trocadéro in Paris. *L'Electricité*, while not looking for a new edifice as a result of the electric exhibition, desires that the event might bear fruit in three ways, viz. the formation of a society, a library, and a museum of electricity.

Preservation of the Colors of Dried Plants.—According to M. Storbzl, the slow immersion of the fresh plant in a boiling solution of one part of salicylic acid in 600 parts of alcohol, and then shaking off superfluous moisture, previous to pressing in the usual way between blotting paper, will more nearly preserve the natural color than any other method.

Milling, etc.

THE ELECTRIC MIDDLINGS PURIFIER.

However simple in outward appearance, a grain of wheat exhibits, when looked into, a curious complexity of structure, organically as well as chemically; and the processes now employed in converting grain into flour are scarcely less complex and curious. Indeed, unless one has made a special study of modern milling he can have no idea of the many processes of reduction and purification a grain of wheat now undergoes between the bin and the flour barrel.

It is doubtful whether any other great industry has during the past ten years experienced so complete a revolution as flour making. For the previous half century or more, from the day when Oliver Evans set up the first automatic milling machinery in his mill on the Brandywine, the industry grew in volume and importance, but underwent no signal or radical improvement in machinery or processes. The non-progressive period came to an end about 1870; and since then change, and rapid radical change has been the order of the day, at least in the great merchant mills, which turn out by far the larger and better portion of American flour.

The causes which led to the era of change were several, chief among them the conditions and exigencies of wheat growing in the new Northwest, the development of cheap railway communication with the seaboard, and the resulting possibility of competing with Austria and Hungary in supplying the flour markets of Western Europe. The problem was to make good white flour out of the spring wheat of Minnesota, and the processes of milling were revolutionized for its solution. To describe in detail even the more characteristic changes in the means and methods of milling thus brought about does not fall within the scope of this paper. It is necessary, however, to indicate roughly the more important of them to enable those of our readers who are not millers to appreciate the improvement in milling processes to be described and illustrated below.

Structurally the wheat kernel is composed of the following parts: (1) The light, straw-like, valueless hull, comprising the three parts called *epidermis, epicarp* and *endocarp*, together making about 3 per cent of the weight of the grain. (2.) The test, or episperm, which forms, with an underlying membrane, the inner skin of the berry. This part carries the coloring matter, and constitutes about 2 per cent of the weight. (3.) The germ and its membranous expansion, say 5 per cent; nutritious but not desirable in the flour, since it carries an oil likely to become rancid and injure the sweetness of the flour. (4.) The central or floury portion, 90 per cent, composed of starch and gluten variously combined. The heart is the softest and contains the least gluten. In the successive layers around the centre the proportion of gluten increases outward, the entire amount varying with the kind of grain, the quality of the crop, etc., etc.

The old process of milling involved but two distinct operations after the wheat had been cleaned—the grinding and the bolting, or separation of flour from bran. Three products were obtained: fine flour, more or less discolored by particles of 1 and 2; a coarser and more granular part, rich in gluten and dark in color, called middlings, and bran, more or less mixed with the other two.

To obtain the largest possible yield of flour the stones were set close together, or the upper stone "low." With soft, starchy, winter wheat, having a tough husk, low grinding gave excellent flour. With the hard and brittle hulled spring wheat the flour was mixed with so much fine bran, which could not be bolted out, that it was unpopular and unprofitable.

The new process was designed to remove these objections to the flour made from Minnesota wheat. The aim now became, not to make the most fine flour and the least middlings at a grinding, but the reverse; it being found that, when properly purified or freed from branny particles, the middlings yielded a flour as white as that from winter wheat and much stronger, owing to its larger percentage of gluten. The new method was characterized as high grinding, the stones being set so far apart at first as to granulate rather than crush the kernel. The stages of this process were four: (1) the granulation of the berry: (2) the separation of the product ("chop" or meal) by bolting into fine flour from the starchy center of the grain, the middlings or hard glutinous portions, and the coarser bran: (3) the purification of the middlings by an air blast, which winnowed away the bran mixed with them: (4) the regrinding and rebolting of the middlings, thus getting a strong, white, "fancy," or "patent" flour.

Under the stress of competition and the necessity of obtaining larger and larger yields of high quality flour, through the increase of middlings and the more perfect separation of discoloring elements, the still more complicated processes of gradual reduction were developed. By this method the aim is to remove the hull as completely as possible with the least breaking, to separate the weak flour of the heart of the grain from the rest, and to convert the more glutinous parts of the berry into high grades of flour by slow and gradual reductions, each time subjecting the several grades of middlings to successive purifications and subsequent reductions by means of high grinding, or by crushing between rollers. It thus came to pass that the work of purifying middlings became the most important part of the milling operation, and the purifiers and their appurtenances the most conspicuous and characteristic portion of the machinery of the flour mill.

The higher quality of the flour produced justified the greater cost and trouble, but the system was not all gain. The fine flour-dust blown about the mill, particularly through the systems of purifiers and into the settling rooms or dust houses, was soon found to be as explosive as gun-powder; and several mills were wrecked by the careless handling of lights or by chance sparks from the rolls or stones firing the dust in the atmosphere of the mill or in the purifiers. The inapplicability of the purifying system to the smaller custom mills, which constitute numerically the larger part of the milling interest, was another though minor objection, the chief objections being the extra life and fire risk involved; the cost and cumbersomeness of the purifying systems; the power required to operate them; the space required for dust houses; the wastefulness of the system, some of the finer flour being blown away with the bran; and the largely increased complication of the work of flour making.

Impressed by the prevailing discontent of millers, both at home and abroad, with respect to the means of purifying middlings in general use, a young American miller, Mr. Kingsland Smith, naturally gave much thought to the problems involved. While making a practical study of the European systems of milling in 1876 and 1877, Mr. Smith conceived the idea of using frictional electricity to remove the bran, and experimented enough with an electrically excited hard rubber roller to convince himself that the matter was worthy of investigation. On his return home, he referred the problem to his friend and former classmate, Mr. Thomas B. Osborne, of New Haven, whose inventive talent he had a high respect for. Young Osborne, then a student at Yale College, undertook the task, and in a short time devised the plan of the desired machine. It consisted of a series of hard rubber rolls (electrified by the friction of hair, silk, wool, or other suitable material), under which rolls the middling were to pass slowly along a shallow receiver, the latter being rapidly shaken so as to bring the bran to the top. The expectation was that the particles of light bran would be attracted to the revolving rolls, where they would cling until carried over a bran receiver into which they could be brushed.

His principal doubts were whether the electrified rolls would not also attract the floury particles, and whether the material attracted might not be repelled so quickly as to defeat the desired object. Both these doubts were dissipated by the action of the first working model of the machine. The principle of his device being happily established, Mr. Osborne added the necessary attachments, and had made a working machine with twelve rolls. This machine was tested in New Haven about a year ago, and from its successful working attracted much attention. It remained to be proved, however, whether the machine would be equally efficient in practical use in all sorts of weather. To settle this question a machine was placed in the Atlantic Mills, Brooklyn, N.Y., where since May, 1880, it has been run almost continuously as a part of the mill machinery. The construction and appearance of the electric purifier will be made clear by the engraving on page 148. The material to be purified—middlings, bran, and flour dust in whatever combination—is received at the further end, and passes slowly under the rolls about two inches below. The agitation of the sieves causes the bran to rise to the surface, whence the light particles leap to the rolls and cling thereto until brushed into a shallow gutter placed in front of each roll. Meantime the heavy and electrically rejected middlings descend by gravity and pass through the bolts in the order of their fineness. Traveling brushes constantly sweep the bran from the gutters into the bran receiver on the left side of the purifier, in which is seen the spiral conveyor. By the time the last line of rolls is reached the material has been successively diminished by the abstraction of the bran and the screening out of the several grades of middlings, until only a trifling quantity of heavy refuse (if there be any) is left to pass over the tail of the purifier into the spout provided for it.

The power required to operate the purifier and generate the electricity employed is so slight that a man can work the entire machine with one hand. The trial machine in the Atlantic Mills purifies over fifty barrels of middlin s a day, and its efficiency appears to be entirely unaffected by lapse of time or atmospheric changes. The machine occupies a space nine feet long, five and a half feet high, and three feet wide. The proprietors of the mill say that it works equally well on spring and winter wheat, and on all grades of middlings, and absolutely without dust. Dust-house material, when passed through the electric purifier, yields fully half its weight of fine flour and middlings suitable for flour.

This alone would effect great economy in the working of large mills employing air purifiers. Compared with the best air purifiers in use, by weighing materials and products, the difference in favor of electric purifying is found to be from six to eight per cent. The saving of space and power is even more remarkable, the extra room required for air purifying and the power needed to drive the machinery and supply the blast being equivalent to one-tenth the capacity of a mill; in other words, without any addition to the power employed, the output of a mill may be increased ten per cent. by the introduction of electric purifiers. For example, the Atlantic Mills have a maximum capacity of 700 barrels a day, and average 600 barrels. The space saved by displacing the air purifiers is 2,500 square feet. At the same time the engine is relieved of work requiring 22 horse power, now employed in driving the fans and other purifying apparatus. The power saved by electric purifying will easily grind 60 barrels a day, and the space saved will amply accommodate the stones and other machinery required to increase the average output to 660 barrels a day.

In dispensing with the use of air blasts, there is no possibility of filling the air of the mill or any part of it with explosive starch dust, and the serious problem of insurance is thus materially simplified. With the source of hazard removed the excessive rates charged for insuring flour mills would be unnecessary.

Taking into account, therefore, the great saving in cost of machinery, in power required, and in space; the more rapid action of the bolts since the material meets with no resistance in passing through the meshes; the more perfect separation of the bran from the flour products; the diminished waste; the fewer processes required to achieve a given result; the diminished fire risk from the absence of dust; the great simplification of the work of milling promised by electric purification and the possible increase in the capacity of mills, the new system can scarcely fail to meet with immediate attention if not favor at the hands of progressive millers. To those operating custom mills, it seems to offer especial advantages, since it makes possible the conversion of grain in small distinct lots into new process flour, giving each customer his own.

