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THE AGREEMENT OF COLOUR THEORIES WITH PRACTICAL EXPERIENCE.

The following interesting paper on the above subject was read before the Art Congress, Liverpool, 1888, by Mr. G. H. Morton, jun., M. S. A.:

At a congress held for the purpose of furthering the development of the industral arts, the subject of colour naturally has a place. It is, I think, an undoubted fact that a large number of British workmen and women might gain a livelihood from occupations in art works, which to a large extent are now done abroad, were they better educated in colour and design. The work people of Italy and France, for instance, have a much keener appreciation of colour than our own; though this may be partially accounted for by the difference of climate and the presence of the chief source of all colour, the sun, to a much greater degree and to longer periods than we can expect in this country, yet, to my mind, these advantages, though no doubt stimulating the native workman in the study of colour, do not of themselves make him a good colourist. It is rather that he devotes time and thought to the subject, and thereby developes that faculty which is possessed more or less by everyone—except, of course, those who are hopelessly colour-blind.

A somewhat analogous case is that of women, who, generally speaking, are much more sensible to colour than men. Their brighter and more coloured attire calls forth the exercise of this particular faculty in ordinary life, and in their many occupations.

It would appear, therefore, that if our workpeople do not excel in colour composition, it may be partially due to their not having the more brilliant surroundings of their foreign competitors; but it is, I think, mainly due to their own neglect in not studying the subject, for by so doing they would naturally, and of necessity, soon learn to discriminate between what was harmonious and pleasing from what was inharmonious and unpleasant.

I had some hesitation in bringing this paper before an art congress because of its scientific character; but this congress being eminently founded for the development of practical work, I was encouraged to think that any definite rules or principles, whereby the agreement of scientific fact and artistic experience might be demonstrated, would be of service to practical colourists, whether artists, decorators, or others. A knowledge of the scientific rules of colour seems to me much more essential in decorative than in picture painting. In the latter, an artist has generally his subject before him; but in decoration and the applied arts, he has, as it were, to invent his colour scheme from his knowledge of colours, all of which are influenced by definite physical laws. It is well known that in decorations, especially those on a large scale, it is impossible for persons ignorant of the laws of colour to judge of what the ultimate effect will be while the work is in progress. Portions only of the colours to be applied are introduced at first, the hues of which will be very materially changed when the remaining colours are added and the scheme is complete. In my own applications of colour I have invariably found that by subjecting my schemes to scientific rules I have not only avoided errors easily fallen into in so relative a subject as colour, but I have certainly attained higher results than I could possibly have done without them, and not had to make repeated alterations, entailing additional expense, so often found necessary as a scheme drew near completion.

Perhaps the most important principle, and that upon which all others depend, is that there are three primary colours; three colours from, or by, which all other colours may be obtained, innumerable as the number of hues, tones, and shades are. Though the three primaries produce all other colours, yet they themselves cannot be obtained by any admixtures. Artists and physicists both agree as to there being three primary colours, but they differ as to the particular colours.

The artist finds, from practical experience, that almost all colours may be obtained by mixtures of three simple or elementary pigments, in different combinations or degree. The physicist explains that all colors are due to the excitation of three simple or elementary nerves, or sets of nerves, in the retina of the eye, by the different lengthened vibrations of which all white light consists. The artist names the colours of the three primary pigments, red, yellow, and blue. The physicist generally names the three primary sensations, red, green, and violet.

It appears, therefore, that there are two sets of primary colours—first, the colours of the primary pigments; secondly, what may be termed the colours of the primary sensations. It is essential to note this distinction; the first set has to do with pigments, or objects causing certain sensations; the second set has to do with those sensations themselves.

It will be observed that, with the exception of the red, the colours of each set are differently named. That red should be the only colour common to both seems very remarkable, and at once suggests the inquiry, whether the hue of red in each case is the same or different? Referring, in the first instance, to the two other colours in each set, we find that they are not common, but are the very reverse. They are not only differently named, but the one set contains the mean colour between two colours of the other set and is therefore opposite, or complementary to the third. Thus green is the mean colour between, or may be obtained by the mixture of the primary pigments, blue and yellow, and is complementary to the remaining primary red Violet is the mean colour between, or may be obtained by the mixture of the primary pigments, red and blue, and is complementary to the remaining primary yellow. Anyone who has mixed pigments knows these assertions to be facts. Yellow is the mean colours between, or may be obtained by the combination of red and green light, and is complementary to the remaining primary sensation, violet. Blue is the mean colour between, or may be obtained by the combination of green and violet light, and is complementary to the remaining primary sensation, named by the physicist red. Physical experiments have proved these statements.

The term red, to though common both sets, cannot be the exact colour obtained by two different combinations, or be produced by the mixture of itself with another colour; such a suggestion seems absurd. It cannot, if we are to understand a distinct hue by the name, be the mean colour between itself and both violet and yellow; that is, the particular hue of red will not remain the same when violet or yellow are added to it. The difference of hue between a red and violet mixture and a red and yellow mixture would be very considerable indeed, about as far apart as two reds could well be. Yet if the two other colors of the one set, when combined produce one of the colours of the other set, it seems reasonable to conclude that the remaining colour red should, when similarly combined, produce a similar result. According to this, however, red and violet produce red, and red and yellow produce red! Two different combinations seem to produce the same result, which is impossible, for the two resulting hues would be, as I have just pointed out, as different as they well could be under the general name of one colour.

Red then seems to be a very general and ambiguous term, for it is evident that the hue of red in the one set is very different from that in the other, that the artist's primary red pigment, and the physicist's primary red sensation, are totally dissimilar—the one being of a crimson or violet hue, the other of an orange hue. It seems desirable, therefore, that either the artist or the physicist, or both, should adopt some more definite term to describe a colour in which they can only agree in name and not in fact, for much confusion, and apparent antagonism, between the art and science of colors, as regards the primary colours, has already been occasioned by this indefiniteness of meaning.

The ambiguity regarding the names of colours is well known and to it much uncertainty may have been due; indeed ambiguity in so relative a subject as colour can hardly be avoided. It requires but a very elementary knowledge of colour effects to know that colours may be made to appear very different by changing, not themselves, but those with which they are associated, or juxtaposed. Red may be made to appear orange or crimson, green may be made to appear blue or yellow, and soon; it entirely depends on what colours are put next to them. Chevreul's book is full of such instances. It is not, therefore, at all extraordinary that colours should be misnamed, when they have such chameleon-like properties. A colour also appears very different under different conditions of light. Two rooms, for instance, coloured exactly alike, but one having a southern, and the other a northern aspect, would appear very different. The yellow light of gas has, of course, a marked effect, as also the coloured light of stained glass. Ambiguity, however, in colour is not entirely due to these causes. Without even taking into account the variableness of the colour sense in different individuals, which is undoubtedly very great, there is another important point, and that is the very gradual way by which the most opposite colours may be connected. There are no distinct lines, as it were, between colours. It would be difficult, indeed impossible, to point out exactly where the red, green, or violet of the prismatic image began or ended; and when out of the innumerable perceivable tints we have to name three, or six, principal colours, it is impossible that the exact hue of each of these colours can be distinctly and definitely described. Only an approximate idea can therefore be given. Of reds we have orange and crimson reds, and all the hues between these two extremes, yet all are reds; of yellows we have orange and greenish yellows, yet all are yellows; and of blues we have greenish and violet blues, yet all are blues. The six principal colours only have been named; but when it is borne in mind that it has been estimated that the eye can distinguish not less than 2,000,000 distinct tints of colour, the difficulty of determining their exact hues will be at once understood.

It is desirable however, that the particular hues of the primary pigment colours and the primary sensations of colour should be as nearly as possible defined, so that we may ascertain their relationship to each other, and also whether there is a difference of hue between the so-called primary red pigment and the primary sensation named red.

The hue of a primary pigment is decided by that hue which will mix with both of the other primary pigments—in other words, with the greatest number of other colours, and still retain brightness, or not cause the compound colour to become "dirty" or "muddy." This is ascertained by practical experience rather than by physical experiment. Most persons know, for instance, that blue and yellow pigments when mixed together produce green, and that blue and red produce violet. The question is, what particular hue of blue will produce the most brilliant green and violet when mixed with yellow and red respectively? It is a simple matter to get one hue of blue that will produce a good green, and another that will produce a good violet, but we have to decide on one particular hue that will mix well with both.

Generally speaking, the hue of each primary pigment tends towards blue, or away from red. The primary blue pigment is of a greenish rather than of a violet hue; this particular hue of blue mixes with both the other primary pigments, yellow and red, with less loss of colour than a violet-blue would do. Let us practically apply this: let Prussian blue represent the primary greenish blue, and ultramarine the violet-blue. It will be observed that Prussian blue mixes well with red on the one hand, and with yellow on the other, producing tolerably bright violet and green. Ultramarine, however, though it mixes even better with the red (because being a violet or reddish blue it is naturally more analagous or sympathetic with red), at once loses colour, and produces a less bright or "dirty" effect when mixed with yellow. Hence the hue of Prussian blue is nearer the hue of the primary pigment blue than the hue of ultramarine. The primary blue pigment is consequently of a greenish rather than a violet hue.

The hue of the primary yellow pigment is in like manner that particular hue of yellow, which will, when mixed with blue and red respectively, produce bright green and orange. a yellow that has a slight greenish rather than an orange tint, King's yellow approaches, as near as most yellow pigments, the hue of this primary; it mixes well with both blue and red, producing tolerably bright green and orange respectively. A warm or reddish yellow mixed with blue results in a "dirty" green or olive, consequently a yellow the reverse of this, a cool, slightly greenish yellow, is the hue of the primary pigment yellow.

The primary red pigment, with which we are most concerned because of its being the name given by artists and physicists alike to one primary in each set, is of a crimson or violet hue, the opposite of scarlet or orange. Rose madder or crimson lake are, for instance, nearer the hue of this primary than vermillion. If we mix any blue pigment with vermillion we at once neutralise the colour, and we do not obtain bright violet or purple. We only obtain bright combinations by mixing it with yellow, the primary pigment nearest to it in prismatic order, and produce bright orange hues. With a bluish red, however, as rose madder, not only is it possible to obtain bright effects when mixed with blue, the primary nearest to it in prismatic order, but when mixed with yellow, the primary most opposite or farthest prismatically, bright orange hues result. Consequently, a red of a bluish hue, as represented by rose madder or crimson lake, indicates the more exact hue of the primary pigment red.

Blue, yellow and red, of the particular hues I have endeavored to describe and illustrate, are therefore the three primary pigment colours.

There is always a possibility of error in describing a colour by reference to a particular pigment. Pigments bearing the same name, not infrequently vary very much in hue from one cause or another. The colour pigments I have enumerated are given as the nearest to the particular hues I wish to describe. Coloured plates, in books on colour, are also often very misleading, due no doubt to printers' inexactness, or the fading of some of the colours.

In all practical mixtures the primary pigments would not necessarily be employed more than any others. The two colours to be mixed would be chosen as nearly as possible in hue. If an artist, for instance, desired a brilliant orange, he would obtain it by mixing a yellow and red as similar in hue as possible, as near together in prismatic order as could be obtained, say any warm yellow and vermillion; to use a greenish yellow or bluish red, as lemon chrome and lake, would of course, introduce some blue, and thus tend to neutralise the compound orange, and make it dull or "muddy."

That the primary pigments should be of bluish hues, is scientifically explained by the vibratory theory of light. It is well known that all colours are caused by vibrations of different strengths affecting the eye; the stronger vibrations excite red, the weaker blue or violet. In combinations of colours, the weaker vibrations are more easily subdued. In mixing rose madder and yellow, the weaker blue and violet, or neutralising colours, which may be said to be present in the madder, are overcome and destroyed, and a bright secondary orange is the consequence. On the other hand, if vermillion and blue are mixed together, the stronger and more powerful vibrations of red and yellow assert themselves to such a degree that the weaker blue is neutralised, and a "dirty" colour having some slight resemblance to violet is the result. In this case the three primaries—red, yellow and blue—are combined, the result of which, of course, produces a neutral or dull compound colour tinged with the predominating colours red and blue, which together make violet.

All colours are properly sensations, caused by the action of light on the retina of the eye. It is now, I think, generally admitted that there are three sets of nerves, and that each of these when excited produces a sensation we name colour. Hence colour does not exist outside ourselves, and, strictly speaking, it is as incorrect to allude to a pigment as a colour as it is to allude to any other sensation as being the object causing it. Instead of naming any object, say red, it would be more exact to say that the object caused us to experience the sensation of red, for often the object itself is the opposite colour of what it appears to be. A colour object, or pigment, absorbs some of the white light shed upon it, and rejects the remainder, the rays rejected affect the eye, and excite there the sensation we name colour. In the case of a red pigment, all the blue and green producing rays have been absorbed, and the rejected rays excite red. No doubt it is much simpler to refer to pigments, or colour objects, as actually being the sensations rather than causing them, and many persons seem to have had great difficulty in grasping the distinction.

The primary sensations are, therefore, the only primary colours, properly speaking. They are generally named violet, green and red. The violet is less red than is commonly conceived by that term; a warm ultramarine perhaps best describes it. Maxwell selected a violet blue between the lines F and G on the spectrum, which, as Prof. Rood points out, is represented tolerably well by artificial ultramarine. Benson, in his "Science of Colour," names this primary blue; but as most authorities adopt the term violet, this name may, I think, be accepted as most correct.

The primary sensation green is represented in pigments by emerald green. There seems little difference of opinion as regards this colour.

The primary red sensation is distinctly an orange red, or scarlet; and, Helmholtz selected a red, not far from the end of the prismatic image, which could scarcely be named orange, Maxwell adopted a red which in the spectrum lies between lines C and D. This is a scarlet red, as Rood states in his "Modern Chromatics," with a tinge of orange, and is represented by some varieties of vermillion. Benson gives vermillion as best illustrating this primary red sensation, and perhaps all the authorities I have consulted describe a red the reverse of a crimson or violet-red. This primary sensation, therefore, appears to be the very opposite in hue from the primary red pigment. It is very evident that the idea conceived by the term red in the one set of primary colours is not the same as in the other set.

In order to avoid confusion, a different name might be substituted for this colour in each set based upon their particular hues, as crimson the primary pigment, and scarlet the primary sensation, which terms I adopted in a former paper on "Colour Harmony," read before the Literary and Philosophical Society of Liverpool, during its seventy-second session. To ignore the old association of the six principal colours, however and the omission of the term red altogether seems undesirable if it can be avoided.

Before attempting to suggest new terms, however, it is neccessary to consider the secondary colours. In pigments they are usually, and I think correctly, named orange, green and violet, and denote the resulting colours from the mixtures of two primaries, red and yellow, yellow and blue, blue and red respectively. All the ambiguity relative to the primaries is also peculiar to these secondary colours, and indeed to all colour terms.

With the exception of the orange, the names of these secondary colours are the same as those given by physicists to two of the primary sensations, and as I have already explained that the primary sensation red is distinctly an orange red, it may, I think, be reasonably concluded that the colours of the primary sensations are the same as the secondary pigments, but much lighter and brighter. The primary pigments will therefore be the same as the secondary sensations. So-called secondary sensations of colour, that is when two sets of nerves are excited simultaneously, are generally named yellow. sea-green, or greenish blue, and pink. They are respectively produced by orange and green, green and violet, and violet and orange. The combination of two pure coloured lights naturally produces a much lighter and brighter colour, hence secondary colour sensations are much lighter, doubly as light as a primary. In order to compare them with a pigment, it is necessary to lighten the pigment by the addition of white. Upon doing so we find that red, yellow, and blue of the hues I described in the early part of this paper as representing the primary pigments, respectively produce pink, pale yellow, and greenish blue, the hues of the secondary colour sensations.

A comparison might also be made by darkening the secondary colour sensations by interposing darkness.

If the foregoing is correct, it follows that the colours of the one set are complementary to the colours in the other, as may perhaps be best shewn in tabular form :

Primary colour pigments (secondary sensations).		Primary colour sensations (secondary pigments).
Blue	complementary to	Orange.
Red	"	Green.
Yellow	"	Violet.

