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THE METALLURGY OF COPPER.

BY JEFFREY H. BURLAND.

I.

METALLIC copper was known to the ancients and its use dates from an earlier period than that of iron, although copper is by no means so extensively distributed over the earth's surface.

Copper, the chemical symbol of which is *Cu* and automic weight 63·4 crystalizes in the tube, octahedron or rhombic-dodecahedron and when fractured presents a pale, salmon-red colored surface with a finely crystalline, or when hammered a fibrous structure. When heated and rubbed the metal has a slightly disagreeable odor and nauseous taste but does not become oxidized to any extent in dry air unless heated to a red heat. In moist air, however, it becomes covered with a green carbonate of copper.

SOLUBILITY. Copper is but slightly attacked when in a fine state of division by cold hydrochloric acid (H.C.L.) or $H^2S\ O_4$, but dissolves in boiling sulphuric acid $H_2\ S\ O^4$, strong nitric acid $H\ No^3$ does not attack it but upon slight dilution the copper, whether in a fine state or not, dissolves rapidly, with evolution of $N^2\ O^2$ nitric oxide and formation of nitrate of copper. When acted upon by sea water an oxychloride of copper is formed.

The metal is elastic and sonorous, possesses malleability and ductility to an eminent degree, and may be beaten into sheets or drawn into wire of moderate thickness, but during the process it becomes hard and has to be frequently annealed by heating to a red heat and cooling rapidly, this producing an exactly opposite effect to that developed in iron by the same process.

In the scale of tenacity it occupies a place second only to that of iron, but this quality varies with a change in temperature, as in other metals.

Copper is valued as a conductor of heat and electricity, but this latter quality is much impaired by the presence in the copper of impurities such as arsenic, phosphorous and cuprous oxide. The metal fuses at about 1091° C near the fusion point of silver 1000° C, and below that of gold 1200°. It expands on solidifying and is not volatilized to any appreciable extent by the ordinary furnace temperatures, but can be volatilized by the oxyhydrogen blowpipe flame When heated to near the fusing point it becomes brittle, and if fusion takes place it has the power of absorbing considerable quantities of cuprous oxide which it retains on cooling. The pigs containing this compound have a longitudinal furrow on the surface extending along their whole length and when fractured exhibit a dull purplish color without the fibrous structure of pure copper.

IMPURITIES. *Commercial Copper* contains al n st invariably small quantities of iron, arsenic, silver and tin. Antimony and sulphur are frequently found, except in Russian and Australian specimens. Gold, cobalt, nickel and bismuth are also found but not so frequently as the others. Lead is present invariably in sheet and bolt copper but not in cake copper.

EFFECT OF IMPURITIES. Iron has the effect of making copper hard and paler in color, antimony and sulphur exercise a deteriorating influence on the malleability and tenacity also giving the copper a greyish shade of color.

Dr. Miller states that copper containing 10oz. of antimony per ton is absolutely unfit for rolling. Arsenic in small quantities hardens but does not impair the malleability to the same extent as antimony. Bismuth effects the toughness and produces a red short copper, cuprous oxide ($Cu^2\ O$) renders it red as well as cold short. From one to two per cent. of lead is rather an advantage in copper which is to be rolled, but its presence to that extent renders the copper unfit for the manufacture of brass.

The only workable deposits of native copper to be found in Canada occur in the upper copper bearing series of Lake Superior, but it also occurs in Siberia, Brazil, Cornwall (Eng.) and its ores are widely and abundantly distributed in nature. Those most important for the production of copper are given below with the percentage of copper in pure specimens.

	Chemical Formulæ.	Metallic Copper p.c.
1. Oxides		
Cuprite	$Cu_2 O$	88·7
Melaconite	$Cu O$	79·8
2. Hyd Carbonates		
Malachite	$Cu^2 Co_4 x H_2 O$ or $Cu Co_3 x Cu O x H_2 O$	57·33
Azurite	$Cu_3 C^2 O_7 x H^2 O$	55·16
3. Hyd Orichlorides		
Atacamite	$Cu Cl_2 x 3 Cu_2 H_2 O$	59·48
4. Hyd Silicates		
Chrysocolla	$Cu Si O_3 x 2 H_2 O$	Variable
5 Sulph des		
Chalcocite	$Cu^2 S$	79·79
Chalcopyrite	$Cu fe S_2$	34·6
Bornite	$Cu_3 fe S_7$	Variable
Telrahedrite	$Cu_3 sb^2 S_7$	Variable

The last mentioned mineral is very variable in its composition as it sometimes contains as much as 30% silver replacing copper and a variety from Spain contains as much as 10% platinum and frequently mercury.

Extraction.—There are two classes of processes for the extraction of copper from its ores, viz., the dry and wet classes.

The dry class of processes includes those consisting of a series of calcinations and fusions varying in number with the composition of the ore treated and is divided into two methods.

The Welsh Method in which the ore is generally treated in reverberatory furnaces, and the *Continental Method* where shaft furnaces are principally used.

The Welsh Method as conducted at Swansea consists of a series of calcinations and fusions (generally six in number) and is based upon the fact that copper has a stronger affinity for sulphur than iron, and iron a stronger affinity for oxygen than copper. The process is applicable where different ores can be procured to mix with the copper pyrites which is the chief ore smelted at Swansea. The mixture of ores must not contain less than 8% nor more than 14% copper for if it contain less than 8% the quantity of fuel is large in proportion to the copper produced and if greater than 14%, copper is liable to pass into the slag.

The following are the proc s es as conducted at Swansea.

1st. *Calcination* of ores to drive off water, carbonic acid and sulphur and to oxidize iron.

2nd. *Fusion* of calcined ores with slag from No. 4, products coarse metal containing from 30% to 33% copper and ore furnace slag.

3rd. *Calcination* of coarse metal, after granulation or crushing, to drive off more sulphur and oxidize more iron, product calcined coarse metal.

4th. *Fusion* of calcined coarse metal with oxidized ores (Cuprite) and slags from Nos. 5 and 6, resulting products fine or white metal and metal slag containing about 2% copper.

5th. *Calcination* of fine metal followed by fusion, products Blister copper containing 95% copper and roaster slag which goes back to No. 4.

6th. *Refining* and toughening, products copper and refinery slag which goes back to No. 4.

I. *Calcination.*—The reverberatory furnaces for this process, are built with a low roof and bed or hearth measuring from 16'–20' x 12'–14' being intended to take a charge of 3–7 tons of ore in the accompanying drawing (Figs 1 & 2) a calciner is represented having the parts exposed to heat built of fire brick and clay. Referring to drawing b b are openings to admit the charge and are closed with tile during the working of the furnace, C C hoppers for reception of ore, DD projections to prevent the ore collecting between the doors E E, F fire grate, G the fire bridge built with a flange to prevent the portion of ore near it from becoming overheated, H H are the flues which conduct away the vapors and products of combustion, K K holes in the hearth through which the ore may be raked into the chamber M after the calcination is complete, M is connected with the flues through which any gaseous matters evolved during cooling may escape.

The fuel used at Swansea is a mixture of anthracite with 25 % cake coal, and the calcination takes from 12 to 20 hours. During that time the ore is frequently stirred to prevent fusion and to expose new surfaces to the action of the atmosphere. At the high temperature to which the furnace is raised the arsenic volatilizes as arsenious anhydride ($As_2 O_3$) and about half the sulphur as sulphurous anhydride (So_2) both passing out by the chimney. Much of the iron meantime becoming oxidized while copper is left as a sulphide with a small quantity of oxide.

II. *Fusion of Calcined Ore.*—The object of this process is to slag off the oxide of iron formed during calcination, and here the silicious ores may be advantageously added to the charge, provided they do not contain sulphur. It will be remembered that during the last process a quantity of oxide of copper was formed which would at a high temperature pass into the slag, thereby, entailing loss, if it were not that sulphide of iron remained from the calcination and at the high temperature necessary to fuse the slag the iron is oxidized passing into the slag and sulphide of copper is formed.

The furnace (Figs. 3 and 4) in which the above reaction takes place is, as in process No. 1 reverberatory with an oval-shaped hearth ⅝ size of the last sloping from all directions towards a depression at the top hole *h* and surrounded by low walls supporting a low, arched roof provided with a hole for introducing the charge from the hopper C, The hearth is separated from the fire grate, at one end by a bridge while at the other end it communicates by the flue D with the chimney M, at F there is an opening protected by iron plates and fire-clay through which the interior of the furnace is inspected and the slags drawn off. The matt or coarse metal is run off through the tap hole *h* into water for granulation, or into moulds and the pigs of metal afterwards crushed for subsequent treatment. The charge is :

Calcined Ore	17 to 18 Cwt.
Oxides, Carbonate and Silicates	3 Cwt.
Slag from No. 4	5 "

The coarse metal as before mentioned usually contains from 30 to 33% copper and forms about 55% of the charge.

III. Calcination.—This calcination has the same object in view as No. 1, that is, oxidation of iron and conversion of about half the sulphur into sulphurous anhydride which is driven off, leaving copper sulphide and oxide of iron with some unchanged sulphide of iron, a calciner is used and the roasting continues from 24 to 30 hours with frequent stirring during that time.

IV. Fusion. The principles involved here are the same as in No. 2, *viz.*, a double decomposition of sulphide of iron and oxides of copper, here introduced with a formation of oxide of iron, which passes into the slag and sulphide of copper.

The charge consisting of :—

Calcined coarse metal.........	30 Cwt.
Carbonates and oxides..................	16 "
Slags from No's 5 and 6.............	5 "

is treated in a furnace similar to No. 3, except that the hearth has no cavity at the tap hole but slopes from all sides towards that point. The time necessary to complete this operation is about six hours and the resulting product fine metal.

Blue metal is produced when an insufficient quantity of oxidized ores have been added, and pimple metal when too great a quantity has been present, whilst the production of white metal indicates the presence of the proper proportion.

The following analyses of white, blue metal and metal slag gives the composition of each.

	White Metal	Blue Metal
Copper..........................	77·4%	56·7
Iron..........................	·7	16·3
Nickel, Cobalt and Manganese...	traces.	1·6
Tin Arsenic....................	·1	1·2
Sulphur......................	21.	23·
Slag and sand mechanically mixed..	.3	·5
Total	99·5	99·3

Metal Slag.		
Silica..		33·8
Alumina..		1·5
Ferrous Oxide..		56·0
Cuprous Oxide..		·9
Other Oxides..		2·1
Lime..		1·4
Magnesia..		·3
Slag Mechanically Mixed	Copper........	2·9
	Iron..........	·3
	Sulphur.......	·8
	Total	100·00

V. *The composition* of the fine metal influences very largely the manner in which this process is carried out, but the principles involved are these : When cuprous sulphide is heated with excess of air sulphurous anhydride is formed, while copper enters into combination with oxygen, further, when oxide of copper is heated with a sulphide of that metal sulphurous anhydride is formed and metallic copper separates.

The charge 3 to 3½ tons of fine metal is placed in the furnace and roasted for some time with excess of air ; when it is thought a sufficient quantity of oxide of copper has been formed the furnace is closed and the temperature raised to fuse the metal. When fusion has taken place the furnace is allowed to cool slightly, but is again raised in temperature toward the close.

The time required for the completion of this operation varies with the quantity of sulphur present but occupies from 12 to 24 hours, the regulus, however, fusing in from four to six hours.

The resulting product is run into moulds and takes the name " Blister Copper" from its having a blistered appearance produced by the escape of sulphurous anhydride during cooling.

The following analyses of roaster slag and blister copper are by Laplay :—

Roaster Slag.	
Silica..	47·5
Alumina..	3·
Cuprous Oxide..	16·9
Ferrous Oxide..	28·0
Oxides of Cobalt, Nickel and Manganese......	·9
Slannous Oxide..	·3
Lime and Magnesia..	traces.
Metallic copper..	2·0
	98·6

Blister Copper in 100 Parts.	
Copper..	98·4
Iron..	·7
Nickel, Cobalt and Manganese................	·3
Tin and Arsenic..	·4
Sulphur..	·2
Total	100·0

One method of making the purest variety of Commercial Copper, is to carry on the roasting of the fine or blue metal until about one half liquates out and is tapped off whilst the furnace temperature is raised and the remainder fused and tapped into moulds. The metal first drawn contains nearly all the arsenic tin, etc , as the alloys fuse more easily than the pure coppert, this is called bottom, or tile copper ; as the alloy is more dense than pure copper it settles to the bottom of the pigs and when cool is knocked off and " best selected" is left.

VI. Refining. *In this operation* the impurities contained in Blister Copper are removed by the action of the oxygen of the atmosphere. The furnace used is very similar to those used in operations No's 2 and 4 except that the fire grate is larger, there is no hopper, or hole through the roof. There is neither hole in the bed or tap hole, but the hearth is inclined towards the door at the end where the molten metal collects in a depression of the hearth.

The charge of from six to eight tons is piled in the furnace in such a manner that the air may circulate freely among the ingots and at first a moderate heat is applied to allow the oxygen to combine with sulphur to form sulphurous anhydride, with arsenic to form arsenious anhydride, and with iron, tin, etc., to form oxides.

When the metal has been subjected to this process for about six hours the furnace is closed and the metal fused and a thin film is formed on its surface ; this is skimmed off, and when a sample of the metal taken out contracts on cooling the roasting is finished.

In order to toughen the metal it has to pass through a process of poling, this consists of covering the surface with powdered anthracite or charcoal, to prevent oxidation of copper, inserting green poles and stirring the molten metal until a sample cut half through and then broken exhibits the characteristic color and fracture of copper.

The effect of this poling is the removal of the oxygen taken up in the last process, but a stage may be arrived at when it will be overpoled making it even more brittle than before poling was commenced ; this effect was at first attributed to absorption of carbon by the copper, but as analyses have failed to prove the

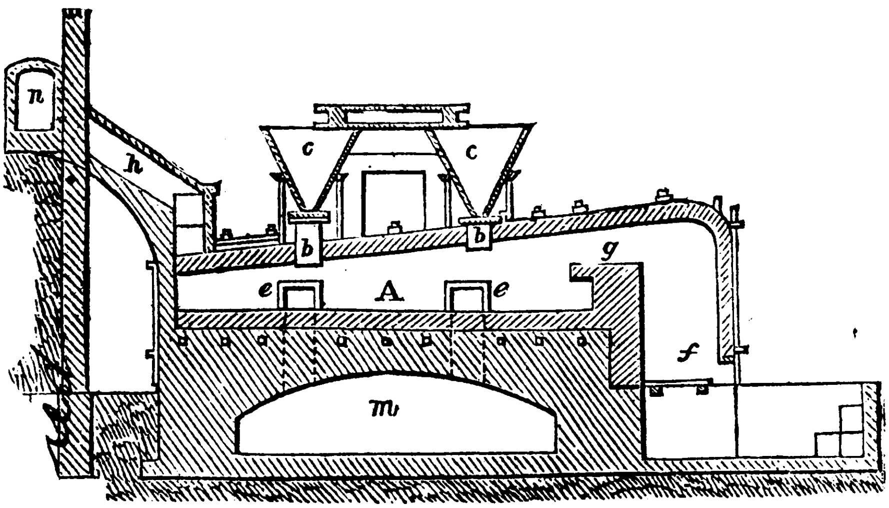


FIG. 1.—VERTICAL SECTION OF ORE-CALCINING FURNACE.

presence of carbon, another hypothesis has been brought forward, *viz.*, that as pure copper exhibits the malleability and ductility of the metal in its highest degree of perfection these qualities have deteriorated owing to the presence of minute quantities of foreign matter which cannot be removed in the refining process and that their injurious effects are neutralized by the presence of a small quantity of oxygen.

The Welsh process is not adapted for use in all countries owing to the character of their ores, and the large quantity of fuel required. Eighteen tons of fuel are used to produce one ton of copper at Swansea.

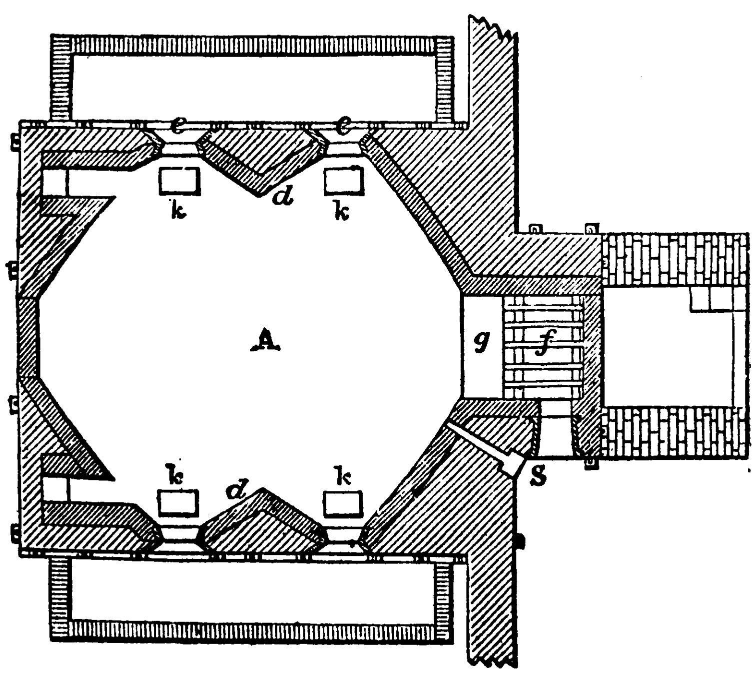


FIG. 2.—PLAN OF THE BED OF ORE-CALCINING FURNACE.

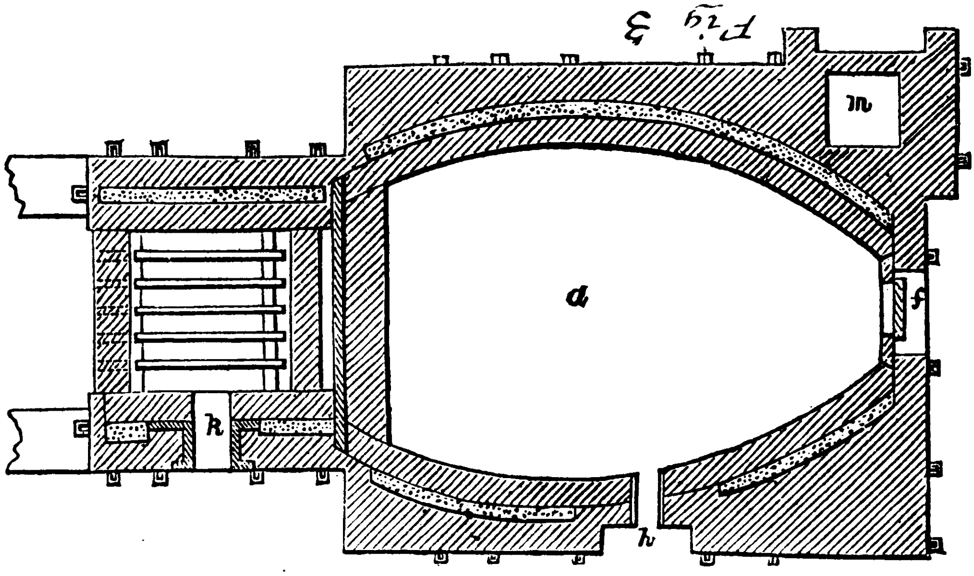


FIG. 3.—PLAN OF THE BED OF ORE FURNACE.

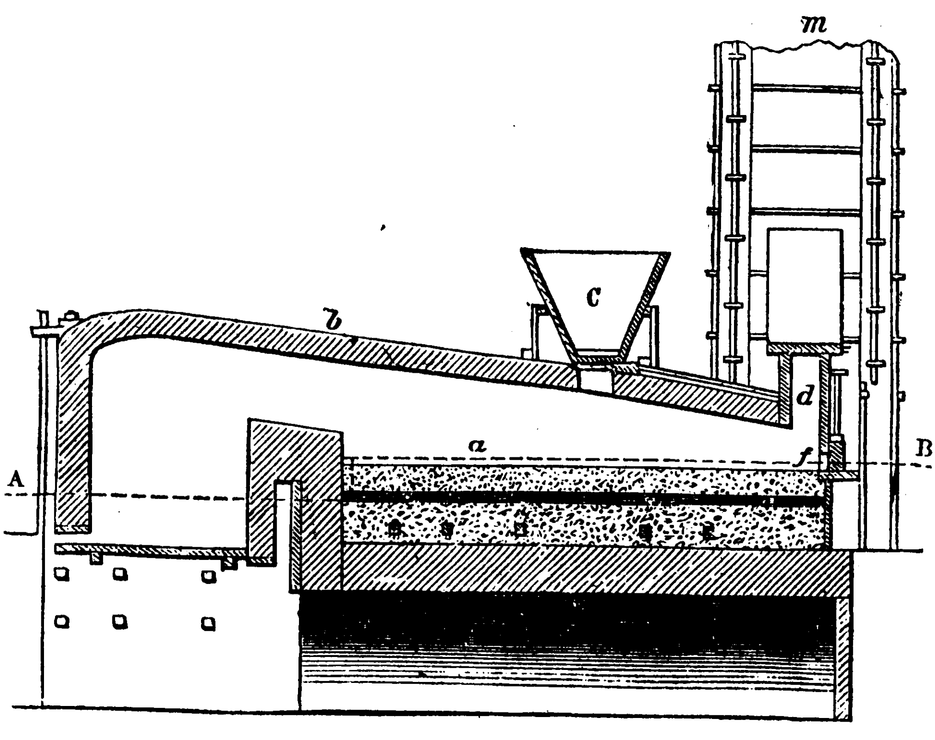


FIG. 4.—VERTICAL SECTION OF THE ORE FURNACE.

Astronomy and Geology.