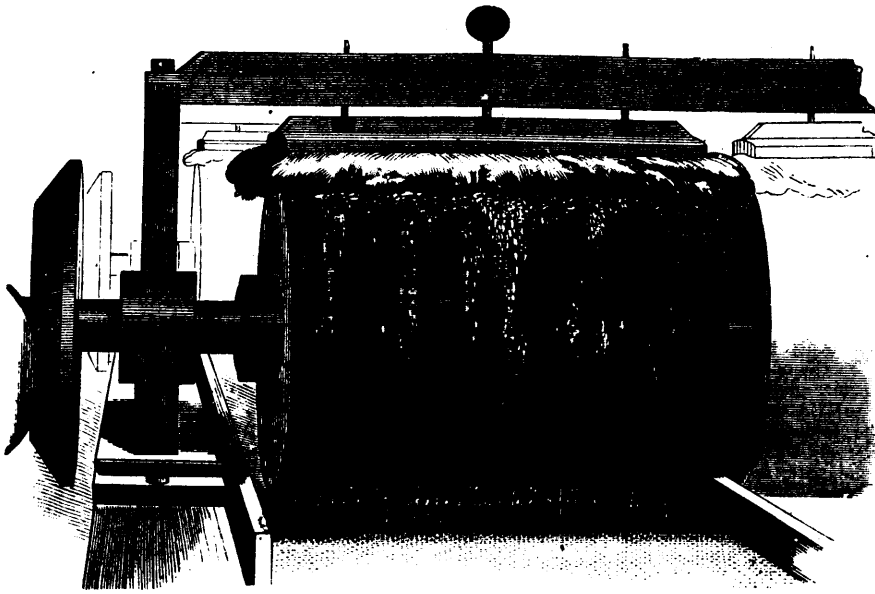
The ultimate importance of the new system, if wider application sustains the promise of its performance hitherto, must be enormous. Our annual wheat crop is equivalent to something like 100,000,000 barrels of flour. The proprietors of the Atlantic Mills say that, "after making all allowances and reductions, we estimate the saving in material alone effected by the electric purifier to be at least 10 cents on a barrel of flour, wheat being at present $1.20 per bushel. By this estimate, the saving of material in milling a year's crop of wheat would be $10,000,000, and this is but one of several savings made possible by electric purifying over purification by air blasts and the machinery now in use.

Little needs to be said in explanation of the detail illustrations, which tell their own story. Fig. 2 shows very clearly the appearance of the bran as it leaps from the sieves and clings to the rolls. The adhering bran is brushed off when it reaches the sheepskin cushion, which lightly touches the top of the roll to electrify the hard rubber. The bran trough in front of the roll has been omitted, to show the behavior of the bran more clearly. Fig. 3 shows the tail of the purifier broken, to expose the shoot for the tailings and the spiral conveyor further in, by which the several grades of middlings are conveyed to their respective delivery spouts.

The Smith-Osborne patents for this process of purifying middlings are owned by The Electric Purifier Company, of New Haven, Mr. John Rice, General Manager. New York office, 17 Moore street.—*Scientific American.*

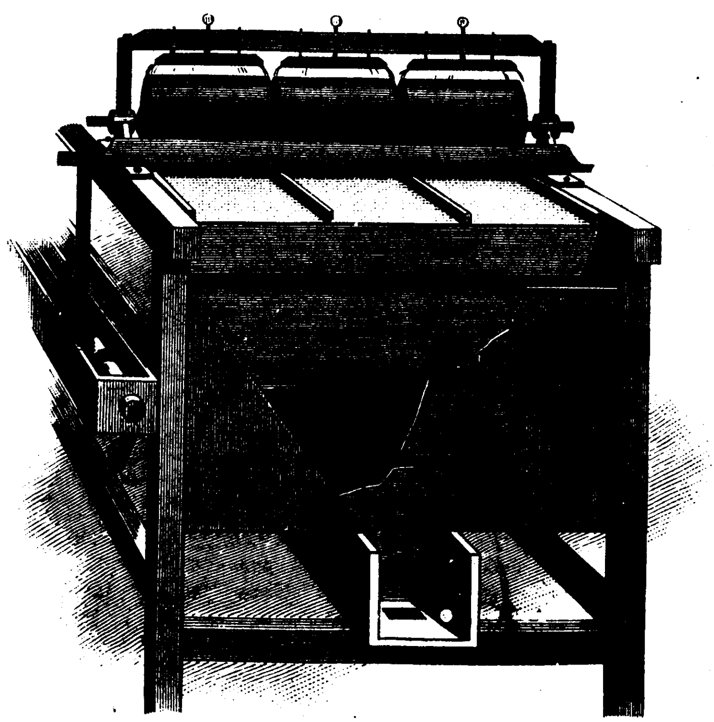
A telephone line has been set up between the Exchange and the Market of Minet el Barseal, at Alexandria, in Egypt.

FLOUR MILLING.—THE ELECTRIC MIDDLINGS PURIFIER.



Action of Electrified Roll on Bran.

ELECTRIC MIDDLINGS PURIFIER.



END OF PURIFIER BROKEN AWAY TO SHOW MIDDLINGS CONVEYOR AND TAILINGS SPOUT.

ELECTRIC MIDDLINGS PURIFER.

Mill Work and Carpentry.

THE CORROSION OF BUILDING STONES.

By W. Matthieu Williams, F.R.A.S., F.C.S.

About fifty years ago two eminent French chemists visited London, and rather "astonished the natives" by a curious fashion which they adopted. They wore on their hats large patches of coloured paper. Coming as they did from Paris, many supposed that this was one of the latest Paris fashions, and the dandies of the period narrowly escaped the compulsion to follow it. They probably would have done so had the Frenchmen shown any attempt at decorative shaping of the paper. The reason why they neglected this was that it was litmus paper, and their object in attaching it to their hats was to test the impurities of the London atmosphere.

Blue litmus paper, as everybody knows now-a-days, turns red when exposed to an acid. The French chemists found that their hat decorations changed colour, and indicated the presence of acid in the air of London; but when they left the metropolis and wandered in the open fields their blue litmus paper retained its original color. By using alkaline paper they contrived to collect enough of the acid to test its composition. They found it to be the acid which is formed by the burning of sulphur, and attributed its existence to the sulphur of our coal. At this time the domestic use of coal was scarcely known in Paris.

Subsequent experiments have proved that they were right; that the air of London contains a very practical quantity of sulphurous and sulphuric acids, and that they are due to the combustion of that yellow shining material, more or less visible in most kinds of coal, and which has been occasionally supposed to be gold. It is iron pyrites, a compound of iron and sulphur. When heated the sulphur is separated and burns, producing sulphurous acid, which exposed to moist air gradually takes up more oxygen and becomes sulphuric acid, which in concentrated solution is oil of vitriol. In the air it is very much diluted by diffusion, but is still strong enough to do mischief to some kinds of building materials.

In manufacturing towns, such as Birmingham and Sheffield, the quantity of this acid in the air is much greater than in London, and there its mischief is consequently more distinctly visible. The church of St. Phillip, which stands nearly in the middle of Birmingham, and is surrounded by an old church-yard, was so corroded by this acid that the stone peeled away on all sides, and its condition was most deplorable. The tombstones were similarly disintegrated on their surfaces, and inscriptions quite obliterated. It became so bad that a few years ago restoration was quite necessary, and it was newly faced accordingly. Some of the old tombstones that are preserved may still be seen, and their peculiar structure is well worthy of study. They display a lamination or peeling away due to unequal corrosion, certain layers of the material of the stone having been evidently eaten away more rapidly than others. Anybody visiting Birmingham may easily examine these, as St. Phillip's churchyard is situated between the two railway stations of New Street and Snow Hill, and is but two minutes walk from either.

Other stone buildings in the town have suffered, but in very different degrees, and some have quite escaped, proving the necessity of careful selection of material wherever coal fires abound. In Birmingham the action of coal fires is assisted by other sources of acid vapour. The process of "pickling" brass castings, *i e.*, brightening their surface by dipping first in common nitric acid ("pickle acky") and then in water is attended with considerable evolution of acid fumes. Besides this very widespread use of acid, there are several chemical manufactories that throw still more acid into the air immediately surrounding them.

As an example of the action of the atmospheric acids of London upon building stones, I have but to name the Houses of Parliament, which have only been rescued from superficial ruin by the restoration of certain blocks of stone, and various devices of siliceous and other washings that have been carried out at great cost to the nation. That such an unsuitable material should have been used is disgraceful to all concerned. The ruin commenced before the building was finished. At the time when its erection commenced there were abundant evidences of the ruinous action of London atmosphere on some kinds of stone and the capability of others to resist it, for some of the oldest buildings in the midst of the city show scarcely any signs of corrosion.

The Birmingham and Midland Institute was established and in practical operation a few years before the present noble building was erected. I was the first teacher there and conducted the Science classes in the temporary premises in Cannon street. Having observed with some interest the disintegration of St. Phillips' Church and other buildings, I was anxious for the safety of the new institute buildings, and accordingly made some experiments upon the material proposed to be used by the architect. The method of testing that I adopted was very simple, and as the practical result has verified my anticipations I think it might be adopted by others.

Firstly, I immersed some lumps of the stone in moderately strong solutions of sulphuric and hydrocholoric acids respectively, and observed whether any visible action occurred after some days. There was none. I then roughly tested the crushing pressure of small samples in their natural state, and subjected similar sized pieces to the acids. I found that there were no evidences of internal disintegration after several days immersion, and therefore inferred that the stone would stand the acid vapours of the Birmingham atmosphere. This has been the case with that portion of the building that was built of the material I tested. As I know nothing of the material which is used for the extension of the building under the present architect, I am unable to make any forecast of its probable durability.

The experiments I made at the time named with this and other building materials justified the conclusion that the worst of all material for exposure to acid atmospheres is a sandstone, the particles of which are held together by lime tone, or are otherwise surrounded by or intermingled with limestone; and that the best of ordinary material is a pure sandstone quite free from lime. I do not here consider such luxurious material as granites or porphories.