The evidence of this relationship distinctly supports the theory that the hue of red in each set is and must be quite opposite. The colour complementary to, or required to neutralise blue, a compound of green and violet, would of necessity be of a totally different hue from that required to neutralise green, a compound of yellow and blue—the blue requires an orange, the green requires a red. A secondary colour being a compound of two primaries also supports it, for the resulting colour from the combination of violet and orange cannot be the same as that obtained by the mixture of yellow and red. The former, if produced without loss of light, that is by the combination of violet and orange light, produces a pale bluish red or pink ; the latter by combination of yellow and red light, or by pigment mixture, produces orange. The primary pigments, therefore, appear to be the same colours as the secondary sensations ; and the primary sensations appears to be the same colours as the secondary pigments, or rather approximate to, for even the most brilliant pigments are dullness itself comcompared with actual colour light.

As a rule, in all combinations of colour light, and of colour pigments, the opposite effects of light occur. Combinations of two colour lights produce a lighter effect ; mixtures of two pigments usually produce a duller effect. The first might be called positive, the second negative colouring. The physicist in all his experiments has the actual light to operate with, and he finds that what he names red, but which I submit would be more correctly termed orange, green and violet, produce perhaps all varieties of colours, hence he names these the primary colours. When an artist, however, mixes two pigments together, he has not the actual light to deal with—he has not orange, green, and violet producing rays, but he has instead three pigments which have absorbed them. The colours of his primary pigments will necessarily be such as have absorbed these colours. The colour of the pigment which absorbs orange is blue ; the pigment which absorbs green is red ; the pigment which absorbs violet is yellow. Blue, red and yellow are therefore the primary pigment colours, and are the reverse and opposite of the primary sensations orange, green, and violet.

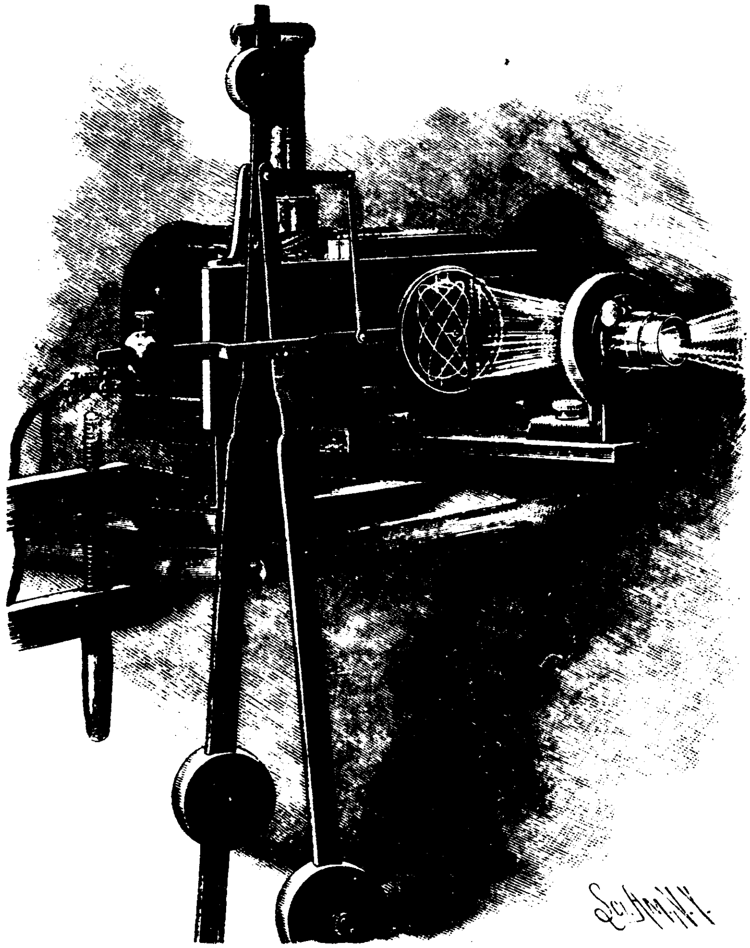
It is possible that the term red, as commonly understood, does not convey to our mind the particular hue of either the primary sensation or the primary pigment. It has been made to do duty for both, and therefore exactly described neither. It denoted a colour too orange in the first case, and too violet in the second. The question, therefore, seems to be whether we should do away with the use of the term altogether, or give it a more definite and perhaps different meaning from what we are accustomed to do. To alter long familiar names is bad policy, and for myself I should perfer to understand by the term red, a colour of a more violet hue than I formerly associated with it. We might, of course, add the prefixes crimson and orange as adjectives ; but did we do so, it would be equally justifiable to add qualifying terms to the other colours, as an orange yellow, greenish yellow, and so on. I would therefore submit that by the term red is meant a colour of a more violet than orange hue, best represented perhaps by the pigment rose madder ; that the primary pigments be still named, as they have always been, red, yellow, and blue ; and that the names of the sensations, caused by the action of light on the three sets of colour appreciating nerves, be named orange, green, and violet.

By adopting different names to each set of primary colours, the antagonism often asserted as existing between the practical and physical facts of colour falls to the ground ; indeed, science supports the knowledge of the artist gained by experience. The colours of either set—the primary pigments red, yellow and blue, or the primary sensations orange, green and violet—when combined in certain relative proportions, produce harmony and neutrality.—*Builders' Reporter and Engineering Times.*

APPARATUS FOR COMPOUNDING RECTANGULAR VIBRATIONS.

The compound pendulum illustrated by the annexed engraving has advantages over those of the usual form, in being adapted to the ordinary horizontal lantern and in being less cumbersome and more easily managed. Perhaps the most important difference between this and other instruments of its class lies in the tracing arm and point. With this apparatus the beautiful curves of Lissajous appear on the screen, while the arm that traces them is invisible. With densely smoked glass this feature is not so apparent, but when colored collodium tracing films are used, it is a novel sight to witness the development of these intricate figures by a point having no apparent support or guide.

An apertured board having a recess for receiving the prepared glass plate forms the body of the apparatus. This board is connected by an iron standard with a base piece which is clamped to the lantern table in the manner shown. To the upper edge of the board is secured an arm provided with a horizontal stud upon which are pivoted two pendulums. The rear pendulum is prolonged above its pivot, and is provided with a right angled arm projecting toward the lantern, parallel with the back board. The upper end of the rear pendulum is provided with two or three interchangeable weights, varying from two to six pounds, and the lower end is provided with a movable weight of twelve pounds. The front pendulum is suspended from the same pivot, and is also furnished with a movable twelve pound weight. To the rod of the front pendulum is pivoted an offset bar, provided at one end with an annular frame containing a transparent glass disk and having at the opposite end an adjustable counterbalance weight. The glass disk is provided with a small central aperture, in which



COMPOUND PENDULUM.

is inserted a fine needle. To the offset bar, half way between its connection with the pendulum rod and the needle, is pivoted a rod which is pivotally connected with the horizontal arm of the rear pendulum.

The offset bar is made of thin spring material, and is bent so that the needle presses lightly upon the prepared glass held in the recess of the back board. The prepared glass plate is retained in the position of use by two spring clips pivoted to the back board and arranged to press upon diagonally opposite corners of the glass. The needle is held away from the glass while starting the pendulum, by means of a thread (not shown) attached to the annular frame and connected with a fixed support in front of the frame and distant about a foot.

The adjustment of the weights for the different figures is ascertained by experiment, and the position of the weights is accurately indicated on the pendulum rods. The apparatus is placed in position on the table and the lantern is adjusted to it.

The colored collodion for the films is prepared by thinning ordinary plain collodion with alcohol diluted with water, then adding to it an alcoholic solution of aniline of any desired color. The glass plate is prepared for use by flowing the collodion over it and allowing it to dry. If the film proves too hard and tough, it may be modified by adding a small quantity of water to the collodion. This film gives a uniform tint on the screen and is dense enough to clearly show the lines of the tracing.

After the tracing point has been drawn back in the manner described, and the prepared glass plate is in place, the pendulums are drawn aside and the rear one is released. At a certain phase of its vibration (which will be determined by experiment) the front pendulum is released. If the needle describes the desired curve, the annular frame is released, when the needle traces the figure which appears upon the screen.—By Geo. M. Hopkins, in the *Scientific American*.

French Polish.—Give the wood a coat of shellac varnish. When dried hard, sandpaper and clean off. Take some shellac, dissolved in alcohol in one vessel, and linseed-oil in another, and roll a little cotton in a piece of chamois, into the shape of a ball. Put a coat of shellac on a small portion of the work, and immediately before it is dry, dip your chamois ball into the oil, and rub over the portion just coated, keeping a steady and strong rubbing motion, and moistening with the oil. Repeat this until you have a smooth and highly polished surface, when you proceed over another part of the work, always lapping it with what is already done, and proceed right along with the work, from one end to the other. Pieces that are not too large should be done all at once. This is the polish used on fine furniture and musical instruments, such as banjo handles, violins, guitars, etc.—A. P. Daire, in *The Hub* (New York).

OUR NEIGHBOUR ACROSS THE WAY.

The planet Mars occupies in the solar system the orbit next outside the earth's, and at times comes nearer to us than any other heavenly body, excepting only the moon and the planet Venus, or now and then a stray comet. But when Venus is nearest the earth, her illuminated surface is turned away; so that the moon alone offers better opportunities for telescopic examination than does Mars when, at its opposition, it is for a season the chief ornament of the evening sky.

The reader must not, however, imagine that, because the planet is then nearer than other heavenly bodies, its distance is really comparable with any geographical distances on the earth's surface. Even under the most favorable circumstances, the distance is never less than about 36,000,000 miles, which is about one hundred and fifty times that of the moon, and a century's railway journey for a "celestial limited," running 40 miles an hour, without stops. Even with a magnifying power of a thousand, which is about the highest that can be advantageously used on any but the very largest telescopes, and under exceptional circumstances, the planet is still optically fully 36,000 miles away, and shows in the field of view a disk about 6½° in diameter, upon which the smallest objects visible would need to be 25 or 30 miles across. A rather powerful field glass, with a magnifying power of six or seven, would bring the moon as near.

It is only about once in fifteen years that Mars comes as near as even 36,000,000 miles. Its orbit is so eccentric, that the interval between it and the orbit of the earth varies all the way from 36,000,000 miles to 61,000,000; and it is only now and then that, as the two planets circle round in their respective tracks, the passing point is where the tracks come nearest. The last instance of a very close approach was in 1877; the next will be in 1892.

Mars is much smaller than the earth, its diameter being only about 4,200 miles. Its bulk, therefore, is only about one-seventh, and its surface about three-tenths of the earth's.

By means of the motion of its swift little moons, it is easy to ascertain that its "mass" (*i.e.*, the quantity of matter it contains) is somewhat less than one-ninth of the earth's, and consequently its density is only three-fourths, and its superficial gravity just about three-eighths, of the earth's; *i.e.*, a body which at the earth's surface weighs 100 pounds, would weigh only 38 pounds there, and a force which here would project a body to an elevation of 100 feet, would throw it there to a height of 265 feet. This is a point of considerable importance in considering the physical conditions of the planet.

When examined by the telescope under favorable conditions, Mars is a very pretty and interesting object. It shows a ruddy disk, which, for some not certainly known reason, is much brighter at the edge than near the centre; in this respect resembling Mercury, Venus, and the moon, but standing in marked contrast with Jupiter and Saturn. According to Zollner, the "albedo," or reflecting power, of its surface is about 26 per cent; that is to say, it reflects about 26 per cent of all the light which falls upon it—about as much as ordinary sand. This is considerably higher than the albedo of either Mercury or the moon, but only about half that of Venus or any of the major planets.

Just at the time of opposition the disk is of course perfectly circular; but at other times it is more or less "gibbous," like the moon a day or two from the full. It varies greatly in apparent size, according to the changing distance of the planet, which ranges all the way from 25,0000,000 miles to 36,000,000.

The disk is mottled with spots and streaks, which are not arranged in belts with an evident relation to the planet's equator, as in the case of Jupiter and Saturn, but are distributed irregularly over the surface. A telescope of not more than seven or eight inches aperture shows them fairly well, and the more conspicuous of them can be seen with much smaller instruments. As we watch them, they drift across the disk from east to west, and many of them are so permanent and well-defined, that by their help we can ascertain the length of the planet's day with great accuracy. The latest and probably most precise determination is that of Bakhuyzen, who gives the time of rotation as 24h. 37m. 22·66s. The only question is as to the odd hundredths of a second.

Most of the spots and markings are permanent, but not all. Bright patches are now and then observed which seem to be evanescent, like sheets of cloud that for a time conceal the oceans and continents beneath, and then rapidly clear away.

Such phenomena, of course, imply an atmosphere more or less like our own, and Dr. Huggins has confirmed the fact by a direct observation of the lines of water vapor in the planet's spectrum. But many things go to show that this atmosphere is much less dense and extensive than the earth's. On Mars great storms and widespread cloud veils are comparatively rare. For the most part the real features of the planet's surface are clearly seen, uncomplicated by overlying mists, while the surface of the earth at any given moment would probably be fully half obscured, as seen from the moon or Mars.

The planet's equator is inclined to its orbit at an angle of nearly 28°, and, as a consequence, Mars ought to have seasons much like those of the earth. One very beautiful phenomenon seems to show that this is actually the case. In the neighbourhood of the planet's poles there are brilliant spots, evidently composed of some substance which reflects light very abundantly; and it is natural to think of ice or snow, because, as Sir W. Herschel observed a century ago, each spot grows larger when it is turned away from the sun, and dwindles in the summer, just as a polar ice cap would. It is worth noting that this snow cap, if such it really is, never comes down to middle latitudes, as does the wintry envelope of our terrestrial snow. In January, "the man in the moon" would see pretty much all that portion of the earth's northern hemisphere which lies above 45° of latitude as one gleaming white expanse, unbroken except where the Atlantic and Pacific Oceans interrupt its continuity. Although Mars is so much further from the sun than the earth is, and receives less than half as much heat to each square mile of surface, it presents no such prevalence of ice in either hemisphere.

This can hardly be due to the scanty supply of water, because the study of the planet's surface markings seems to indicate that nearly half the globe is covered by seas and oceans; not, indeed, nearly so large a fraction of the whole as in the case of the earth, but quite enough to furnish a fair supply of rain and snow.

The northern hemisphere of Mars is of a comparatively uniform orange-colored tint, and is supposed to be mainly land, though it incloses certain dark spots, which, likely enough, are inland seas. The southern hemisphere, on the other hand, is for the most part darker, with here and there islands of the lighter colored surface. From this southern ocean, as it is supposed to be, great bays, like that of Bengal, and arms like the Red Sea and the Baltic, penetrate deeply into the northern continent; indeed, as Proctor long ago remarked, a very striking characteristic of Mars is the manner in which land and water are divided and intermeshed, there being on the planet no unbroken mass of land to correspond to the Asiatic continent, nor any ocean like the Pacific.

The principal features of the planet's geography (strictly areography) are now quite beyond question, and have been several times fairly mapped. Thus far, however, no satisfactory nomenclature has been settled. Upon Mr. Proctor's map the names assigned are mostly those of astronomers who have made contributions to our knowledge of the planet's topography. Thus we have the continents of Herschel, Dawes, Maedler, and Secchi, the oceans of Dawes and De la Rue, and the seas of Kaiser, Beer, and Delambre. Schiaparelli, on the other hand, with better taste, derives his names from ancient geography and legend. We have for the land masses, in the order before mentioned, Libya, Acria, Arabia, and Chryse. Syrtis Major replaces the Kaiser Sea (which is, on the whole, the most conspicuous object on the planet), and De la Rue Ocean becomes the Mare Erythræum. But while the principal features of the planet's configuration are thus fairly well made out, especially those near its equator, there is no such agreement in minor details, and the different maps are widely at variance. Schiaparelli, of Milan, who has had the great advantage of the Italian atmosphere, has introduced into his charts a great number of delicate objects, which have never been satisfactorily seen by others, though many partial confirmations have been obtained. In place of the comparatively ill-defined and hazy streaks seen here and there by other observers, he represents the northern hemisphere of the planet as covered by a network of fine, hair-like lines, which he calls "canals," and supposes to be water-ways. Some of these extend over 90° of the planet's circumference, or nearly 3,000 miles in length, with a width not to exceed 30 or 40 miles.

In Schiaparelli's map of 1877, which is the one usually copied in the text books, only a few of the canals appear, but on his more recent charts there are nearly sixty of them.