ANCIENT TIDES AND GEOLOGICAL PERIODS.*

I suppose the most-read book that has ever been written on geology is Sir Charles Lyell's "Principles." The feature which characterises Lyell's work is expressed in the title of the book, "Modern changes of the Earth and its Inhabitants considered as Illustrative of Geology." Lyell shows how the changes now going on in the earth have in course of time produced great effects. He points out triumphantly that there is no need of supposing mighty deluges and frightful earthquakes to account for the main facts of geology. There is, however, one great natural agent of which Lyell does not take adequate account. He does not attach enough importance to the tides. No doubt he admits that the tides do some geological work. He even thinks they can do a great deal of work. The sea batters the cliffs on the coasts, and wears them into sand and pebbles. The glaciers grind down the mountains, the rains and frosts wear the land into mud, and rivers carry that mud into the sea. In the calm depths of ocean this mud subsides to the bottom; it becomes consolidated into rocks; in the course of time these rocks again become raised, to form the dry land with which we are acquainted. The tides, says Lyell, help in this work. Tidal currents aid in carrying the mud out to sea; they aid to considerable extent in the actual work of degradation, and thus contribute their quota to the manufacture of stratified rocks. Such is the modest *rôle* which Lyell has assigned to the tides, and no doubt the majority of geologists have acquiesced in this doctrine. Nor can there be any doubt that this is a just view of tidal action at present. That it is a just view of tidal action in past times is what I now deny. Lyell did not know—Lyell could not have known—that our tides are but the feeble surviving ripples of mighty tides with which our oceans once pulsated. Introduce these mighty tides among our geological agents, and see how waves and storms, rivers and glaciers, will hide their diminished heads. I must attempt to illustrate this view of tidal importance in ancient geological times. Let me try by the aid of the tides to explain the great difficulty which every one must have felt in regard to Lyell's theory. I allude to the stupendous thickness of the Palæozoic rocks. Look back through the corridors of time in the manner in which they are presented to us in the successive epochs of geology. We pass rapidly over the brief career of pre-historic man; then through the long ages of Tertiary rocks, when the great mammals were developed; back again to the much earlier period when colossal reptiles and birds were the chief inhabitants of the earth; back again to those still earlier ages when the luxuriant forests flourished that have given birth to the coal-fields; back once more to the age of fishes; back finally to those earliest periods when the lowest forms of life began to dawn in the Palæozoic era. As we date remote ages astronomically by the distance of the moon, so we date remote ages geologically by the prevailing organic life. It is a great desideratum to harmonise these two chronological systems, and to find out, if possible, what lunar distance corresponds to each geological epoch. In the whole field of natural science there is no more noble problem. Take, for example, that earliest and most interesting epoch when life perhaps commenced on the earth, and when stratified rocks were deposited five or ten miles thick, which seem to have contained no living forms higher than the humble Eozoon, if even that were an organised being. Let us ask what the distance of the moon was at the time when those stupendous beds of sediment were deposited in the primæval ocean. We have in this comparison every element of uncertainty except one. The exception is, however, all important. We know that the moon must have been nearer to the earth than it is at present. There are many very weighty reasons for supposing that the moon must have been very much nearer than it is now. It is not at all unlikely that the moon may then have been situated at only a small fraction of its present distance. My argument is only modified, but not destroyed, whatever fraction we may take. We must take some estimate for the purpose of illustration. I have had considerable doubts what estimate to adopt. I am desirous of making my argument strong enough, but I do not want to make it seem exaggerated. At present the moon is 240,000 miles away; but there was a time when the moon was only one-sixth part of this, or say, 40,000 miles away. That time must have corresponded to some geological epoch. It may have been earlier than the time when the Eozoon lived. It is more likely to have been later. I want to point out that when the moon was only 40,000 miles away we had in it a geological engine of transcendent power. On the primitive oceans the moon raised tides as it does at present; but the 40,000-mile moon was a far more efficient tide-producer than our 240,000-mile moon. The nearer the moon the greater the tide. To express the relation accurately we say that the efficiency of the moon in producing tides varies inversely as the cube of its distance. Here, then, we have the means of calculating the tidal efficiency for any moon distance. The 40,000-mile moon being at a distance of only one-sixth of our present moon's distance, its tidal efficiency would be increased 6 x 6 x 6 fold. In other words, when our moon was only 40,000 miles away it was 216 times as good a tide-producer as it is at present. The height to which the tide rises and fall is so profoundly modified by the coasts and by the depth of the sea, that at present we find at different localities tides of only a few inches and tides of 60 or 70 feet. In ancient times there were no doubt also great varieties in the tidal heights, owing to local circumstances. To continue our calculation we must take some present tide. Let us discard the extremes just indicated and take a moderate tide of 3-feet rise and 3 feet fall as a type of our present tides. On this supposition, what is to be a typical example of a tide raised by the 40,000-mile moon? If the present tides be 3 feet, and if the early tides be 216 times their present amount, then it is plain that the ancient tides must have been 648 feet. There can be no doubt that in ancient times tides of this amount and even tides very much larger must have occurred. I ask the geologists to take account of these facts, and to consider the effect—a tidal rise and fall of 648 feet twice every day. Dwell for one moment on the sublime spectacle of a tide 648 feet high, and see what an agent it would be for the performance of geological work! We are now standing, I suppose, some 500 feet above the level of the sea. The sea is a good many miles from Birmingham, yet if the rise and fall at the coasts were 648 feet, Birmingham might be as great a seaport as Liverpool. Three-quarters tide would bring the sea into the streets of Birmingham. A high tide there would be about 150 feet of blue water over our heads. Every house would be covered, and the tops of a few chimneys would alone indicate the site of the town. In a few hours more the whole of this flood would have retreated. Not only would it leave England high and dry, but probably the Straits of Dover would be drained, and perhaps even Ireland would in a literal sense become a member of the United Kingdom. A few hours pass, and the whole of England is again inundated, but only again to be abandoned. These mighty tides are the gift which astronomers have now made to the working machinery of the geologist. They constitute an engine of terrific power to aid in the great work of geology. What would the puny efforts of water in other ways accomplish when compared with these majestic tides and the great currents they produce? In the great primæval tides will probably be found the explanation of what has long been a reproach to geology. The early palæozoic rocks form a stupendous mass of ocean-made beds which, according to Professor Williamson, are twenty miles thick up to the top of the silurian beds. It has long been a difficulty to conceive how such a gigantic quantity of material could have been ground up and deposited at the bottom of the sea. The geologists said, "The rivers and other agents of the present day will do it if you give them time enough." But unfortunately the mathematicians and the natural philosophers would not give them time enough, and they ordered the geologists to "hurry up their phenomena." The mathematicians had other reasons for believing that the earth could not have been so old as the geologists demanded. Now, however, the mathematicians have discovered the new and stupendous tidal grinding-engine. With this powerful aid the geologists can get through their work in a reasonable period of time, and the geologists and the mathematicians may be reconciled.—*Nature.*

*From a lecture delivered at the Midland Institute, Birmingham, by Professor Robert S. Ball, LLD., F.R.S.

To Clean Brass.—Rub the surface of the metal with rottonstone and sweet-oil, then rub off with a pieee of cotton flannel, and polish with soft leather. A solution of oxalic acid rubbed over tarnished brass soon removes the tarnish, rendering the metal bright. The acid must be washed off with water, and the brass rubbed with whiting and soft leather. A mixture of muriatic acid and alum dissolved in water imparts a golden colour to brass articles that are steeped in it for a few seconds.

THE TOTAL SOLAR ECLIPSE OF JULY 29th, 1878.

Slowly, but perhaps not the less surely, is our knowledge of Solar Physics being extended by successive observations of those grand and impressive phenomena, Total Eclipses of the Sun. Nor does the Eclipse of which the records lie before us appear to yield much to any of its predecessors in the interest of the observations which were made, or in that of the deductions which have been derived from them.

From the noble quarto volume of 426 pages issued by the American Government, we learn that the preparations made for the study of this Eclipse in those parts of the United States lying in or near the line of totality were most extensive and complete; no less than twelve separate expeditions having taken part in the observations, and reports of various importance, together with a large number of sketches appearing from no less than ninety-three observers, some of them ladies. As is pretty well known, several of our own countrymen, including Messrs. Haskins, Lockyer, Loder, Penrose, Ranyard, and Schuster, crossed the Atlantic for the purpose of observing the Eclipse of 1878. Mr. Penrose, however, is the only one of these who contributes to the Volume of the U. S. Naval Observatory: Dr. Schuster having given an account of his observations in the *Monthly Notices* of the Royal Astronomical Society (as did, in fact, Mr. Penrose too), and Mr. Ranyard's observations having only just been issued in a separate form by the Society. The first thing which will strike the reader who possesses any familiarity with Eclipse literature, is the curious difference between the drawings of the Solar Corona of 1878 and that of 1870. Its most marked feature in the more recent eclipse is its enormous extension in the equatorial regions of the Sun, and its comparative absence in his polar regions. There is a practical consensus of testimony that the outer corona terminated on the western side of the Sun, in a kind of of fish-tail bifurcation; a structure existing, according to a few of the numerous drawings, in the eastern part of the equatorial Corona too. Curiously radiated thin streaks of light are shown by some of the observers as issuing from the Sun's polar regions. As we remarked, however, in reviewing Mr. Ranyard's admirable Eclipse Volume (XLI.) in the *Memoirs* of the Royal Astronomical Society (*English Mechanic*, Vol. XXXI., page 223), there is nothing more curious than to note, under what a totally different aspect, two persons, even drawing side by side, may delineate the same object. In the American Volume facsimiles of the original sketches are given, and while some observers appear to have noted accurately the difference of intensity between that part of the Corona immediately circumjacent to the sun, and the fainter outer one to which the projections of which we have just been speaking belong; others seem to have seen little or nothing beyond the bright and narrow Coronal Ring, which nearly followed the Sun's outline. It may, though, now, we think, be held to be an established fact that this extension of Coronal matter in the direction of the Sun's Equator is a characteristic of periods when there are few sunspots; the wonderfully curved and complicated structure, and the more equable distribution round the Sun indicated in the 1870 photographs and sketches pertaining particularly to periods when sunspots are numerous. We may remark that Professor Newcomb ingeniously shaded that part of the sky in which the Sun and Moon were situated at the time of totality, by means of a disc mounted on a pole, and by thus hiding the central and more brilliant part of the Corona was enabled to trace a narrrow ray of faint light some 6° on each side of the sun. "They struck me," says Professor Newcomb, speaking of these rays, "as having a great resemblance to a representation of the Zodiacal light on a reduced scale."

There can be now no doubt that Coronal polarisation is radial and upon the present occasion it appears to have extended without diminution down to the very limb of the Moon itself. In 1870, some of our readers may possibly remember that it distinctly became weaker as it approached the lunar limb. Polariscopic photographs, taken at La Junta, Colorado, seem to indicate that in 1878 polarisation decreased sensibly from the Moon's limb outwards.

The spectroscopic observations appear to point to the conclusion that the major part of the light of the Corona was reflected light. Mr. Ranyard succeeded in taking a photograph of the Eclipse with what he calls a "slitless spectroscopic camera," consisting, in effect, of a flint-glass prism of 45° placed in front of a very short-focussed object-glass. He had made elaborate preparations for photographing the Corona in a camera of 13in. aperture and 74in. focal length, belonging to Mr. J. Kennedy-Esdaile; but after one plate had been properly exposed, the thoughtless mischief of a boy-assistant caused the camera to be removed off the Sun, and the remaining plates were, of course, failures. That Mr. Ranyard did not immolate this youth upon the spot, would seem to speak volumes for his Christian forbearance and control of temper. It is curious and interesting to add that the very accidental shifting of the Sun's image on the plate, while taking the Spectroscopic photograph, has supplied us with most valuable evidence of the nature of the Coronal light. It is evident, from a study of this photograph, that the light by which the Coronal image was impressed came from the region of the H line in the Solar spectrum: in other words, that it was light of the same refrangibility as that by which ordinary terrestrial photographs are produced on the sensitive material. Hence the inference is obvious that the Corona must consist of discrete particles reflecting common sunlight; and not of glowing or incandescent gas at all.

We commenced by saying that the study of the phenomena of successive Eclipses has added, and is adding to our knowledge of the physical constitution of the Sun. It does so directly in a way which must be at once apprehensible. It does so indirectly by furnishing hints to future observers exactly what to look out for Let us hope that the lessons thus taught will not be lost upon those upon whom the pleasant and important task of observing the total Eclipse of May 17th will devolve.—*English Mechanic.*

Telephonic Concert.—A trial performance, in connection with the Crystal Palace, has been made at a private reception by Major Flood Page, at his residence in the Crystal Palace Park. The transmitter was placed in the great organ at the Palace, and one wire was conveyed to the manager's house, three furlongs away. From this distribution was made to six sets of receivers, so that half a dozen persons at a time could listen with both ears to the music. The higher passages came out with more distinctness than the lower, but all were rendered clearly and pleasantly, so that a practical musician could dissect the music and say what stops were being used. Occasionally, by way of variety, other sounds, such as the movement of the people were transmitted. A remarkable and novel effect was given by the simultaneous conveyance of spoken sounds, with the musical notes. Side by side with the transmitter to Major Flood-Page's house was another one, in connection, by the same wire, with the residence of Colonel Gourand, about a mile and a half on the other side of the Palace. Messages were sent to Mrs. Gourand while the same wire was transmitting the musical passages, and her replies could be distinctly heard through the music. This result, which is analogous to the duplex telegraph system, offers the prospect of a remarkable development in the application of the telephone. The performance on this occasion imbued the listeners with a belief in the possibility of transmitting concerts and operatic performances to private houses.

Regulations for Theatres in America.—In anticipation of the development of the electric light, and its approaching introduction into the theatres, the Fire Board of New York has formulated the following directions:—1. The conducting wires ought to have a conductivity superior by 50 per cent to that which has been found by calculation needful for the number of lights which each of the conductors feeds. 2. The wires shall be carefully insulated and covered twice with a substance approved by the Board. 3. All the wires shall be securely held by non-conducting supports, and placed at a distance of at least two inches for the incandescent lights and eight inches for the arc lights; and at eight inches from all other lines and conducting substances. They are to be placed in such a way that they can be carefully and easily examined by the inspectors. Whenever it may be necessary to cross partitions and floors with the wires, contacts with metals and all other conducting substances are to be protected by means which shall be submitted to the approval of an inspector of the Board. 4. All arc-lamps ought to be protected by globes of glass, closed at the lower part, to save efficaciously the dropping of sparks and incandescent particles from the carbons. For the fronts of shops, of mills, and all other places where there are inflammable materials, there ought to be placed on the summit of the globe a chimney and a spark-catcher. The conductor supports of chandeliers ought to be isolated and covered like the wires. Naked lights are expressly forbidden.

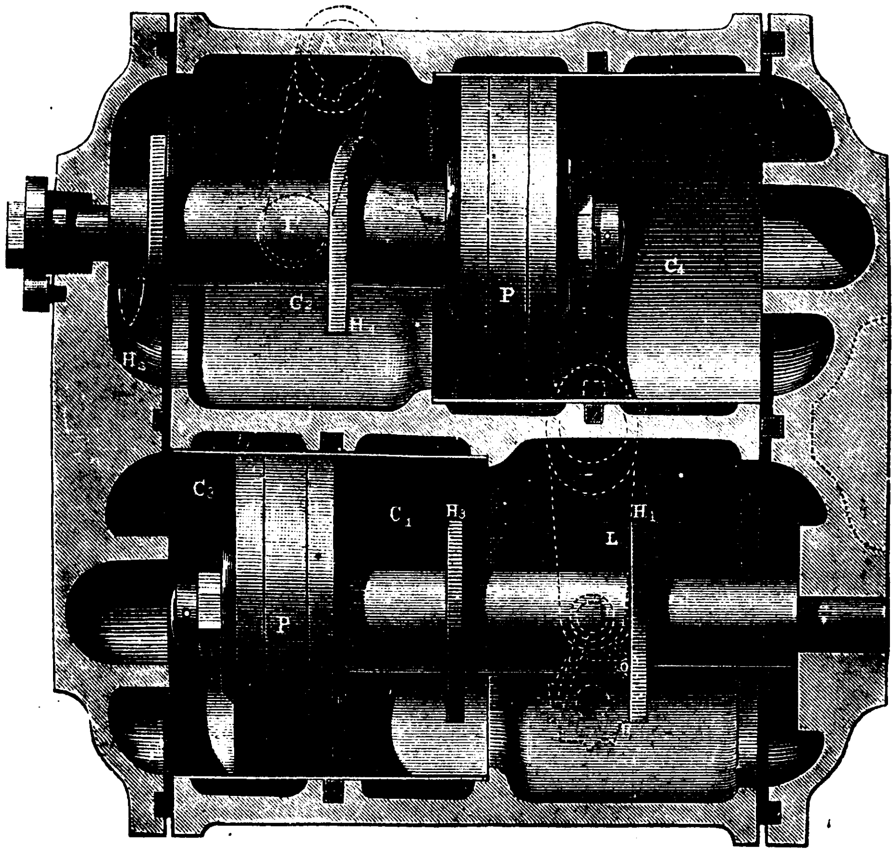


FIG. 3.—HORIZONTAL SECTION THROUGH THE AXIS OF THE PISTONS.

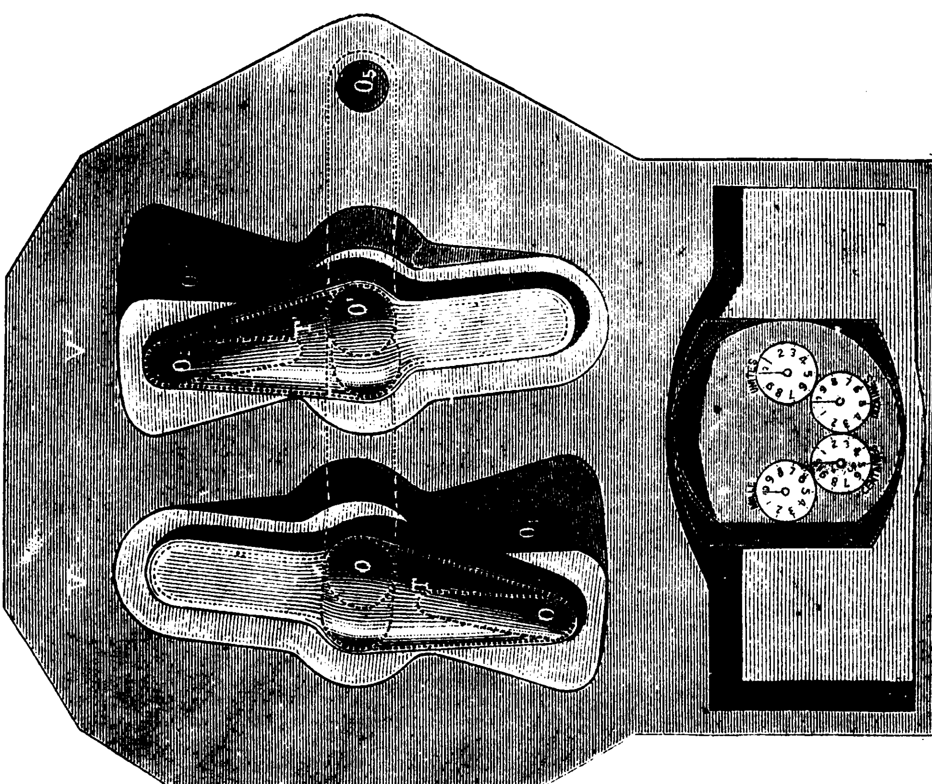


FIG. 2.—PLAN OF THE APPARATUS.—THE DOME REMOVED TO SHOW DISTRIBUTION.

FRAGER'S WATER METER.

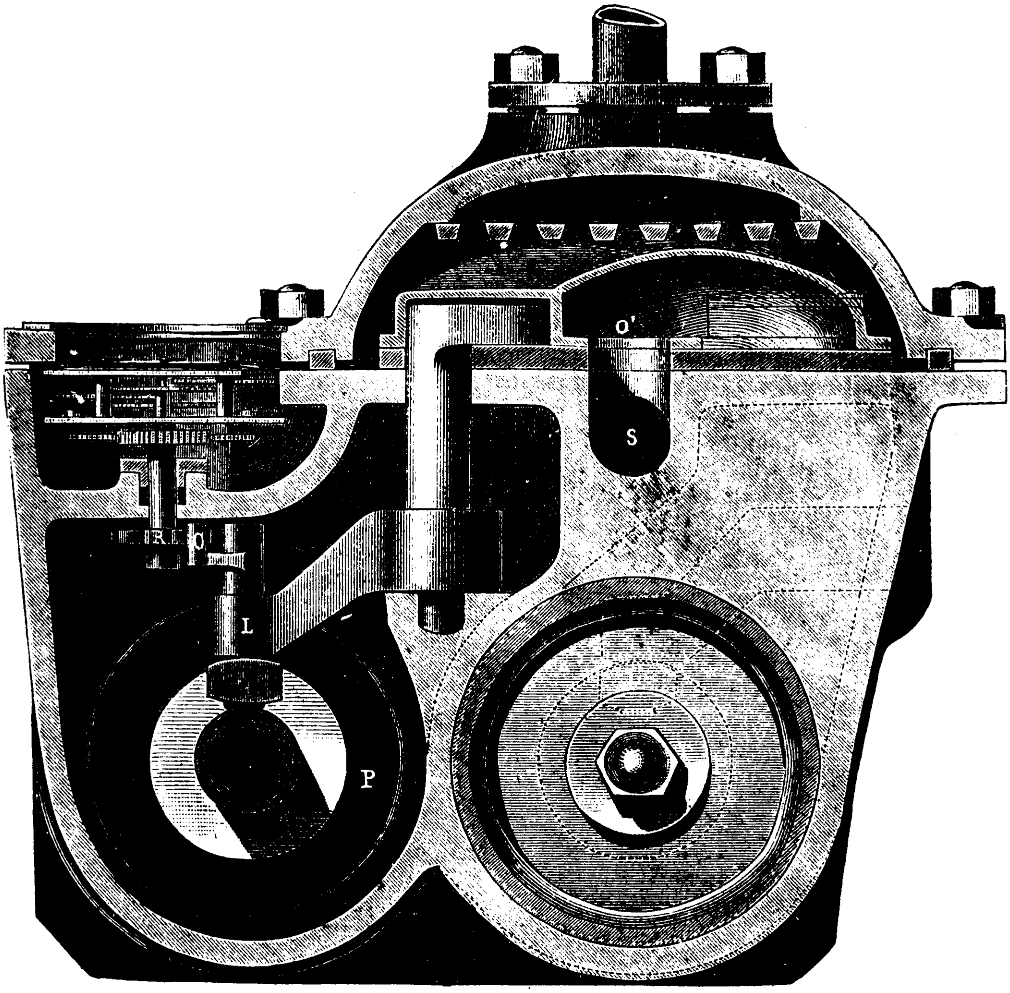
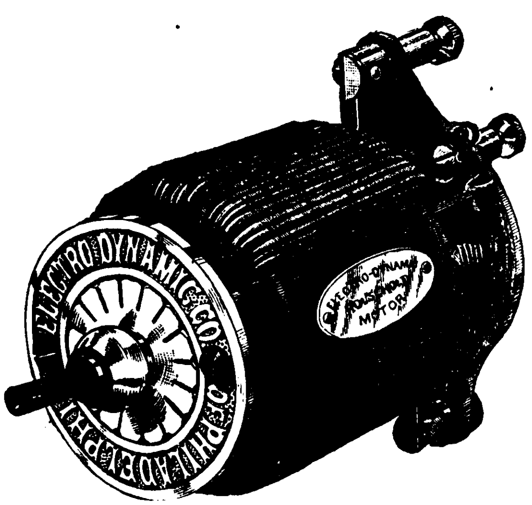
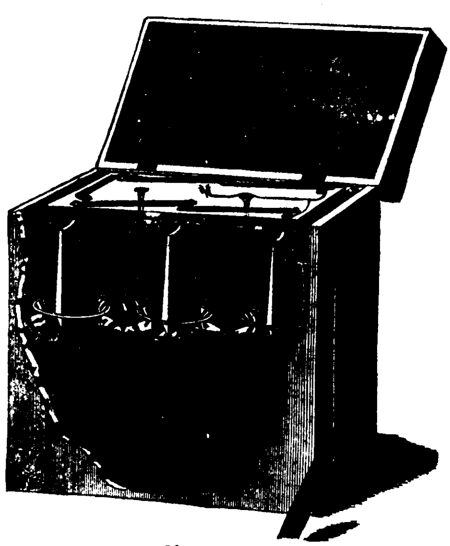


Fig. 1.—VERTICAL SECTION.