Compact limestone, such as good homogenous marble, stands fairly well, although it is slowly corroded. The corrosion, however, in this case, is purely superficial and tolerably uniform. It is a very slow washing away of the surface, without any disintegration such as occurs where a small quantity of limestone acts as binding material to hold together a large quantity of siliceous or sandy material, and where the agglomeration is porous, and the stone so laid that a downward infiltration of water can take place; for it must be remembered that although the acid originally exists as vapour in the air, it is taken up by the falling rain and the mischief is directly done to the stone by this acidified water. This, of course, is very weak acid indeed. That which I used for testing the stone was many thousand times stronger, but then I exposed the stone for only a few days.

As above stated my experiments were but rude, but I think it would be quite worth while to construct crushing apparatus capable of registering accurately the pressure used, and to operate with standard solutions of acid upon carefully squared blocks of standard size, and thus to make comparative tests of various samples of stone when competitors for building materials are offered. In the case of the Birmingham and Midland Institute building there was no such competition, the choice was left entirely to the architect and my examination was conducted upon simply the material already chosen with the intent of protesting if it failed. As it stood the test I merely reported the action informally, no action being demanded.

WOODEN BOILERS.

The almost incredible feat of making steam boilers of wood was accomplished 76 years ago in Philadelphia, where they were used to furnish steam to the pumps for pumping up the river water for the use of the city water works. They however lasted only two years, when it became so difficult to keep them steam-tight that they were abandoned for iron boilers. How was it possible to heat water in wooden boilers? It was accomplished by having an iron fire-box 12 feet long, 6 feet wide and 2 feet deep, placed inside a rectangular wooden chest, 14 feet long and 9 feet square, made of plank nearly half a foot thick, securely bolted together by iron rods passing through the planks. The iron fire box had 8 vertical flues of one foot in diameter, through which the water circulated, and around which the fire acted, and passed upward and through an oval flue, first above the fire box, carried from the back of the boiler to near the front and back again, when it passed out into the chimney. It was expected that these boilers would be very economical, on account of the non-conducting property of wood; and so they were to a certain extent, as the boilers did not need any protecting covering The leakiness, however, entirely counteracted the other advantages, and the system had to be abandoned.

Fine Arts.

GOBELIN TAPESTRY.

Hand-made tapestry may be said to have died out about the commencement of the seventeenth century, but tapestry made upon the loom is still in existence at the Gobelin manufactory in Paris, and at Windsor, in England. Since attention has been so much directed towards ancient needle work, the old hand-made tapestries have been thought worthy of revival, and the work has been so arranged as to come within the compass of ladies' ornamental needlework. Without, therefore, emulating the vast dimensions of the ancient tapestries, or rendering the work tedious by the time required for its execution, full directions are given for reproducing the Gobelin tapestry, it being felt that the novelty and quaintness of the work will be fully appreciated.

Like the true Gobelin, the work is executed from the back, and can be made either of purse silk, filoselle, or single Berlin wool. The latter with bold patterns, should be selected by all beginners until the minutiæ of the work is understood. A strong wooden embroidery frame, with webbing up the sides, is required for the wool work, while small ones also with webbing at the sides are sufficient for the silk. The frames used for Guipure d'Art, and cov red with silk, are large enough for many pieces of tapestry. The patterns chosen are the same as are used for cross stitch on lin n or Berlin detached flowers sprays, or landscape patterns ; the first named being the easiest, should be chosen to commence with. The frames are set up and the work is sim lar, whether done with silk or wool, the difference being in the coarseness of the execution. The frame being ready, cords are carried backwards and forwards from one piece of webbing to the other. These cords should be of fine, well-made whipcord, and should be laced in closely together and perfectly parallel. They take the place of canvas in ordinary wool-work and bear the stitches, therefore it is of vital importance to the work that they should be put in at even distances, close together, and tightly stretched. Their number must be the same as the number of lines required in the pattern, therefore they must be counted and carefully arranged. Whipcord is used for the wool ; very fine twine for the silk tapestry.

Commence to work from the bottom of the frame at the left hand side. Thread a wool needle with a shade of grounding color, and tie it on to the first cord, bring the wool up over the cord. Put the needle in over and under the second cord, and bring it out forming a loop on that cord with the wool, and so that the returning wool crosses over the wool coming from the bottom cord ; then make another stitch on the right of the one just formed, and on same cord. These two loops count as one stitch ; they must be always drawn up evenly and close together. The next stich is made on the third line in the same way, and so on until every line of cord has a stitch upon it, and the top of the frame is reached. The wool is then fastened off, and another line commenced from the bottom, and close to the first made one. The appearance on the right side (the work being executed on the wrong) is like the tight loops seen in carpets. For groundings, one shade of color is carried straight up the work, but designs of various colors have to be more carefully treated. It is necessary then to thread a number of needles with the shades of color, to secure them, and work them in in their places, carrying the wool along the work where not required, putting it in and making a stitch, and then carrying it on again until the top of the frame is reached. It will be easily understood that each shade of color will increase the difficulty of the work, and therefore, it is advisable to commence with but few. When silk Gobelin is worked, the silk need not be threaded, but sufficient for one line should be wound upon a thin fine card, and that passed through the cords and the loops so made, as the silk on the card will keep fresher than when threaded. Silk work in Gobelin is very beautiful, the variety of shades and the number of stitches used contributing to give it a soft and pleasing appearance ; but the work will be more useful when executed with wools, as it will form a change to cross stitch, will be as durable, and, as it is executed from counted patterns, it will be within the compass of everyone. Gobelin will form excellent cushions, fender-stools, mantle and table borders in wools, but will need joining where long lengths are undertaken. The silk Gobelin is useful for hand screens, bags, pincushions, and for squares in chair backs alternately with heavy lace.

Another plan for imitating Gobelin tapestry with silk is only practicable for small articles, such as necktie ends, bags, hand screens. It is done on the right side and the stitches taken over fine knitting needles. The patterns are the same as before described, the pins taking the place of cords. A silk or satin foundation stretched on a frame is necessary, and the pins tacked on to this close together with strong tacking threads. The embroidery silk is brought from the back of the material, passed over the knitting needle and returned to the back, and passed over the needle again close to the first place to complete the stitch. Two or three stitches of the same color close together on the same line may be done at once, but the tendency of the work should always be upward from the bottom line to the top, and but little deviation from this rule allowed. The material being the ground, only the pattern is worked. The needles should not be large, as they are withdrawn, and, if big, leave loops too long for beauty. When the pattern is finished, paste the back of the work with embroidery paste, and leave the needles in position until this is thoroughly dry, then pull them out. The work may then be further enriched with a line of gold thread couched round every portion of the outline, should the design be an arabesque. If both sides are shown, as in a necktie, a piece of silk should be laid over the back part, but this is not otherwise necessary.—*American Cabinet Maker.*

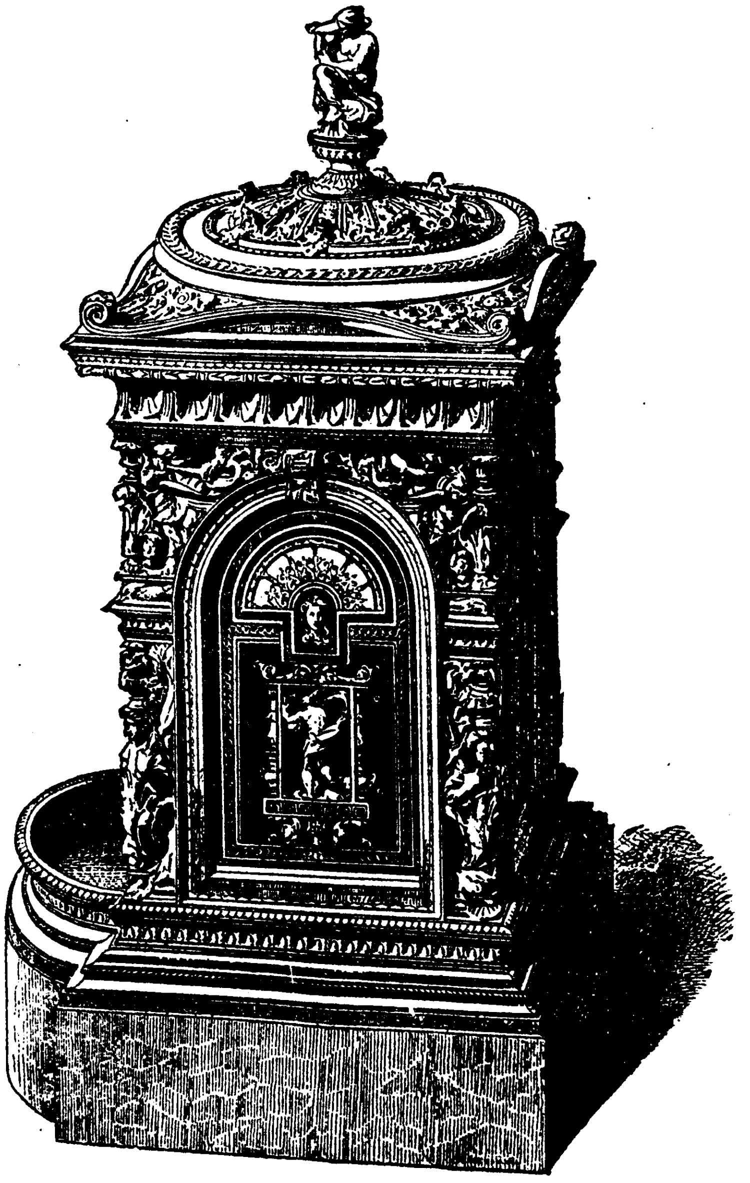
AN ARTIST'S IDEA OF A HEATING STOVE.