The most remarkable thing about them remains to be stated. In 1881 he found most of them to be *doubled;* the single lines which intersect the continental masses had almost without exception become *pairs* of parallels, like the two tracks of a railroad, with a very uniform distance of 150 or 200 miles between them. We say "had become," because it is his opinion that this "gemination" of the canals is a temporary phenomenon, depending somehow on the progress of the martial seasons.

These observations have naturally excited much discussion, and at present scientific opinion is considerably divided in regard to them. No other astronomer has been able to observe the canals in any such extent and perfection as Schiaparelli with his telescope of only eight inches aperture; but several others, especially Perrotin at Nice, have seen something of the sort, and furnish a partial confirmation of his work. The "gemination" of the canals is so remarkable and so inexplicable, that many are disposed to think the phenomenon a purely optical one, due to some astigmatism and imperfect focus of either the instrument or of the observer's eye; or else (as Mr. Proctor suggested rather vaguely) an effect of diffraction in some way. If it were not for the observations of Perrotin, I for one should accept the theory of astigmatism, for I have myself often seen delicate single lines in the solar spectrum appear double from some slight pinch of one of the lenses in the spectroscope. But it is very difficult to see just how two different observers, with two such different instruments as the twenty-nine inch telescope at Nice and the little eight inch at Milan, could see the phenomenon alike if it were merely optical. There is some mystery about the matter, and it is clear that we must wait for further and more conclusive evidence before building any considerable structure of theory upon the reported facts. The only suggestion so far made which seems worthy of mention here is that the "canals" may be water courses of some sort, at times flooded, and at other times drained off, so as to become invisible.

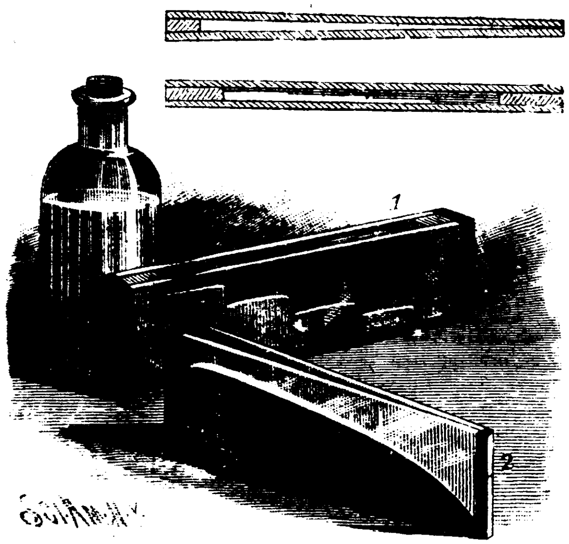
During the last opposition (in April) the planet's nearest approach to the earth was about 56,000,000 miles, and it was so far south in the sky that it could not be very well observed in Europe or this country. But both at Milan and Nice some of the canals were seen, and seen as double for a time. Perrotin also reported that a continental tract which he had named Libya (a part of Proctor's "Herschel Continent") *had mostly disappeared, as if inundated.* While this observation of his is partially confirmed by some observers, it has been positively disputed by others. With the Lick telescope, Libya was seen last spring by Professor Holden on several occasions; in fact, whenever it was favorably placed for observation at the time the telescope happened to be directed on the planet. Nor was anything seen at Mount Hamilton like the "gemination" of any of the canals, though in some instances a widish streak was observed, in place of the sharp and narrow line delineated on the map.

The two little satellites (discovered by Professor Hall at Washington in 1877) were, of course, seen and easily observed.

It is to be hoped and expected that the great telescope on Mount Hamilton, with its advantages of situation and its freedom from the atmospheric embarrassments which so seriously interfere with the work of our other large instruments, will in 1890 and 1892 be able to solve definitely the interesting problems that our neighbour propose for our investigation.—By Prof. C. A. YOUNG, in the *Popular Science News.*

Princeton, Nov. 9th, 1888.

A prominent feature of the *Office* (66 Duane street, New York) is articles on the subject of advertising, being addressed to advertisers with the special purpose in view of instructing them in the judicious use of printers' ink. Occasionally a little humor is interspersed with what would otherwise be less entertaining reading. For example, a correspondent in the current issue narrates a bit of experience that will bear repeating. An advertising solicitor was confronted at the entrance to an important establishment by a conspicuous placard bearing the inscription, "No Contracts for Advertising Made Here." Now, it happened to be a firm with whom he had never done any business, and he was not the kind of a man to be stopped by a notice of this sort. Boldly entering the sanctum, he selected with practiced eye the man most likely to be the one he wished to interview, and, presenting his card, awaited developments. An inspection of the pasteboard revealed the probable object of the caller, and the head of the firm sternly asked if he had not read the notice on the door. The solicitor promptly replied, "Yes; I read it very carefully, and came in to inquire where the advertising contracts are made if they are not made here." The ready wit of the advertising man saved the day for him, and although he was not succeessful in carrying out an order in his pocket at that time, it was not very long before the firm gave him a generous contract. They remained his steady customers for years.—*Exchange.*



MERCURY TROUGHS.

POURING WATER INTO A SIEVE.

EXPERIMENTS IN CAPILLARY FORCE.

What may be termed the reaction of capillarity as manifested between solids and liquids is divisible into two classes. One of these is illustrated in the case of a liquid wetting a solid, typical examples of which are found in blotting paper, in the drying action of a towel, and in many experiments founded on this general basis. Where the liquid wets the solid, the forces of adhesion and cohesion are both developed, and a distinct type of phenomena comes into play. But where the liquid does not wet the solid, as in the case of mercury against wood or glass, an action dependent on cohesion alone, or very slightly modified by adhesion, is produced. In the illustrations accompanying this article several illustrations of what may be termed the capillarity of cohesion are shown.

It is a well-known fact that if water is poured between two plates of glass held a slight distance apart, but nearer at one end than at the other, the fluid will rise the highest between the plates where they are the closest. The liquid will thus form a curve, in general sense a hyperbola concave upward. The water is attached to the glass by adhesion, travels upward, and by cohesion draws the liquid column after it, naturally to the greatest height, where there is the least liquid or the lightest column to be drawn. But if for the water we substitute mercury—a fluid which does not wet glass—the force of adhesion does not appear, cohesion draws the mercury strongly together and pulls it down to the greatest distance, where there is the least mercury to be acted on. This place is, of course, where the glass is closest, so that if mercury is poured between two plates of glass nearer at one end than at the other, it will rise to the greatest distance where the plates are farthest apart, and will descend in a curve convex upward. This curve will be directed toward the part of the glass plates which are nearest together. It is the reverse of the water curve.

In Fig. 2 of the drawings is shown such a trough, containing mercury. The upper sectional figure shows its construction. It is made of two pieces of glass cemented together by means of a little sealing wax, two of their edges being in contact, and two held apart by a slip of glass or cardboard. A piece of paper may be cemented over the bottom with gum tragacanth as a cementing material, or the opening may be closed with sealing wax or otherwise, as desired. This forms a wedge-shaped trough. When mercury is poured into such a receptacle, it takes a very peculiar shape, shown in Fig. 2. In Fig. 1 of the same illustration a variation on this is shown. Here the tank is constructed of plates of glass parallel one to the other; but before being put together, a series of strips of paper are pasted on one of them, each slip being about one-fourth of an inch or more shorter than the one beneath it. In this way the open space is divided into a series of step-like divisions of varying width, each division, however, having practically parallel sides. If mercury is poured into this trough, it will arrange itself into a series of steps, as shown in Fig. 1.

In the next illustration, the same idea is carried out and applied to water. A cup is made of No. 50 gauze. The seams are joined by soldering, and the bottom has its edges bent upward, and is also soldered in place. It is then heated, when perfectly dry, and thoroughly coated with paraffine. This fills the meshes. When sufficiently coated, it is again heated, and the paraffine is expelled from the meshes by sharply blowing against them. If now the cup is held as shown and water is poured into it very gently and along one of its slides, there is no difficulty in filling it to the depth of three inches or more with water. This illustrates water held in a sieve. If a finger of the hand holding the cup is wet, the water as it rises to the level of the moistened part will at once rush out. If, when the cup is full, the wet finger is rubbed on the bottom, this will be sufficient to cause the water to escape. The cup will float upon water for an indefinite period, but if inverted and placed like a diving bell, will at once sink.

The water in this experiment practically forms a film or membrane, not touching the wire gauze and holding the body of the water together. The figure on the upper part of the cup is an attempt to show how the water rests upon the wires. The little film is bowed down between every two wires, forming a species of sac.

The experimenter must remember to have his hand perfectly dry. It is very curious, as the water rises, to feel its chilling effect through the wire gauze without the hand being at all moistened.—*Scientific American.*

RUSSIAN SHEET IRON.

The inquiries we receive from time to time respecting Russian sheet iron demonstrate that there is a demand for that article which is badly supplied, as well as a good deal of ignorance respecting the method of its production. It is generally supposed that the mode of manufacture is a dark secret, which cannot be penetrated—indeed, quite recently, a newspaper paragraph has been in circulation in which it is asserted that Russian sheet iron is produced in a huge walled town, from which no workman is ever allowed to depart alive. This statement is an absurdity on the face of it. As a matter of fact, there is no particular secret in the matter, seeing that Dr. Percy described the process a great many years ago, and quite recently Mr. F. L. Garrison has contributed a paper on the subject to the United States Association of Charcoal Iron Workers. Mr. Garrison visited the works in the Ural district of Russia and saw the sheet iron made; consequently his paper possesses unusual value and interest to all producers and users of fine sheet iron.

The ores used are chiefly those from the Maloblagodatj mines, the chemical composition being: Metallic iron, 60 per cent.; silica, 5 per cent.; and phosphorus, 0·15 to 0·06 per cent. The ore is either made into malleable iron in various kinds of bloomaries, or is smelted into charcoal pig iron, and then puddled or dealt with in a Franche-Comté hearth. The blooms or billets are rolled into bars 6 inches wide, ¼ inch thick, and 30 inches long. The bars are first assorted, and the inferior ones rerolled. Those accepted are carefully heated to redness, and cross-rolled into sheets about 30 inches square, the process necessitating from eight to ten passes through the rolls. The sheets thus obtained are again twice heated to redness, and rolled in sets of three each, great care being taken that every sheet before being passed through the rolls is brushed over with a wet broom made of fir, and at the same time powdered charcoal is dexterously sprinkled between the sheets. The sheets receive ten passes through the rolls, and are then trimmed to a standard size of 25 by 56 inches. They are then further assorted, the defective ones being thrown out, each sheet is wetted with water, dusted with charcoal powder, and dried.

That done, they are made up into packets containing 60 to 100 sheets, and bound up by the wasters. The processes of annealing and finishing are thus described by Mr. Garrison:—

"The packets are placed, one at a time, with a log of wood at each of the four sides, in a nearly air-tight chamber, and carefully annealed for five or six hours. When this has been completed, the packet is removed and hammered with a trip-hammer, weighing about a ton, the area of its striking surface being about 6 by 14 inches. The face of the hammer is made of this somewhat unusual shape in order to secure a wavy appearance on the surface of the packet. After the packet has received ninety blows equally distributed over its surface it is reheated, and the hammering repeated in the same manner. Some time after the first hammering the packet is broken and the sheets wetted with a mop to harden the surface. After the second hammering the packet is broken, the sheets examined to ascertain if any are welded together, and completely finished cold sheets are placed alternately between those of the packet, thus making a large packet of from 140 to 200 sheets. It is supposed that the interposition of these cold sheets produces the peculiar greenish color that the finished sheets possess on cooling. This large packet is then given what is known as the finishing or polishing hammering. For this purpose the trip-hammer used has a larger face than the others, having an area of about 17 by 21 inches. When the hammering has been properly done, the packet has received sixty blows equally distributed, and the sheets should have a perfectly smooth, mirror-like surface.

"The packet is now broken before cooling, each sheet cleaned with a wet fir broom to remove the remaining charcoal powder, carefully inspected, and the good sheets stood on their edges in vertical racks to cool. These sheets are trimmed to regulation size (28 by 56 inches), and assorted into Nos. 1, 2, 3, according to their appearance, and again assorted according to weight, which varies from 10 to 12 pounds per sheet. The quality varies according to color and freedom from flaws or spots. A first-class sheet must be without the slightest flaw, and have a peculiar metallic gray color, and on bending a number of times with the fingers, very little or no scale is separated, as in the case of ordinary sheet iron."

It is the peculiar feature of Russian sheet iron to possess a beautifully polished coating of oxides—what the Germans term "glanz"—and it is in securing that finish that the makers and workmen excel. The trade has been in the same hands for a very long series of years, and the men naturally possess the accumulated skill of generations of their predecessors. It must be remembered, also, that the iron ores used are very pure, containing but small traces of phosphorus and no sulphur, and that they are smelted and the product heated exclusively with wood fuel. It is not very easy to understand the exact effect of the powdered charcoal, nor the effects of the interposition of the cold finished sheets between those not yet cold. Mr. Garrison says that the Russian ironmasters attribute the excellence of their product to these peculiarities of treatment, and he seems convinced that there is no secret about the process. If he is right, then, it would seem to follow that there ought to be no special difficulty—given similar materials and fuel, and with the same methods of procedure—in turning out sheet iron as good as the Russian article in this or any other country. In view of the demand for Russian sheet iron, it might pay some of our sheet rollers to make the experiment at all events.—*The Ironmonger* (London).

SMALL TIMBER BETTER THAN LARGE.

The statement that a 12 by 13 inch beam built up of 2 by 12 planks spiked together is stronger than a 12 by 12 inch solid timber, will strike a novice as exceedingly absurd, says the *Mississippi Valley Lumberman*. Every millwright and carpenter knows it also, whether he ever tested it by actual experience or not. The inexperienced will fail to see why a timber will be stronger simply because the adjacent vertical longitudinal portions of the wood have been separated by a saw; and if this were the only thing about it, it would not be stronger, but the old principle that a chain is no stronger than its weakest link comes into consideration. Most timbers have knots in them or are sawed at an angle to the grain, so that they will split diagonally under a comparatively light load. In a built-up timber no large knots can weaken the beam, except so much of it as is composed of one plank, and planks whose grain runs diagonally will be strengthened by the other pieces spiked to it.

To find the velocity in feet per minute necessary to discharge a given volume of water in a given time, multiply the number of cubic feet of water by 144, and divide the product by the area of the pipe in inches.

ABOUT HEMLOCK.

Hemlock is gradually coming to the front among Michigan forest products. It makes its way slowly against a deep-seated prejudice as uncompromising as the slivers on the wood. Everybody in the North-west is in love with pine, and until recently hemlock was scouted as of no account. Within a few years it has been cut to some extent in Michigan for local use, and manufacturers are crowding it on the attention of dealers and consumers. It sells mostly in the form of dimension and lath, though a considerable quantity of shingles are made out of hemlock. The planking for block street paving in this and other Western cities is largely of it. In Missouri River cities cypress has been substituted for it. Dimension has made relatively more progress in Southern Michigan, Indiana, and Ohio, than farther West. However, in this city a number of heavy dealers, with a large trade in the West and South-west, have managed to handle considerable quantities of hemlock. A commission dealer in this city, who does a business in the pine product of Western Michigan, says that hemlock is bound to assume prominence in the lumber trade of the West. The timber is in Michigan, and it will not be wasted. Dimension, when bone dry, is lighter than pine, which is favourable to its shipment. It is about $2 a thousand or more cheaper than pine, selling in this city at $8 a thousand, when pine sells at $10 to $10.25. It is really a stronger, stiffer material for scantling and joists than pine, provided the timber is sound and does not have too much shake. It is claimed that a good run of hemlock lumber can be procured in Michigan, and that is the only kind that is worth talking about or making any account of. Poor hemlock is good for nothing but firewood, and is more snappish and noisy than valuable for that. There is, however, a difference of view about the relative utility of hemlock and pine for joists. A Western man, deeply imbued with the prejudice for pine, will not even admit that hemlock makes as good joists as pine, but such an assumption is not clearly provable. In Pennsylvania and the Eastern States hemlock is considered good enough for almost any rough lumber purpose. In the West the carpenters are down on it because it is harsh stuff to handle, and works harder than pine. They are bound to fight it to the bitter end. But it will be crowded on to them gradually, and they will be obliged to use it.