Electric Motor.



Electric Battery.

Griscom's Electric Motor.

Engineering, Civil & Mechanical.

FRAGER'S WATER METER

In 1872, M. Frager introduced to the notice of water-supply companies a new water meter, which was very favorably received, and which from that time to the present has been extensively used by the companies supplying water to various of the larger towns and cities of France. Recently the inventor has greatly modified the construction of the apparatus, so that it is exceeding simple, moderate in price, and is not influenced in its correct working by variations in pressure. The operation of this meter, which is shown in the annexed cuts, is as follows:—

The water enters the meter through the inlet pipe, which empties at the top of the distributing box. It traverses a sieve, which serves to remove the larger impurities, and exerts its pressure against the slide valves T and T'. This pressure is transmitted to the measu ing cylinders, C_1 and C^4, from the cylinders, O_1 and O^4, which stand open. Since, at the same instant, the orifices, O_2 and O_3, are in communication with the outlet pipe through the intermedium of the ports of the slide valves which cover them, the spaces, C_2 and C_3, are in a state of discharge, and the pistons P and P'', which separate these chambers from the first, tend to displace themselves toward the left. The piston, P', abutting against the end to the left, by the extremity of its rod, remains immovable; but P moves forward toward this same end, and, striking against it, admits a cylinderful of water into C^1, at the same time expelling a like quantity of water from C^3. Before reaching the limit of its travel, it displaces the slide valve, T', which uncovers the orifices, O_3, and covers up the orifice, O_4. As a consequence of these displacements the pressures are reversed in the cylinder, C^1; C_2 is charged; C^4 is discharged: and the piston, P. shoved toward the right end, drives a second cylinderful of water into the discharge pipe. Before stopping at the end of its travel, it displaces the slide valve, T' which uncovers O_3, and covers O_1. Owing to this displacement, the pressures are reversed in the cylinder, C_1, and C_3 is charged, while C^1 is emptied. The piston P, moves toward the right, driving a third cylinderful of water into the discharge pipe, displacing, on arrival at the end of its travel, the valve, T, and thus causing the expulsion of a fourth cylinderful of water by the piston, P'.

The different parts of the mechanism have now returned to their starting point, except the ratchet wheel, R, which has moved forward but one tooth, while the apparatus has been distributing the four cylinderfuls of water. This ratchet wheel actuates the clockwork which registers the quantity of water that passes through the meter. The movements just described take place as long as the inlet cock remains open.

It only remains to add a few complementary details.

Each piston, toward the end of its travel, actuates the valve which distributes the water into the other cylinder. To effect this the piston rod carries two cams, H_1 and H_3, or H_2 and H_4, which alternately act on the friction roller at the lower extremity of the controlling lever, L or L'; the latter moving on the axle, A or A'. The eccentric head of this axle is situated under the port of the slide valve (in a compartment separated from the one which operates to distribute the water) in such a manner that it pushes along the valve and carries it around the axle, now over the right orifice, and then over the left one. The mechanism which transmits motion to the clockwork is also very simple. The lever, L, carries a pawl, Q, moving about a vertical axle. When the lever is placed toward the left the pawl engages with the ratchet, R, and causes it to move forward one tooth in pivoting itself around its own axis. When the lever turns backward the catch of the pawl becomes disengaged, and is carried back to its starting point by the action of the centre of the ratchet wheel on the tail of the pawl. The ratchet wheel itself moves the clockwork by means of an axle, which, after passing through a stuffing-box enters the clockwork case. Finally, the meter is provided with an ingenious arrangement which allows the fact to be ascertained at any moment as to whether the apparatus is water-tight. To effect this object, the cams, H^2 and H^4, of the piston P', are made helicoidal in shape, so that if the piston rod, (and consequently the cams) be revolved about half a turn to the left, the cam, H_2, in consequence of its peculiar shape, is thrown out of the way and no longer engages the lever L', to a sufficient degree to displace the slide valve, T. The piston, P, will then remain pressed close up against the left end of the cylinder, and the piston, P' against the right end. The meter will thus stop working, and the flow of water will cease entirely if there be no leak. To set the meter in operation again, it is only necessary to move the stoppage eccentric back to its first position, when the helicoidal flange of the cam, H_2, acting on the lever, L', and displacing the slide valve, T, will put the apparatus in motion. If after bringing back the stoppage eccentric to its proper position, it be immediately turned to the left, the apparatus begins operating and stops anew after dist ibuting four cylinderfuls. It is easy then to ascertain: (1) Whether the meter has any leaks; and (2) whether the capacity of the four measuring cylinders is in proper accordance with the clockwork.

The apparatus is easily taken apart and put together again, and, as regards construction, is exceeding strong. With the exception of the piston packing (which is rubber), all the parts are of metal. There is hardly any need of speaking of the applications which may be made of the water meter. But, there is one, however, which we consider proper to dwell on, since it offers to manufacturers a means of controlling the operations of their generators and engines. It is the measurement of the feed water. By a special arrangement, the meter may be placed on the supply pipe of the feed pump. There is a safety valve provided for the prevention of accidents, and a check valve for preventiag back flow from the boiler. From the very construction of the apparatus, it is able to work equally well with either hot or cold water. The exact knowledge of the quantity of water vaporized by the boiler allows, by comparison with the weight of coal consumed during the same time, of ascertaining with the greatest certainty the cost per pound of steam, and of determining the choice of coal. Besides this, if the revolutions of the driving shaft of the engine be counted, the expense of steam per revolution of the flywheel may be estimated; and thus the movements of the engine can be regulated so as to prevent that increase in the consumption of fuel which follows an excess of speed. The use of the water meter and of the revolution counter results then in a considerable reduction in the expense of fuel, while at the same time it allows the behavior of the boilers and engine to be ascertained at any moment.—*Scientific American.*

Scientific.

AUTOMATIC ELECTRIC TIME SIGNALLING APPARATUS.

—Shuey's. This ingenious instrument automatically secures absolute precision of time in the ringing of warning and starting signals for railroad trains, street cars, steamers, and wherever the ring of bells or sounding of other signals is required at any predetermined periods of time.

To any good clock or regulator are attached contact points which close an electric circuit between a battery and the signaling instrument every minute. Where minute-moving electric dials are in use, no change in the clock is necessary, as the instrument can be placed in the same circuit which controls them. The time wheel of the instrument is provided with a hole in its periphery for every minute in twenty-four hours—1,440—and by means of its electrical connection with the regulator it is moved one step at each minute oftime. To set the instrument to any time table, it is only necessary to place a small metallic screw in the hole corresponding with the hour and minute at which each train is to leave the station.

Each screw in its proper place will not only cause the starting bell to strike at precisely the right time, but will, in addition, sound a warning of two, or three, or more blows upon the same or other bells at two, three, five or any number of minutes in advance of starting time, according to the requirements of the railroad company, the instrument being easily adjusted to operate any system of warning and starting signals already in use.

The time wheel once arranged in consonance with the time table, the signals are automatically repeated day after day, until a change in the time table is made.

The signals may be sounded on one or many bells of auy size and at any desired distance from the clock or instrument

By the use of a conveniently arranged switch, the automatic contact points may be instantly cut out, and hand-push buttons on the instrument placed in the gong circuit for use when trains are late or special, or at any time when a temporary suspension of the regular signals is desired without making a change in the time table.

GRISCOM'S ELECTRIC MOTOR.

A committee of the Franklin Institute appointed to examine and report upon the merits of this ingenious apparatus, have lately published the results of their labors. They are favorably impressed with the utility of the motor, and recommend "Griscom's electric motor and battery to the favorable consideration of the Franklin Institute as an apparatus possessing great power in proportion to its size, simplicity in its construction, excellence in its mechanical details, and general adaptability for household use." This recommendation of the committee was approved by the Board of Managers of the Institute at their meeting held November 9, 1881.

We give in the following an illustration of the apparatus and the battery, and a brief summary of the committee's report upon this invention, which appears to represent a useful and valuable application of electricity as a motive power for many domestic uses. The mechanism of the Griscom motor may be described as follows: The motor consists briefly, of two semicircular electro-magnets, which together form a ring; their poles project inward, and, together with the wire coils, forms a cylindrical tube within which a Siemens armature revolves. The poles extend laterally beyond the ring, forming supports for the brackets which carry the bearings of the armature and the brushes of the commutator. In order to reduce the wear of the journals to a minimum, the bearings are made four times the diameter of the shaft, and the direction of the wear is always from the point of nearest approach, so that the poles of the armature and magnets can never come in contact from this cause—a frequent source of annoyance and danger in former motors. The friction wheels of the brushes are in pairs, and the shape of the commutator is such that one wheel will always touch one-half of the commutator before its companion leaves the other. The tension of the belt is readily adjusted by means of a fork which carries the motors.

The battery consists of six one-gallon cells, into each of which plunges a plate of zinc 4 inches long and 2 inches wide, and two plates of carbon exposing a like surface. The large amount of liquid (electropoion) is merely to save the trouble of frequently recharging; a battery containing six drachms per cell gives equal power, but for a shorter period. It is estimated that the battery once charged, will continue to supply the motor with sufficient power for all ordinary use of a sewing machine in a private family for many months, or probably one year, without refilling.

Respecting the power of the motor, the committee report that as this depends upon the quantity of electricity furnished by the battery, it is easily regulated by raising and lowering the plates in the exciting fluid. They found that when the plates were but partially immersed in the fluid, sufficient power was generated to answer for all the ordinary requirements of a sewing machine, and that when fully immersed the power generated was sufficient to drive a large needle through sixteen layers of cotton cloth at a very rapid rate. The operation of immersing the plates in the battery fluid is accomplished in several ways. Where the motor is attached to a sewing machine, this is done by a movement of the treadle, and the speed of the machine is kept under complete control by the pressure of the foot, by which the plates are immersed to a greater or less depth. When the foot is removed, the plates are automatically withdrawn from the fluid. The motor proper is 2¼ inches in diameter and 4 inches long, and weighs but 2½ pounds. It is securely attached beneath the table of the sewing machine by a light frame.

The exciting fluid of the battery consists of a mixture of sulphuric acid and bichromate of potassa, which has the merit of giving a powerful current and of evolving no noxious fumes. The method of graduating the strength of the current, and consequent speed of the motor, is as simple as it is effective. A very slight pressure of the foot on the treadle suffices to start the machine as gradually as may be desired; the speed may then be increased up to one thousand or more stitches per minute, which, it is said, is considerably faster than is now attained by professional sewing women, while others seldom sew more than 300 to 400 stitches per minute.

Two forms of the battery were shown, in both of which the plates are automatically raised above the bath when not in actual use. In one form this is accomplished by means of a spiral ring attached at either end of the bar to which the plates are permanently fastened. In the other a similar result is attained by means of a counter-weight on the small arm of the lever attached to the treadle.

Tha committee conclude their report with the statement that the important novel feature in this battery consists in the size of the cells, which thus enables it to continue operative, without recharging, for a great length of time. As the current is necessarily intermittent when the motor is running, and as the plates are frequently raised and lowered by the operator to accomodate the needs of the work of sewing, the main objection to the ordinary Grenet battery—namely, the rapid deterioration when the constant current is required—is avoided to a great extent, while its advantages for household and occasional uses are retained. These are as follows: It generates no gases or vapors that are practically deleterious; the zinc elements do not, as in other batteries, require frequent amalgamation or attention, and when not in use are simply raised above the fluid and allowed to drain.

In reviewing the report of the committee, we fully coincide with their opinion as to the many practical and useful features which the Griscom motor possesses. The only point where it appears to us the committee has not properly investigated, is the important one of the permanence of the battery. This the committee pass over with the remark that "it is estimated that the battery once charged will continue to supply the motor with sufficient power for all ordinary use of a sewing machine in a private family for many months, or probably one year without refilling." If this fact can be verified, the great practical value of the motor will be obvious; but it does not appear that the committee took the occasion to verify the estimate, or if they did, it nowhere appears in their report.

It appears to us that what the Griscom Motor requires is something like the secondary battery of M. Faure, which could be sent around to private houses at regular intervals, charged from a dynamo-machine with as many foot-pounds of electrical energy as would suffice for the uses of the family for two or three months, and replaced by freshly charged ones. As we were informed by representatives of the company a short time ago, that they have been engaged in perfecting their battery before putting their machines upon the market, it is possible that the idea here advanced may have occurred to them.—*Manufacturer and Builder.*

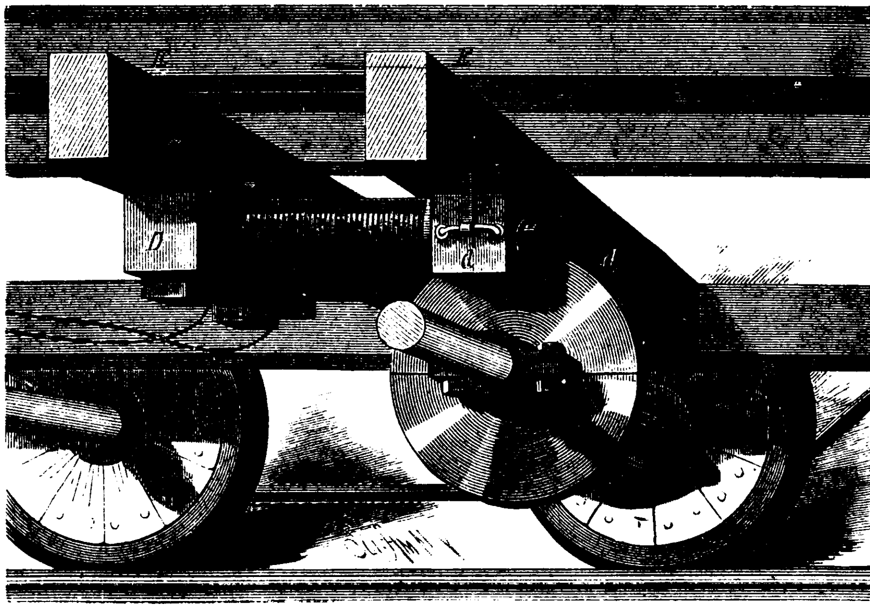
ELECTRO-MAGNETIC BRAKE.

We give an engraving of Mr. Edison's recently patented electro-magnetic brake. It is designed for use on any style of railroad vehicle, but is more specially intended for use in connection with a system of electro-magnet railways.

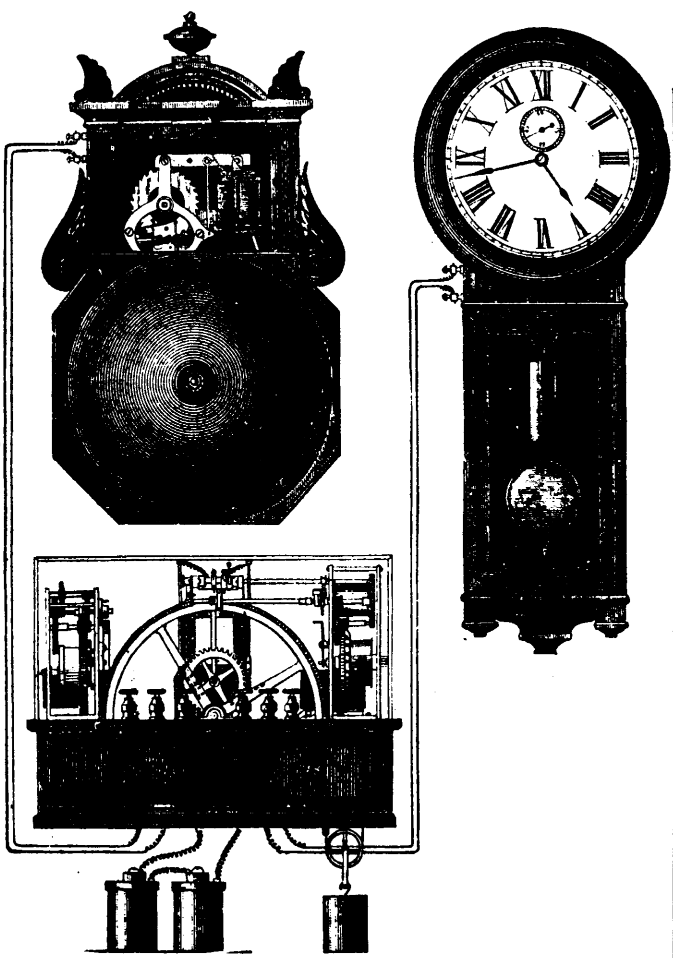
The invention consists in placing an electro-magnet in such relation to some rotating metallic portion of the running gear of the vehicle to be stopped that the magnetic current shall be through the rotating metallic portion, the electro-magnet being furnished with movable heads, which may move toward and clasp the rotating portion whenever the circuit of the magnet is closed. Upon the axle, and at or near its centre is rigidly fixed a disk of iron, which rotates with the axle and between the polar extremities of an electro-magnet supported from the bottom of the car. The cores of this electro-magnet are extended beyond the coils, forming a spindle, which is reduced in size when necessary, the ends being screw-threaded to receive nuts. Upon each spindle is placed a block of iron forming a polar extension, secured in place by the nut.

The orifices in the blocks, into which the spindles pass, are elongated, so that the blocks or polar extensions may have a movement to or from the fixed disk upon the axle rotating between them. The polar extensions are normally held away from the suitable spring of low resistance. When it is desired to use the brake a circuit from any suitable source of electricity is closed through the coils of the electro-magnets when the polar extensions mutually attract the disk, and the attractive force causes them to move to the disk and grasp it between them, causing a retardation of stoppage in its rotation, and so acting as an effective brake upon the wheels.

Herr Hornstein has communicated to the Vienna Academy the result of his recent researches in connection with the asteroids. He thinks that the number of those with a diameter of over 25 geographical miles is extremely small, and that probably all such were discovered before 1859. The number of asteroids with a diameter less than five miles seems also to be very small, at least in the parts of the asteroid zone next Mars; in the outer regions next Jupiter there may be a more considerable number of these very small bodies. Most asteroids seem to have a diameter between five and fifteen miles.

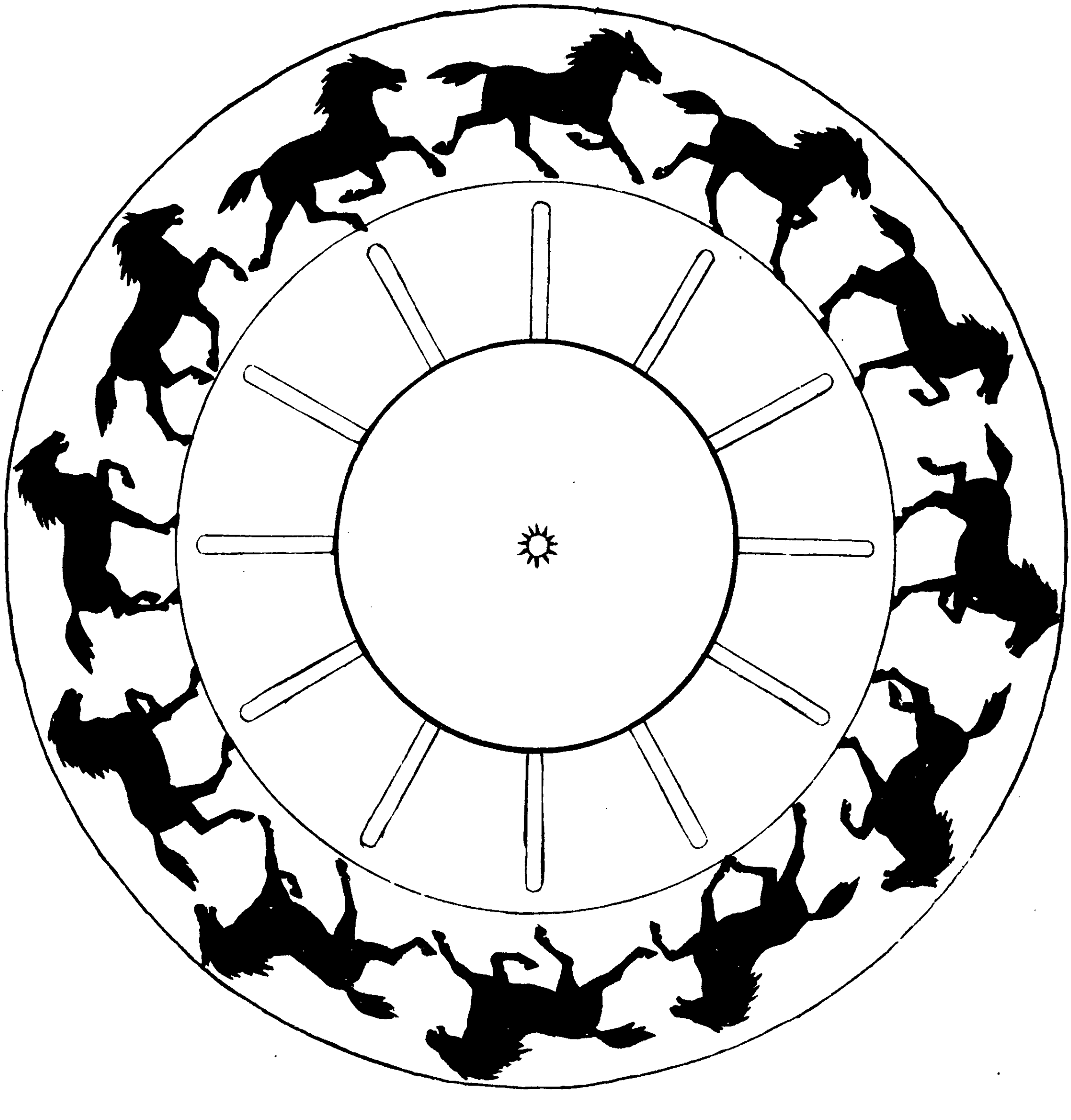


EDISON'S ELECTRO-MAGNETIC BRAKE.