We show in the accompanying cut a perspective view of a stove designed by the late Alfred Stevens, one of the most eminent of English sculptors. His work can be better valued now than it was in his troubled life-time. The genius of a sculptor, some of whose work has been not unreasonably compared with that of the great Michael Angelo, was but half understood by his countrymen, who allowed him to sacrifice his hard-earned savings and indeed his life in the attempt to complete a public monument for the execution of which Parliament had voted an insufficient appropriation. We speak of his great work, the memorial to the Duke of Wellington, designed for St. Paul's Church-yard, London.

Alfred Stevens was born in humble circumstances in Blandford, Dorsetshire, in 1817, his father being a painter of signs. As a child he showed remarkable talent for painting, and at the age of sixteen, through the liberality of a friend of the family, was sent to Florence to study the works of the old masters, and of Salvator Rosa, especially. Later he entered the studio of Thorwaldsen in Rome, turning his attention to plastic art, and remaining with that master several years. At the age of twenty-five, so well had he improved his opportunities that he returned to his native village with the feelings, talent and expression of thought, as well as the practical methods, of an Italian of the Middle Ages—a Pisano or a Ghiberti. He settled in London, and taught at the art school of Somerset House. He removed to Sheffield in 1850, executing decorative work in iron and silver for manufacturing firms of that city. For many years he did valuable service to domestic art by designing innumerable decorative objects of daily use, nearly all of which were distinguished by the finest taste—decorations proper in metal, stone and marble, to say nothing of works of higher pretentions, with which the names of manufacturers rather than of the real designer were associated. Thus his best years were consumed in making the reputation of others. While working for Hoole & Robson, in London, he produced for them stoves, fireplaces and fenders of admirable design, which made the fortune of the firm at the great exhibition of 1851. Thousands of Londoners pass examples of his work almost daily, without knowing to whom they are indebted for them. It was he who designed the admirable bronze doors and the portal of the School of Mines, in Jermyn street, and the little sejant lions on the iron posts before the grille of the British Museum, as well as the very handsome grille itself.

Stevens received from the government the commission for his Wellington Memorial in 1857. Fourteen thousand pounds was the sum voted for its execution. But it was inadequate, and was exhausted long before the completion of the work, which, indeed, was never finished, although it is understood that it remains in such a condition that it could be easily completed. Eighteen years after Stevens began his Wellington Memorial, during which time he was censured for his delays and suffered much disappointment, his career was suddenly closed by an attack of apoplexy, brought on by worry and overwork. Thus, what was to have been the crowning glory of his life proved to be his financial ruin, and indirectly the cause of his death.

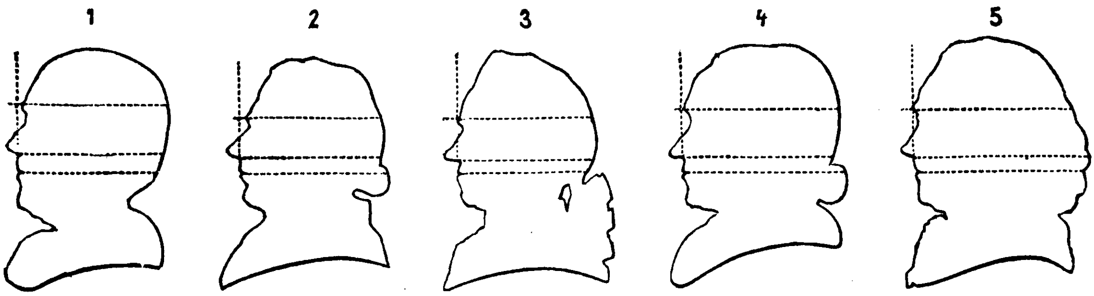
The stove which we show is one which challenges attention as full of most pleasing suggestions. It is shapely, substantial, and in every way richly ornamental. The front is mostly open, holding an ample grate inclosed by a border of ornament in



DESIGN FOR A STOVE, BY THE LATE ALFRED STEVENS.

keeping with the character of the sides. We do not say that it perfectly conforms to our ideal, for the human figures seems to us out of place in association with the idea of high temperatures. To give such a design as this its full value, it should be copper plated and bronzed, the oxide being buffed off from the projections to give a pleasing effect of high lights and emphasize the modeling. So treated, it would be beautiful, and if such stoves could be bought, even at high prices, we should find a new demand of which the trade never hears at present.

Is such a design as this practicable—supposing, of course, that it is acceptable as to its art features? In one sense, yes; in another sense, no. It is not a stove of the kind which could be pushed for a large sale among retailers, nor one in which the price could be made low to compete with some rival stove of the same class. It could not be weighed up and sold at so much a pound. If made, it would have to be handled, valued and sold as a work of art. Such a trade is not open to everybody. It requires extra care and skill in production, and such a stove must be sold on a very different basis from the average open stove or base burner. It is a new line of business entirely, and those who are not prepared for something new would do well to let this kind of thing severely alone. As a casting in iron, the stove shown in our illustration is practicable. It can be made, but it will cost probably twice or three times as much to make it as it would to cast an equal number of pounds of metal from average wood patterns. The patterns will cost vastly more, and the man who should try to make "a line" of such stoves and run them in competition with anything else in the market, or to change them from year to year, would be ruined. So he would be if, seeking art, he failed to reach it. There is no failure so absolute as a pretentious attempt at art which is spoiled by ignorance, by bad taste or by a sacrifice of beauty to the mechanics of construction. The sheet-iron figures of Justice which surmount so many of our court houses are not art work. They are simply abominations which make the judicious grieve and wonder that Providence, in its inscrutable wisdom, permits such things to be. We warn the trade against this kind of art which is likely to originate in anything but an intelligent study of the principles of design. It will be neither fish, flesh nor fowl. Better a thousand times than this a continued adherence to styles which make no pretensions to art.—*Mining and Scientific Press.*



SPECIMENS OF SILHOUETTES OBTAINED BY LAVATER.

LAVATER'S APPARATUS FOR TAKING SILHOUETTES.

We reproduce, as a historical curiosity, an apparatus which was formerly much talked about, obtained a great success, and attracted the attention of savants and of physiologists, but which is entirely out of use at present.

Lavater, in his celebrated work on Physiognomy, describes it as an accurate and convenient machine for drawing silhouettes. The engraving represents the apparatus so well that it is not necessary to enter into a minute description of it.

"The shadow," says Lavater, "is projected upon a fine paper, well oiled and dried, and placed behind a piece of plate glass, supported in a frame attached to the back of the chair. Behind this glass the artist is seated ; he holds the frame with one hand and draws with the other."

The proportions of a silhouette, on the authority of Lavater, must be judged principally from the length and breadth of the face. "A correct and well proportioned profile should be equal in breadth and height. A horizontal line drawn from the point of the nose to the back of the head (provided the head be erect) should not exceed in length a perpendicular line which extends from the top of the head to the junction of the chin and neck. All of the forms which deviate sensibly from this rule are so many anomalies."

In support of these observations Lavater gives a number of specimens of silhouettes, and insists upon the conclusions which he deduces from their study. We give five of these specimens. In No. 1 Lavater sees an upright soul, an even temper, taste and frankness ; in No. 2 the contour of the nose carries the infallible

LAVATER'S APPARATUS FOR TAKING SILHOUETTES.—(FROM AN ANCIENT ENGRAVING OF 1783.)

mark of a good temper; in No. 3 we have clearness of judgment. This science of physiognomy appears puerile to us. It may have afforded an agreeable recreation, but nothing more in a scientific point of view. Lavater nevertheless obtained a great success in Europe. A crowd of persons flocked to Zurich to see the celebrated philosopher and demand of him the secrets of their character and even of their destiny. Lavater with uncommon sagacity was seldom deceived in his judgments; it was thus that he divined the characters of Necker, Mirabeau, and Mercier. The impartial historian must acknowledge that if the work of Lavater is vague, undecided, and sometimes errs in the domain of the imagination, Lavater himself was a man of lofty spirit, faithful to the grand principle of morality. With the idea of unmasking character, and opening the human soul, as one would a book, to inquire into its depths, he produced a great sensation among his contemporaries.—*La Nature.*

MAKING PLASTER CASTS IMPERVIOUS TO WATER.—Some time ago the Prussian Minister of Commerce and Industry offered a prize for the best method of treating plaster casts so as to render them impervious to the action of water. It is well known that at present plaster casts, when exposed to the action of the atmosphere, speedily lose their sharpness of outline by the solvent action of rain water, besides in a short time becoming soiled by the lodgement of dust in the pores of the plaster. For these reasons, this material, otherwise excellently adapted for the multiplication of the costliest and most finished artistic objects, is quite unfitted for exposure to the atmosphere in the parks, gardens and public places where it would be exposed to the action of the weather.

The object of the offer of the Prussian Minister above alluded to, was to obtain a process that would do away with these objectionable qualities that at present limit the utility of plaster, and to develop if possible a procedure or method of treatment which would render objects of plaster practically independent of atmospheric influences of deterioration. This desirable object, it appears, has been attained by Dr. Reissig, to whom the prize offered by the above named official was lately awarded.

Dr. Reissig's procedure has for its object the twofold purpose of providing a surface upon the plaster which should not wash away, and which at the same time should prevent the entrance of dust, so that the objects could be readily cleaned from time to time by washing. He proposed two methods by which these objects may be accomplished: First, by converting the plaster surface into sulphate of baryta and carbonate of lime by treatment with baryta water; or, second, by converting it into silicate of lime by treatment with silicate of soda or potassa. The first process is described as being the simpler and cheaper one. It depends on the fact that plaster of Paris, a hydrous sulphate of lime, is converted by the action of baryta water into the sulphate of baryta—a totally insoluble substance—and caustic lime, which last is speedily changed, by contact with the air, into carbonate of lime.

In carrying out the process, the author recommends the immersion of the plaster objects, which should be quite clean, in a tolerably concentrated bath of baryta water, in which they should be permitted to remain for from one to ten days, according to the thickness of the water-proofed surface that it is desired to obtain. After removal, washing off with lime water, and wiping off with white cotton or linen rags, the objects are to be left to dry. They are then thoroughly water-proofed. They are still, however, porous, and therefore liable to speedy deterioration on exposure from the lodgement and absorption of dust, etc. To remedy this, Dr. Reissig coats the water-proofed articles with an alcoholic soap solution. This penetrates readily into the pores of the plaster, and the evaporation of the alcohol leaves behind a layer of soap which fills up the pores, and when washed, the soap is converted to suds, with which the dust is readily washed off.