Hemlock lath is worthy of consideration by all Western house builders. Fanciers of it claim that it is better than pine, for the reason that it is free from pitch, and it never stains the plastering. A builder of houses on an extensive scale in this city was induced to try hemlock lath. Both pine and hemlock were used in the same structure, and the result was clearly in favour of hemlock, for the pine stained the plastering, and the hemlock did not, the difference being plainly noticed at a glance. The experiment was so satisfactory to the builder that he will go in for hemlock lath in the future.—*North-western Lumberman* (Chicago).

A building journal says "that on the average, in frame dwellings, building hardware, porches and piazzas should be estimated to last twenty years; outside paint five and inside seven years; shingles and outside blinds, 16 years; cornice and base, 40 years; weather boards, doors, windows, stairs, newels and inside blinds, 30 years; sheathing and dimension lumber, 50 years; sills and first floor joists, 25 years." This is not quite correct. Under ordinary conditions the life of a frame building is from 10 to 15 per cent. more than given.

ELECTRIC PROSTRATION.

New conditions develop new diseases.

The "railway spine" has taken its place in medical nomenclature, and the "caisson disease" has also been recognized. Now a third has been added to the list, in a condition which has received the name of "electric prostration."

This is a disorder, says the *Medical Era*, of Chicago, that affects those who work under strong electric lights. After an exposure of one or two hours, the workers have a painful sensation in the throat, face, and temples, the skin becomes of a coppery-red color, there is irritation of the eyes, with profuse lachrymation, lasting forty-eight hours. After five days there is desquamation of the discolored skin.

These symptoms do not follow exposure to the ordinary Edison light, but to one of excessive strength, such as is used in electric furnaces for the quick heating of metals. Some mitigation of the symptoms may be procured by the use of dark-colored glasses, but not entire immunity. The effects seem to follow exposure, not to the heat, which is not great, but to the intensely brilliant light.

Thus has a new industry created a new disease, for which the profession will be called upon to find a remedy.

THE ORIGIN OF PETROLEUM.

In a paper read before the New York Academy of Sciences, on November 26th, Professor J. S. Newberry gave his views as to the origin of petroleum as follows:

The origin of petroleum has been a vexed question, chemists holding one theory and geologists another. The eminent chemist, Mendeljeff, supposes it to be formed from inorganic elements by natural synthesis, but Mandeljeff had no personal acquaintance with our great American oil-fields. His theory is a theory only. In volcanic and metamorphic regions the inorganic elements exist abundantly and in juxtaposition, but oil is never found there, thus refuting the theory.

The geologist finds that oil is always associated with bituminous shales or limestones. Near the outcrop of the carbonaceous shales which underlie Western New York and Pennsylvania, oil and gas springs are found associated in position, and evidently so in origin. South of Cleveland, Ohio, oil and gas are found above such shales. They seem to originate in these shales, and are formed from organic matter, which goes on decaying. Coal, if left out in the open air, loses its volatile matter in the same way that these bituminous shales are doing. Thus spontaneous distillation is constantly going on, and petroleum and gas are issuing from decomposing organic matter. Petroleum, decomposing in its turn, throws off volatile gases, leaving tar, asphalt, ozocerite, albertite, grahamite (asphaltic coal), asphaltic anthracite, and as the last term of the series graphite, from which all volatile matter has escaped. The transition from oil to asphalt is very well seen in Canada, also in the Pitch Lake of Trinidad, which is fluid in the centre and gradually solidifies toward the edges. At Canajoharie, petroleum oozing from the Utica black shales in ancient times has formed seams of anthracite from the thickness of a sheet of paper to those several inches thick. At a mine in Idaho eruptive rocks have formed dykes in carbonaceous (cambrian) shales, and fissures are filled with anthracite, also a residue from ancient petroleum. In the Laramie rocks of Northwestern Colorado are veins of albertite 10 to 20 feet thick, resulting from petroleum which came from the Colorado shales below.

All these examples indicate the methods of operation of natural agencies through seculiar periods. But similar processes are even now going on. We may see on a small scale the formation of oil in pools where vegetation is decaying. In such places, remote from the great oil-fields, a thin film of oil is formed on the surface of the water, and on poking up the mud with a stick, bubbles of marsh gas are set free from the bottom.

All these phenomena point clearly to vegetable tissue as the origin of the various hydrocarbons, whether gaseous, liquid or solid. Some small proportion may be of animal origin, as adiprocere is not infrequently cast up by the sea, but the great deposits must be of vegetable origin. This is confirmed by microscopic examination of bituminous shales, which are found to be full of broken vegetable fibres. A possible source of oil and gas are the minute algæ, such as now in summer abound in some lakes to such an extent as to render the water green and opaque.

These considerations throw light on the question of permanence or failure of supply in gas and oil wells. If the theory of the speaker is correct, first, gas and oil springs and wells must be confined to strata overlying beds of organic matter, such as coal, carbonaceous shales and bituminous limestone; second, gas and oil will flow from such deposits as long as any organic matter is left; third, the daily flow of gas and oil will be small, and great accumulations of either can only take place where fissures or coarse, porous rocks serve as a reservoir, and impervious strata above prevent escape and cause the accumulation of hundreds of years of daily product. Hence gas and oil wells will continue to flow for ages, but when the stocks in reservoirs are exhausted, or the current production is divided among many wells, the product may be so reduced as to be of little or no value.

The oil wells of Mecca, Ohio, prove the continual formation of petroleum. These wells are bored in the Berea grit, a sandstone which overlies the Cleveland shale, a sheet of carbonaceous matter. When first opened the Berea grit was found saturated with oil, and several hundred wells were bored in close proximity. These soon drained away the accumulation of oil, and within three months every well was supposed to be exhausted and was abandoned. Now a small but remunerative industry is maintained there by pumping each well a few days in the year. The quantity taken from each, though small is constant, proving a continued production. As no oil has been obtained there below the Cleveland shale, and gas and oil are seen escaping from that in a multitude of places, we must conclude that they come from the shale.

History confirms this view of permanency in supply. The Chinese have used petroleum for 2000 years and the Hindoos for many hundreds, and the spontaneous flow upon which they have depended has been constant. On the shores of the Caspian, enormous and apparently constant quantities of gas and petroleum have escaped from the ground from time immemorial. The Babylonian asphalt used as a mortar is a petroleum product furnished by the fountains of Hit, which are apparently flowing now as they did thousands of years ago. In all these localities the spontaneous outflow of oil (that is, the daily product of subterranean distillation) has been used, and such sources of supply are permanent, but the steam pump will certainty exhaust local reservoirs of oil, and numerous gas wells will exhaust a territory, however productive in the beginning.

In discussing the paper, Mr. Hidden took issue with the theory of the vegetable origin of petroleum, adducing the fact that carbon from meteorites has been distilled and oil obtained and that quartz and granite are found sometimes heavily charged with carbonic acid, either gaseous or sometimes even in a liquid condition.

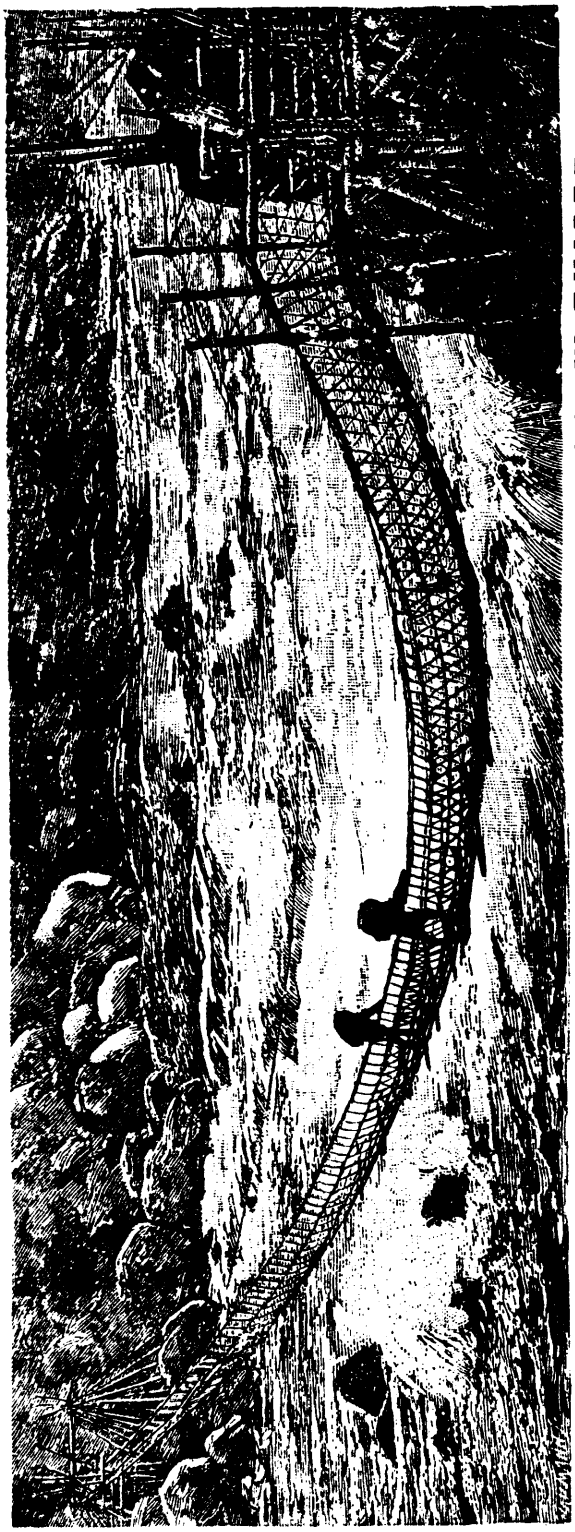
Prof. Newberry replied that the granites which contain carbonic acid and graphite are sedimentary rocks which have been metamorphosed by heat, and their organic hydrocarbons distilled. He had only attempted to explain the origin of the petroleum of this world; we do not know anything about the conditions of things in worlds other than our own, but analogy justifies the inference that similar causes produce similar effects elsewhere as here.

PRIMITIVE SUSPENSION BRIDGES.

It is worthy of note that the type of modern bridge that has reached its highest development in the United States in the superb and costly structures which span the Ohio river at Cincinnati and Pittsburgh, the Niagara river at the Falls, and the East River at New York, should also be that which is found among primitive peoples in various parts of the world. We refer, of course, to the suspension bridge. In Humboldt's travels in New Spain, he refers to bridges of ropes used by the natives of the country. These ropes are three or four inches in diameter, made from the fibrous roots of some of the native plants, and are secured by fastening them on both sides of the chasm or stream to the trunks of trees. These ropes—two of them being stretched side by side—form the supports of the bridge proper. The body of this superstructure is formed of a number of canes or bamboos, laid crosswise, and secured at their ends to the ropes, forming a considerable loop, in the bottom of which the footway of canes or logs is secured. The canes forming the body of the bridge are lashed together securely, and are prevented from collapsing under the weight of the travelers by cross-ties placed at intervale below the floor and fastened to the suspension ropes by pieces of cane, which act the part of stiffening rods to keep the suspension ropes apart. As may be imagined, these primitive structures are anything but reassuring to the inexperienced traveler who is obliged to use them, and the distinguished scientist just named gives a graphic account of his experience in crossing these frail structures, which the least awkwardness or loss of presence of mind, exhibited by grasping the ropes for support, causes to sway in the most alarming fashion. In the mountainous region of the western portion of South America, such primitive suspension bridges are still numerous. They are very safe and durable, notwithstanding their apparent frailness, and are reported to last from 20 to 25 years.

Suspension bridges have been in use in Thibet, China and Japan from the most ancient times. Knight, for example, speaks of a bridge spanning a river of the province of Yunnan, in China, which is known to have been built 2000 years ago. A much larger one, spanning the river Pei, is also spoken of by the same writer. The suspension portions of this structure consist of chains fastened to supports above and below, to prevent swaying, and the floor of the superstructure is formed of planks. In Japan, a suspension bridge of bamboo, reported to exist over the river Fuji Kaira, is said to be one hundred feet above the level of the river, and to have a span of sixty feet.

Tamer, in his "Voyage to Thibet," mentions a suspension bridge at Tchni-Chien, near the fort of Chuka. This is described as being 140 feet long, and to be passable for horsemen. The English papers, which have more or less to say of this peculiar and little-known country and its people, because



PRIMITIVE SUSPENSION BRIDGE OF BAMBOO, IN THIBET.

of the military operations at present going on, lately gave extensive publicity to a graphic pictorial description of a portion of Thibet, its people and their customs, from the pen of Col. C. J. Cramer Roberts. From this publication we obtain the following description and picture of one of these primitive suspension bridges:

"The last sketch of this series represents the great cane suspension bridge over the Teesta, river, which on its way collects most of the tributary streams ever rushing down from the great glaciers of the Kinchinjunga range, and is even here a powerful stream, sweeping down everything before it—boulders, giant forest trees—in its headlong course. This fragile fabric of a bridge, which appears as if the very winds could blow it away, is the only means of communication that the natives of this part of the country possess. It consists chiefly of tough wattles or small bamboos, closely interlaced, and capable of supporting two or three ordinary coolies with good heavy loads on their backs. But these bridges require a cool head to cross over them, as the footway is seldom more than six inches wide; in fact, were it not for the slender bamboo handrails, it would require the nerve of a Blondin to venture on such a spider-webbed concern, swayed about by the breeze over the torrent roaring below."—*Manufacturer and Builder.*

THE ELECTRIC BLOWPIPE.

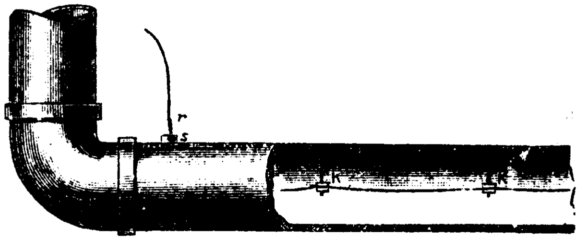
BY SAMUEL SHELDON, PH.D., PROF. HARVARD UNIVERSITY.

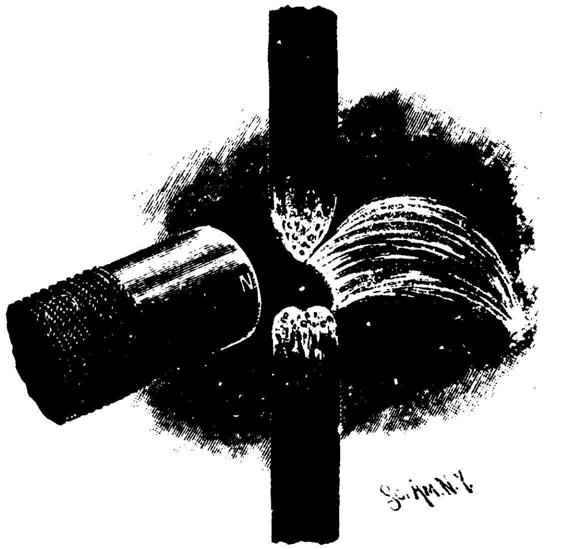
The application of dynamo-electric currents for the welding of large pieces of metal, in the mechanic arts, has been practically demonstrated as a success. But its employment has been, of necessity, limited to large workshops, where the amount of work of this character would warrant the purchase of a dynamo. Furthermore, the danger attending the use of powerful currents has deterred many from making use of them, because they have had in their employ mechanics of only ordinary attaments, with no especial knowledge of electricity.

Besides the Thomson-Houston system, which employs a current of very great strength but small electro-motive force, and where the pieces to be welded are brought into contact, two general methods employing the electric arc have been used. The first consists in making an electrode of each of the pieces to be welded, a small space being left where the welding is to take place. If a strong current be sent through, it forms an arc of great heat at this space and the metals are melted, and, running together, form a compact whole. The second consists in connecting both of the parts to be welded to one end of the circuit, while the other end is connected to a movable point, which is brought into close proximity to the joint, and, the arc being formed, gives the same result as before.

For many pieces of work these methods are not practicable. For instance, oftentimes when two pieces are brought into their proper relative positions, if a current be sent through after the first method, arcs will be formed at several places, and junctures will be made in places not desired. Again, in the employment of the second method, the use of two hands is often essential in the manipulation of the work, in which case a second person is necessary to apply the second contact. It is well known that two persons cannot co-ordinate their movements in the efficient manner in which one can those of his two hands, and the result is often an inferior grade of workmanship.