ELECTRIC TIME SIGNALLING APPARATUS.

THE MAGIC WHEEL.



THE PHANTASMOSCOPE, OR MAGIC WHEEL.

In an illustrated article upon the "Horse's Motion Scientifically Considered," which appeared in the *Scientific American* Supplement, No. 158, January 11, 1879, the use of the zoetrope was suggested for showing the appearance of a horse in motion

A zoetrope, although not complicated requires considerable care and mathematical precision in its construction ; but the phantasmoscope, or magic wheel, is comparatively simple, consisting as may be seen by the accompanying illustration, of a disk of any diameter revolving upon a pin in the center. Figures in different poses of arrested action are painted or pasted upon the one side ; under each figure is an oblong opening or slot. Much amusement can be derived from this old and simple toy. We herewith give one with the correct positions of a horse trotting 2:40 gait, drawn in silhouette upon the outer margin of the wheel.

Cut the phantasmoscope, or magic disk out, following the outer circle with the scissors ; this done, paste the disk upon a circular piece of cardboard. Under each figure, at the oblong places, cut a corresponding opening through the paste board. Fasten the wheel to a stick or handle by means of a pin at its center on which it can freely turn. To use the toy, stand in front of a mirror, as shown in the small illustration ; hold the disk before the eyes, and look through the slots under the figures, and turn the wheel rapidly. The horses' legs will commence to move as in life, and as each successive position drawn upon the phantasmoscope is the exact one taken by a trotting horse, the horses in the mirror will all appear to be in actual motion on a fast trot. If the eye is directed over the margin of the pasteboard disk, an indistinct blur is all that is seen. The principle is generally well known and easily explained. It pertains to the phenomenon known as the persistence of vision. When the eye is directed through the slot the figure of a horse is seen for an instant as the opening passes the eye, and the impression is retained after the object is shut off by the intervening portion of the board between the slots until another horse appears through the succeeding opening, when an additional impression is made, the same as the preceding impression, except a slight change in the position of the legs. These impressions follow each other so rapidly that they produce upon the retina of the eye the effect of a continuous image of the horse, in which the limbs replaced by a succession of positions, present the appearance of a file of horses in actual motion.

For young scientists this beautiful experiment will be found very entertaining.—*Scientific American.*

Mechanics.

THE FORCE OF A CROCODILE'S JAW.

Some unique experiments have lately been made in France, on the strength of the masseter muscles of the crocodile (a muscle passing from the cheek bone to the lower jaw). M. Paul Bert received ten gigantic crocodiles (*Crocodilus galeatus*) from Saigon, which were transported alive to France in enormous cages weighing 3,000 kilogrammes. Some of these crocodiles measured ten feet, and weighed about 154 lb.

The reader can easily understand how difficult it must be to manage such ferocious animals in a laboratory; and it was only by the assistance of the managers of the Zoological Gardens that this dangerous task was accomplished.

In order to measure the strength of the masseter muscle of the crocodile's jaw the animal was firmly fastened to a table attached to the floor; the lower jaw was fixed immovably by cords to the table; the upper jaw was then attached to a cord, fastened by a screw ring to a beam in the roof. There was a dynamometer placed on this cord, so that when the animal was irritated or given an electric shock, the upper jaw pulled on the cord, and registered the force of its movement on the dynamometer.

With a crocodile weighing 120 lb. the force obtained was about 308 lb. avoirdupois. This does not equal the actual strength, for as the dynamometer is necessarily placed at the end of the snout, it is really at the end of a long lever, and must be measured by finding the distance between the jaw muscle and the end of the jaw, to show the real force of the jaw muscles, which equals 1,540 lb. As this experiment was performed on a crocodile already weakened by cold and fatigue, its force when in its natural conditions of life must be enormous.

This power of 308 lb. represents a power applied over the whole surface of the crocodile's mouth. In reality it is first used by the enormous teeth that overlap the others in the front of the jaw, and by a simple calculation the pressure of these teeth is estimated to be equal to the pressure of 400 atmospheres. The power of the crocodile's jaw was compared with that of an ordinary dog weighing about 44 lb. whose jaw was measured in the same way. A force of 72 lb. was obtained, which, when multiplied like the crocodile's, was found to equal the pressure of 100 atmospheres.

In comparing the weight to the jaw force of these two animals it is found that a crocodile is one-third stronger, weight for weight, than a dog.—*La Nature.*

ABOUT TOOLS.

Imprisoned criminals have accomplished most astonishing feats in their efforts to escape. A large proportion of a certain unsavory class of literature consists of the recital of feats of this character. These men, it is true, have nothing else to divert their attention, and are impelled by a motive stronger than the desire of gain in the prosecution of their purpose. An instance of this kind which occurred very recently is a notable example of difficulty overcome. An imprisoned convict, without tools or material, contrived to manufacture a key with which he opened difficult locks and effected his escape in spite of the watchfulness of his guards. He scraped lead from a water pipe which ran through his cell, made a fire of splinters from his furniture, melted the lead in his spoon, and cast the keys without attracting the attention of his watchers.

Men in similar condition have performed prodigies in the way of cutting iron bars, drilling through iron doors, breaking through heavy stone walls, constructing ladders, weapons, keys files, saws, hammers and other tools. They have tunneled long distances beneath deep foundation walls and accomplished feats which would be regarded as difficult even with the aid of the best implements. It is said also that the finest and most perfect tools known to mechanical experts have been fabricated by criminals in order to effect their depredations upon society: coins have been counterfeited which could only be detected in the melting pot, and bank notes which could not be detected at all. This unlawful work has been performed under the greatest difficulty, under fear of discovery and terrible punishment, at night, in remote places, under ground in localities where the ordinary sounds of work would be the means of detection and without a thousand hindrances in the way. The tool makers and tool users have furnished their quota to the ranks of evil doers, but in the main in spite of their surpassing ability these wrong doers have and are constantly defeated and made to suffer, because in all society they are largely in the minority.

A retrospect of the result of tool making and tool using shows very clearly that the destiny of nations has been decided oftener by their position and capacities in this respect than by any other factor in the case. It is under stating the matter to say that tools have revolutionized the world, for they have not only done this scores of times, but they have been a constantly acting force in bringing about the slower and deeper reaching changes which have passed over human society. To illustrate by an instance which comes within the personal knowledge of many readers of this paper. The cotton gin, by the use of which the production and use of cotton was rendered possible to an unlimited extent, placed the scepter of commercial and political power in the hands of the cotton raising section of the United States. People talk about "great moral ideas," "race peculiarities," "the diffusion of intelligence," and other influences which brought about the condition which existed just before the rebellion, but the simple fact is, that the cotton gin made cotton the most profitable crop that the world ever saw upon a large scale; consequently the cotton growing sections controlled the national power.

It was not the genius of statesman nor the inherent ability of the people, but the ease, celerity and cheapness with which this implement separated the cotton seed from its fiber that decided the course of national history for a century. The order of things instituted was broken up by a process similar to that which began it. Another section of the country, having been driven to study the tool making problem, did so with such good success that there was greater profit in the industries which were connected with tools than with that of producing the raw material that they worked upon. In other words, there was more money in manufacturing cotton than in raising it. In the meantime tools and methods were discovered; the work of wood, iron bars, chemicals and all other necessities of humanity had kept pace with the textile improvement. When the struggle for supremacy came the moulders had the best of the business.

To-day the tide is turning the other way, so far as locality is concerned; the tool makers are spreading themselves over the producing regions, and in a few years there will be a total change of the geographical center of power. The prophetic gift is not necessary to enable one to see that what may be called the tool making interest will continue to control our national destiny, neither does it require great perspicuity to see that the benefits of great improvements in appliances are coming nearer to the individual, Patents are expiring year by year in the most important processes, monopolies which have heaped up money in few hands are tottering, prices of finished products are steadily and permanently falling and the cost of the necessaries of life is constantly decreasing.

Through the efforts of the genius inspired tool makers of the past, life will be made easy for generations to come.—*Manufacturer and Builder.*

NOTES ON THE LATHE

The extraordinary antiquity of the art of turning is universally admitted. Some writers, indeed, have fancifully called the lathe the father of mechanism; but, at all events, the date of its actual origin is lost in the impenetrable obscurity of remote ages. Turning, the art of giving some curvilinear form to various hard substances, whether wood, metal or bone, and of engraving or impressing thereon figures and designs, has indeed been assigned as an invention to Theodorus of Samos, somewhere about 550 B. C. — so, at least, Pliny asserted. It is indisputable, however, that the simpler and earliest form of turning—that effected by the agency of the potter's wheel—was in general use among the more civilized races of the world at a very much earlier period. The Scriptures, as every one knows, contain many references to the potter's wheel. In one instance we are told that the prophet Jeremiah went down to the potter's house, and "behold, he was doing a work on the wheel, making a vessel of clay with his hands." This original and rude precursor of the modern lathe, however, is probably older than the Bible itself, for among the many extraordinary remains of inconceivably remote periods disinterred from some of the buried cities of Egypt, are examples of work which bears the unmistakable signs of having been produced by the action of the lathe.

In the East a rude kind of lathe has been employed with surprising effects for generations. It consists of only a couple of ordinary uprights stuck in the earth. A common nail through each acts as the centres in which the work rotates, actuated by the drill-bow. The work, of course, is thus raised but a short distance from the ground, and the operator, sitting in the customary posture of the orient, viz., squatting, employs his feet with much dexterity in the labor. It will be recollected by some of our readers, perhaps, that at the Paris Exhibition of 1867 a number of Eastern artificers succeeded in turning out some very excellent work from a lathe of this simple kind.

The extraordinary manipulative cleverness of Hindoo workmen with such a lathe is familiar to all of us. The Indian turner resembles in not a little our own peripatetic grinders of edge tools. Aided by one assistant, he soon puts up his rude lathe wherever he has settled temporarily for the purpose of working. Two posts are thrust into the earth, and the work is mounted between the centres. A strong cord is carried round it, and his assistant imparts the requisite motion. The turner usually grinds the edge of his tool by his feet and takes the handle in his hands.

Some rude peoples have, however, a more improved variety of these primitive lathes. There is a frame consisting of two cross pieces united by a tie bar, on which they slide, and capable of being wedged. These cross pieces have strong spikes in them, making the centres. The lathe is placed on the ground and fastened with a few spikes. A perfectly straight bar is placed across the transverse pieces close to the work, and thus affords a rest for the turning tools. A lathe of this type is to be found in Spain, Egypt, and probably in Morocco.

It appears that the continuous motion of the fly-wheel does not properly belong to the lathes of the ancients, who seemed to be acquainted only with the alternate revolutions due to the bow.

A rare German book of the date 1568, exhibits a turner working a sphere in a lathe, and is the earliest record of a lathe mounted on standards.

There is good reason for believing that the earliest books devoted to this important art was issued at Lyons in or about 1700. A much more recondite and practical treatise on the subject is undoubtedly Bergeron's well-known and exhaustive work, in three profusely illustrated volumes. Bergeron was a maker of lathes and most of the tools then employed by turners. Subsequently, various works came out on the art, and it is noteworthy that some of the best are by Frenchmen.

We must not omit reference to Holtzapfel. He produced no less than six volumes, the initial one appearing as recently as 1847. This work is undoubtedly a standard authority, but unfortunately its cost has put it quite beyond the reach of most of those for whose benefit it was designed.

The existing lathe varies from the watchmaker's liliputian tool, which has a horse-hair for a cord, to the colossal machine capable of taking up work of thirty feet diameter, while it is needless to add that the introduction of cast-iron as a material for lathes has given an enormous impetus to this important and now indispensable tool.—*Machinist & Wheelwright.*

A FLY-WHEEL CAT.

A white cat which was about Winchester's shop was missed recently. In the forging department of the drop shop is an upright engine where the blowing is done for the forges. The other morning the man started his engine, and looking about the wheel he noticed something on the fly-wheel. The wheel was making a great number of revolutions per minute—going so fast that the spokes were invisible. He did not make out what it was, but paid no particular attention to it, as he thought it was the sun shining on the wheel. Glancing that way occasionally, he noticed the same thing several times. He started the engine at 7 o'clock, and at about 9:30, noticing the object again on the wheel, he thought he would stop the engine and see what it was. He stopped it and got over where it was, and found it was a white cat clinging to the wheel. There the cat had been hanging on for two and a half hours. He took the cat down, and it had become cross-eyed. He put the cat in a box and cared for it, and in about two or three days it began to get around and its eyes commenced to have their natural look. In about a week it came to the room of the foreman, J. D. Eager, a branch of the forge department. Mr Eager fed it and commenced to train it. The animal reciprocates the kindness shown, remaining about the forge all the time and evincing quite an interest in the business, and is quite a pet among the workmen. The above is a fact.—*New-haven (Conn.) Journal and Courier.*

IMPROVED FIRE-EXTINGUISHING APPARATUS.

We give an engraving of a fire-extinguisher adapted to receive one or more streams from hydrants or steam fire engines, and to discharge the water in a single solid stream, which is found to be much more effective and capable of reaching through greater distances than the several streams used separately.

The nozzle, A, consists of three portions—the butt, *a*, barrel, *b* and tip, *c*. The nozzle is screwed to the barrel, so that it can be removed or exchanged for a larger or smaller one. The butt is fitted at its end with a number of screw nipples or tubes, *e*, for connection of the hose pipes. Within the butt, valves, *é*, are fitted to close over the apertures by internal pressure, so that water cannot escape by the nipples not in use. The butt is also formed with a socket that receives the end of a lever or handle, *g*, by which the nozzle is manipulated.

The nozzle is mounted on a truck, and a forward truck is provided for supporting the forward end of the nozzle. This truck is fitted with a short reach having a socket in its end for receiving a long reach attached to the main truck. In going to and from the place of use the forward truck will be used, and for that purpose a draught pole and a driver's seat are fitted on the truck. When the fire is reached the forward truck is to be removed, the manipulating lever is put in place, and two or more lines of hose are connected to the nipples, and the device is aimed by manipulation of the handle, and a solid stream combining the smaller streams is discharged at one point.

To protect the operators the truck is provided with a shield or screen, D, consisting of a frame covered with canvas and strengthened by rope or wire braces. The side bars of the frame are hinged or jointed, so that the shield can be folded compactly when not in use. A hose pipe with a spray nozzle is connected with the nozzle to keep the shield wet. These arrangements allow the firemen to approach closely to the fire with the nozzle.

This invention was recently patented by Mr. Daniel B. Lynch, of Grass Valley, Cal.—*Scientific American.*

SAFETY SHIELD FOR CIRCULAR SAWS.

In using circular saws as usually arranged the workman is in great and constant danger of maiming or destroying his hands or arms by bringing them into contact with the cutting edge of the saw. He is also in great danger of being struck by splinters, clocks, or boards which are liable to catch in back side of the saw and be hurled forward with sufficient force to injure or kill the workman.

The engraving shows a self-acting safety shield by which the descending or front part of the saw is automatically protected, so as to prevent anything coming into contact with this part of the saw until the shield is temporarily removed, for the purpose of sawing, and the shield is extended so as to shield or cover the back or ascending part of the saw to prevent anything from coming into contact with it there.

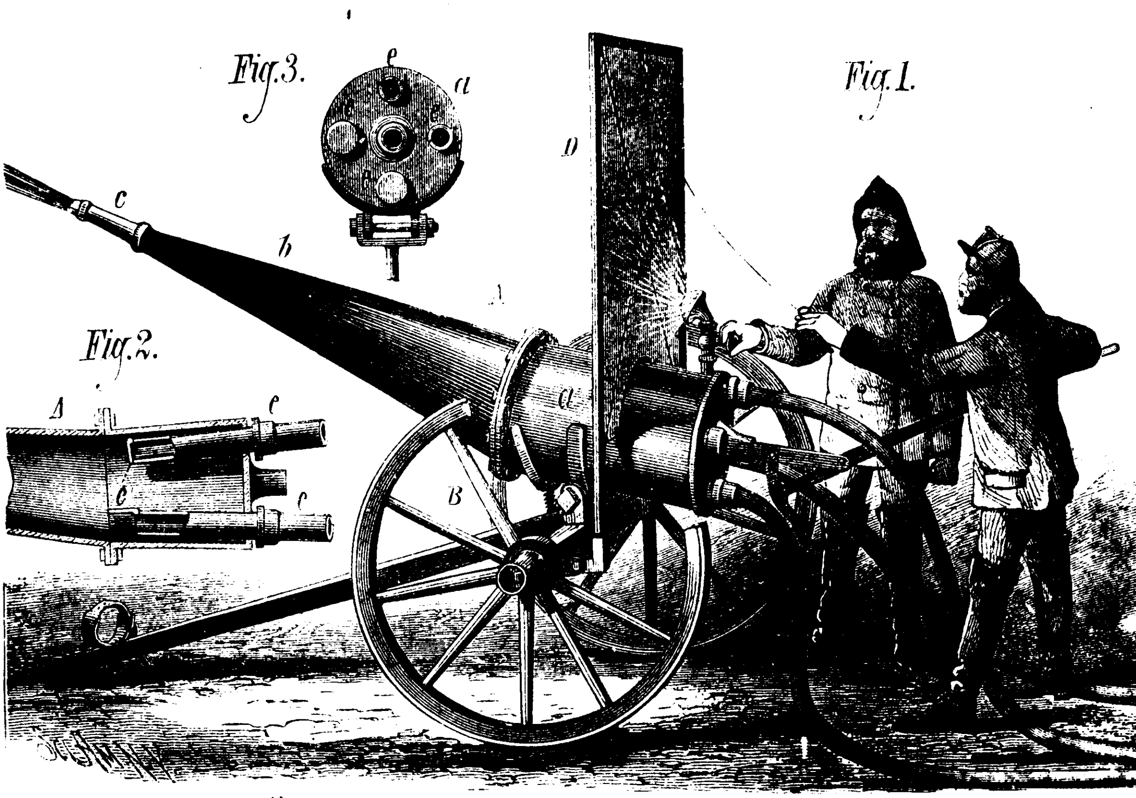
This self-acting safety shield is made of a plate of iron or steel, of about the thickness of the saw, the shield being curved to the radius of the saw, and is of sufficient breadth to give the proper rigidity. It is placed at a given distance from the teeth of the saw, and is provided with movable plates and adjustment slide and screw to suit the alterations in the diameter of the saw by wear, or the substition of smaller for larger saws, or stuff deeper than the cutting of the saw.

The shield is attached to an arm hung upon a stud concentric with the saw mandrel, and is balanced by a counterpoise under the table. The semi-circular shield is about 1½ inches deep and the same thickness as the saw. The forward end is so formed that the piece of timber to be cut raises the shield, but the latter rests upon the timber and forms an effectual guard which prevents the workman from bringing his hands or arms into contact with the cutting edge of the saw.

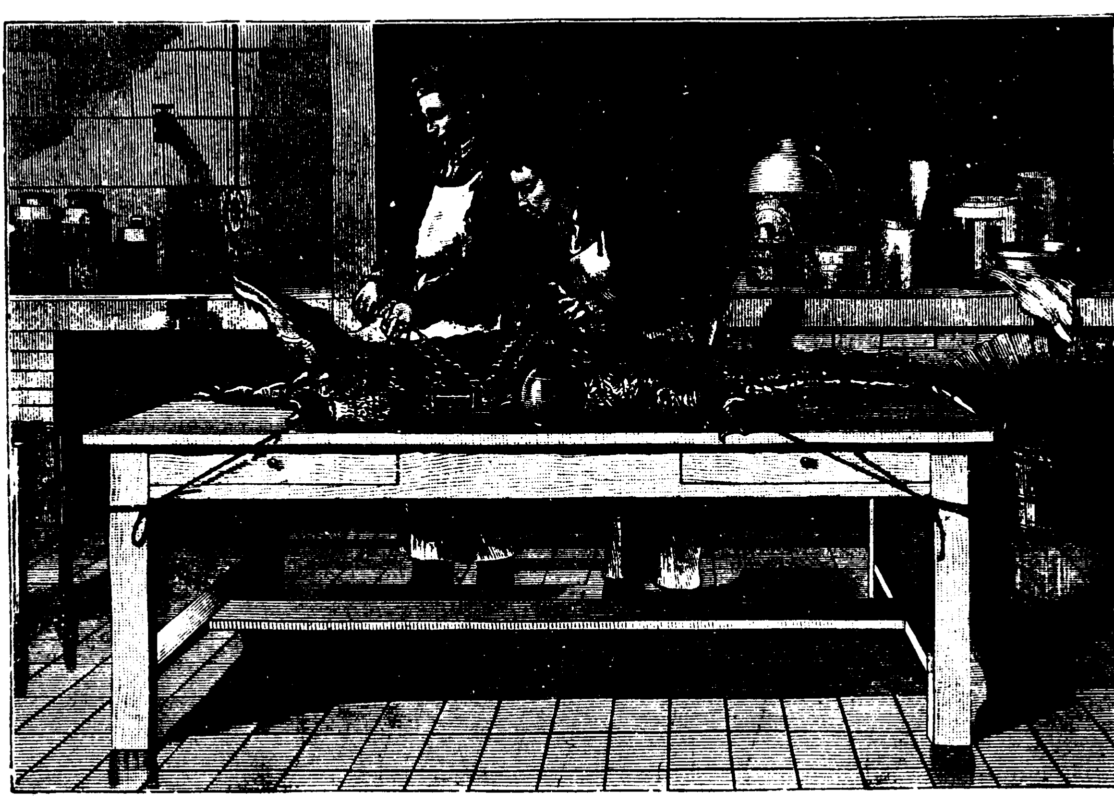
As soon as the timber has passed from the saw the shield returns to its original position, entirely covering the saw, and so remains until raised by the next piece of timber.

This device received the highest award at the trial at the Royal Agricultural Society at Derby, in July, 1881, and it will commend itself to all mechanics.