A PUBLIC meeting of Dublin citizens has been held at the Mansion House, to consider the question of the site of the proposed science and art museum. A resolution was passed requesting the Government to carry out the proposal as speedily as possible. The suitability of the Merrion Square site, or a site between Kildare Street and Merrion Square, was debated; but a resolution in favor of the Kildare Street site was adopted, and it was resolved that the Government be requested to open up a new street from Kildare Place to the Green, so as to give the building a southern aspect. Such an institution has long been an acknowledged necessity in the Irish capital and we trust that the recommendation will be carried out.

Educational.

TECHNICAL EDUCATION.

We have heretofore given, in connection with the sketch of Mr. Cooper's life, a particular account of the Cooper Union, in New York, an institution specially devoted to the "advancement of science and art in their practical uses in life."

This institution is one of those distinctively American institutions to which we wish to call the attention of all interested in education in the country. It affords an example of a technical school, the spirit and general methods of which ought to be embodied in our common school systems.

A technical education, simply means a practical knowledge and training so acquired as to enable the student to enter upon the immediate practice, while at school, of those methods and usual results which make up the various occupations, professions and trades in which men engage "for a living." It develops and involves personal independence and self-support in the young while still at school. This may seem a difficult problem to solve; and, at first, can be approached approximately. But the pupils of the Cooper Union, in the Female Art School alone, earned for themselves last year over $10,800 out of the very process of instruction. Most of these pupils are engaged in self-supporting occupations, in the various stores and workshops in the city, and come only in the evening for instruction; yet they learn about as much as do "College students," who are wholly dependent upon others for support.

The difference is, that boys are *sent* to college; but they *come* to the Cooper Union.

The American people need a system of common schools, leading up from the simplest methods of training the infant mind for usefulness, to the complete mental preparation required for solving even the most complicated and difficult problems that can be set before the human mind. But all these schools, except the "Infant Schools," can, in a great measure, and should, be made self-supporting through the products of the work of the pupils in their very process of study. Even translations of Greek and Latin, if properly made, can be turned to account in some "literary magazine," and the test of practicability can be constantly applied so that every kind of knowledge, study, or course of training, shall be made to do present service in society, and be "made to pay"—in the common phrase. What is the use of asking a pupil: "How many barleycorns will go around the earth?" when the store, right next to the school-house, furnishes a thousand useful problems for his arithmetic?

What an injury it is to the independence and even self-respect of a young person, that having spent five, six or eight years in "a course of study," and "having graduated," he must needs, as he stands trembling on the verge of actual life obliged to earn his own living, but not knowing a single occupation or skilled employment, now seek to find somebody who will teach, employ and at the same time pay him to be useful in society.

Ought not this to be done at the very start, without waiting till the boy or girl is 14 or 16 years old?

To teach, to employ and to pay at the same time—this is the problem that must be solved by our system of American common schools. Let the American people ponder over this great problem.

Such a system of common schools, academies and colleges as we now have, is calculated to build up certain intelligent and wealthy classes, and leave the mass of the people ignorant and dependant. The poor, below a certain level which includes a large majority of the people, can gain but little or nothing that is practical out of these institutions of instruction wherein the mind of the pupil is trained without employing his hands, or his hands employed without producing any useful or paying result. The "old apprentice system" was better than that.

Since that system has passed away by the introduction of machinery and a "new order of things," we must interweave its spirit and design into our system of common schools. Let this system be divided into three grades, schools of agriculture, schools of mechanics, and schools of the five professions, viz.: the teacher, the physician, the lawyer, the minister and the statesman.

The professional schools should receive their pupils as graduates from the schools either of agriculture or mechanics. In each of the schools the object must be to teach; but to teach so as to employ; and to employ so as to earn something towards self-support. This is the fundamental idea of a "Technical Education." The "Manual Labour Schools," so called, have aimed at this idea, but have carried it out imperfectly, and being invidiously confined to the poor, they have failed to stand against the rivalry of the common system, where no such distinctions are made.

Our system of "Technical schools" must draw their resources from the whole wealth of the commonwealth. They must draw within their reach every child of the land by a compulsory and yet a free education. They must have a "beginning, a middle and an end"—and the end must be the fitting of human beings for the practical conduct of a useful, a noble and a happy life. Peter Cooper, the venerable founder of the Cooper Union, says, in his "open letter" addressed to President Hayes, "Let us promote and instruct industry all over the land, by founding, under national, state and municipal encouragement, industrial schools of every kind that can advance skill in labor. "We need the industrial school of art and science, and it should be made the duty of the local governments to provide a practical education for the mass of the people, as the best method of "guaranteeing to every State, a Republican form of government."

A writer on this subject, well says, "The increasing poverty of the masses, the decay of public health, the decline of private and public virtue and simplicity of life, the warnings of the truest men and women of the nation—all alike proclaim the necessity of educating the head and the hand together, and that this is the great need of the nation. It will not do," he adds, "to say that children have no time to study and work at a trade; for the success of the "half-time system" is already too well established. The Hon. Mr. Newell is right in maintaining that the time given to the tricks of spelling, mental arithmetic, grammar and geography, could be applied to much better purposes."

As to the cost of Industrial and Technical education, it can be made the cheapest as well as the noblest investment of the nation. For a small outlay, not exceeding thirty dollars a year on each student apprentice, we can put skill and productiveness in him or her for life; raise labor to intelligence and position, spread industry to every man, woman and child in the community, and strike a destructive blow at the pauperism, drunkenness, vice, crime, disease and insanity that are now undermining the life of the nation. We need an entire revolution in the spirit, the methods and the aims of our common school system.

An eminent educator, near Boston, told the writer a few days ago, that the "High School for Girls" in Boston was proved by statistics to have contributed to the prostitutes of that city to a degree that called attention. Why? One would suppose that their superior education would lift them out of that sphere of life. The answer was: "At their graduation the girls know nothing by which to earn their own living, except to teach in the methods they have been taught. If they have no taste for this, or if they find the market for teachers "overstocked," they must earn their living somehow else. Whoever employs them has to teach them also, and lose money at first in supporting them till they have become useful. The girls have learned to despise "unskilled and servile labor," and they can practice none other. How can they drop into that class after their education? Flattered by designing men, solicited by bad examples, in the midst of the refinements and innocent pleasures for which they long; pushed on by absolute want and "hungry for life"—is it a wonder that many of these "highly educated" but simple creatures yield to the seductions and delusions of vice?"

The chief element in this sad story is the want of any industrial capacity above the "unskilled and servile forms of labor" and the "hunger for life."

Our common school system is fit only for those children whose parents can support them till they can support themselves by some skilled employment which they learn outside of the schools. These schools create a class whose minds are filled with facts, principles and "notions" called knowledge, which can be turned to little or no practical use in "getting a living," and who revolt against any servile form of labor. It is equally true that most children have to leave school before the age of twelve or fifteen in order to earn their own living; the parents cannot support them. These make the ready material for the criminal and pauper classes.

A few statistics will here illustrate the bearing of this remark.

"The statistics of the House of Refuge or Society for the Reformation of Juvenile Delinquents, in New York, (1878), show that during the past year, although the total number of children committed to the care of the Society was less than the preceding, the percentage for actual crime was larger. Out of 699 commitments, 344, or nearly one-half, was for crime; while the remainder were vagrants, truants and disorderly characters. The majority of the offenders were between the ages of eleven and fifteen years, the average of all the children committed being eleven years, ten months and twenty-seven days

"The statistics also show that among the children committed during the past year, were 78 between the ages of seven and ten years. Of the criminals, the majority were sent from the Police Courts and Courts of Special and General Sessions in the city."

"A careful examination was made of the antecedents of 523 out of 699 cases, and the following results were found: Four hundred and seventeen resided in tenement houses and shanties, 56 in private houses, and 55 had no recognized homes. Of these it was ascertained that in 314 cases the homes were comfortably furnished, while in 146 other cases the homes were destitute of those ordinary comforts which would tend to make the happy ones for children. The social condition of the families is another interesting point. In nearly four hundred cases the parents were living; in thirty cases the parents had separated.

"Of the total cases mentioned, there were 44 whose parents had other property besides that of household furniture, and 333 cases where the parents had only household furniture. The records of the habits of the children before commitment to the House of Refuge show that early influences have much to do with making thieves and other criminals. Of the children in the House of Refuge at the making up of the last statistics, only 82 attended school regularly—forming a very small percentage of the large number who attend public schools—while 405 never went to school, or did so very irregularly. Previous to commitment 129 were habitually employed, while 391 were habitually idle."

These statistics show that "poverty and ignorance are the parents of crime." But it is not ignorance of "Greek, Latin and mathematics," nor arithmetic, geography and grammar. It is industrial ignorance and want of skilled employments.

The last item in the statistics given above tells the whole story: "Previous to commitment 130 were habitually employed and 391 were habitually idle." J. C. Z.

—*Industrial News.*

PECULIAR INDUSTRIES.

Among the many peculiar industries ferreted out by the special agents of the Census Bureau, one of the most curious is reported to have been discovered in Boston, where a firm is reported to be doing a large business in making an imitation honey in the comb. Singular as this statement appears, there seems to be no reason to doubt it. According to the account given by the special agent to whose knowledge the case was brought, the comb is molded out of paraffin wax, in good imitation of the work of bees; the cells are then filled with simple glucose syrup, flavored doubtless with some genuine honey, and sealed up by passing a hot iron over them. The product is sold for the best clover honey, and much of it is said to be shipped to Europe.

Other observations of interest which were made, were that the confectioners, besides using glucose very largely as a substitute for cane sugar, likewise employed immense quantities of white earth (*terra alba*). It is practically harmless, and being very cheap, is used by the trade to make weight and bulk.