Now, the peculiar behavior of the electric arc, when placed in a strong magnetic field, affords at once a simple and efficient means for welding. A dynamic attraction or repulsion occurs between the rectilinear current of the arc and the amperean currents of the field, and this results in the drawing or driving out of the arc into a point, which is very similar to the point of flame projected from a blowpipe. The form may be seen from the above sketch.





THE ELECTRIC BLOWPIPE.

The heat at the point of the arc is intense, and suffices to melt any of the metals. A piece of No. 14 copper wire held at the apex melts instantly.

This extreme heat in such a convenient form can be the means of bringing electro welding within the reach of all shops where arc lamps are employed for illumination. By a mere nominal alteration the lamp may be made to perform the double function of illumination and welding. To attain this end, a straight electro-magnet wound with coarse wire is only necessary. This is placed with one end toward the arc, and may be fixed in one position (to be determined by experiment, and depending upon the direction of the desired point of the arc), or made movable in a horizontal plane on a level with the arc. The two terminals of the magnet coil are inserted anywhere in the main circuit, or, if found necessary, may be shunted from the same. The connections, once made, can remain undisturbed, and, without influencing the main line, the lamp performs its two functions.

In the employment of the arc for electro welding, the operator must, of course, wear colored glasses for the protection of the eyes. Care must be used in the selection of these, for some of the coloring matter used (especially in blue and red glasses) absorbs the light given out at the apex of the arc, and this would be detrimental to fine work.

The electric arc, when in a strong magnetic field, exhibits another peculiarity. It is known that if a circuit, traversed by a strong current, be broken under ordinary circumstances, a moderate spark will ensue, accompanied by a snap similar to that given by a toy cap when exploded. If, however, the break be made in a strong magnetic field, an extremely large spark follows, accompanied by a peculiarly sibilant report, as intense as that of a pistol. The effect is very startling when unexpectedly made.

If a strong field be brought to bear upon the interrupter of the primary circuit of a Ruhmkorff coil, the spark emitted by the simple secondary coil equals in magnitude and length that which would be produced under ordinary circumstances were the secondary in communication with a large condenser. This simple means may often be employed to advantage in work with a Ruhmkorff, when a long spark is desirable and, at the same time, any electrostatic residue, owing to the condensers, is to be avoided.—*Scientific American.*

BRASS AND ITS TREATMENT.

Brass is perhaps the best known and most useful alloy, says the Boston *Journal of Commerce*. It is formed by fusing together copper and zinc. Different proportions of these metals produce brasses possessing very marked distinctive properties. The portions of the different ingredients are seldom precisely alike; these depend upon the requirements of various uses for which the alloys are intended. Peculiar qualities of the constituent metals also exercise considerable influence on the results.

Brass is fabled to have been first accidentally formed at the burning of Corinth, 146 B.C., but articles of brass have been discovered in the Egyptian tombs, which prove it to have had a much greater antiquity. Brass was known to the ancients as a more valuable kind of copper. The yellow color was considered a natural quality, and was not supposed to indicate an alloy. Certain mines were much valued, as they yielded this gold-colored copper, but after a time it was found that by melting copper with certain earth (calamine) the copper was changed in color. The nature of the change was still unsuspected.

Alloys of copper and zinc retain their malleability and ductility when the zinc is not above 33 to 40 per cent. of the alloy. When the zinc is in excess of this a crystalline character begins to prevail. An alloy of one copper to two zinc may be crumbled in a mortar when cold.

Yellow brass that files and turns well, may consist of copper 4, zinc 1 to 2. A greater proportion of zinc makes it harder and less tractable; with less zinc it is more tenacious, and hangs to the file like copper. Yellow brass (copper 2, zinc 1) is hardened by the addition of two to three per cent. of tin, or made more malleable by the same proportion of lead.

There would be less diversity in the results of brass castings if what was put into a crucible came out of it. The volatility of some metals, and the varied melting points of others in the same mix, greatly interfered with the uniformity in ordinary work. Zinc sublimes (burns away) at 773 to 800 degrees, while the melting heat of the copper with which it should be intimately mixed in making brass is nearly 1,750 degrees. Copper, zinc, tin, and lead in varying proportions form alloys, always in definite quantity for a given alloy. The ease with which some of the metals are burned away at comparatively low temperatures, renders it a very easy matter to make several different kinds of metal with the same mix. This very thing occurs, and the great difficulty in getting bearing brasses uniform in quality causes some engineers to babbitt all bearings as the best way to insure uniformity. One lot of castings may be soft and tough, another hard, and so on.

Zinc is added the last thing as the crucible comes out of the furnace, and the mixing of the mass is a matter of uncertainty. If the metal is too hot for the zinc a large percentage goes off in the form of a greenish cloud of vapor, and the longer the stirring goes on the more escapes. The two metals which enter into the composition of brass have an affinity for each other, but they must be brought into intimate contact before they will combine. Some brass founders use precautions to prevent volatilization of the more fusible metals, introducing them under a cover of powdered charcoal on top of the copper.

"Brass finisher" is a term many understand as applied only to those who produce highly-furnished brass works; but it is not so; the brass finisher's work is not the superior class of work supposed, most of it being comprised in gas fittings, ormolu mounts, etc., but the highest class of brass finishings is a totally different process. Fittings for gas work, all finished well enough for their several purposes, and as well done as the price paid for them will allow, as well as the mountings for furniture, must obviously be produced at a low rate, in order to supply the demand for cheap work of this character, most of which is simply dipping, burnishing, and lacquering.

Let us follow the process of finishing the highest class of brass work, says the *Engineer*, of Glasgow. Before commencing to polish, all marks of the file must be removed, and this is done thus:—Having used a superfine Lancashire file to smooth both the edges and surfaces, take a piece of moderately fine emery paper and wrap it tightly, once only, round the file. By having many folds round the file the work becomes rounded at the edges, and so made to look like second-rate things. Some use emery sticks, made of pieces of planed wood about ⅜ inch thick and ¾ inch wide, quite flat on the surfaces. They are covered with thin glue, and the emery powdered on to them, and then allowed to dry hard. Most common work is rubbed over, not to say finished, with emery cloth. This will not do for good work. The paper folded once round the file is used in a similar manner to the file, and when the file marks disappear, and the paper is worn, a little oil is used, which makes it cut smoother. The edges and surfaces being prepared to this extent, the edges must be finished. To effect this take a piece of flat, soft wood, and apply to its surface a little fine oil-stone powder; be sure that it is quite clean, as it is very annoying to make a deep scratch in the work just as it is finished; perhaps so deep that it will require filling out.

Clean, crude borax, which has been melted and ground to a fine powder, is the best welding fluxes that can be produced.

Tests have recently been made in Germany with the electric light for night firing. The targets were placed 400 meters from the rifleman, and the powerful light 200 meters behind the position of the rifle. The results were most satisfactory, nine out of ten shots fired hitting the target.

TRACING CURVES BY PHOTOGRAPHY.

In the *Bulletin* of the Académié des Sciences de Belgique, M. Eric Gérard describes a new method of automatically registering observations by means of photography. *Engineering* says: In making a research in the variable current supplied by alternate current machines, he had got very good curves by using an extremely delicate and aperiodic galvanometer, the inertia of the moving parts also being extremely small. A beam of electric light was reflected from a very small concave mirror attached to the moving portion of the galvanometer through a lens, falling finally on to a sheet of sensitive paper, on which is cast a very minute image. After some trouble very good results were obtained in this way, but not being completely satisfied, he cast about for some other method of obtaining the same end, the arc light in particular being costly and troublesome. His new arrangement consists of a moderate-sized Ruhmkorff coil, the spark from the secondary coil of which plays between a piece of aluminum wire and the point of a carbon for an arc lamp. The two electrodes are fixed at least one millimeter apart. The spark is projected on to the movable mirror aforesaid, and thence to the sensitized paper, which may be wrapped round a drum, or more conveniently simply stretcheonad frame, which can be allowed to fall between guides. The period of the sparks depends solely on the elasticity of the spring of the vibrator of the primary coil, and the number of spots photographed in unit length of the curve on the sensitized paper forms a convenient time scale. By connecting the electrodes of the secondary coil to a couple of small Leyden jars, a very short and white spark is obtained, the position of which is invariable. This plan has the advantage of reducing the dimensions of the numerous spots which make up the curve photographed.

PHOTO. TRANSPARENCIES.

After fixing the positive, wash it very thoroughly—say for at least an hour—in a constantly changing stream of water, and a final treatment with hydroxyl or one of the hypochlorites in very dilute solution will not be a disadvantage. A solution composed of twenty grains each of chloride of mercury and chloride of ammonium in an ounce of water is next applied, until the image is uniformly whitened throughout its whole thickness, as judged by its appearance from the back of the glass. After that another very thorough washing is necessary, either in a constantly changing stream, or else, after some three or four minutes under a tap, a long soaking of, at least, half an hour, or preferably longer. The washing at this stage cannot be too complete.

Next, for the toning solution. This consists of a solution of moderate strength—say, twenty to fifty grains to the ounce —of sulphide of potassium or "liver of sulphur," the application of which is continued until the desired depth of tint it attained. Potassium sulphide is not a particularly desirable adjunct to the dark room on account of its offensive smell, but so long as there is no sensitive paper, carbon tissue, or similar delicate matter lying about, the inconvenience will end with the smell.

The tones produced under this treatment are of the most pleasing character, ranging through varying shades of purple, and are quite independent of the color or character of the image before bleaching. But it must be borne in mind that the final color, after drying, is colder, or verges more toward blue, than when the picture is wet. This borne in mind, and with a little experience in judging the point at which to stop, no difficulty will be experienced in getting uniform and pleasing tones for transparencies on any good plates.

ELECTRIC WELDING OF METALS.

Our illustrations this month show one of the most remarkable results arising from the recent development in and application of electricity. Its influence upon the working of metals will be so great that it is difficult at the present time to comprehend it. We refer to the electric welding of metals by the process invented by Prof. Elihu Thomson, of the Thomson-Houston Electric Company.

Hitherto welding has been confined to wrought iron and steel, and the most perfect welds had only about seventy-five per cent. at their best of the strength of the solid bar. Other metals than these could not be welded by any means whatever. The process of welding iron by the blacksmith is at the best crude and imperfect.

Now all this seems destined to be suddenly changed in all industrial works. Not only iron is perfectly welded in a very short period of time, but all kinds of metals can be welded with equal facility not only to each other but to any other kind of metal. Moreover, the line of junction of the welded pieces—in the case of iron at least—is stronger for an equal sectional area than the original bar, this being due apparently to the fact that the fusion of the metal by the electric current eliminates the cinder present in all wrought iron bars, so that the line of junction of the welded surfaces is more homogeneous and consequently stronger than the original section of the bar.

The principle involved in this new art is that of causing currents of electricity to pass through the abutting ends of the pieces of metal which are to be welded, thereby generating heat at the point of contact, which also becomes the point of greatest resistance, while at the same time mechanical pressure is applied to force the parts together. As the currents heat the metals at their point of junction to the welding temperature, the pressure follows up the softening surface until a complete union or weld is effected, and as the heat is first developed in the interior of the parts that are to be welded, the interior of the joint is as united as the efficiently visible exterior. This is the weak point about an ordinary weld, as may be seen by reference to the accompanying figures. Figure 1 shows full size a piece of half-inch iron welded by electricity, the electrotype being made directly from the specimen, which was filed down to the centre line to obtain a section through the centre, and then etched with acid, the engraver's services not being brought into requisition at all. The difference between the character of the weld and that done at the ordinary forge is well shown by comparing Fig. 1 with Figs. 3, 4, 5, and 6, which show ordinary welds, the electrotypes being made in the same manner as in the case of Fig. 1, and first appeared in the *Locomotive* in April, 1884, the object being at that time to show the imperfections of the ordinary weld, 5 and 6 showing the result when the attempt was made to weld iron and steel together. We regret that we have no specimen of iron and steel electrically welded, but the welds of dissimilar metals by the electrical process are, we are informed, just as perfect as between two pieces of iron.

Fig. 2 shows the external appearance of the electrically welded bar; it shows the upsetting of the ends of the bars as they are brought together. Removing this projecting portion with a file or in the lathe so that the bar has a uniform diameter, and pulling apart in a testing machine, the break nearly always takes place ouside of the weld.

The machines built by the Thomson Electric Welding Company are generators of electricity so constructed as to produce in the most economical manner the low-pressure current need-

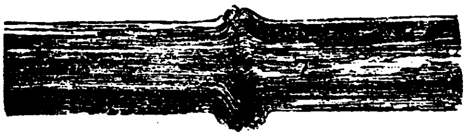


FIG. 1.

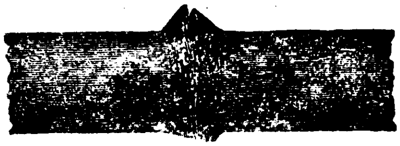


FIG. 2.

FIG. 3.

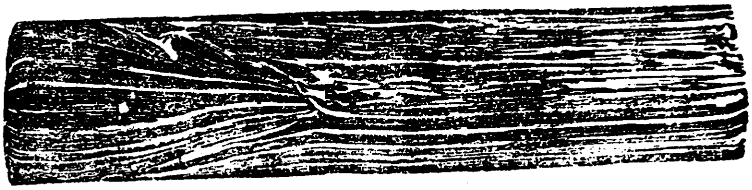


FIG. 4.

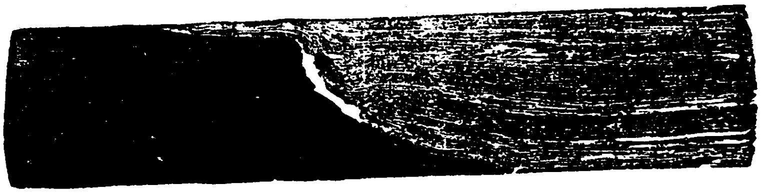


FIG. 5.

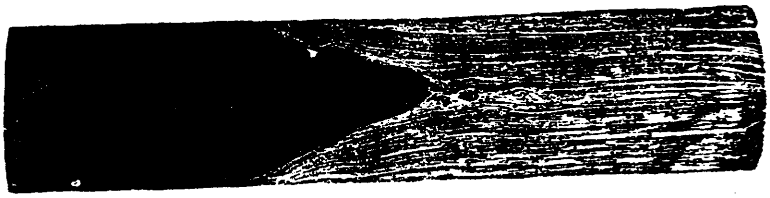


FIG. 6.

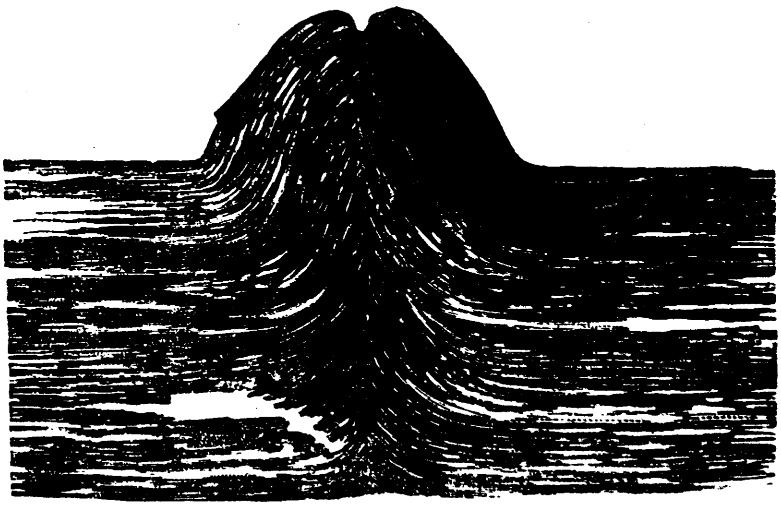


FIG. 7.

ELECTRIC WELDING OF METALS.

ed to do the work. They are of sizes and types suited to the kind of work to be done. They are built to be driven by a belt in shops where there is no dynamo used ; where a dynamo is used for any purpose whatever its current can be used for welding by utilizing it in a properly designed machine of what is called the indirect type.

The amount of power required to do this welding is used for so short a time that its cost is really nothing, a few seconds only being required to weld the largest bars. Twenty horse-power is the amount actually consumed in welding a half-inch bar, as shown in our cuts, the actual time consumed in welding being not over three to four seconds, as was witnessed by the writer recently.