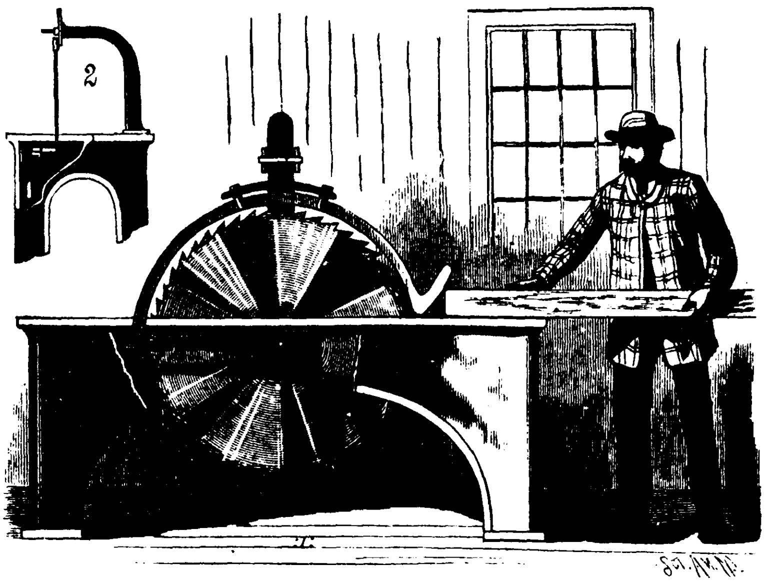
Further information may be obtained by addressing Mr. R. W. Taylor, Patent Safety Shield Works, Bury St. Edmunds, Suffolk, England.



LYNCH'S FIRE-EXTINGUISHING APPARATUS.



EXPERIMENT TO DETERMINE THE POWER OF A CROCODILE'S JAW.



TAYLOR'S SAFETY SHIELD FOR CIRCULAR SAWS.

THE JACKSON HEAT-SAVING AND VENTILATING GRATE.

Domestic.

THE JACKSON HEAT-SAVING AND VENTILATING GRATE.

It is a fact noticed by all who have made a study of the statistics of the sanitary condition of the American people, that the last half century has witnessed a startling increase in the number and kinds of diseases that have their origin, either immediate or remote, in the breathing of foul air—namely, that which is contaminated by the breath of human beings and by exhalations from their bodies, or is poisoned by emanations from decomposing matter that, in gaseous form, enter our dwellings, and remain there in consequence of defective ventilation.

With the increase of wealth and general culture, great progress has been made in protecting dwellings against cold and wind and storm, by making the walls weather-proof, the windows and doors impassable avenues to the winter blasts, and the fire-places sealed to the escape of heat generated within the walls. Elaborate and costly decorations adorn the walls, the floors and ceilings are beautiful to look upon; but in these artistic and costly homes "the blighting, withering curse of foul air is found," and the shadow of death rests over them all. In the struggle to keep the cold air out, the necessity for admitting an abundance of pure warm air into the dwelling is neglected, and the story of this neglect is written upon the pale faces of the children and imprinted upon the weakened fabric of their lives.

The effect of a temperature of the air in our houses a few degrees below that of the body, is almost immediately noticeable in a feeling of discomfort, and we soon seek to remedy the fault by perfecting the method of heating the rooms, or by preventing the entrance of cold air in them. But the effects of breathing a vitiated atmosphere (the impure condition of which in our dwellings is probably either brought about, or is maintained by the very means employed for increasing the temperature) are not immediately noticeable, and though so direful in their character are overlooked and neglected on that account. It is for this reason that any system of ventilation that depends upon the agency of the inmates of our dwellings for its regulation or its operation, is defective, and to a great extent valueless. This is the great fault of the prevalent system of ventilating by means of registers for the admission of pure cold air near the floor and for the emission of the warm and supposed impure air near the ceiling. Even if these work as they are theoretically supposed to, they will generally be found closed in cold weather, and their office thus entirely destroyed. But even where due diligence is taken to keep such ventilating registers always open, they generally fail to work satisfactorily; first, because the impurities of the atmosphere are not confined to the higher levels of the room near the exit registers; second, because when they operate, they carry off a large amount of *pure* heated air that is needed for comfort in the rooms; and thirdly, because they frequently will not work at all, since the exit registers do not communicate with heated flues.

It is a truth that is rapidly becoming recognized by householders, that the heating apparatus employed in the dwelling should also perform the office of a ventilator for it. The chimney has been aptly called the lungs of a house, and where its office is unobstructed, it may prove a very efficient ventilator. Dr. Hartshorne in the Health Primer entitled "Our Homes," says: "Every room in the house intended to be occupied, should have in it an open fire place. Especially it is important for an open fire-place to be in every sleeping-chamber. For a sick person, the difference between a wood fire on the hearth and the usual heated air or coal stove in the room, is immense. It may in critical cases make the turning point between death and recovery."

There are, however, two prominent objections to the open fire place, and to the ordinary form of fire-place grate: First, though they are excellent agencies for removing the air from the lower levels of the room (removing, as they frequently do, the whole air contents of the room once every fifteen or twenty minutes), they provide no means for supplying the vacuum thus produced, and thus they cause drafts of cold air about the windows and of impure air from the surrounding rooms. Second, they supply to the rooms in which they are placed but a very small fraction of the whole heat product of the fuel. From the careful tests of Gen. Morin, the deduction is made "that of the heat generated by the fuel in an ordinary fire-place, about one-eight only is utilized in the room."

The Jackson heat-saving and ventilating fire-place largely remedies both these defects. As will be seen by a reference to the accompanying engraving, fresh air from immediately outdoors is taken into a shaft directly under the grate, and enters a chamber beneath the fire, where it is partially heated, and thence passes into chambers surrounding the back and sides of the fire-place, and it conserves in these the heat that is usually lost in the brick-work of the fire-place. Passing thence in the direction of the arrows, this now heated current circulates about the tubular flues, five in number (one of which is distinctly shown in the cut), which convey the smoke to the chimney above. Finally, this heated air, which, it will be observed, is pure air from outside the building, enters the room through the open frieze of the grate-frame, and from its levity ascends in a current to the ceiling. A double office is thus fulfilled. A very large part of the heat usually lost in the fire-place is conserved and added to that directly radiated from the fire, making the grate equal in heating power to over three ordinary grates of the same size; and an amount of pure, warm air equal to that taken from the room by the exhaust of the chimney, enters from the heat-saving chambers, and thus all drafts from the windows and doors are prevented. A continually augmented volume of pure warm air, occupying the higher levels of the room, and a continual draft being made by the fire-place from the colder, impure air from the lower levels, keeps up a constant atmospheric circulation, and thus automatically the room is thoroughly ventilated.

The makers of this fire-place, Messrs. Edwin A. Jackson & Bro., of 315 East 28th street, New York, have these grates in use in nearly every State in the Union, where they are heating with them large rooms that ordinary grates would utterly fail to heat, and at the same time are most efficiently ventilating them. Reports were given from Michigan during the intensely cold weather of last winter, that one of these grates was thoroughly heating and ventilating rooms equal in size to one 20 feet wide by 25 feet long.

These grates by special adaptation, are arranged for setting in exterior or interior walls, and on any floor, also for the use of ash-pits where desired.—*Manufacturer and Builder.*

Educational.

MANUAL EDUCATION.

With the advent of machinery, says the *Shipping List*, the apprentice system, through which the members of the old guilds taught the art and mystery of their respective callings, has almost disappeared, and nothing has yet arisen in its place to teach the rising generation that manual dexterity which marks the complete master of his trade. The apprentice system was fitted to the old system of manufacturing by hand in the homes of the artisans, where the deftness of hand was taught to the apprentice by a number of years of more or less tentative practice. By a judicious application of the method of trial and error the youth became a workman of average skill in his vocation, greatly to the profit of his instructor. His long years of servitude may have seemed an extravagant price for his industrial education, but that education was at least thorough. The indentured apprentices who faithfully observed their contracts with their employers and instructors were almost invariably turned out excellent workmen.

But by the introduction of machinery, the concentration of capital and the division of labor, the perfect education which the old artisan or mechanic received is no longer profitably applicable to the conditions under which his art is prosecuted in most departments. For example, when a shoe is made by some twenty distinct operations, a knowledge of one of which is only necessary for the operatives engaged in its manufacture it is manifestly a waste of time and labor to teach each operative the manual dexterity required to adroitly perform the nineteen operations which he is not required to know. A perfect knowledge of shoemaking in all its branches, is therefore, no longer profitable to the large manufacturer, and hence the old system has almost passed away. And so it is in nearly all the other principal trades. Carpenters, capable of building a modern house in its entirety are no longer to be found, at least in cities and large towns, the work being divided into a dozen different trades. Yet the perfect knowledge of a trade in all its branches is essential to superior excellence in any special branch; for the mind must have a certain grasp of a subject in order to completely master its details. The great army of specialists which has grown out of the system of a division of labor are deficient in knowledge to enable them to intelligently fit their respective parts to the whole. A large percentage of the artisans of to-day are mere machine tenders, and as such they are inferior to what they would be if they were skilled artisans, and the consequence is a decline in the superiority of many of the products of labor.

We have surpassed the world in the invention of labor-saving machines, and in ingenious combinations of mechanical forces, while production has been greatly cheapened in respect to many things which were once luxuries, and which now add to the comfort of all but the very poorest households. But in those finer works in metal, and especially in the florid iron-work of a past age that is the wonder of modern artisans, we have nothing that will bear comparison. These and other examples of skilled handicraft teach us how much we have still to learn, and what before long, with the increase of wealth and luxury, may be required of our artisans and mechanics. Aside, however, from any such demands, the necessity of providing thorough training in mechanical and art industries is pressing upon us, especially in the way of employment for the rising generation, and the first step in progress towards skilled workmen and perfect work is to provide good trade schools for those who are ambitious to become masters in mechanism.

The want of these schools is happily beginning to be appreciated and supplied. The classes in industrial art established and maintained by the Metropolitan Museum of Art have already done good service in New York by the art education in skilled industries that they promote and encourage. Several trade schools have also been opened there for the purpose of making thorough, efficient, practical mechanics by teaching those who desire to earn a living by their trade, and by offering to others already engaged in various handicrafts the means of improving their knowledge of them, and of putting them in the way of becoming foremen and employers of labor. The work in the schools is conducted in the same manner as in a first-class shop, practical instruction being given by mechanics skilled in the different branches of their trade under the supervision of the manager of the schools. It is obvious that the intention of the promoters of these schools is to make thorough workmen and to lift mechanical operations to a higher plane than they have hitherto reached among us, and by this means to dignify the sphere of the workman. The want of such instruction, in the absence of the old guilds and of the training which they gave to the apprentices which they received as candidates for memberships has long been felt. It has led too often to careless work, and has prevented all but the energetic and studious few from becoming acquainted with the very highest branches of mechanical industries. The charge for a course of instruction in these schools is but a trifle, and all the materials required in the practical part of the business are furnished free of charge. We hope to see a rapid increase of these schools in our principal cities and large towns, as from their multiplication the best of results are to be looked for.

MANAGEMENT OF WORKMEN.

BY S. W. GOODYEAR.

How can it be possible to lay down any rigid rules by which the proprietor, superintendent or foreman shall be governed in his treatment or management of either journeymen or apprentices? With the fact before us that men differ so much in their capacity to learn, and in their temperaments and dispositions, coupled with the influence which family relations, or social surroundings may have upon men, often transforming the naturally careless man into one of the most painstaking of workmen, or on the other hand changing the best of workmen to the worst of "slouches," is it not rather the fact that the secret of successful management lies not in the direction of that impartial treatment which is so often recommended but in closely observing the differences in men, and treating them accordingly? It seems to be the opinion of some that the reason why certain foremen get so large a proportion of bad work from the men of whom they have charge, is because they do not often enough accord full praise for the good work which is done. Upon inspecting the job which the apprentice or journeyman has thought to be good enough, some foremen invariably have fault to find, or if not actually finding fault, they accept the work saying: "It will have to go I suppose." It may be very unpleasant to the really good workman, who knows what good work is, and takes pride in doing it, to work for a man who never appears to appreciate his endeavors. If, however, he is a true mechanic, this will not deter him from doing good work. His self-respect, and actual love of nice mechanical operations will keep him in the right track. Neither praise nor flattery are needed to get good work from such a man. On the other hand it is a fact that there are many mechanics who never do a job quite as well as it might or should be done, and to praise, or accept whose work as passable even, without cautioning them to do better next time, would be to them not an incentive to do better work in the future, but an encouragement to follow their natural inclination to see how poor a job they can make pass. There are men who must be handled as carefully as you would handle eggs, men with much spirit, extremely sensitive, on the watch continually for fear they will be either ill-treated or slighted. These are, nevertheless, in some cases, the best of workmen.

There are men who can be changed from one kind of work to another twenty times a day, ready to break off smilingly in the midst of a job, never annoyed, and always doing good work. Such a man is a prize, but no more so than the man who will scowl, and even growl or quit if you insist upon changing him about from one job to another. The latter individual is so constituted that when he commences a job he fully charges his mind with all the details from beginning to end, and to take him off until it is completed, disturbs him beyond his power of endurance. There are men who need driving up to get a fair day's work from them, and others who need holding back to prevent their work being slighted in their endeavors to do too much. Men and boys there are who have bright cheerful homes, whose lives outside the shop are kept pure through the influence of right-minded fathers and mothers, brothers and sisters, or wives and children; while others—away from relatives and friends, make a boarding house simply a place in which to eat and sleep, not a home, their leisure hours spent in amusements, or indulgences.

Many of the hours which should be devoted to sleep even, are spent by them in a manner which impairs both mental and physical abilities. There are those who are quick to comprehend, either by drawings or instructions, all the requirements of a job of work, and still others, who at a glance think they see the whole, and to any explanation are ready to say, "yes," "of course," "that's plain enough," yet still go on and make a "mess" of the whole job. Ultimately it is found that these individuals not only knew nothing about what they said so glibly, "yes, I understand," but that they have not the capacity to learn. Next come those of apparently dull comprehension, of whom there are some who can tell you truly they "don't see through it," and others who, not quick to see, will, if time be given them to investigate, never stop short of the most thorough understanding of the minutest details. Again, there are men who are so awkward as to be kept for months or years from attempting even to do any thing requiring skill and dexterity, but who, becoming piqued at the implied lack of confidence in their ability, determine to not only do, but to *excel in doing* at the first opportunity, that which has been supposed to be impossible for them learn to do even tolerably, and who succeed in their resolution. There are men of good natural ability as inventors, to snub whom, and to ignore whose many suggestions, is, to render them almost useless in the shop. On the other hand, there exist a class who continually suggest improvement in machinery and processes, whose plans it will never do to adopt. If those who talk so glibly about how to manage help, and how easy it is to always turn out good work, often saying that "it is just as easy and takes no longer to do work just right," would consider that the superintendent or foreman who get the blame when bad work passes through his hands is many times obliged to get along with men who not only do not understand, but have not the ability to learn what is right, they would change their minds about the easy duties of those who have charge of help.—*American Machinist.*

Some interesting contributions to a knowledge of hysteria have been made by M M. Dumont-pallier and Magnan, in a recent note to the Paris Academy: and it would appear that phenomena in hysteric persons, attributed to a mysterious radiating *neuric* or nerve force in the person producing them, may be explained more simply as results of mere physical action, on a state of greatly exalted sensibility. One experiment proving this remarkable sensibility, consisted in bringing one end of a caoutchouc tube, about 20 ft. long, near the foot of a patient, while a watch was brought to a speaking trumpet at the other end of the tube. The foot was at once set in rhythmic motion, the movements responding exactly to the ticking of the watch.

WORKSHOP SKETCHING.

BY JOSHUA ROSE, M. E.

It has been remarked that just so many views of a piece of work are necessary as will suffice to contain all the figured dimensions of the piece without requiring to mention in writing the shape of the piece or any part of it. Illustrations of

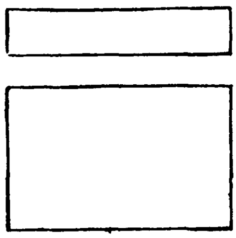


Fig. 1.

this are given in the engravings. Fig. 1 represents a rectangular in which but two views are necessary for the purpose. A view of one side and one edge gives all the dimensions of the piece. Suppose the piece to be wedge-shaped in any direction; then another view will be necessary, as is shown in Figs. 2 and 3. In the former the wedge or taper is in the direction of its thickness.

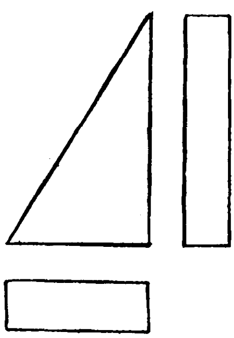


Fig. 2.

As an example of a case in which three views are necessary, let us take a piece such as in Fig. 4, where at *A* is an end view, at *B* and *C* two side views and at *D* an edge view, and we shall observe that from *A*, *B* and *C* alone we could not obtain a full idea of the piece, although all the dimensions could be marked thereon.

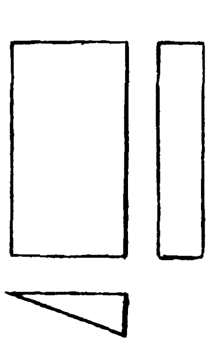


Fig. 3.

This occurs because the two side views are alike, but neither of them shows that the piece is wedge-shaped on two sides as shown at *D*. The point *E* is supposed to come to a fine edge, and therefore to have no sensible thickness. In the absence of any lines, the point *E* would always be assumed to be in the centre of the piece, it being understood that if it were to be to one side of the centre piece a centre line would be drawn so as to show how much it is to be to one side.

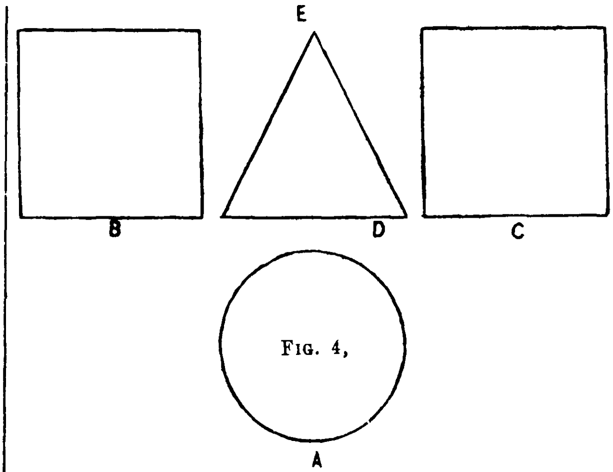


Fig. 4,

There are many cases in which a third view may be avoided by line shading, wherein a side and an edge view are given, the line shading showing that the piece is round at its base and on its edges, and that it is taper. A side and an end view—the latter being line shaded—will show the same thing, although less clearly, since it has to be assumed that the sides of the taper are flat from the character of the shading.

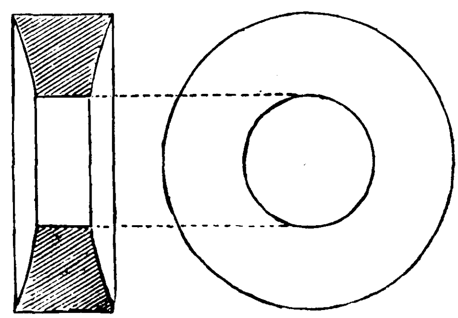


Fig. 5.

But there is more work in the line shading than in the extra oultine view, which is therefore preferable, especially since the dimension figures would show more clearly. Outline views, however, will not in some cases show the form of the figure, however many views be presented. An example of this kind,

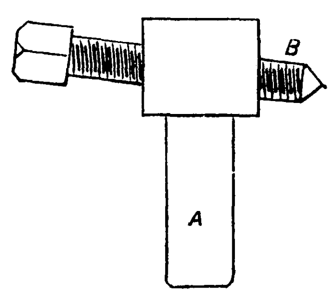
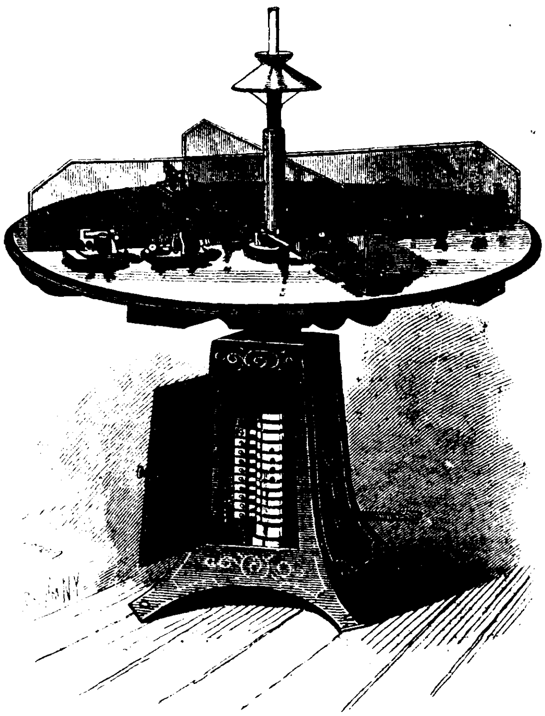


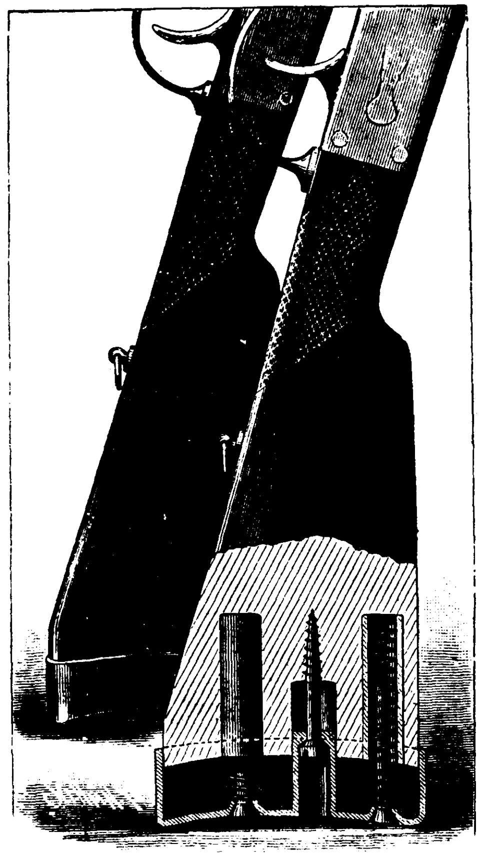
Fig. 6.

which occurs frequently in practice, is a cupped ring such as shown in Fig. 5.