Great quantities of tomato catsup, it has been ascertained, are made without outlay for the raw material, the ingenious manufacturers gathering the skins and refuse of the great tomato canning establishments.

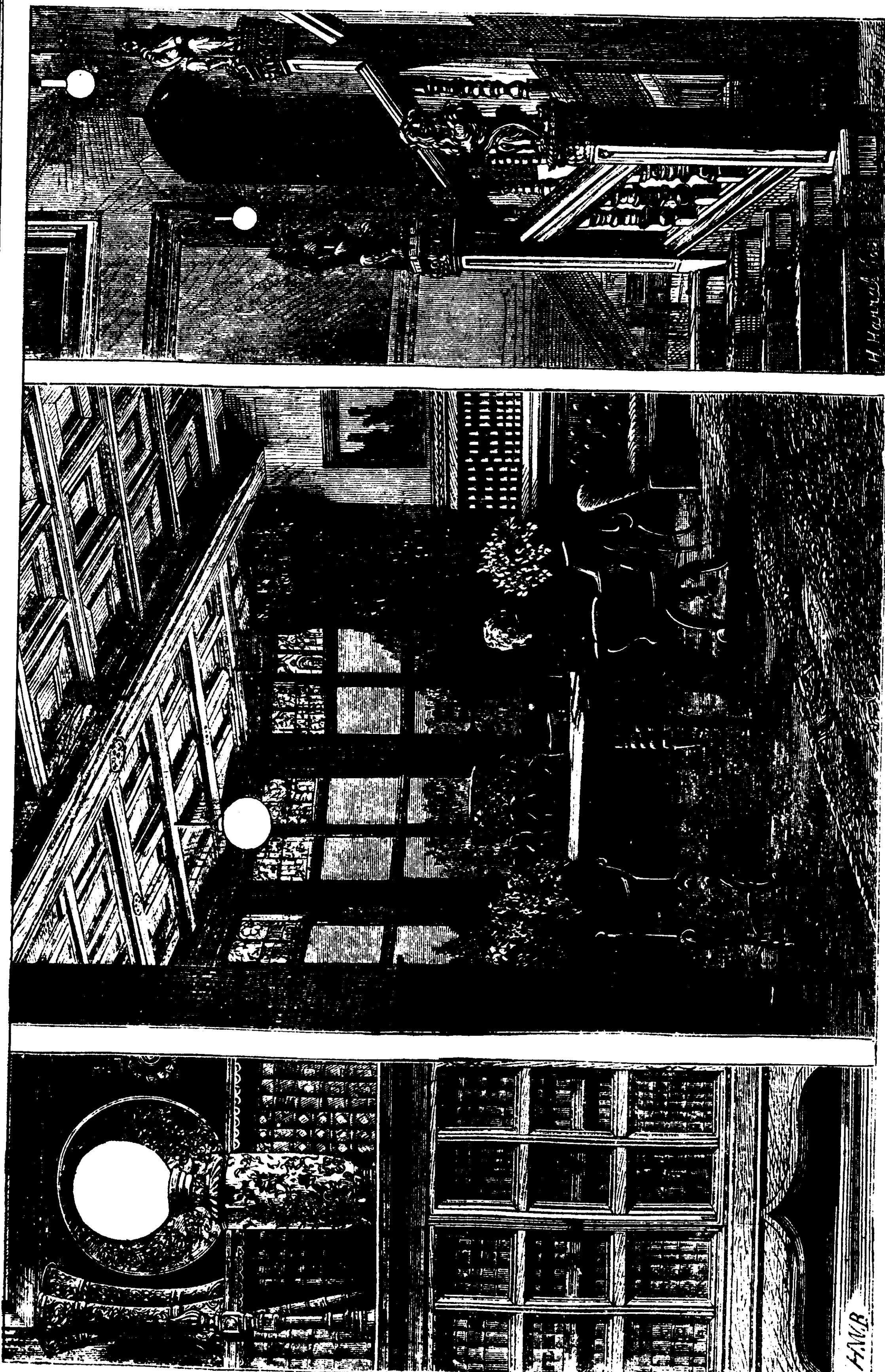
Another industry, the magnitude of which would certainly not be suspected, is the manufacture of paper patterns for dresses and wearing apparel. In New York alone, there are reported to be no less than ten such establishments, which consume many tons of paper and dispose of many thousands of dollars' worth of such goods all over the country.

The manufacture of artificial flowers and feathers is reported to be a rapidly growing industry.

The work of the Census Bureau seems to have been planned in a far more extensive and systematic manner this time than on previous occasions, and the results when published promise to be of the utmost value.

ONE THOUSAND MILES OF PAPER A WEEK.

The readers of any of the metropolitan dailies may well be prepared for large statements as to the tons of paper used by those of great circulation, but a correct appreciation can probably best be had, as to the extent to which white paper is devoured regularly on daily newspapers, by the simple announcement that the New York *Herald* uses over a thousand miles of white paper, five feet and three inches wide, every week of the year.



LIBRARY.

BAY WINDOW FROM LIBRARY.

STAIRCASE.

THE ELECTRIC LIGHT AT SIR WILLIAM ARMSTRONG'S.

A CURIOUS INHABITANT OF THE SARGASSO SEA AND ITS NEST.

THE ELECTRIC LIGHT AT SIR WILLIAM ARMSTRONG'S.

The distinguished Tynesider began to use the Swan electric lamps some six or seven weeks ago at his country residence, at Cragside, Rothbury, near Newcastle, and one of the most remarkable facts in his experience with it is that he obtains the motor or mechanical force, which is in due course converted into electricity and eventually into light of brilliant whiteness, without the use of a steam engine, or gas engine, or anything of the sort. Of course, he must employ a dynamo-electric machine so as to generate the requisite electricity, but that is set in motion by a six-horse power turbine used as the motor, and which is so disposed close by a neighbouring brook as to take advantage of that natural source of power. The turbine and generator are situated about 1,500 yards from the mansion, and, therefore, as the electric circuit has to be completed, a stretch of copper wire of twice that length, or 3,000 yards, has to be used. But after that has been done, and all the lamps are in position and put in circuit, the light for the whole of the house is got for nothing. Now, let us see what the light amounts to. Sir William Armstrong has 45 lamps distributed through his house, but as he can switch off the current from room to room, he never requires to have more than 37 in light at once, and for that number of lamps six-horse power proves to be amply sufficient, notwithstanding the great length of the conducting wire used, and the dissipation of energy consequent thereon. His library, a room of 33 ft. by 20 ft., with a large recess on one side, is well lighted by eight lamps, four of which are clustered in one globe of ground glass suspended from the ceiling in the recess, while the remainder are distributed singly and in globes in various parts of the room upon vases which were previously used as stands for duplex kerosene lamps. The lighting of the dining-room is also effected by the use of eight lamps, six of which are grouped together in one glass shade suspended over the centre of the table, the other two being used singly as bracket lamps, one at each side of the room. Twelve overhead lamps are employed to light a picture gallery, which is also used as a drawing-room; but when the eight lamps in the dining-room are no longer wanted, the current supplying them is switched off to the gallery for lighting eight additional lamps, making twenty in all. Sir William remarks that the gallery is agreeably lighted even with the twelve lamps, while with the full illumination the pictures are seen as distinctly as in daylight. In the passages and stairs the lamps are, for the most part, used without glass shades, and present a very beautiful star like appearance, not so bright as to pain the eye in passing, and very efficient for lighting the way. The turbine and generator at Cragside are occasionally used in the daytime for the transmission of motive power to a second dynamo-electric machine acting as a motor to drive a sewing machine. It does so with good effect, but Sir William Armstrong is not prepared to say how much of the original power is realised, or what should be the proportions between the generator and the motor to give the best effect.—*Engineering and Building Times.*

Natural History.

A CURIOUS INHABITANT OF THE SARGASSO SEA AND ITS NEST.

What is generally known as the Sargasso Sea is the vast area of 260,000 square miles, more or less, to the west and south-west of the Azore Islands, reaching to the Bahamas westward, and finding its northern and southern boundaries in the 36th and 19th degrees of latitude. Other areas, notably that in the Pacific, five hundred miles E. S. E. of New Zealand, and, again, one thousand miles west of San Francisco, possess the same characteristics, but the former is the best known and defined. The great Atlantic currents form a gigantic eddy, thus collecting the algæ that forms its component parts. The vegetable fauna is generally comprehended in the two genera, *Fucus* and *Sargassum*, of the latter two species, namely, *vulgare* and *bacciferum*.

The disconnected masses of weed that make up the "Sargasso Sea" are usually "from a couple of feet to two or three yards in diameter, sometimes much larger; we have seen, on one or two occasions, fields several acres in extent, and such expanses are probably more frequent nearer the centre of its area of distribution. They consist of a single layer of feathery bunches of the weed (*Sargassum bacciferum*), not matted, but floating nearly free of one another, only sufficiently entangled for the mass to keep together. Each tuft has a central brown thread-like branching stem studded with round air vesicles on short stalks, most of those near the centre dead and coated with a beautiful netted white polyzoon.

After a time vesicles so incrusted break off, and where there is much gulf weed the sea is studded with these little separate white balls. A short way from the center, toward the end of the branches, the serrated willow-like leaves of the plant begin; at first brown and rigid, but becoming, further on in the branch, paler, more delicate, and more active in their vitality. The young fresh leaves and air vesicles are usually ornamented with the stalked vases of a *Campanularia*. The general color of the mass of weed is thus olive in all its shades, but the golden-olive of the young and growing branches greatly predominates. This color is, however, greatly broken up by the delicate branching of the weed, blotched with the vivid white of the incrusting polyzoon, and riddled by reflections from the bright blue water gleaming through the spaces in the net work. The general effect of a number of such fields and patches of weed, in abrupt and yet most harmonious contrast with the lanes of intense indigo which separates them, is very pleasing.