In Fig. 7 an attempt has been made to show on an enlarged scale the section in Fig. 1. This is a difficult matter to do ; but under a power of about 40 to 50 diameters on a compound microscope, the denser and more homogeneous structure of the iron through the line of the weld is beautifully shown. With an ordinary weld the microscope is not as a rule needed to show actual separation of the surface supposed to be welded.—*Dominion Mechanical and Milling News.*

NEALE'S TELEPHONE.

I wish to draw your attention to a new telephone working on entirely a new principle to Bell's receiver. There is no diaphragm, but it works with a magnetic core and two coils ; the core is made up of several small iron tongues, of which you can have any number. The instrument is then entirely boxed up, and two hearing or receiving tubes are placed to the box, and the different voices can be distinguished through it as plainly as through a Bell receiver.

This instrument works as follows :—

Fig. 1.—N and S represent the north and south poles of three magnets, each of which is divided in the centre, and an adjusting screw fixed to each one. The tongues n^2, n^3, n^4, n^5, and n^6, are fixed firmly in the iron case, E, and the tongue, s^1, s^2, s^3, s^4, and s^5, are fixed firmly in the iron case, F. Now between these tongues are placed solid bars of iron, some thick and some thin ; for instance, the pieces between the tongues, s^1, and s^2, s^3 and s^4, n^3 and n^4, and n^5 and n^6, are all thin bars, say about $\frac{1}{8}$th or $\frac{1}{16}$th inch thickness, and these bars are placed as below, viz., two to each tongue, and leaving a small vacant space, P, fig. 2, up the centre, to enable the sound to come through from the vibrating of the separate tongues.

The bars between s^2 and s^3, s^4 and s^5, n^2 and n^3, and n^4 and n^5, are thick, say about $\frac{1}{2}$-inch, and there is also a vacant space left there through the centre of the tongues to allow the sound to come through the holes, G, in the backs of the iron cases, E and F. These tongues are then all screwed firmly together in each case, because the more firmly they are put together the better they will work. Between the coils, C and D, where the tongues meet, they should have about $\frac{3}{8}$-inch quite *free play* entirely, but the other part of the core should be quite solid and firm. Other plates of iron, m and m^1 and n^1 and n^1, should be placed at the top and bottom of the tongues, and a screw put through each, so as to hold them firmly together, because the more firmly these are made and the better and stronger the iron the better they will work and the more distinct. After this two coils, C and D, are fixed on plates M and M^1, and wound with No. 40 wire and about 120 ohms on each coil. A and B are the two terminals.

The working is as follows :—The magnets n and s induce the magnetism in the tongues, and consequently the poles of the magnet are now removed to between the coils C and D ; as they stand now, taking the five tongues, n^2, n^3, n^4, s^1 and s^3, n^2 attracts s^1, but s^2 drives s^1 away, they both being the same poles of a magnet, therefore there are two forces acting on s^1 ; it is the same with s^3, s^2 is attracted by the opposite magnet, n^3, but s^2 is driven away by the same magnet, s^1, and it is the same with all the tongues, each one has two powers working on it, and no matter how many tongues you place in the instrument, you still get the same forces acting on each tongue, and as your magnetism increases or decreases, according to the current that is sent through the coils, so will the different forces act on your different tongues, which you will find will all work together in unison.

I tried one of these instruments with a Crossley transmitter, and found it worked remarkably well. I made my tongues from a sheet of rather thick tin—No. 21 Birm. wire gauge ; if thinner sheets are used they will not work so well.—FRED. W. NEALE, in *Electrical Review.*

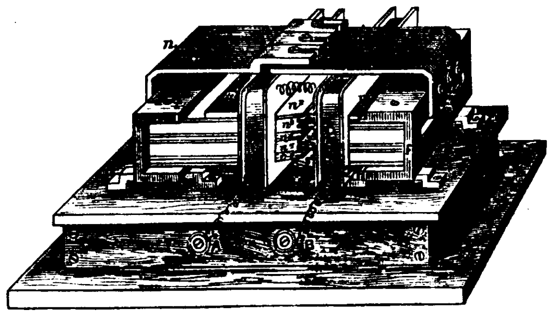


FIG. 1.

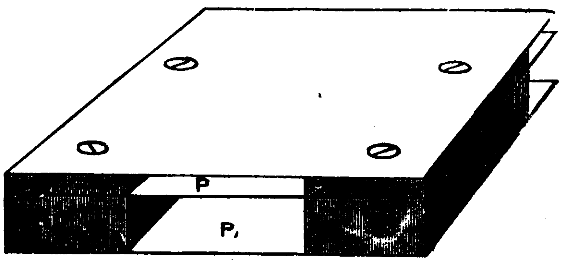


FIG. 2.

The shells of all crustacea get red when boiled ; those from salt water more than those from fresh. The result is the same whether the animal is in the shell or not.

A NEW METHOD OF PREPARING SILICON.—H. W. Warren suspends small bars of ferro-silicon immersed in dilute sulphuric acid from the positive pole of a battery, and resting upon a platinum plate that forms the negative pole. After solution of the iron, the residue consists of graphite, silica and amorphous silicon ; this residue is heated to redness in carbon dioxide, and then to bright redness in a closed iron tube with zinc. The silicon is dissolved by the zinc, and is obtained in crystals when the zinc is treated with hydrochloride acid. If aluminum be used instead of zinc, and the temperature raised to whiteness, graphitoidal silicon is obtained.

OMISSIONS IN CONTRACTS.

Incompletely-drawn plans and specifications are among the penalties which an exacting age inflicts upon architects. In a lately-decided case of appeal, in which a quantity surveyor had been employed to take out quantities, and they turned out to be defective, it was ruled that the surveyor did not guarantee his work, so that the contractor was the sufferer. The blame in both instances must be thrown on the eagerness there is to obtain low tenders for the work. If the surveyor is inaccurate, or omits large items, the fault must be laid to either his own carelessness or that of the architect. A little closer acquaintance with the inner workings of the architect's duties will readily convince us that there are exceptional temptations to inaccuracy. The client gives instructions that cannot be reasonably complied with ; he wants a great deal more than can be included in the contract for the sum he proposes to spend on the building, and the architect is often disposed to take these incompatible orders. A high-handed client, of the precise, matter-of-fact character, says, "I want a building of certain accommodation, but the cost must not exceed so and so." The architect accedes, preparing designs that he knows cannot be carried out for the amount, but that might, by a little cooking and compromise, be built for the money. It will not do to parley or explain with a client of this sort. Answers must be "yes" or "no." No half-measures or compromises will satisy. If the building cost more this kind of client has a ready remedy. He declines to pay the architect's bill, on the ground that his orders were disobeyed. Many in practice can point to several cases in which this disagreeable alternative has suggested itself to the mind of the close-fisted client. The *dénouement* is as sudden as it is unexpected. We remember an instance where a client refused to pay the architect on the ground that an extra charge had been passed by him for the grates to a house, which the client had imagined ought to have been included in the contract sum or tender. In vain did Mr. Architect expostulate on the unreasonable nature of the demand made upon him. The amount claimed for commission was nearly £100. The grates had cost the client about £60 ; thereupon he refused to pay the architect. There had been, at an early preliminary conference, something said about leaving the grates out of the contract, and the architect had too hastily concluded that such was an order, and he readily embraced any omission that would reduce the tender. The architect brought an action to recover his commission, which ended in a compromise. Omissions in specifications are the inevitable result of demanding more than the sum to be expended will allow. One case of the kind may be noticed. The architects were instructed to prepare the necessary plans and specifications for a house, the cost not to exceed a certain sum. Tenders were invited ; but they were all higher than the client wished to spend, and he therefore undertook to make certain reductions in the work, and accepted a tender which did not include the painting and paper-hanging. The contractors finished their contract. The client grew angry at the omission, and called upon the architects to compel the contractors to carry out the terms of the specification, in which there was a general clause to the effect that anything required to complete the building to the satisfaction of the owner should be done, even though not described. They refused to consider this clause as binding in the case mentioned. Though legal advice was sought, better counsels prevailed, and the owner completed the omitted work at his own expense, but held the architects liable. We do not know whether the deduction from their charges was made or not. Legally, there would be no ground for such a proceeding. The ordinary individual has a strange idea about omissions. He regards them as extras, for which the architect is solely responsible. Of course, the secret of this notion is the conviction that there ought to be nothing left out, that all tenders should be inclusive. He does not look at the unreasonable demand made by him upon the architect to supply what he requires at a cost that is quite insufficient. He obtains low tenders ; but if by chance some item like a cupboard is left out, he reproachfully comes to the architect and asks him to call upon the builder to have it fitted up. Tendering in these days is very much a matter of cutting down, taking advantage of small slips in the specifications, trimming this or that item of materials or labour. The responsible builder who will not stoop to these cheeseparing practices in his estimating puts against each item a full price. But the trimming or low-tendering practice is one in which the architect—as we have shown —is inclined to participate, and to make compromises with exacting clients. The surveyor employed to take out the quantities knows that by making them too full he may lose a commission—the recent decision has at least taught him that his responsibility shifts to the contractor. In the long run the employer sustains the loss. He is likely to have the brickwork or joiner's work scamped. Little or nothing is lost by an omission so long as the cost afterwards incurred does not exceed the expense at first, had it been originally included in the contract. This extra cost is the only one which a court of law could charge to the negligence of the architect. Yet clients look upon the omission as an extra ; they do not see it other than in the light of one. In a properly drawn up contract the owner pays for nothing that is not introduced, and under a fair schedule a contractor can only charge for the omitted work at the same rate as if he had at first included it in the tender. The only question is, whether the owner suffers any damage by the omission. Let us suppose the specification included pugging and sound boarding to the floor, but that this item was admitted from the quantities. The cost of afterwards making good the omission would be greater, as it would necessitate the taking up the flooring ; the owner would be put to increased cost if he undertook the work, and he might fairly claim damage for delay. So he might if it had been decided to board and felt the roof, and the contractor had omitted to include the work in his tender. On the contrary, other items, such as painting or graining, sash fastenings of a superior quality, could be subsequently undertaken without incurring an expense beyond that originally contemplated.

Building competitions are now so often a matter of sharp practice—among builders who compete to win—that we must expect to find the instruments prepared by architects and surveyors have lost in precision and accurracy. Experience has shown that builders accept contracts and sign specifications containing the most equivocal clauses. It is customary to find specifications provide for trenches to be excavated to depths that may be necessary to insure a solid foundation—a clause open to the wildest guessing. In other cases a clause is inserted to the effect that the contractor is to provide materials and execute works that may not be specified, but which are necessary to complete the building. More remarkable still, we find builders agreeing to sign these documents and willing to undertake the responsibilities and risks of contracts of this kind. They argue that if they refused to undertake the risks others would do so, the result being that incompetent men would have it all their own way.—*The Building News.*

SIMPLE EXPERIMENTS IN PHYSICS.

The enormous pressure developed in a hydraulic press is a subject of wonder, even to those who perfectly understand the principle involved in its operation. Men regard with interest anything that furnishes an exhibition of power, and it is difficult to avoid thinking that in the hydraulic press power is actually created in some mysterious way. However, nothing of this kind happens. A hydraulic press is simply a power convertor, in which a certain pressure per square inch, acting on a small area, is able to produce the same pressure per square inch on a large area, thereby multiplying the pressure. The sum total of all the power utilized in the press is exactly equal to the sum total of all the power applied to the press, less friction.

Before proceeding with the hydraulic press it will, perhaps, be well to examine some of the principles which underlie its operation. A hollow metallic globe (Fig. 1) is provided with openings, at the top and bottom, and upon four or more of its sides. Around these openings there are collars, over which are stretched and tied diaphragms of rather thick but elastic rubber, the upper diaphragm being omitted until the globe is filled with water. The globe being placed upon a suitable support, pressure is applied to the upper diaphragm, when it is found that the pressure is transmitted through the medium of the water not only to the diaphragm at the bottom of the globe, but in an equal degree to the diaphragms upon the sides of the globe, thus showing that the pressure is exerted by the water equally in all directions, and at right angles to the surfaces with which it is in contact. This is a simple illustration of Pascal's law.

Probably there is not a more striking example of the effects of hydrostatic pressure than that presented in Pascal's experiment, in which he burst a stout cask by inserting in it a tube about 30 feet high, and filling both the cask and tube with water. This experiment, in a modified form, is illustrated by Fig. 2. A tin cup of 6 inches diameter, and having a wired edge, is furnished with a leather or rubber cover, tied over the top of the cup so that it may have a motion of a half inch or so. In the side of the cup is inserted a tube which extends upward above the top of the cup 24 inches, and is furnished at its upper end with a funnel. The diameter of the tube is of no consequence; the result will be the same whether it is small or large. The cup is filled with water by submerging it with the tube in a horizontal position, with the tube uppermost, and alternately pressing in the flexible covering and then drawing it outward. This operation soon drives out the air and fills the cup with water. The cup is placed with the pipe in a vertical position, and a board is laid over the flexible cover and pressed to expel all of the water above the rim of the cup.

Now, by placing a twenty-five pound weight upon the board and pouring water into the tube, the weight will be lifted and sustained. This experiment shows that a great pressure may be produced by a small column of water. In this case the cup, with its flexible cover, represents the large cylinder and piston of a hydraulic press, the tube stands for the pump cylinder, the small water column in the tube for the piston, and the weight of the column for the power applied. By increasing the height of the water column, the pressure will be correspondingly increased.

Fig. 3 shows two communicating vessels of different diameter. The larger one is divided at a point, *b*, near its base, and reunited by means of a packed joint. When water is poured into one of these vessels, it rises to the same level in both. By removing the upper portion of the larger vessel and tying a flexible cover over the lower part, it is found that a column of water in the smaller vessel extending to the point, *a*, will be exactly counterbalanced by a certain weight placed on the flexible cover, as in Fig. 4. The weight required will be exactly that of a column of water of the diameter of the larger vessel and equal in height to the distance between the flexible cover and the level of the smaller column, *a*. This may be shown by removing the weight, replacing the upper part of the larger vessel, as in Fig. 5, and filling it with water up to the level, *a*. The weight of water required in the larger vessel to thus lift the smaller column to the point, *a*, will be found to be the same as that of the weight removed.

It seems paradoxical that no variation in the size or form of the upper portion of the larger vessel can make any difference in the results, provided the same water level is maintained; but it must be remembered that the whole question is simply one of pressure per square inch. The weight will as readily balance a large column as a small one, the vertical height being the same in each case.

In Fig. 6 is illustrated a hypothetical hydraulic press, above which is given a diagram showing the relative areas upon which pressure is exerted. To the two square communicating vessels, A, B, are fitted the pistons, *a*, *b*. The piston, *a*, is one inch square, and consequently has an area of one square inch. The piston, *b*, is five inches square, and consequently has an area of twenty-five square inches. If the spaces below the pistons be filled with water, it will be found that, in consequence of the equal distribution of pressure throughout the confined body of water, a weight placed on the piston, *a*, will balance a weight twenty-five times as great placed upon the piston, *b*; that, for example, a downward pressure of five pounds upon the piston, *a*, will, through the medium of the water, cause a pressure of five pounds to be exerted on every square inch of surface touched by the water, and that the movable piston, *b*, having twenty-five times the area of the piston, *a*, and receiving on each square inch of its surface a pressure of five pounds, will be forced upward with a pressure of one hundred and twenty-five pounds.

A press of this description would have no practical value, inasmuch as a movement of the piston, *a*, through the space of five inches would lift the piston, *b*, only one-fifth of an inch. To lift the piston, *b*, five inches would necessitate a piston, *a*, having a length of one hundred and twenty-five inches (over ten feet).

To obviate this difficulty, the pump piston of a hydraulic press is of a reasonable length, and valves are provided by means of which the short piston, by acting repeatedly, will accomplish the same results as would, in the other case, require a very long piston.

In Fig. 7 is shown a very simple and easily constructed hydraulic press, which has considerable utility. It is made of pipe fittings, valves, rods, and bolts, that are all procurable almost anywhere.