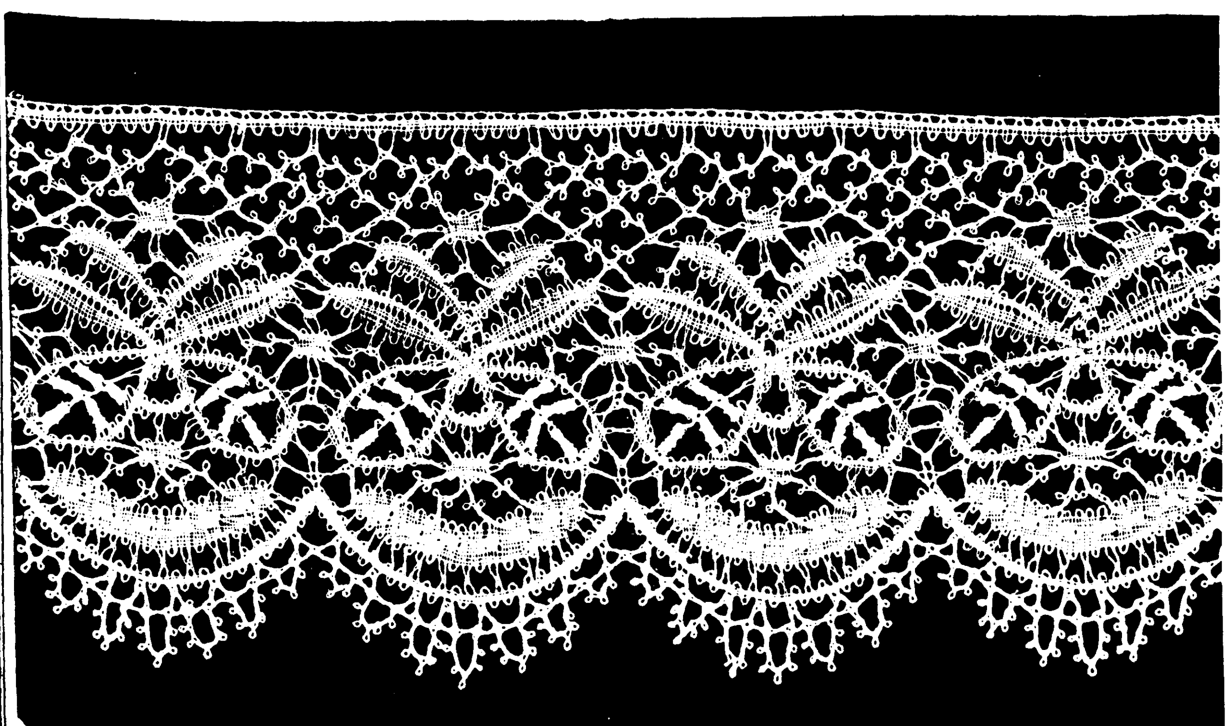
Fig. 6 shows an example in which a piece having a screw passing through a square head and having a plain round stem may be shown in one view. The screw is shown by the lines denoting its thread, its head obviously being square, with the corners chamfered. That the head is square is shown by the fact that its junction with the body is shown by a straight line, which would not be the case with any other than a square head.—*Machinist & Wheelwright.*



Garber's Revolving Telegraph Table.



White's Cushioned Gun Stock.



SPECIMEN OF CELLULOID PRINTING PLATE.

Miscellaneous.

REVOLVING TELEGRAPH TABLE

The engraving shows an improved revolving telegraph table patented by Mr. John L. Garber, of Greeneville, Ohio. The table is divided by glass partitions into a series of subdivisions for the several sets of instruments. Each compartment of the table requires four strips or rings of metal around the central post, a separated insulated wire leading from each ring to their respective instruments on the table, the wires being placed in a shallow groove directly back of the rings and metal collar. The central post revolves in the central hollow leg of the table, and the hollow leg is provided with a series of contact springs, consisting of a segmental plate attached to a countersunk stem fitting into a socket and pressed against the plates or rings of the central post by a spiral spring, these contact springs or their sockets are connected with the local battery or main line. To the under side of the table is fastened a perforated ring, into the aperture of which a vertical locking bar fits, which is pressed upward by a suitable spring, and can be withdrawn by depressing a foot lever on the under side of the base frame of the table.

For conveniently illuminating the different sections of the table a lamp or gas burner is mounted at the intersections of the glass partition of the table. When the operator wishes to use any certain set of instruments he depresses the foot lever, which permits the table to be turned until the desired set of instruments is in front of the operator, who does not leave his seat. The foot lever being released the table is locked in position. This table may be arranged for two, three, or more sets of instruments, the number of rings and contact springs varying accordingly.

The advantages of this device will be apparent to telegraphic engineers and operators. The removal or insertion of switch plugs or the turning of switches is entirely avoided, the necessary changes being made automatically as the table is turned.

IMPROVED CUSHIONED GUN STOCK.

The engraving represents an adjustable and yielding gun stock lately patented by Mr. Hiram W. White, of Yankton, Dakota Territory. The gun stock is made in the usual form, except at the butt, where opposite sides are made parallel for a short distance to receive the yielding butt, which caps over it, and is capable of sliding on or off the butt within prescribed limits.

The butt has an inwardly projecting thimble or socket near the middle for receiving a long screw that extends into the wood of the stock and serves to adjust the butt and to limit its outward movement.

From the butt two parallel guide pins project into guide holes in the stock, and are surrounded by spiral springs, which tend to press the butt outward as far as the adjustment of the screw will permit.

This construction renders the butt of the gun elastic, so that the shock of the recoil will be modified so as to be scarcely noticeable. The degree of elasticity can be adjusted by turning the screw in or out, so as to suit the strength of the gunner or weight of the gun, and the strength of the charges fired from the gun.

The length of the stock may be varied by turning the screw in or out to adapt the length of the stock to the gunner's arm.

Another advantage in this improved stock is that there is no tendency to raise or tilt the muzzle, and thus detract from the accuracy of the aim at the instant of firing.

This invention while it adds very slightly to the expense of a gun, greatly increases the facility and comfort in using it. The engraving shows a sectional view and also an external view.

PRINTING PLATES OF CELLULOID.

One of the latest applications of the remarkable material known as celluloid, and one that promises to become in time very useful and valuable, is its employment in the preparation of printing surfaces, as a substitute for the common stereotype and electrotype. At common temperatures, celluloid is an exceedingly tough, highly elastic substance, possessing sufficient hardness to withstand the roughest usage in the press, and being at the same time quite indifferent towards most chemical reagents, it is affirmed that it can be used with great success in printing with the most sensitive and brilliant colors for which the copper faced electrotype or the stereotype could not be employed, because of the chemical action of the metallic surfaces upon the colors.

Celluloid possesses the property of softening or becoming plastic at a moderate temperature, a property which is taken advantage of in the numerous applications of the substance to mold or press it into various shapes and forms. In the production of printing plates, this property is likewise made use of to press, with suitable appliances, a sheet of celluloid, properly softened with the aid of heat, into the surface of the engraving, or a plaster cast of the same, or a page of type to be copied. When removed, and cemented to a block of wood type-high, the celluloid printing plate is ready for the press. The operation, as will be inferred from the foregoing statement, is an excedingly simple one. When it is not important whether the lines of the print should be reversed, the celluloid plate may be prepared directly from the engraving or object to be copied. In copying samples of lace and other delicate textures, leaves, ferns, and many other materials and objects, the impression is made directly by pressing the object to be copied into the surface of the plastic celluloid. The plate then requires simply to be cemented to the wooden block to be ready at once for the press. Such blocks being taken directly from the object are absolutely correct fac-similes, such as could only be approached by photography.

By this means the most delicate lace patterns are reproduced cheaply, and with the greatest ease and the most exquisite detail; and leaves, ferns and the like with all their delicate veining. The total absence of "grain" in the celluloid renders it possible to secure a perfectly smooth, glassy surface, from which these exquisitely delicate impressions can be printed far better than from a metal surface, even were it possible to produce from results in metal. The utility of the celluloid plates for producing fac-similes of the most delicate textile fabric, prints of which can be mailed as samples, and the advantage they afford in the preparation of plates for illustrating many subjects of natural history, are too obvious to require more than mention.

The durability of the celluloid printing plates is represented to be considerably greater than that of metal plates, this superiority being due to the great toughness and elasticity of the substance, which resists the breaking-down and wearing of the fine lines in the press. The impressions yielded by the celluloid plates, also, by reason of the perfectly smooth surface of the substance in the raised portions, are affirmed to be very much superior to anything that can be obtained from metal stereotypes or electrotypes. We have seen prints of lace patterns taken from plates prepared by direct impression, that were simply exquisite, and far ahead of anything that could be produced in metal by the processes now in use. The fact that the celluloid plates can be used with the most delicate and sensitive colored inks has already been mentioned.

A plate of this kind is shown in the accompanying illustration, from which an idea of the extreme delicacy of the work it is possible to execute in celluloid may be had. This work is now being done by the Celluloid Stereotype Company, of No. 11 Frankfort street, New York.

We regard this latest adaptation of celluloid as being the most useful and valuable of the applications of this remarkable substance, and anticipate that it will soon come into very general use.—*Manufacturer and Builder.*

SAFETY IN RAILWAY TRAVELLING.

The dreadful disaster on the Hudson River Railway, at Spuyten Duyvil, on Friday evening, the 13th of last January, has naturally filled the traveling public with dismay and attracted the attention of all thoughtful men toward ways and means for preventing similar catastrophes. Properly speaking this horrible affair cannot be called an accident since it appears that it was the result of the most reprehensible carelessness and recklessness on the part of both the passengers and those in charge of the train and the track.

It is admitted that a train has a right to stop at any point on the track for any cause. Even if the air brake was set in action by an unauthorized person, bringing the train to a standstill, this was no excuse for the train following to plunge into it. The point lies in a defective system of back signaling for warning approaching trains in time that for some cause or other the train ahead has been stopped. Says the *American Railroad Journal:* "The local train which followed the Albany express was not stopped in this case, and under the system it is not necessarily surprising, though it is shameful beyond expression that it was not. The rules of the railroad company were sufficiently explicit in this matter, but there was no guarantee of their being carried out save the faithfulness and ability of two men, the brakeman at the rear of the express train and the engineer of the local. The disability or carelessness of either one of these men must result in destructive consequences. This is the risk in all such cases where the sole dependence is upon one man, and this risk is very conspicuous in the case of a man stationed at the rear of a long train, where his movements cannot be watched by a superior officer, or his disability noticed and promptly met by a companion."

In this connection there is an interesting article in a recent issue of the London *Lancet*, on

BRAIN WORK AND SIGNAL MEN,

which points out how dangerous it is to depend upon any one man to discharge uninterruptedly the peculiar duties of a switchman or signalman for any given length of time. Says the *Lancet*:

"No one who has any practical acquaintance with the working of the human brain should fail to recognize the fatuity of a policy which intrusts the safety of many thousand lives and limbs to the integrity and precision of mental functions performed by one brain continuously during several successive hours. Let any student of psychology apply scientific tests to the operation of his own brain for even two or three hours at a stretch, and then say whether such sustained attention as is requisite for the precise discharge of duties such as those which devolve on a railway pointsman can be reasonably expected of it. We have no hesitation in asserting that the demand made on the attention of the officials placed in the signal boxes at junctions where there is much traffic is monstrous. In the nature of things physical there must be periods when memory fails and the mind is wandering. If it were not for the "habit" formed by practice, the task imposed could not be performed. The higher cerebral centres are, to some extent, relieved of the strain put upon them by delegating a large share of their proper work to the lower automatic centres; but even with this relief the tension is excessive, and the way in which some measure of ease is purchased by "habit" is in itself a source of special peril. Now, we contend that such work as involves the safety of railway trains, with their crowded carriages, should never be done automatically. The signalman or the pointsman ought always to exercise judgment in reference to each particular act he performs. His hours of labor should be so regulated that he shall be able to keep up an intelligent consciousness of what he is doing; and he should at all times have another brain—not the brain of a boy, but that of a man as well skilled as himself—to aid and sustain his own mental efforts. We shall be told that this would greatly increase the cost of working railways. Let it be conceded that it would probably double the expense. Nevertheless, we say no signalman or pointsman should be allowed to work from "habit," automatically—as most of the men now do—and no signalman or pointsman should work singly, that is, without the assistance of a man equal to himself in point of intelligence and experience. Any one of a score of physical accidents may befall the brain at any moment without the least warning, and some of these contingencies are peculiarly likely to occur in a man shut up in a signal box for several successive hours. He may have vertigo, congestions or bloodlessness of the brain, confusion of thought, loss of memory, from either of several physiological conditions. He may have transient attacks of epilepsy, or such slight but mentally potent arrests or excesses of function as occasionally ensue when the circulation is disturbed from any cause, possibly even a passing dyspepsia, or a slight chill of the surface or hunger. When the lives of hundreds of confiding passengers are made to depend for safety on the perfect integrity of a single brain, with no better excuse than it would cost more to retain another brain in aid of the first, we cannot help thinking the greed of dividends has reached a point at which public opinion may be fairly asked to express itself."

THE BLOCK SYSTEM.

This system of signals is much advocated by certain journals. The *Railroad Journal* says: "One of the chief results of it is that the absence from his post of the signalman or his disability leaves the signal in such a manner as to notify the engineer to stop, which the rules require him to do in all cases until the signal indicates that the "block" ahead is clear. In cases where this system is not used there evidently is an imperative need that there should be some one on the train whose first duty it should be in the case of an accident or an unusual stop to see that every trainman is at his post, and especially that no disability or carelessness has prevented the brakeman on the rear car from performing his important duties." But even this system cannot be depended upon. On the 9th of December there was a terrible accident in the Canonbury Tunnel, England, when no less than four passenger trains came together which were run on the block system. Says the *Mercantile Gazette* of London, for December 16th: "We have evidence that the block system in which so much confidence has been placed is in the hands of incompetent or careless servants itself a source of danger." The General Superintendent of the N. Y. Central and Hudson River Railway testified in the matter of the Spuyten Duyvil horror, that the block system of signals is used at the Grand Central Depot in New York, but that on the Pennsylvania Railway, where it is in use, a number of collisions have occurred. It would seem therefore that some system of automatic signals must be devised which will be operated with unerring certainty by the train itself, so that every train moving along a track shall announce to a train following its exact position. As we have shown, human brains cannot be depended upon. Here is a field for inventors to exercise their skill.

APPLIANCES FOR SAVING LIFE.

The horrors of this disaster were increased by the fact that, as usual after a collision, the train took fire and the imprisoned passengers were destroyed. There were neither axes, hooks, ladders, buckets, extinguishers, or any other appliances at hand for rescuing passengers and saving life. When cars may be heated by steam and illuminated with electricity, it is criminal neglect to use open stoves and sperm oil, and in the light of recent events it seems that every car should possess a complete equipment of appliances for extinguishing fire and rescuing imprisoned passengers. A passenger testified that an entrance through the splintered car could have been made in two minutes with axes, and such passengers as were alive rescued. It would seem that the time has come when legislative action must be invoked to compel all railway officials to make use of the latest and best improvements for the safety of the traveling public.—*Industrial News*.

Architecture and Building.

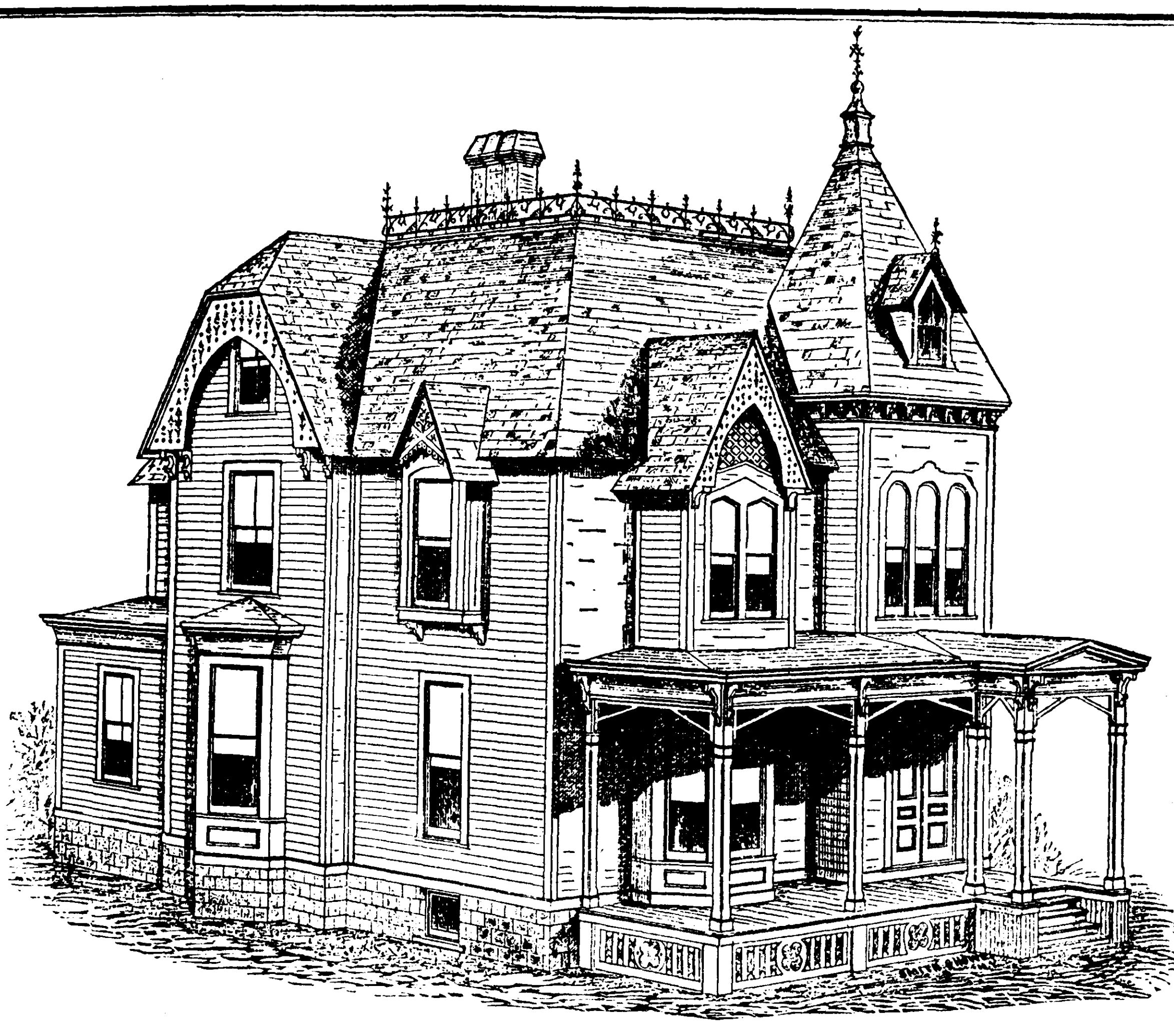
DESIGN FOR SUBURBAN RESIDENCE.

The suburban residence illustrated on the opposite page, was recently erected for Mr. W. A. Smith, at Richfield Springs, N. Y., and gives evidence in its admirably arranged interior, and well broken exterior, of an intention well carried out to combine comfort and beauty without extravagance.

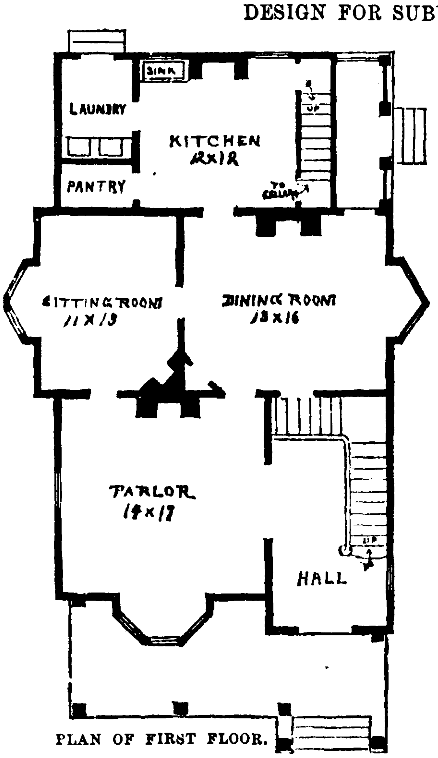
The large entrance hall is in itself suggestive of hospitality, while the bay-window in each of the three principal rooms gives to them an air of cheerfulness and comfort fully in keeping with this impression, enhanced by the open fire-place in each room, that in the sitting-room being a cosy affair tucked up in a corner.

The space in the bedroom story appears to have been utilized in a most economical manner, and it would seem hard to make a better arrangement of the same number of bedrooms and closets, for each bedroom is provided with a closet, and an extra one—presumably for linen—is shown in the hall.

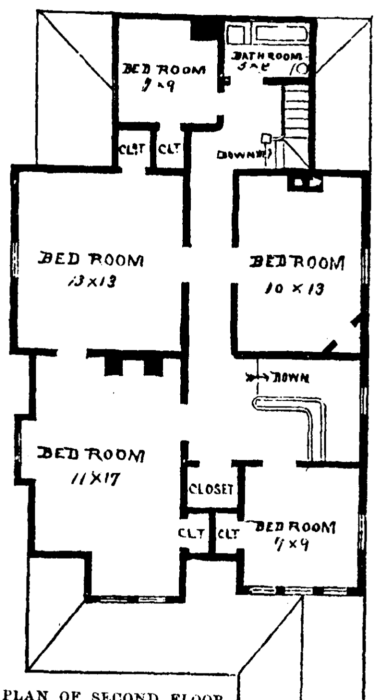
Good judgment is shown in breaking the lines of the exterior of the house, a few simple devices serving to give life to it all. A glance at the architect's specification shows that while the ultimate cost of ehe house has been kept in view, nothing has been done that would in any way affect its strength. The size of some of the timbers are here given; Beams in first story, 2 x 10 inches, set 16 inches to centers; in second and attic stories, 2 x 9 inches, 16 inches to centers, each tier having cross- bridging; the sills, 4 x 10 inches; the plate is two 3 x 4's spiked together; the studs are 2 x 4 inches, the window and door studs being 3 x 4 inches. The building is sheathed and covered with felt paper, and then clapboarded. The roof is shingled. The interior finish is pine, wood-filled and shellacked. Inside blinds are used, and are made of butternut, the slats being of ash. The cost is about $3,000.