The animal life of this area is characteristic and has certain peculiarities well worthy the attention of the student. It consists of shelless mollusks, as the *Scillæa pelagica*, a short-tailed crab, the *Nautilograpsus minutus*, quanties of membranpora, and a peculiar fish, the subject of our illustration, known as the *Antennarius marmoratus*. The writer was fortunate in observing the latter on the outskirts of this vast area. It forms one of the most interesting examples of the many creatures that find safety in protective resemblances. As above mentioned, the weed as it floats assumes all shades of olive, and the fish in color is its exact prototype, flecked with irregular patches of darker and lighter shades. Not only in color does it mimic the weed, but in general appearance, the head and fins being dotted here and there with fantastic barbels of flesh that to the ordinary observer seem bits of weed growing upon it. Even the white polyzoon growing on the algæ is imitated, and a careful examination is necessary to distinguish the fish from its surroundings. It was oftener found lying in among the weed, but where the patches were small, was frequently seen lazily swimming around in clear water. Its nest, seen in the accompanying illustration is, no less a curiosity. It is a round or oval ball of weed, intwined and wound together in a most complicated manner by an invisible viscid secretion from the fish. The pieces of weed are first roughly caught together, and the eggs deposited among the branches; then the invisible bands are wound around, gradually drawing them into the oval form, about as large as a base ball. The instinct, and its peculiar endowment by nature, place this fish among the most interesting of the finny tribe.

STEAM PACKING.—Mr. Watson in his *Mechanical News*, says that the best packing he ever used for faced joints, either steam or water, is common drawing paper soaked in oil. After a short time the heat of steam converts it into a substance like parchment, so that it is practically indestructible. It has the advantage of stripping readily from surfaces when it is desired to break a joint.

Inventions.

SKETCHES OF INVENTORS AND DISCOVERERS.

DR. HORACE WELLS, THE DISCOVERER OF ANÆSTHESIA.

The names of the three claimants are Dr. Horace Wells of Hartford, Conn.; Dr. Wm. T. G. Morton and Dr. Charles T. Jackson, of Boston.

On the memorable evening of the 10th of December, 1844. Dr. Horace Wells attended a lecture and an "Exhibition" of the amusing effects of nitrous oxide, or "laughing gas," given by Dr. G. Q. Colton in Hartford. Among the persons who inhaled the gas was a young man by the name of Cooley. While under its influence Cooley danced and jumped about the stage, and bruised his legs badly by running against some wooden benches. On sitting down he was surprised to find that his legs were bloody and that he had severely bruised himself. He told Dr. Wells, who sat next to him, that he was not aware that he had run against the benches, neither did he feel any pain so long as the effects of the gas lasted.

At the close of the entertainment Dr. Wells asked Dr. Colton why a tooth might not be drawn without pain while under the influence of the gas; and related the experience of Cooley. Dr. Colton replied that he did not know, as he had never tried the experiment. Dr. Wells said he believed it could be done, and was willing to try the experiment on himself. He asked Dr. Colton to bring a bag of the gas to his office the next day, and he would have a tooth drawn while under its influence. Accordingly, on the 11th of December, 1844, Dr. Colton took a bag of the gas to the office of Dr. Wells. Dr. Riggs, a neighboring dentist was called in to perform the operation. Dr. Colton administered the gas, and Dr. Riggs extracted a molar tooth. On recovering consciousness Dr. Wells exclaimed: "*It is the greatest discovery ever made; I did not feel it so much as the prick of a pin!*"

This was the first operation ever performed with a true anæsthetic. Dr. Colton then instructed Dr. Wells how to make the gas, and started off on his exhibition business. Dr. Wells got up the apparatus, made the gas, administered to a number of persons for teeth extraction, and then went to Boston to make the discovery known to the world. He called on a large number of his brother dentists, as also a number of leading surgeons, stating what he had done. They all treated him with ridicule, and scouted his pretended discovery. Among others who ridiculed his discovery was his former pupil in dentistry, Dr Wm. T. G. Morton. Dr. Wells went to Cambridge College, and asked old Dr. Warren, the lecturer on surgery, to introduce him to the class at the close of one of his lectures. Dr. Warren did thus introduce him saying: "Here is a gentleman who pretends that he has discovered something which will destroy pain in a surgical operation. He wants to address you; if any of you wish to remain and hear him, you can do so." Dr. Wells addressed the class—or such portion as remained—and at the close of his remarks administered the gas to a boy and extracted a tooth. The bag was taken away a little too soon, and the boy screamed out, though afterward he said he felt no pain. The students hissed, and considered the experiment a failure.

Wells, after laboring and meeting rebuffs on all sides for several weeks in Boston, returned to Hartford and resumed his dental practice—using the gas successfully as an anæsthetic. Bishop Brownell, and some forty of the most respectable citizens of Hartford have given their depositions, that during the year 1845 Wells extracted teeth for them without pain, using the gas as the anæsthetic. Among these was Dr. P. W. Ellsworth, now living in Hartford, Conn.

At the close of 1845 or the beginning of 1846, Wells went to Europe with the hope of regaining his impaired health. While in Paris he presented the subject to the Academy of Sciences, and the Academy conferred upon him the honor of an M.D.

We come now to Drs. Morton and Jackson. Dr. Morton, having seen newspaper notices of Wells' operations with the gas, and remembering the statements of Wells, went to Dr. Jackson, who was a chemist, to learn how to make the gas, as he wished to test the value of Wells' pretended discovery. This was during the month of September, 1846. Dr. Jackson said to him, that "gas exhilarates, and makes people, laugh, dance, etc. If you wish to try anything, why don't you try ether? That will exhilarate"—evidently having no faith in the success of either gas or ether. Upon this hint or suggestion, Morton purchased some ether, and tried it on a boy, Eben Frost, on the 30th of September, 1846. *This was the first experiment made with ether.* Morton reported the success of the experiment to Dr. Jackson, and they then introduced a series of experiments to test the value of the new agent. On the 27th day of October, 1846, they jointly applied for a patent for the discovery of the anæsthetic effects of ether, which was called, in this connection, "Letheon." Dr. Jackson wrote a letter to the Academy of Science in Paris, claiming that *he* had discovered the anæsthetic powers of ether, but his letter was sealed and inclosed in another, with the request that the inner letter should not be opened till further instructions. He seems to have been in some doubt as to the value of the discovery. At a later period, the date of which we cannot give, Dr. Jackson pressed his claims before the Academy, and he was recognized as the discoverer of anæsthesia! And that record stands in the Academy to this day.

It should be here stated, in justice to Dr. Jackson, that having made several experiments with the nitrous oxide gas recommended by Dr. Wells, and having failed therein to produce anæsthesia therewith, he had become strongly confirmed in the belief that the gas had no anæsthetic property, and consequently felt justified in claiming his use of ether as the first use of an anæsthetic to prevent sensibility to pain.

While the application for the patent was pending in the Patent Office, Dr. Jackson, entertaining doubts of its value, assigned all his interest in it to Morton, taking an agreement from Morton that he should pay him (Jackson) ten per cent. of all he made out of it. Dr. Jackson then wrote to the Commissioner, stating the fact of the assignment, and requesting that the patent should be issued to Morton, which was done.

When Wells returned to the United States he was astounded to learn that Morton had obtained a patent for the discovery of the anæsthetic effects of ether, and claimed the honor of *the discovery of anæsthesia!* An excited discussion in the Boston *Medical Journal* followed between Dr. Wells and Dr. Morton on the subject. This discussion so worked on the sensitive nature of Wells that he became deranged, and committed suicide in the city of New York on the 24th of January, 1848.

Up to this period no one had used the nitrous oxide gas as an anæsthetic save Wells and even he with indifferent success. After the death of Wells, Drs. Morton and Jackson claimed that nitrous oxide was *not* an anæsthetic, and that insensibility to pain could not be produced by it. In one of Dr. Jackson's medical books he says: "By oft-repeated experiments, inhaling protoxide of nitrogen (nitrous oxide) myself, and by administering it to others, in every possible way, by large and small orifices, I soon became fully satisfied that *it possessed no anæsthetic properties.*" This opinion was promulgated, and prevailed throughout the country from the time of the death of Wells, in 1848, till 1863, when Dr. Colton revived the use of the gas, and demonstrated not only that it *was* an anæsthetic, but altogether the best anæsthetic for brief operations. This fact also accounts for much of the misunderstandings which arose as to the true discoverer of anæsthesia.

During this interval of fifteen years, the gas passed out of the public mind as an anæsthetic, and the honor of the discovery of anæsthesia was generally accorded to Morton. Morton admitted the priority of Wells's experiments, but said that "as nitrous oxide is *not* an anæsthetic, Wells discovered nothing—I am the discoverer of anæsthesia." Virtually admitting that if nitrous oxide *was* an anæsthetic, Wells was the discoverer.

During this interval of fifteen years Dr. Colton was lecturing and giving amusing exhibitions through the country of the curious effects of the gas, but not being either a dentist or a surgeon, he had no occasion to use it as an anæsthetic, although he often spoke of it as such.

In the month of June, 1863, Dr. Colton, in the course of a lecture given in New Haven, Conn., detailed his experience with Wells, stating that since the death of Wells he had never been able to induce a dentist to try the gas as an anæsthetic. Dr. J. H. Smith, who was present, declared that he would try it, provided Dr. Colton would administer it. The result was a triumphant success. Dr. Colton then determined to come to New York and establish an Institution for the extraction of teeth with the gas; and as his name had been so long identified with "laughing gas," he called the institution the "Colton Dental Association," with rooms in the Cooper Union. This association have, during the past seventeen years, given the gas to over 121,000 patients without a fatal result.

It is due to Dr. Colton to state that this revival and demonstration of the value of the gas is attributable chiefly to his exertions, and that it led the medical and surgical journals throughout the country and in Europe to review the whole subject of anæsthesia, the result being that, almost without an exception, they have awarded the honor of the discovery to Dr. Horace Wells.