To the baseboard is secured a flange, into which is screwed a short piece, A, of gas pipe. On the upper end of the pipe is screwed a coupling, into which is inserted a bushing, from which the internal thread has been removed. In the bushing and in the pipe, A, is inserted a rod of cold rolled iron, a bar of brass, or a short section of shafting, and the space in the coupling around the rod is filled with hemp packing, which may be compressed, as required from time to time, by screwing in the bushing. The flange at the bottom of the pipe, A, is connected with the pump, B, by the pipe, C, in which is inserted a discharge, as shown. The pump cylinder is in-

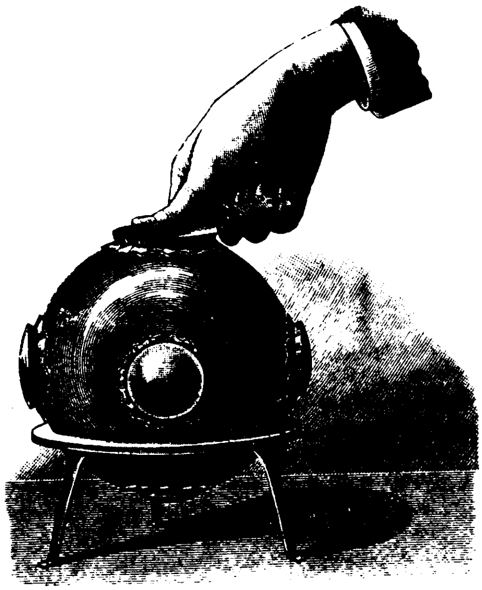


Fig. 1.—Demonstration of Pascal's Law.

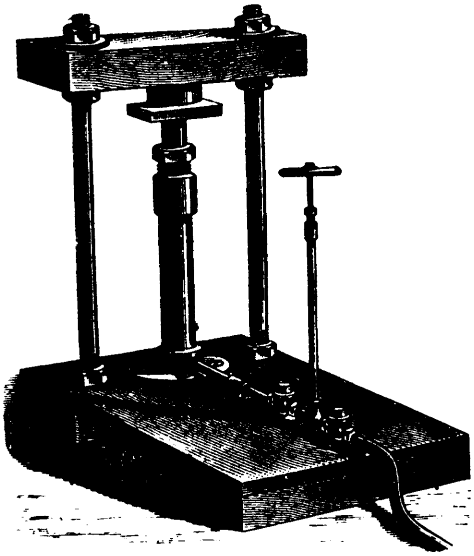


Fig. 7.—Simple Hydraulic Press.

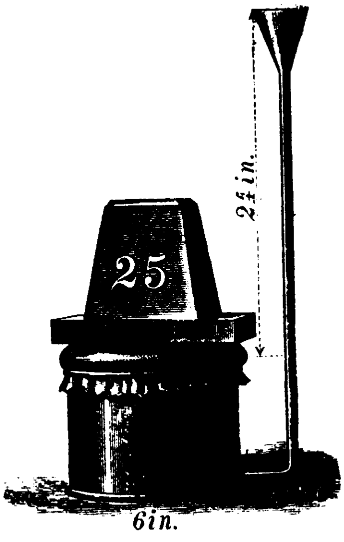


Fig. 2.—Pascal's Experiment

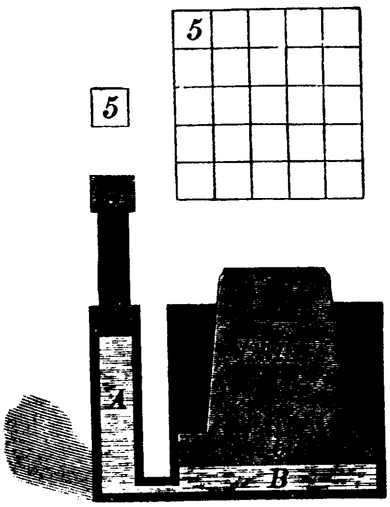


Fig. 6.—Principle of Hydraulic Press.

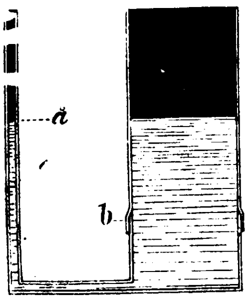


Fig. 3.

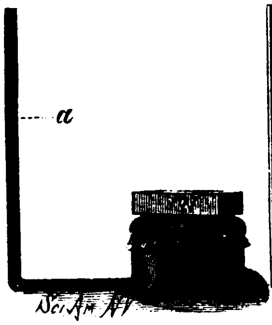


Fig. 4.

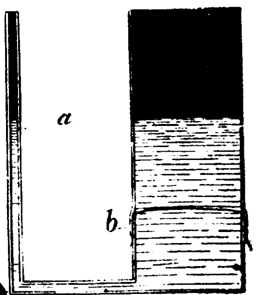


Fig. 5.

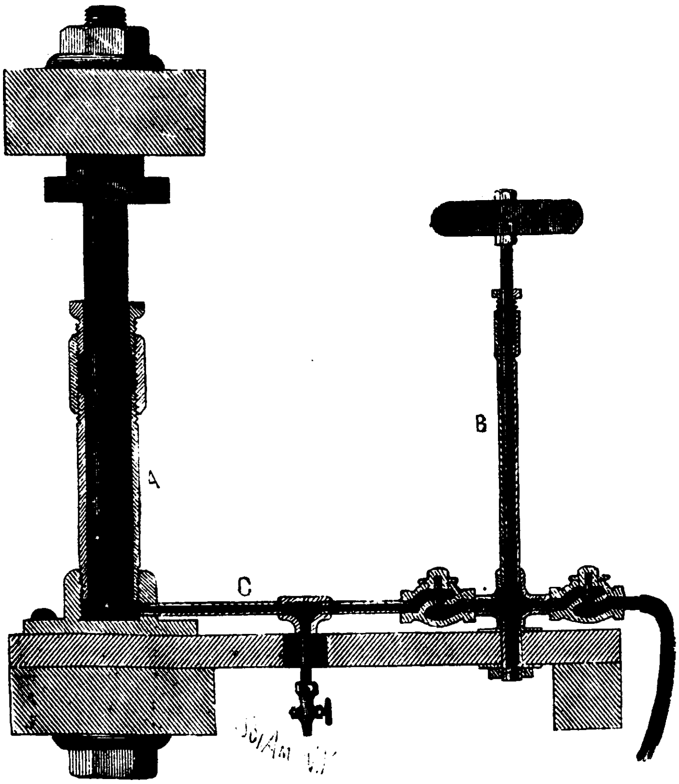


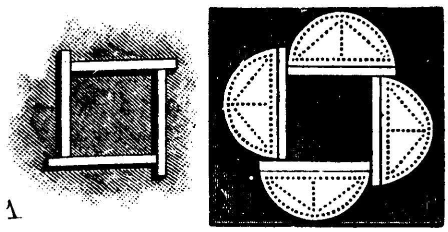
FIG. 8.—SECTIONAL VIEW OF SIMPLE HYDRAULIC PRESS.

serted in a crosstee, to opposite sides of which are attached ordinary check valves. The tee is fastened to the base by a plugged piece of pipe, extending through the base and provided with a nut, which clamps the base tightly. The barrel of the pump is in all respects like the press barrel, except in size. The piston consists of a ½ inch brass rod, to the upper end of which is attached a T-handle.

A heavy bar of wood is supported over the pipe, A, by bolts extending through the base and through a re-enforcing bar under the base. The check valves both open toward the cylinder, A, and the outer one is provided with a rubber suction pipe. Water is drawn into the pump by lifting the piston and forced into the press barrel by the descent of the piston. The proportion of the pressure attained to the power applied will be as the area of the large piston to the area of the small one. With pistons of respectively 2 inch and ½ inch diameter, a pressure of 3,000 pounds may be produced easily. If it is desired to create a greater pressure, the barrel, A, may be made of hydraulic tubing, and a lever may be applied to the pump piston.—BY GEO. M. HOPKINS, in *Scientific American.*

A BOY'S INVENTION.

Dr. L. K. Klemm, of the Technical School of Cincinnati, Ohio, tells, in the *Journal of Education*, of a rather interesting instance of the inventive genius of a boy which had been stimulated and developed by technical education. At a tile manufactory near that city, it was the practice to have different sized steel forms for each size of tile. Whenever it was necessary to make a new size of tile, a new form was necessary, the cost of which was $18.50. In the course of a year this item became quite a heavy expense. A boy, whose name it is unnecessary to mention, was passing through the works one day with his father, and his attention was called to this fact, whereupon he said he had a suggestion he would like to make. Upon being given paper and pencil, he made the accompanying diagram after a few minutes' thought, stating that the steel bars could be arranged to form either squares or rectangular tiles. It was then explained to him by the manager that it would be necessary to provide some means of retaining the bars in position, as the moulds had to be subjected to a



A BOY'S INVENTION.

heavy hydraulic pressure, which would separate them, unless they were fastened securely in place. He then suggested backing the bars with plates as shown, which should be provided with holes, enabling them to be screwed firmly to the table, which should be provided with corresponding holes. In this way a solid form was provided, which could be used as a universal mould for tiles of various sizes and shapes. The idea was a good one, and reflects much credit for originality upon its youthful inventor.

BOILER INSPECTION.

The following address delivered by the President at the Convention of Boiler Inspectors held at Pittsburgh, Pa., Nov. 20th, is worthy of the careful consideration of every steam-user :—

Gentlemen of the Convention : We have assembled for the purpose, as I understand it, of taking counsel one of another as to the best means of accomplishing the objects for which the office of boiler inspector was created. The number of lives annually lost by explosions of steam boilers is so great, that it appears almost incredible that a majority of our states and cities have done nothing towards securing a proper inspection of so necessary and yet so dangerous an adjunct of our manufacturing and mercantile industries. In all manufacturing establishments of any importance, steam power is a necessity ; and in hotels, mercantile establishments and other large buildings, it has come to be regarded as an essential requisite. Nothing that is so extremely dangerous, so liable to cause the loss of life and valuable property, as steam boilers undoubtedly are, should be permitted to be controlled by men who are ignorant of their management and know nothing of their danger. One more source of trouble and serious accident, resulting from the use of steam boilers, is chargeable to the unwise policy of steam users employing inexperienced and incompetent men as engineers ; a position so responsible as that of engineer of a stationary engine is acknowledged to be, should not be occupied by a man who knows nothing of the management either of an engine or boiler. Why does any man incur such a risk to his own safety and that of his property ? There is but one answer; an incompetent man will work for less money than a competent man will. Should this be allowed, should any man, because thereby he may save a few dollars a month, be permitted to endanger the lives of his employes and of his neighbors ?

Most men of middle age have a vivid remembrance of the frequent occurrences of boiler explosions on our waterways ; they were happening weekly. I once recollect of three explosions in one week on the Mississippi river, with a loss of one half million of dollars and sixty odd lives. There were hundreds of lives and thousands of dollars worth of property continually being killed or burned, or finding a final resting place at the bottom of some river or lake. It is not so, to-day, for we seldom hear of the boiler of a steamer exploding, although there is a larger number of marine boilers at the present time than there was before or during the war. What has wrought this wonderful change ? Inspection of boilers and competent licensed engineers. The inspectors are competent men appointed by the general government to examine every steamer's boiler, and no one can assume the position of marine engineer unless he is armed with a certificate of the government that he has been examined and found to be qualified for the position. Why should not the applicant for the position of engineer of stationary engines and boilers be subjected to a similar test ? Not in a few cities, states or countries, but the service should cover the entire country.

I have a list of explosions from March 1870 to March 1888 which I do not claim comprises all the explosions. It gives 2,267 explosions with 4,068 killed and 4,710 wounded. Of these, 801 explosions where 1,476 were killed and 1,122 wounded, were of threshing machines and saw mills. By carefully looking over the records of explosions, you will find in localities where there is an inspection service, there is not to exceed one third the explosions that occur where there is no inspection service ; you will also find in localities where an insurance company is doing inspecting there is quite a reduction in the number of explosions. It cannot be expected that the insurance inspection would be as effective as state or city, as it cannot be made compulsory. I find in the city of St. Louis that the insurance inspection is a great assistance to our service.

We have much to learn, and no one should hesitate to avail himself of all knowledge that presents itself, come whence it may. We should willingly learn all we can relating to our special duties and as willingly apply all we know to the accomplishment of the good work in which we are engaged ; we are endeavoring to protect life and property of the people and there is no service that is so great a protection to life and property. I also hope that before we separate we shall have effected a permanent organization. We should meet annually that each one may receive new encouragement and strength from the experience of the previous year.

The press can be of immense benefit to us and the service we represent, by disseminating facts bearing upon the subject of boiler inspection. As to what may be done here I have no doubt that the reporters will place us in a proper light before their readers. There is no aid so desirable, none so powerful as the support of a free, fearless and untrammeled press and its mission is to give its readers unvarnished facts and such comments as may be deemed necessary to a proper understanding of the subject.

HOW TO MAKE A GOOD FLOOR.

Nothing attracts the attention of a person wishing to rent or purchase a dwelling, store-room, or office, so quickly as a handsome, well-laid floor, and a few suggestions on the subject, though not new, may not be out of place.

The best floor for the least money can be made of yellow pine, if the material is carefully selected and properly laid.

First, select edge-grain yellow pine, and not too "fat," clear of pitch, knots, sap, and split. See that it is thoroughly seasoned, and that the tongues and grooves exactly match, so that when laid the upper surfaces of each board are on a level. This is an important feature often overlooked, and planing-mill operatives frequently get careless and in adjusting the tonguing and grooving bits. If the edge of a flooring board, especially the grooved edge is higher than the edge of the next board, no amount of mechanical ingenuity can make a neat floor of them. The upper part of the groove will continue to curl upward as long as the floor lasts.

Supposing, of course, the sleepers, or joists are properly placed the right distance apart and their upper edges precisely on a level and securely braced, the most important part of the job is to "lay" the flooring correctly. This part of the work is never, or very rarely ever, done nowadays. The system in vogue with carpenters of this day of laying one board at a time, and "blind nailing" it is the most glaring fraud practiced in any trade. They drive the tongue of the board into the groove of the preceding one by pounding on the grooved edge with a naked hammer, making indentations that let in the cold air or obnoxious gases, if it is a bottom floor, and then nail it in place by driving a six penny nail at an angle of about 50° in the groove. An awkward blow or two chips off the upper of the groove, and the last blow, designed to sink the nail head out of the way of the next tongue, splits the lower part of the groove to splinters, leaving an unsightly opening. Such nailing does not fasten the flooring to the sleepers, and the slanting nails very often wedge the board so that does not bear on the sleeper. We would rather have our flooring in the tree standing in the woods than put down that way.

The proper plan is to begin on one side of the room, lay one course of boards with the tongue next to, and neatly fitted to the wall (or studding, if a frame house), and be sure the boards are laid perfectly straight from end to end of the room and square with the walls. Then nail this course firmly to the sleepers, through and through, one nail near each end of the board on every sleeper, and you are ready to begin to lay a floor.

Next, fit the ends and lay down four or six courses of boards (owing to their width). If the boards differ widely in color, as is often the case in pine, do not lay two of a widely different color side by side, but arrange them so that the deep colors will tone off into the lighter ones gradually. Push the tongues into the grooves as close as possible without pounding with a hammer, or if pounding is necessary take a narrow, short piece of flooring, put the tongue in the groove of the outer board, and pound gently on the piece and never on the flooring board. Next, adjust your clamps on every third sleeper and at every end joint, and drive the floor firmly together by means of wedges. Drive the wedges gently at the start and each one equally till all the joints fill up snugly, and then stop, for if driven too tight the floor will spring up. Never wedge directly against the edge of the flooring board, but have a short strip with a tongue on it between the wedge and the board so as to leave no bruises. Then fasten the floor to the sleepers by driving a flat-headed, steel wire nail of suitable size, one inch from either edge of every board, straight down into each sleeper. At the end joints smaller nails may be used, two nails in board near the edges and as far from the ends as the thickness of the sleeper will permit. Proceed in this manner until the floor is completed and you will have a floor that will remain tight and look well until worn out.

Sueh minute directions for so common and simple a job sound silly, but are justifiable from the fact that there are so many alleged carpenters who either do not know how, or are too lazy, to lay a floor properly.—*Southern Lumberman.*

FINISH FOR REDWOOD.