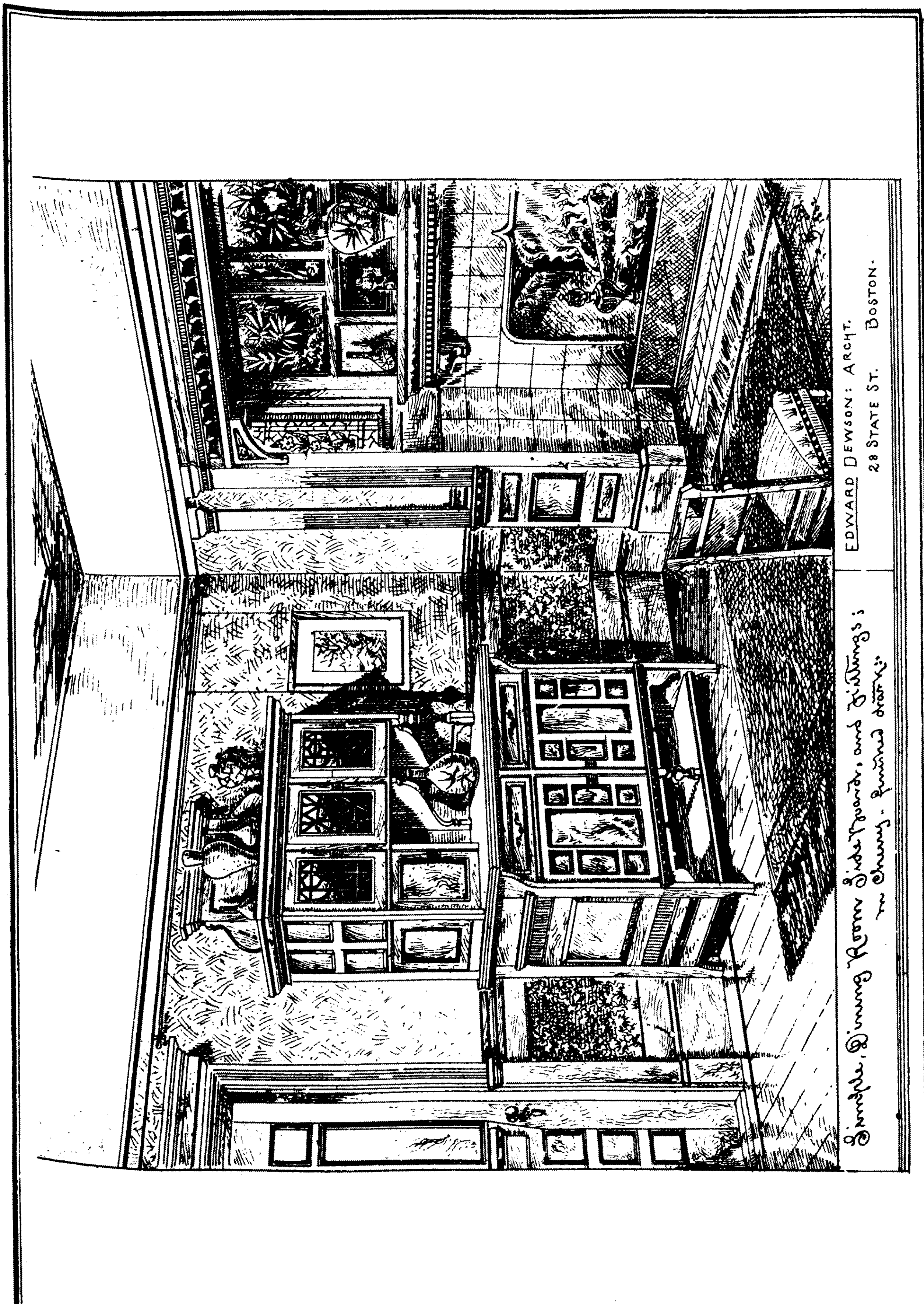
DESIGN FOR SUBURBAN RESIDENCE, COSTING $3,000.



PLAN OF FIRST FLOOR.



PLAN OF SECOND FLOOR.


Simple, Dining Room Sideboard, and Fittings;
EDWARD DEWSON: ARCHT.
28 STATE ST. BOSTON.

Cabinet Making.

RE-GILDING PICTURE FRAMES.

The tools required for the job are the following: A pint basin with a lip, two moderate sponges, and two small finger sponges, three fitches, one flat, ¼ in. wide, one round ¼ in., and one ⅜ in. or ½ in., round. We will count these three one set, for sizing. You will want another set for whiting, another for claying, one fitch for skewing, one small sash-tool for washing off, and one about 1 in. in diameter for duster, a gilder's cushion, a gilder's tip, a camel-hair dabber, a gilder's knife, some fat pipeclay, some prepared whiting, some plumbago, oil gold-size, crystal size, or parchment cuttings to make some, two agate burnishers, one round, about the diameter of a goose-quill, and one oval, larger, or about double the above on the broad part, and some composition made of glue, whiting and linseed oil. The picture taken from the frame, dust well, and proceed to wash off with clean water, not letting your brush hold too much, to make your work too wet. When washed off, let stand by for some time to get dry and steady. Now is your time to make all ornamental work good, or repairs. To work the compo you will need two pieces of brass wire, one about ¼ inches and one about ⅛ inches full, bent in the shape of an *f*, the ends being flattened to form a kind of trowel in miniature, such as are used by artists in clay modeling. Make your compo warm, and work it well, that it may not work lumpy. Having some hot glue, dab some upon the sore place, press your compo upon it; in a few minutes you may proceed to shape it to correspond to the rest of the pattern. Having made all things shipshape, that which is to be matt, *i.e.*, the bottom of design, is to be laid down with gold size very sparingly, and after that has been gilded, if the prominent parts or that which is in relief is to be burnished, it is to be sized and clayed; then, after being allowed to dry, another coat of weak size; this is allowed to dry. When you are about to lay the gold on, wet it with clean water. The oil gold-size will take from two to five hours before it will be fit to receive the gold, and will depend, in a great measure, upon the weather. This oil gold-size is composed of prepared linseed-oil, very finely ground litharge, and stone ochre. The cushion-knife and tip can be dispensed with, although these and the dabber are all held in the hands when laying on the gold by the professional. The cushion is a board about the dimensions of a half-sheet of note paper, the back half of which is walled around with a piece of parchment about 2½ in. high; the floor of the cushion is wash-leather, as it is usually called, prepared with red chalk; on the under side is a strap to strap it upon your thumb, or the gilder's thumb of the left hand, the hooded or walled part projecting over the back of the hand, the fingers being curled.

The tip is placed between the second and third finger, and the knife between the little finger and next, and the dabber between the forefinger and thumb. He takes a book of gold and shakes out three or four leaves into the hood—pell-mell as it would seem to the uninitiated, places the book down in a safe place, takes the knife and picks up one of the leaves and tosses it about, gives it a puff of wind from his lips, and there it is spread out upon the cushion without a wrinkle in it. He then proceeds to carve it up into the shape or size pieces that he sees most convenient to cover his job. He then returns the knife to its proper plaee, and takes the tip, which is some long badger hair between some card for a handle. He whisks the tip over the hair upon his head or down his whiskers, and applies it to a piece of the leaf gold; it instantly picks it up like a magnet. By these means he conveys and deposits the gold where required, replaces the tip, and takes the dabber and dabs it down. Some will dab with the dabber between the little finger and next upon the right hand with the dabbing part outside, and will pick up and dab and cover a frame in a few seconds. After covering (see that it is all covered) let stand for an hour or two, and skew off. That is done by the skewing fitch; the tool is held between the thumb and forefinger of the right hand, and pressed lightly down upon the gold, and a slight skewing or twisting action given to it, and the fine gold or pounce liberated by the action is skewed by the same action into the interstices and angles of the pattern that the dabber could not get at. Continue this action with the powder under your brush, until you have gone around your frame; then skew your gold powder off on to a highly glazed piece of paper and preserve. When you commence gilding, the best plan is to spread a sheet of manilla paper under your work—this is a very highly glazed paper of a whitey-brown hue, and very tough; the parts to be burnished should have at least two coats of size and whiting and of clay before gold is laid on. Thus far I have spoken about the matt and ornamental work; now for the dead and burnished. Having washed and repaired mitres, etc., and set aside to steady or dry, have some No. 1 glass paper and rub down with finger or cork rubber. Give one coat of parchment size and whiting; the size must not be too thick or thin, that it will not congeal at the ordinary temperature of the room or atmosphere. But the test of the thumb and finger is the best criterion to go by; if too thick your work will peel off when placed in a warm room, or on a hot summer's day. If new work, a coat of weak size first, next whiting and size; let dry and rub down. A second coat, dry and rub down, then a coat of clay, then drop down and go over with weak size, and set by to dry. When dry see that there are no cracks or chance of its peeling off. Then, with clean water and soft brush lightly damp, and lay the gold on immediately after and dab down. Let stand by to dry. The flat remaining dead, the hollow or bead may be burnished. The burnishers here mentioned are curved like a horn that you can get into a hollow, a quirk, or over a bead. When completed so far, you may either size or varnish; but let me tell you that neither improve gilding.

It is usual to size matt and ornamented work and dead upon moldings. It is a great protection against dust. If not sized, it would soon be smothered in dust, and no dusting or washing would remove it or improve it. Now for sizing: Take a clove of garlic about as thick as a quill, and finely grind up with a little water. Mix with a couple of tablespoonfuls, let settle and filter. Dissolve size in it and apply. This will lay the rough surface, and is said to protect it from that nuisance, fly-soils, but if you would like to varnish that, you may remove the fly-soils with impunity. Take ½ oz. gum-sandarac to half-pint good spirits of wine, and in another small phial (about an ounce), put one pennyworth of saffron. When the former is dissolved and settled clear, pour off, and add some few drops of stain until of the desired color; go over the gold with a coat of very weak size, and, when dry, varnish and turn upside down to dry free from dust. The way I have made oil gold size—take, say a pound of white lead and red lead, mix with half-pint of good raw linseed oil, pour about a gill of boiling water into it; when well mixed up let stand for a day, then add another half-pint of oil, and well stir up twice a day (morning and night), and in a few days you will have a beautifully clear, fat oil, almost colorless; this must be mixed or ground up with stone ochre and litharge, not as a paint, but as a stain, and to render it siccative; this may, when prepared, be kept some considerable time, without drying, in a jar or gallipot, if covered with a piece of paper, dressing the top with oil, but will dry in a very little time when put on very thin, as for gilding, as I said before, subject to the state of the weather. I have known it to be ready in an hour, and not to have been fit in five hours. Being a great fumbler with the cushiontip, etc., through not having practice, your humble servant used to cut his books in half from front to back, or into three, and fish out with a small damp fitch or camel-hair pencil, and deposit and dab down. Deep, extra deep gold, is used for the purpose. If you prepare your own whiting, it must be well washed, and remain to allow the coarse to settle a few seconds, and then decant it into another jar to settle; finally, make a tray of a square of blotting-paper double, pinch up the corners, and put upon a Bath-brick; pour the water off as far as you can, and the thick into the tray. The brick and paper will soon absorb the water, and your whiting, after the paper covers are taken off, will be free from grit, and may be placed in a jar or bottle fit for use. Your plumbago must be served the same, and your clay, and about two per cent. plumbago is mixed and washed with your clay, after being washed separate, and your clay is fit for use. By the Bath-brick the liquor is absorbed very readily, and preparations of this kind, and precipitates, filters, etc., reduced to a minimum of trouble. Your sponges you will find use for in case of swamping.—*American Cabinet Maker.*

When a sound is produced near the sounding-board of a piano, the chords in unison with the sound, or with one of its harmonies, are, it is known, set vibrating. M. Bourbouze has lately observed that if a microphone be applied to the sounding-board, the sound transmitted in a telephone-circuit is considerably strengthened, and neither the distinctness nor timbre of the voice are sensibly affected. Thus, with a sounding-board containing three octaves (the extent of the voice), and a carbon microphone on the side opposite that of the strings, he makes a very sensitive transmitter.

Fine Arts.

REMOVING PRINTS FROM THEIR MOUNTS.

It is by no means an unusual circumstance that, for some reason or other, it becomes necessary to remove a photograph from its mount. Possibly it is mounted on the page of an album, and it may be desired to frame it or transfer it to another; or, on the contrary, it may be framed and it is desirable to place it in an album; or, again, the style of frame and mount is not in accord with others with which it is to hang, or, what is by no means improbable, the print has faded, and it becomes necessary to replace it with a fresh one, retaining the original mount, which bears an autograph that it is important to preserve.

Now, the removal of a print from its mount—as, no doubt, many from experience are aware—frequently proves to be by no means such a simple operation as at first sight it may appear, and the attempt often leads to the destruction of a valuable picture, or—what in some cases is an equal misfortune—the original mount is injured to such an extent that it becomes worthless.

If we could always ascertain the mountant employed much trouble would be saved, as we should then at once know how to proceed. In the present instance we shall assume that we are entirely ignorant of it. The first thing to do supposing the print to be framed, is to take it out, and, if it be in a cut-out mount, to remove that. If the print were framed by a photographer, in all probability it would be simply secured to the mount by strips of gum paper; but if by a picture-frame maker or a professional mounter, it will, no doubt, be glued to the mount, in which case, unless care be taken in separating it, the picture may be torn at the edges. The best plan is to gently force it away from the mount by passing the blade of a palette knife round the opening from the inside. After removal the picture is closely examined to see if any clew can be obtained as to the kind of cement with which it is attached. If it be "rough mounted," probably some of it may have exuded from the edges, and then its color may serve as a guide; for if it be dark in color it is no doubt either glue or dextrine, and if the former it may be detected by wetting it with saliva, when its well known odor will be developed.

India rubber has been so little employed as a mountant that the probability of that having been used is somewhat remote; yet it may have been. In that case, if the picture have been but recently mounted, it may sometimes be removed by raising one corner with the point of a penknife, and then gently peeling it off; or, if the mounting be of an old date, possibly the India rubber may have perished, and then its removal is easy enough. Failing this the picture must be saturated with benzole, and this will soften the rubber and permit of an easy removal. If the mount be of plate paper the benzole is better applied from the back.

We will now suppose that India rubber was not the mountant employed; therefore the print should be immersed in clean cold water, where it may be allowed to soak for an hour or two, trying it from time to time to see if the mountant has softened at all. If so, a longer immersion will, no doubt, allow of its removal. If, on the contrary, after several hours' soaking the cement show no signs of yielding, the print should be put into warm water for a quarter of an hour or so, when, if the mountant be glue or gelatine, the print and mount will be easily separated.

With this treatment most of those materials that are employed for mounting photographs will have yielded, but there are some kinds of starch which will obstinately resist it—even after many hours' soaking in both hot and cold water. When we get an obstinate case such as this, it is better to abandon the idea of removing the print from the mount, but to reverse the order of procedure and remove the mount from the print. Doubtless, from the prolonged soaking, the mount itself will have shown signs of succumbing, and we, therefore, proceed to separate the sheets of paper of which it is composed (one by one) until we get to the last—that to which the print is attached. It is now removed from the water, placed face downward on a plate of glass, and flooded with warm water. The paper is now abraded and carefully rubbed off, bit by bit, with the finger, and with care and patience it may be entirely removed without injury to the picture.

Supposing the print has been mounted in an album, the treatment above described cannot be applied. We must, therefore, proceed as follows: First get two plates of tin, or pieces of waterproof paper (such as are employed in copying books), somewhat larger than the pages, and several sheets of damp, white blotting-paper a little smaller. Now place several sheets of the latter at the back and front of the leaf carrying the print, inclose the whole between the tin plates, and put them under pressure. The tin plates will effectually protect the other leaves of the album from the moisture. After resting for an hour or two (during which time the blotting-paper must be kept damp), if the print cannot be removed the blotting paper should be ironed with a hot laundry iron. After this treatment the print can no doubt be easily removed, and any adherent cement cleaned off with a soft sponge and warm water. The leaf is then pressed between several thicknesses of dry blotting-paper; after which sponged both back and front with strong alcohol, and again blotted off. If this treatment be repeated several times the alcohol will remove the greater of the water, and the leaf when dry will not be nearly so much cockled as if it were allowed to dry spontaneously.

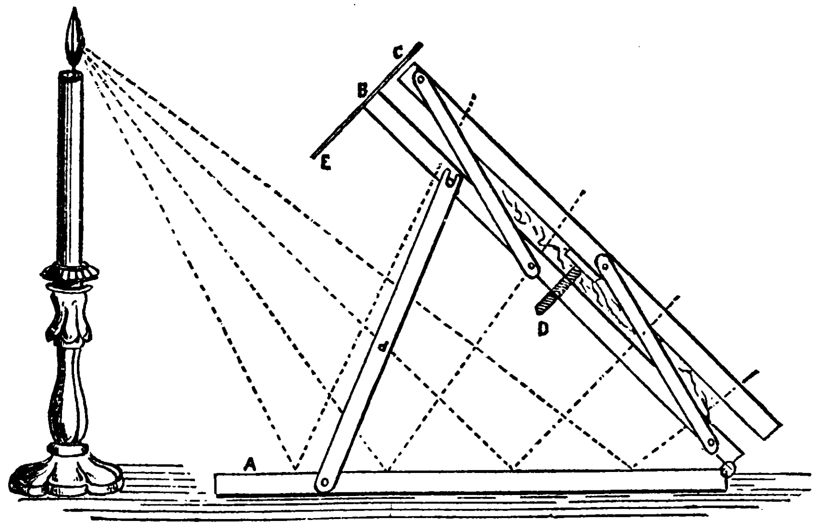
It sometimes happens that it is necessary to remove a print which has faded from its mount, and the latter may contain a title or an autograph, which it is impossible to replace. Under these circumstances we proceed in much the same manner as with the album, taking care, however, that the blotting-paper as well as the water with which it is moistened is scrupulously clean, as plate paper is most easily soiled. In an obstinate case, the print being of no value, it may be rubbed off piecemeal, as was recommended for removing the last sheet of paper, when the mount had to be destroyed. After the print has been "coaxed off" the margin of the mount should be thoroughly wetted, and then dried between sheets of blotting-paper, which will keep it flat. In putting prints on mounts that have borne other pictures care should be taken they are trimmed a trifle larger than the old ones, so that they overlap the space previously occupied.—*Brit. Journal of Photography.*

THE SKIAGRAPH.

A is a looking-glass laid flat upon the table; B and C are wooden frames each holding a square of plain glass. The flower to be drawn is laid between the glasses, which can be kept at any distance apart by means of the parallel links on each side, and the screws at D. A piece of paper is laid upon the upper glass, and by the light of a candle reflected from the mirror, the shadow of the flower is projected through the paper, and its outlines can be easily traced. The paper can then be removed, and the shading and coloring copied from the object, which is held in the same position between the glasses. A skilful draughtsman may despise such aid, but it has been found useful for drawings aiming rather at correctness of shape and size than at artistic effect. The shadows will, of course, be very slightly larger than the object. The machine might also be useful to designers of Christmas cards, or floral patterns of any kind. It can easily be made with a common looking-glass and two picture frames, and a pieces of brass wire. A cardboard screen should be placed at E to prevent the light from falling directly upon either side of the paper. Everything must have a Greek name nowadays, so we call it the skiagraph. —*Knowledge.*

EDISON'S NEW ELECTRIC LAMPS.

Further improvements in his incandescent lamps have been lately made by Mr. Edison, the main features of which will be understood by the following diagrams and description, which latter also includes an account of his new arc lamp. The object of that part of the invention shown by Figs. 1 and 2 is to secure increased economy in the manufacture of the lamps by simplifying the blowing of the glass globes, and secondly, to clamp the leading wires easily and cheaply to the carbon filaments or bridges as they are termed. The blower takes the glass from the melting-pot, and shapes it as seen in Fig. 1, leaving an opening large enough to allow the carbon to be passed into the globe. The leading wires are laid through a glass tube, seen in position in Fig. 2, which has a swelled part to fill up the orifice left in Fig 1. The wires at one end are firmly sealed by melting the glass around them. Where this sealing takes place the leading wires are of platinum, but on either side they are of copper, taking the form of copper ribbon where the connection is made with the carbon filament, in order that they may be wrapped around the bridge and have abundance of surface contact. The wires being sealed in the tube and connected to the bridge, the latter is passed into the globe and the two parts are firmly attached by melting the

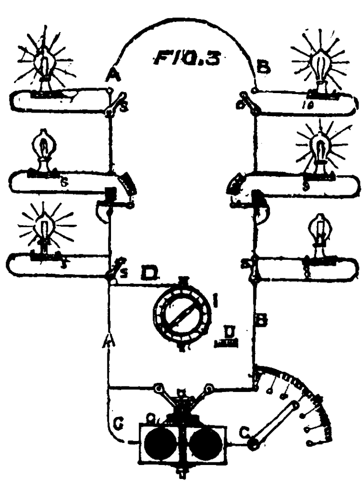


THE SKIAGRAPH.

glass around the bulb or enlargement of the tube. Another feature of this improved lamp is a modification in the filament itself, which is so made as to have a less resistance at one terminal than at the other. When carbon filaments are used for lighting by incandescence, it is found that the carbon is carried from the negative to the positive end—a phenomenon which has been described as "electrical carrying." The amount depends, it appears, on the resistance of the filaments, the degree of incandescence, the E. M. F. between the clamping-wires or electrodes, and the condition of the vacuum. To obviate this difficulty, as far as is possible at present, Edison makes one end of the carbon, the negative, thicker than the other, so as to reduce the resistance at that end of the bridge; but he says, definitely, that in the present state of the art, it is impossible to manufacture a carbon which will not eventually be destroyed. The tube seen at the top of Fig. 1 is for attaching to the vacuum apparatus, and when the globe has been exhausted or otherwise completed, it is melted off and sealed, as seen in Fig. 2. To prevent any serious inconvenience from failure of lamps, arrangements have been made by which two can be placed close together, and on the failure of one the current will be automatically switched to the other. There are several ways of carrying out this part of the invention, but Fig. 3 will probably serve to explain that and some other features of the system, as it shows how one lamp may be put out without extinguishing others in the series. A B is the main circuit, C the field-magnet circuit with the resistance, and C is a derived circuit with the electro-dynamometer I inserted, G is the generator, and *s s* are switches which can be used to short circuit the branches 5, 7, 8, 10, and in the case of 8, the lamp is shown short-circuited and extinguished. In 6 and 9 are illustrated the means provided for avoiding any difficulty from a lamp breaking. Here there will be seen a small magnet with a pivoted armature, and a resistance shunt-circuit. In the ordinary condition, when the lamps are at work the magnet is excited and keeps the armature up, thus breaking the resistance-circuit, but should a lamp fall, the circuit is momentarily broken, the armature drops on to the lower stop, and the current passes through the resistance shunt instead of through the lamp branch circuit. To prevent the blackening of the glass globes by the deposition of carbon, Mr. Edison attaches to each lamp a short magnet or a coil of wire which attracts the highly electrified carbon vapour downwards towards the clamps.