Dr. Morton deserves great credit for the persistence with which he pushed the use of ether in the Massachusetts General Hospital, amid great difficulties and discouragements, till it was recognized and adopted by the profession. Dr. Jackson deserves credit for suggesting the use of ether in place of nitrous oxide, and for his part in the first experiments made with it. But the substitution of ether for the gas does not constitute a new discovery. Dr. Willard Parker of this city, in a letter written on the subject says: "I further say, it being known that nitrous oxide would produce anæsthesia in surgical operations, it would suggest to any one having any knowledge of the two substances that sulphuric ether would produce the same effect, and the substitution of ether for gas does not merit the name of discovery."

PREVENTION OF EXPLOSIONS IN COAL-MINES.

In the midst of the present depressed state of the coal-trade, the question of the safety of mines (especially with regard to those terrible explosions) is rightly receiving the serious consideration of the mining profession. Various schemes have been devised and planned; but either from their being not practicable or too costly, they have not been adopted. The method, however, which I am about to describe has neither of these objections: it is quite practicable, and does not involve much cost. It is well known that in those coal seams, and adjacent beds of black shale, which give off explosive gas, the goaves become filled with it—at once a magazine of gas, and it is to these goaves which can be traced, directly or indirectly to nearly all the large explosions, so that it is the clearing of these goaves to which we must direct our attention in order to lessen the number of explosions. My plan consists of putting down bore-holes out of the return air-courses in the highest seam through the goaves and unworked coal of the lower seams, so that explosive gas, which is specifically lighter than air, will rise up the bore-holes into the return air-courses of the top seam, and thence be carried away by the return air-current to the upcast shaft. In the accompanying sketch, B represents boreholes, U the upcast shaft; the arrows indicate the direction of air and gas currents. The bore-holes will have to be surmounted by a bent tube, one end inserted in the bore-hole, and the other standing out in the direction of the air current, so as to protect the hole from the air current and loose materials. It will be observed that a bore-hole is kept immediately back from the face of the coal. This is a precaution necessary when beginning to work the long-wall, for after a portion of the coal has been taken out, the roof settles down upon the pack walls and timber employed to keep the roads open; this settling down extends upwards to where the strata is more firm; the result of this is that a horizontal fissure is formed between the solid rock and that which has settled down, in which a large quantity of gas may be accumulated. After a while, when more coal has been taken out, the rock breaks away from a higher level, and over a more extensive area, and owing to its great weight, it suddenly crushes the broken mass lying below it, and displaces with great violence the accumulation of gas contained therein, which is forced into the working places among the workmen and their lights, thus fouling the air-current, so that by having a bore-hole put down, as the gas accumulated, it would make up the bore-hole before the second crush took place. The same thing would take place in starting to work the broken under any system. It will be observed that bore-holes are put down into the goaves that have been formed any length of time. It has been stated before that these goaves form natural gasometers, being above the level of the wo kings of the mine, the gas in them being elastic and less in volume, and occupies less space when the density of the air is greatest, and with a diminution of atmospheric pressure, as when the barometer falls, the volume of the gas increases and issues out into the workings; this, however, may be avoided by using the bore-holes, as the gas would then rise up the bore holes and be discharged into the return air-current. The utility of the bore-hole put down through the fault will be obvious when it is remembered that instances of faults giving off inflammable gas are very frequent. It sometimes happens that there are spaces of a few feet area in the leaders of these faults, in which are stored up, at immense pressures, large quantities of explosive gas ready to appear as blowers as soon as tapped. The same thing exists in unworked coal: fissures sometimes pierce the strata, and are filled with explosive gas. In collieries using the return air furnace, care must be taken not to allow those return air-currents into which the bore-holes discharge to go over the furnace, but they must be conveyed by a separate drift into the upcast shaft. With the present boring facilities, holes can be put down with very little cost, and when the circumstances of the upper seam admit, would amply repay the trouble and cost.

T. L. E.

CALIFORNIA MINES.

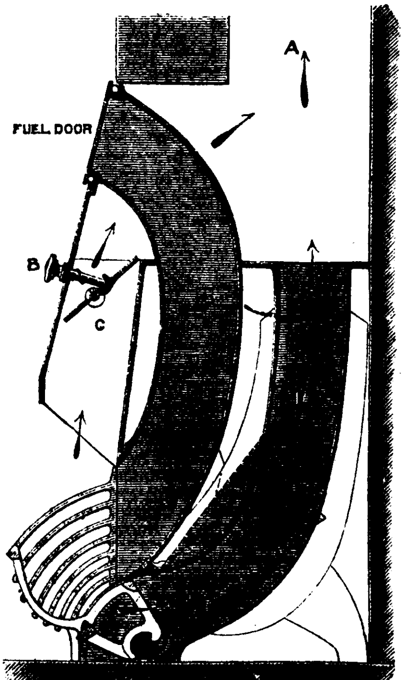
An impression seems to prevail to some extent that because other sections of country are prosperous in mining matters, and people are leaving California for those sections, California mining matters must be at a standstill. This is by no means the case. California mining is now being conducted on a more substantial basis than ever before. While there have been no great excitements, no special advertising and no great stir over the mines of this state, they have been, and are, doing well and generally paying their owners.

Until Bodie came to the front there were very few California mines called on the Stock Board, but at that time a number were put on the lists. On the decline of stock gambling it was generally supposed by those with only a superficial knowledge of the matter, that the California mines felt the result to their detriment. This is not so. The stock market had very little effect on California mining, for the reason that our mines were not favorites to deal in, with the exception of a few of the bodies. The great mining counties of the State were, some of them, not represented on the Board by a single mine.

Up in the mountains where mining is carried, work is progressing steadily at the various mines. The owners attend to their business and work away without much reference to outside influences. The owners are seldom heard of. Nothing is telegraphed about properties unless stock is to be sold. As most of the mines of this State are not stock jobbing enterprises, we do not hear of their being heralded abroad as bonanzas.

As an illustration of how mining matters are going on in this State we may quote the following paragraph from the Nevada *Transcript*, published in Nevada county, the most prominent county in the State.

"Every indication points to the fact that we are to have a lively mining season, and perhaps one which will excel all others in the past. There are more hydraulic mines in operation than there have been in a great many years, and their clean-ups thus far have been larger than usual. The Hirchman claim is the only one not in operation. The quartz prospects here were never better than they are now. There are more first-class claims in operation than ever before, and a large number of good claims whose prospects are exceedingly flattering, to say the least. Before many months there will be sixty new stamps added to the already large number in this district. This of itself will give work to two or three hundred more men, and should bring renewed prosperity. There will be, before the year closes, twenty new stamps erected at the Murchie, a new twenty stamp mill at the Mount Auburn, and twenty more stamps added to the Merrifield, making sixty in all, as far as heard from."



A, common flue to up and down-draught.
B, valve to shut off up-draught.
C, up-draught.
D, fuel chamber.
E, smoke-flue for down-draught.
F, counter-balance weight to front bars.

THE "WONDERFUL" GRATE.

THE "WONDERFUL" GRATE.

The *Building News*, reporting a discussion at a recent meeting of the Royal Institute of British Architects, gives an illustration of a new grate, named the "Wonderful," which was described by the inventor, Mr. Samuel Russell, in the following terms:—

It burns throughout the day and night without attention; the quantity of fire is regulated at pleasure; the intensity is regulated at pleasure; when set to any desired quantity and intensity it continues to burn with but slight variation; it consumes nearly all its smoke; the fire is always bright and clear, no black coal being seen; it is very clean when in use and requires no fire-irons; it gives a large supply of pure warm air; it burns anthracite coal, coke, or cinders, or any combination of these; the chimney-flue does not require sweeping oftener than once in four or five years; the cost of fuel is one penny for six hours; no coal-box is required in the room. Mr. Russell continued as follows:—For the accomplishment of these purposes the grate is provided with two flues, one passing upwards in the ordinary way from above the fire, the other commencing below the fire and passing up behind it, the two communicating at any convenient point above the fire. At the junction of these two flues a valve is formed capable of being regulated so as to divert the draught in either direction. When the valve is open, leaving a free upper draught, the fire is very mild, and in proportion as it is closed the fire increases in intensity, and produces almost a white heat when quite closed. Thus any fire desired may be obtained by simply turning the knob which regulates the valve. Another portion of this invention consists of a vertical tube or chamber for containing the fuel, the lower end of which opens into the back of the grate. It is charged from the upper end, which is then closed air-tight. The fuel by the action of its own gravity continues to supply the consumption of the fire. The double flue and valve, as already stated, regulate the intensity of the fire. To regulate the quantity the front bars are made to draw forward, a counter-balance weight always tending to draw them back, with a catch to fix them in any desired position. When the catch is removed, the backward pressure stops the fall of fuel, the fire becomes gradually less, and is finally extinguished. By this arrangement a small quantity of fire may be kept burning throughout the night, the bars in the morning being drawn forward, and a scuttle of coal supplied starts it afresh for the next four-and-twenty hours. As the fuel enters at the back the smoke is evolved from it before reaching the fire, and whether the up or down-draught, or both, are in force, it is consumed, the only escape for it being through the fire. The recess in which the grate stands forms a hot-air chamber through which the external air, or where this is not practicable, the air of the room, passes.

It appears to be doubted in some quarters whether nitric acid is capable of igniting vegetable stuffs. Herr Kraut has lately stated that the inflammability of sawdust, straw, hay, tow, cotton, or wood-shavings, by means of nitric acid, may be easily proved by experiments, thus: A rectangular wooden case, about 25ctm. long and 40ctm. high, is filled to a height of about 20ctm. with one of the materials named; on this is placed a glass vessel holding 25 to 100 cub. ctm. of nitric acid (of at least 1 5 sp. gr.), the rest of the case is then filled with hay, straw, or the like; the glass is smashed, so that the liquid may be well distributed; then wooden lid is placed on the case. In one or two minutes vapours are visible, a little later a thick white smoke appears (due to the decomposed nitric acid), then the smoke of the packed material. If the lid be opened in five to ten minutes from the beginning, the case is found filled with carbon in lively glow, and this, on entrance of air, is inflamed, and often sets the wood of the case on fire. The experiment should be made in the open air.