Mr. Edison has also patented some improvement in arc lamps, the chief feature of which is rotating one or both carbons around their longitudinal axes at a high speed—some two or three thousand revolutions a minute—the object of which is "to secure a steady light." As a motor he uses a Pacinoti ring or clockwork. Such an arrangement appears to unnecessarily complicate an already complicated device, and it is doubtful whether the advantages to be gained compensate for the extra cost and liability to derangement.—*English Mechanic*

FIG.3



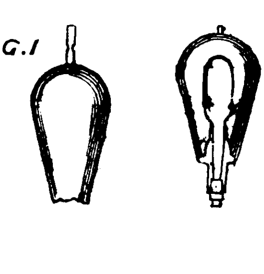
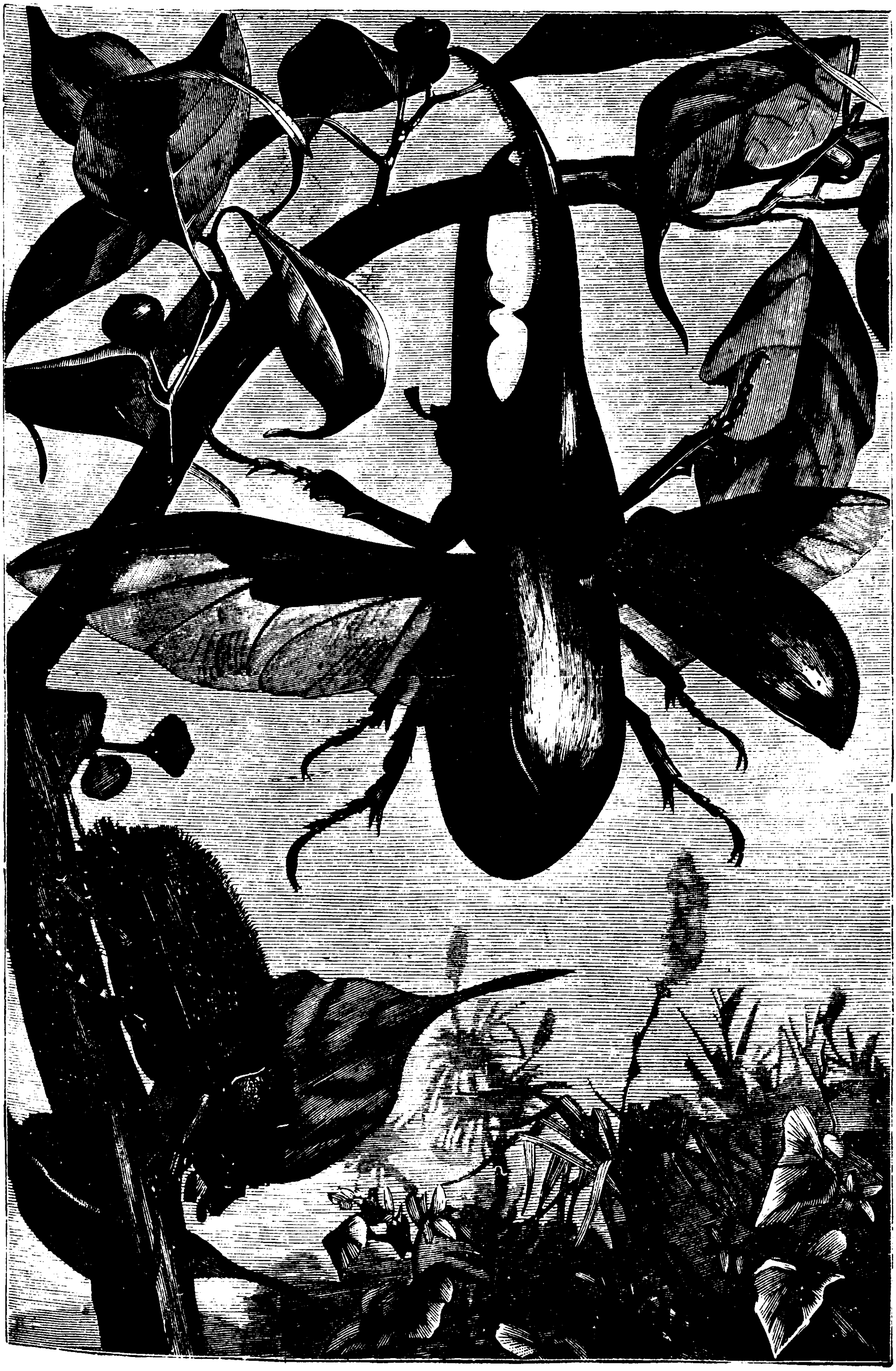


FIG.1 FIG.2



THE HERCULES BEETLE—MALE AND FEMALE.

THE ELECTRICAL STORAGE OF ENERGY.

In a lecture delivered before the Newcastle (Eng.) Literary and Philosophical Society, Mr. Swan, after describing what was meant by the storage of electricity, said:—

What they wanted was to have energy so stored that the electric current might be actually waiting to pass, ready to flow at any moment when the channel in which it had to circulate was completed. Happily there was a way of obtaining an electric current in a very direct manner by means of stored chemical energy. This chemical energy might be dormant for any length of time and give no outward sign of power, and yet in an instant, as by a touch of a magician's wand, it sprang into powerful action. Sir William Thomson had made careful measurements of the energy stored in the Faure cells, and found that one weighing 1½ cwt. could store energy of one horse-power for one hour. If they supposed that store cells were applied to produce electric light, at this rate one ton of cells would supply sufficient current for ten Swan lamps during six hours. Two things were clear from this—first, that unless the price at which such cells were sold was much higher than the intrinsic value of the material of which they were made and their simple construction suggested, their cost need not be prohibitory of their use ; second, that the bulk and weight of a set of cells to do any considerable amount of work would be too great to admit of the idea that it would be practicable tomove them for the purpose of charging. In some exceptional cases the cells might be carried from place to place, just as gas was occasionally carried in bags. It was much more easy to carry the electric current from a fixed and distant dynamo-electric machine to the store cells by means of wires than to carry the cells to where the dynamo was, just as it was easier to carry gas to a distant place in pipes than in a metal gas holder. There were, however, special cases where store cells might with advantage be carried to a distance to be charged, and one such case was that of coal mines, where it might be found convenient to employ small store cells in portable cases, and to send them to a safe and central part of the pit, where a dynamo might be fixed for charging a portable case of store cells and lamp of this kind were exhibited, the cells being some belonging to Professor Herschel. The case was carried by a leather handle, and the lamp, which consisted of a clear double glass globe, entirely closed, and guarded by strong wire, was attached to it by means of a wire-conductor of considerable length, so that a miner might hang up the lamp where he was working, and place the charge cells a little distance away. The light emitted by the lamp was clear and much superior in quality to the light of an ordinary safety lamp, and the lecturer remarked, as air was not required for it, and as the globe was air-tight, it was a safety lamp in the strictest sense of the word. He thought also it would have the advantage of being an economical lamp. For lighting railway carriages he thought the most feasible arrangement would be to have a small dynamo and sets of store cells for each carriage. The arrangement for working the dynamo might be extremely simple. The armature might be attached to one of the axles of the carriage. Whenever the carriage moved there would be a current of electricity generated if the circuit was closed through the lamp and store cells. When the cells were full they would be thrown out of action automatically. The same dynamo could easily be applied to store current in another set of cells, to be used for the working of an electro-magnetic brake, which might be of great power, with very small abstraction of the motive power of the engine, for the principle of accumulation here came into play most advantageously. Whether railway carriages and tramcars were to be in future driven by electricity was not yet a settled question, but it was certain that whenever (if ever) they were so driven, electric storage of energy would play an important part in bringing it about, Some people had the idea that by means of store cells they should have portable electricity extensively employed—a daily supply of electrically stored energy delivered at their doors like milk, the empty cells to be taken away when the full ones were brought. It was not likely that this idea would be realized. There was no form of energy so easily conveyed to distance as the energy of electricity, and to think of carrying it about in boxes instead of sending it on its distant journey through wires was to ignore one of its most valuable properties. The probability was that in every house lighted by electricity, there would be a fixed set of cells occupying a place, and perhaps also a space not unlike that which a water cistern occupied in a house. These cells would be in a communication through insulated and hidden wires, with a main central electric supply, and would either be kept charged by continual connection with the main, as their water cisterns were, and with a regulating appliance equivalent to the automatic feed of a water cistern ; or the current would be turned on for a few hours each day until the cells of one district were fully charged, and then the current would be turned on to another district to charge cells of that district. With reference to the application of electricity to the production of motive power, at present they depended on motive power for the production of electricity. It was, therefore, a roundabout process to introduce motive power from motive-power-produced electricity. Still, there were cases in which the economy of producing motive power on a very large scale, and the facility with which this power might be subdivided and distributed by means of electricity would make the reproduction of motive power in this roundabout way both economical and convenient, notably in cases where at no great distance from a town or populous district, requiring motive power for industrial purposes, there was some great stream or waterfall, and in connection with electrical storage it was within the scope of probability that the fitful power of wind and the intermittent power of tides might be made more practically serviceable in the development of motive power. It was quite a common anticipation—perhaps most strongly entertained by those who had least knowledge of the question—that electricity would one day supersede steam. The possibility of this could not be denied, but at the same time it was equally undeniable that they were a long way from such a revolutionary change. They did not even see the road by which it was likely to come. They merely saw that the steam engine, admirable as it was as a piece of mechanical ingenuity and skill, was yet waste of energy to the last degree. Sir William Armstrong had put down the waste of heat in a steam-engine of the best construction at 90 per cent. Only 10 per cent. of the heat stored in coal and actually evolved was utilised in the resulting motive power. This enormous waste of heat energy in the steam-engine certainly left room for hope that some even more economical means of producing electricity than that possessed by the dynamo-electric machine might be discovered.—*English Mechanic*

COLLAPSE OF A LARGE GASHOLDER.

The Newark *Daily Journal* gives the following account of the collapse of the gasholder belonging to the Citizens' Gaslight Company, on the evening of January 31st ult.

About seven o'clock it became evident to those in charge of the works of the Citizens' Gaslight Company on Front street, that the iron frame which held the gasholder was giving way. Two of the columns were cracked, and the fierce gale which was blowing caused the iron frame to bend and twist, so that at every moment the structure was expected to go down. Mr. Andrew A. Smalley, the president of the company, was sent for, and he immediately stationed men at each end of the street to warn those who might intend to pass of the danger. Several families residing in the neighborhood left their houses and some prepared to remove their furniture. The gasometer was 97 feet in diameter, with a capacity of about 300,000 feet, and was about one-third filled. The gas was being drawn off and transferred to another holder, when, a few minutes before nine o'clock, the structure went down, and as it fell, with a hissing sound, a column of flame more than 50 feet shot in the air. People were momentarily blinded with the sight. Women became frantic and even some men thought for a moment that the day of judgment had come. The flame was visible only for a minute, and then the whole portion of the city north of the canal was left in total darkness. The fire department turned out, but there was no occasion for their services. No person was injured, and, with the exception of the blistering of paint on the cupola of Ballentine & Sons' brewery, no buildings received any serious damage.

Mr. Smalley stood in a doorway within 30 feet of the gasometer when it fell, and he remained there. He says he had no fear. He believes the flame was caused from sparks struck from the iron frame when in falling it crashed against the sides of the tank. The gasometer was torn and rent like a great balloon cut in pieces. There was no explosion ; it was simply a collapse. About 20 feet of the wall along Front street is broken down, and 10 feet of the coping thrown from the side wall. Beyond the destruction of the gasometer and frame this is all the loss the gas company has sustained, except the loss of gas and custom. The damage is estimated at $20,000. The tank is uninjured.

The gasometer was erected about thirteen years ago. The columns, which were of cast iron, show numerous old cracks and flaws in the iron, indicating that the contractor had done his work very imperfectly. There were no braces or stays at the base, and, considering the bad material and the careless construction, it now seems strange that the structure stood as long as it did. Gasometers are strengthened at the base of the columns with extra braces of wrought iron.

Connection with the mains of the Newark Gaslight Company has already been made, and Mr. Smalley promises that to-night no part of the city shall suffer from want of gas. Fortunately the new gasometer in Orange is ready for use, though it has not yet been used.

About sixty days will be required in which to rebuild the gasometer. The columns are always kept ready by the contractors, and they will be put up immediately. The main delay will be in building the holder.

Harrison was brightly illuminated by the burning gas. At the time a number of firemen were in the engine house, and they hastily made a start to roll the apparatus before they discovered their error.

The flame from the gas was witnessed by many residents of Roseville, Orange, Montclair, and many other elevated suburban places. It burst upon the stormy sky in a broad red glare, and seemed like an enormous cloud sweeping with lightning rapidity at the houses. Many women were frightened, as even at two miles distance the flame seemed to dart at the windows, and during a moment rooms in which no lights were burning were brilliantly illuminated. The time during which the flames were seen could not have exceeded one minute. They disappeared as suddenly as they came.

THE COMBINATION GAS MACHINE.

Within the past ten years great improvements have been made in the construction of the special type of illuminating apparatus popularly known by the name of "gas machines." In general terms, these devices are designed to produce a gaseous illuminant, consisting commonly of air charged with the vapor of one of the volatile commercial products of petroleum. The material used for this purpose is uniformly that which is known as gasolene, and the vapor laden air is distributed and burned precisely like coal gas. The conveniences which such automatic gas generators afford to those living remote from cities, or in towns and villages where coal gas is not used, by placing the luxury of a brilliant illuminating, gas at their disposal, made these machines very popular from the time of their first introduction, now over twenty years ago. It required, however, a number of years, and numerous improvements in important details, to entirely obviate certain serious objections that were urged against them. These related particularly to the disposition of the inflammable gasolene from which the gas was generated, and other less essential points affecting the safety of the apparatus under all the possible conditions of actual use.

These objections at the present day have been very satisfactorily met in many forms of these machines now in use. The modern gas machine, where ordinary care and intelligence are exercised in its use, answers every reasonable requirement that could be demanded on the score of safety.

A typical machine of this class, embodying in its design and construction all the improved features above alluded to, is that known as the "Combination" gas machine.

The apparatus consists substantially of three parts: First, the air pump and its mechanical attachments, the object of which is to force the current of air over or through the volatile gasolene; second, the carburetor, in which the gasolene is stored in such a manner as to expose a large evaporating surface, so that the air forced through it by the pump shall readily charge itself to saturation with the hydro-carbon vapor; and third, the system of distributing pipes, through which the vapor laden air—now an illuminant—is conveyed to the burners. The air pump consists of a metallic chamber, strongly built and air-tight, containing a meter wheel working in water, and deriving its power from the gravitation of a heavy weight suspended from the ceiling. This pump is usually placed in the basement or cellar of the building to be lighted. A pipe conveys the air into the top of the pump chamber, whence it is conveyed by the meter wheel from the side of the chamber through a suitable connecting pipe provided with a governor for regulating its pressure, and also a check valve, into the carbureting chamber. This portion of the machine is located at a distance of from 20 to 50 feet from the building. It consists of a flat cylindrical chamber, capable of containing a large supply of gasolene; and the liquid is so disposed therein as to afford a great length of evaporating surface over which the air forced by the pump must pass. For additional security, the carburetor is buried to a convenient depth in the earth, and surrounded likewise with a water chamber. From time to time (once, say, in three or four months), as may be necessary, the carburetor is filled with fresh material through a pipe leading from the buried chamber to the surface of the ground, with which communication is established through a flexible tube with the barrel of gasolene. By this system of construction the refilling of the carburetor is accomplished without risk or danger.

From the carburetor the vapor laden air, now suitable for illuminating purposes, is forced through the system of pipes communicating with the burners throughout the building to be lighted, in the usual manner as with coal gas. It will be understood from the foregoing description that the pump can only operate when one or more of the burners are in use; when these are closed, the back pressure on the meter wheel holds it immovable. The air pump is made amply large, so as to obviate the necessity of frequent winding up of the weight—once or twice a week is as often as this operation need be repeated. A governor is provided near the side of the air pump, whose office is to automatically regulate the pressure upon the burners; a check valve is also provided to prevent the back flow of gas from the carburetor to the pump in case of accident or breakage. A hand-wheel on the pump shaft for holding the pressure, enables the machine to be wound up while the lights are burning. The burial of the carburetor in the earth outside of the building, and surrounding it with a water tank, has two advantages. It obviates all probability of risk or danger in connection with the storage of a large amount of gasolene, and the refilling of the chamber; and it serves to keep the temperature of the liquid practically uniform at all times of the year. This feature is a point of considerable importance, as the quality of the gas furnished by such machines will vary very greatly when the gasolene is exposed to atmospheric changes. By this disposition of of the carburetor, the liquid is maintained at nearly a uniform temperature, the amount of evaporation kept at about the same rate, and the quality of the gas is caused to vary very little, summer and winter.—*The Manufacturer and Builder.*

THE HERCULES BEETLE.

(SEE PAGE 93.)

The Hercules beetle, (*Scarabeus hercules*) is one of the largest and best known of the beetle family. It is found in Guadeloupe, Colombia, Martinique, and occasionally in the neighborhood of Rio Janeiro, and varies slightly in size and color in these different places. In Guadeloupe are the largest specimens, possibly the best developed horns, and its curious habits have long attracted the attention of naturalists and travelers.

The male beetle is of a shiny black color, with long claw-like horns, covered on the under side with reddish-grey hairs arranged like a brush. The wing-cases are greenish-yellow, spotted with black, in the living insect, but occasionally in preparing them for collections, the wings absorb a black substance from the abdomen and turn gray. This may be remedied by washing in benzine, which will restore the yellow color.

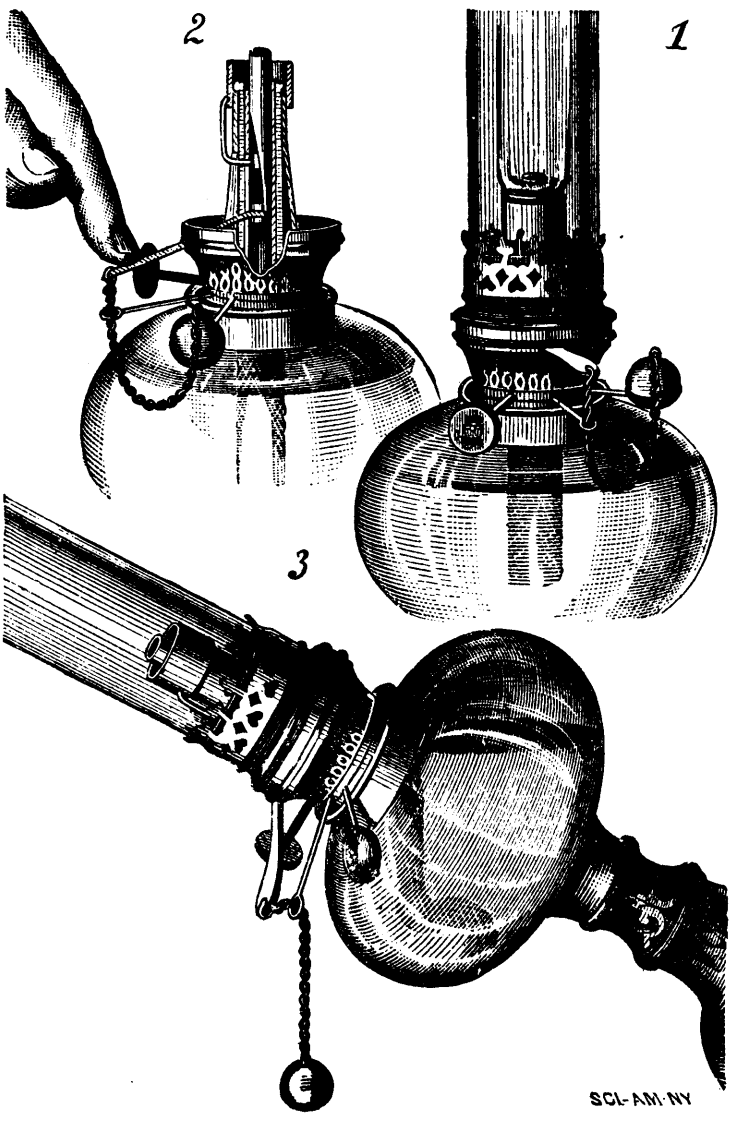
The male is over three inches long, including the horn, which, with the corselet, of which it is the elongation, measures nearly one-third of the whole length.

This insect may often be seen to seize the young shoots or branches of a tree between his strong horns, (see illustration), and then turning rapidly around and around, by the aid of his wings he cuts off the branch.

This revolution is so rapid that when the branch breaks off the beetle is often thrown to the ground with great force.

It has been supposed that he does this to obtain the sap of the tree, though his mouth would seem more suitable for devouring the green leaves.

The female has no horns, so it must be discovered by observation in what way she is able to obtain her food. She differs in other ways so much from the male that she might at first sight be supposed to belong to a different species. She is much smaller and has brown hairy wing cases, very rough and knobby on the shoulders. She deposits her larvæ in the trunks of decayed trees, where she forms a shell of woody *débris* glued together for their protection.—*La Nature.*



KOHLER'S EXTINGUISHER FOR ARGAND BURNERS.

The engraving shows a very simple and effective extinguisher for kerosene lamps, recently patented by Mr. C. H. Kohler, of 235 Superior Street, Cleveland, Ohio. The device answers the double purpose: First, of an extinguisher for use whenever it is desired to put out the light in the safest and most convenient manner without blowing into the chimney or turning down the wick—either of these methods being very dangerous, and, second, of an automatic extinguisher, which insures the instantaneous putting out of the light should the lamp be turned over, thus preventing the fires which are so frequently caused by kerosene lamps being upset.

Many of the accidents resulting in the destruction of life and property might have been avoided had this safety device been used.

A sleeve is fitted over the outer side of the wick tube and connected by a wire arm with a smaller tube within the wick tube. The lower end of this tube rests upon a support inside the wick tube, Air to supply the flame is admitted to this tube through an opening in its side. A lever pivoted in the side of the burner extends into a slot in the inner movable tube, and has at its outer end an eye, to which is attached a chain carrying at its opposite end a small metallic ball having sufficient weight to move the connected sleeve and tube, so that whenever the ball is displaced from its socket, in case the lamp should be overturned, it drops. and in its fall raises the extinguishing device and shuts off the supply of air to the flame, which then goes out instantly. To insure a direct pull on the lever, the chain passes through an eye formed on the end of a wire projecting from the side of the burner, To operate the device by hand, all that is required is to press on the lever.

Fig. 1 shows a lamp with the improvement attached; Fig. 2 is a sectional view, showing the manner of operating the device by hand; and Fig. 3 shows a lamp partly overturned, with the extinguisher being operated automatically.