A prominent dealer in redwood supplies the following formula and directions for treating redwood finish. We understand it is a practice that has been indorsed by successful experience in San Francisco. Take 1 quart spirits of turpentine, add I pound corn starch, add ½ pound burnt sienna, add 1 tablespoonful raw linseed oil, add tablespoonful of brown japan. Mix thoroughly, apply with a brush, let it stand say fifteen minutes, rub off all you can with fine shavings or a soft rag, then let it stand at least twenty-four hours that it may sink into and harden the fibres of the wood; afterward apply two coats of white shellac, rub down well with fine flint paper. then put on from two to five coats best polishing varnish; after it is well dried rub with water and pumice stone ground very fine, stand a day to dry; after being washed clean with chamois, rub with water and rotten stone, dry, wash as before; clean and rub with olive oil until dry. Some use cork for sand-papering and polishing, but a smooth block of hard wood like maple is better when treated in this way. Redwood, according to a Californian's idea, will be found the peer of any wood for real beauty and life as a house trim or finish.

AN EXCELLENT WHITEWASH.

A whitewash for indoor work is made of two pounds of Paris whiting, one ounce white glue; dissolve the glue in warm water. Mix whiting with warm water; stir in glue, and thin with warm water.

ON CERTAIN SURFACES FEEBLY SENSITIVE TO LIGHT.*

BY J. W. OSBORNE.

The specimens which accompany this statement are suggestive, inasmuch as they tend to illustrate the widely extended range of photo-chemical action and the part it plays in everyday phenomena. In thinking and speaking of substances sensitive to light, photographers and others are apt to remember only the haloid salts of silver, chromic acid under restraint acting on organic matter, asphaltum, and a few salts of iron and platinum, which short catalogue does, in fact, include all the sensitive bodies used in practical photography.

But as everyone knows, this list may be indefinitely extended (if the degree of sensitiveness be disregarded), and the accompanying specimens serve to show such extension in certain directions. Broadly, the results should not be regarded as new, though in the manner of their preparation and presentation some novelty may be claimed for them.

On sheets Nos. 1 and 2, three samples of colored commercial paper will be found which are bleached by light, and which give, therefore, a negative when exposed under a negative. On sheets 2 and 3, exposed papers colored for the purpose with eosine and methyl violet are exhibited, which likewise establish the fact that these colors under the luminous influence give rise to colorless compounds. But, though a great number of colors used in the arts are bleached by light more or less rapidly, this is by no means a universal rule. On sheet No. 1, a small piece of commercial orange paper is shown, part of which has been darkened by exposure. Specimens of paper colored with picric acid will also be found on sheet No. 4, in which the darkening to a brown is very marked.

The duration of the exposures required to produce these photographic effects is very considerable when the change is carried to its maximum, varying from twenty to thirty-five or forty hours in direct light, which was the only kind of exposure employed in these experiments. Such substances are perhaps from four hundred to eight hundred times less sensitive than chloride of silver paper. Indications of photo-chemical action are, however, visible in much less time. On sheet No. 2, a piece of eosine paper exposed under two strips of black lace shows a faint positive after half an hour. Also on sheet No. 3, a piece of methyl violet paper similarly exposed shows the gradually increasing strength of the positive (by contrast) after one, two, and three hours.

The fact that printing and writing papers become brown by age is familiar to most persons, but that this change is essentially photographic is not a common belief. On sheet No. 5 will be found pieces of newspaper taken from the New York *Tribune*, the Baltimore *Sun*, and the Washington *Evening Star*, on which photographic images have been impressed by simple exposure under a dense negative. These papers were subjected to no preparatory treatment, establishing the fact that the newspapers we read daily are (probably all) printed on papers sensitive to light and adapted for the production of positive pictures. On sheets Nos. 6, 7, 8 and 9, such pictures will be found on *Evening Star* paper, made by direct exposure to the sun's rays, under collodion negatives. A fact of some significance is that some of the experiments on *Evening Star* paper were made on sheets which had been very carefully washed before exposure. The washing was

* Presented before the Society of Amateur Photographers of New York.

done by causing a rapid film of water to flow over and under the paper at the same time, for two and a half hours. The paper was then dried and exposed. This treatment did not seem to affect the sensitiveness of the paper to light, and the presumption would seem to be justifiable that the sensitive compounds present are not soluble in water.

The time required to produce the maximum effect is about fifty hours, but this must often be exceeded if any part of the negative is in the least obscured by cloudiness. The color produced by exposures on such papers is peculiar. When the paper is clean and in good condition, as in Nos. 6, 7, 8 and 9, a very pure golden bronzy color is produced, which can be appreciated only in strong white light. I will not now discuss the nature of the resulting brown yellow compound, except to say generally that it is not easily acted on by the chemical reagents, and that it undergoes a very peculiar darkening by the application of heat alone, as by ironing the paper bearing such a photograph with a moderately hot flat iron. On sheet No. 8, a piece of paper is mounted with two tints on it longitudinally, half of which (divided across the tints) was heated in the way described, and which is, in consequence, much darkened. The print above it on the same sheet was also so developed or intensified.

Sheets Nos. 10, 11, and 12 have mounted upon them pieces of white pine, of different qualities, upon which photographs have been produced by exposures under stencil negatives, made by cutting openings in tinfoil, and pressing it into close contact with the surface of the wood by means of a plate of glass properly clamped thereto. The exposure required to produce these photographic images varies from thirty to fifty or sixty hours. On sheet No. 13 a piece of poplar is shown, the picture on which was produced in twenty hours, for it seems probable that of all the woods in common use, poplar is the most sensitive and gives the darkest color when fully exposed. In making these experiments it is important to obtain a fresh surface on the wood, to effect which, in the case of an old piece, a good deal of the outside has often to be removed by the plane, for the penetration of the light is often considerable.

It seems probable that this darkening of wood (which is very commonly though rather vaguely attributed to the action of the air) is related to the photographic effect obtainable on printing papers. These are now hardly to be had without an admixture of wood pulp, and the present inquiry (inasmuch as it proves the phenomena to be strictly photographic) may have a practical bearing if it points to means which will keep printing papers white indefinitely.

On sheet No. 1, the bleaching action of light upon a dried leaf is exhibited, and on No. 5 a piece of parchment is mounted, which has also, though substantially white, become a little whiter where the light has acted. As far as it goes, this would tend to show that the "yellowing of parchment by age" is not a photo-chemical process. This parchment had a very long exposure.

As connected with this general subject, I would call to mind the investigations of Mr. Thomas Gaffield, of Boston, who established conclusively more than twenty years ago the slow effect of light on colorless glass, in gradually giving it color, sometimes pinkish and sometimes yellow, the former being apparently due to a reoxidation of the reduced manganese employed to counteract the iron. These changes often required years for their completion.

Experiments only just completed tend to show that pure cellulose in the form of the finest filtering paper is not sensitive to light, at least a constant exposure in a horizontal position to diffused and direct sunlight failed in two weeks to produce any perceptible change in color. On the other hand, the same filtering paper colored with picric acid and similarly exposed for the same time, about one hundred and forty hours of diffused and direct sunlight, gave a coloration as before, when sized and calendered paper of the best quality was the kind treated with the acid. On sheet No. 14 two pieces of the above filtering paper prepared with picric acid and exposed horizontally, as stated, will be found, but one of them has been washed in hot water till all the soluble matter has been removed. This treatment of the exposed print tends to raise the contrast by letting the darkened parts appear as on white paper. It also shows the insolubility of the darkened portions in hot water, the production of which was effected by light alone.

Simultaneously with the above exposures, another was made of the same duration and in the same way. This was the presentation of a thin stratum of commercial picric acid on glass to the same illumination as that already mentioned, under a stencil tinfoil negative and a plate of glass covering the same. The picric acid was darkened as before very decidedly, though it would be difficult to exhibit the results in a satisfactory way at a meeting of the society.

In concluding this paper, and to account for its incompleteness in certain ways, I may be permitted to explain that the investigation, the results of which are here given, was not undertaken with a practical purpose in view, but simply to determine the limits within which bodies may be properly described as sensitive or non-sensitive.

RECENT ADVANCES IN THE METALLURGY OF IRON.

The metallurgists, evidently, have yet much to learn in understanding the influence of other elements in modifying the properties of iron and steel. In respect of its extreme sensitiveness to the presence of the smallest appreciable quantities of foreign substances, iron seems to stand alone, and the possibilities which this fact opens to investigators are almost limitless.

The peculiar effects of carbon, silicon, sulphur and phosphorous on the physical properties of iron have long been known, and play an important role in its utilization. It has only lately come to light, however, that aluminium, in so small a quantity as the one-tenth of one per cent (that is, one part in 1000), renders wrought iron and steel distinctly more fusible.

More recently, the observation has been made that additions of this element to cast iron, in quantities from one-fourth of one per cent up to one per cent, produced most favorable effects, rendering inferior irons soft, and fitting them to foundry use.

Now manganese is coming to the front as a useful addition to irons and steels, and from various sources we learn that it promises to yield results quite as valuable as those obtained with aluminium. In a paper recently presented to the Iron and Steel Institute by R. A. Hatfield of Sheffield, England, he claims to have obtained in experiments in making steel with a high percentage of manganese, "results which are entirely novel, and appear to show the way to an absolutely new sort of metal for various purposes."

His experiments were made with the idea that steel with high manganese might give a hard material, but without the brittleness of spiegeleisen, seeing that the carbon would be much reduced. The results obtained show some novel features, which it will be of interest to briefly summarize."

"After many trials a material was produced combining great strength with hardness, but the puzzling and apparently paradoxical result was discovered that, although steel, if it may be so termed, with 4 to 6 per cent of manganese, and less than ½ per cent of carbon, was so brittle that it could be powdered under a hand-hammer, yet by adding twice this amount of manganese, just the contrary effect was produced, and a material was obtained containing apparently new properties, as compared with any iron or steel hitherto manufactured. Briefly, the material may be described as follows: That containing from 2½ to 6 per cent is extremely brittle in its cast state, then a return in strength gradually takes place, and, with about 9 to 10 per cent, a cast bar, 2½ inches square, can be bent considerably out of the straight without breaking. This continues up to about 14 or 15 per cent, when a decrease occurs in actual toughness, though not in transverse strength, and after about 20 per cent is passed, then a rapid decrease again takes place. It should be stated that these remarks apply specially to the material in its cast state.

"Manganese steel is not so liable to honeycombs as ordinary steel and the addition of silicon is unnecessary. It is very fluid and can be run into thin sections, but cools more rapidly than ordinary steel, and its contraction is decidedly greater. The latter fact explains the reason of its piping and settling so much, both in the ingots and in castings; with proper heads or runners, however, this diffiiculty can be obviated. It is manufactured by any of the ordinary steel-making processes, the basis, *i.e.*, the material before the manganese is added being perferably decarbonized iron (practically pure iron, Fe), or mild steel. The ferro-manganese is added in a molten state or very highly heated. The steel is then ready for casting into ingots or other forms."—*Manufacturer and Builder.*

POSTAL STREET CARS.

Mr. Frank Brown, postmaster of Baltimore, Md., makes a very useful suggestion in relation to the utilization of street cars to assist in the rapid collection and delivery of city mail matter. In most of the large European cities they now have pneumatic tubes, by which the quick delivery of special messages is accomplished at a high charge. But a much quicker, cheaper, and more serviceable system for the public might be easily arranged if the street cars were employed. In New York not only might the street cars, but the elevated street railways might be brought into the work, and the city provided with a splendid system of postal delivery and collection. We have heretofore urged this matter upon the attention of the government. We wish some of our senators and representatives in Congress would take up the matter. It is simple and easy of accomplishment, and might by quickly put in operation.

The introduction of such a system, in addition to its great convenience for the public, would put an end to all those disgraceful interruptions of traffic that periodically take place when roughs obstruct the cars, abuse the drivers, and threaten the lives of honest citizens. The street car lines would then be declared mail routes, and no stoppage of travel would be tolerated.

Mr. Brown's suggestion in respect to the city of Baltimore, given in a letter to the New York *Tribune*, is as follows:

It is my intention, if approved by the department and the companies, to place letter boxes on the rear dash of every car in Baltimore City, and to have collectors collect mail from all sections of the city and deposit it in the first car that passes them, the collector to remain in his district and continue collecting and dispatching to the main office during the entire time he is on duty. Under this arrangement the dispatch and delivery of the mail would be greatly facilitated, as many of these letters would arrive at the office to make trains they now miss, and, in addition, the citizens of this city would have full benefit of the special delivery system, as a letter placed in a box on one of these car lines will proceed immediately to the post office (instead of remaining in a street box to be taken up by collector), and on its arrival at the main office be delivered by special messenger.

As the car passes the nearest point to the post office they would not be called upon to stop, but only to slow up sufficiently to allow the collector to open the box, take out the mail, and close the box. No additional expense would be incurred by the department other than the cost of the boxes, which would be nominal. The city being covered with a network of railways, every section would have equal advantages so far as the rapid collection of mails is concerned, and the letter carriers would not be forced to carry immense bags of mail through the rain, slush, heat, and cold to the post office. The street lamp-post boxes would remain intact, as at present. In the event of a "tie-up," or strike, these street boxes would be used as they now are, and the letter boxes on the street cars would be unused, as the cars would be packed in the sheds of the various companies. In case of a fire, which might blockade the cars, the collector on whose district the blockade occurrep would be ordered to proceed to the fire immediately, empty the boxes, deliver, and report to the office.

SOME GOLDEN RULES.

The following, from an unknown source, contains advice which experienced business men endorse and young men will do well to follow:

Have but one business, know it thoroughly, and attend personally to its minutest details. Be self-reliant, concentrate your energies in a determination and supreme effort to conquer success. Keep your own counsel, attend strictly to business, and never dabble in anything foreign to it, curtail your expenses, never sacrifice safety to prospective large returns, cut short your losses and let your profits run on, and make your prime movers industry, economy, and fair dealing. It is the merest rant and bosh to rely on Luck. He is always indolent and whining, folding his arms, drinking and smoking, waiting for big prizes in lotteries, or lying abed expecting a letter with news of a legacy. On the contrary, Labor and Pluck are the invincible heroes who conquer success; they strike out new paths, create, contrive, think, plan, originate, take all legitimate risks, toil to surmount obstacles, push forward, win renown by success. The glorious galaxy of successful business men and illustrious authors have all been hard workers. Shun bad company and the prevalent vices of the day, never loan a borrowing friend more than you are able to lose if he cannot pay, and never take a loan on importunity. Never borrow money to speculate with. Acquire knowledge. It is only enlightened men who successfully hold their own with the surging masses who throng the road to riches. Avoid law and legal squabbles of every kind. In discussing business disagreements, keep cool. Make all the money you can and do all the good you can with it, remembernig that he who lives for himself alone lives for the meanest man in creation. If engaged in public business, advertise it; be punctual in meeting promised payments; keep short accounts; settle often; be clear and explicit in making bargains. Be civil and obliging as well as decisive and prompt with customers, and do not overtrade your capital. Finally, in the maturity of life, don't out by retiring from business; keep bright by useful effort, remembering that industry and happiness are inseparable.

PREVENTION OF TYPHOID FEVER.

BY R. HARVEY REED, M.D., SECRETARY STATE SANITARY ASSOCIATION AND HEALTH OFFICER, MANSFIELD, OHIO.*

You all, no doubt, remember the terrible scourge of typhoid fever that visited Plymouth, Pa., only a few years ago, during which 1,104 persons were stricken down with this foul disease, of whom 114 died, while the actual cost of that epidemic was carefully estimated at $97,120.25, all in hard cash, saying nothing of the loss to that village from 114 deaths, whose yearly income, when in health, amounted to $18,419.52, to all of which is yet to be added the sorrow and suffering that cannot be measured in dollars and cents.

An investigation into the cause of this greatest of modern local epidemics by so eminent an authority as Dr. Benjamin Lee, Secretary of the State Board of Health of Pennsylvania, showed that in a house on Girard Avenue, in Philadelphia, a blacksmith was taken down with typhoid fever in September, 1883. After a few days, however, he was removed to the Episcopal Hospital, from which he was discharged on the 13th of the following October.

In the following May or June, 1884, a street car conductor, who was boarding at the same house on Girard Avenue, was taken down with the fever, and also taken to the hospital for care and treatment.

In the following July, a huckster, boarding at the same house, was attacked with typhoid fever and sent to the same hospital.

Here were three cases, all boarding at the same house, and all taken down with typhoid fever, the attacks ranging over a period of about eleven months.

A CASE OF AERIAL INFECTION.

Dr Lee tells us that from all the information he could gather by personal inspection and diligent inquiry of neighboring physicians and other observant citizens, he had not the slightest doubt that, while there were numerous and glaring unsanitary conditions in the vicinity, the real cause of the cases of typhoid fever occurring in this ill-fated house on Girard Avenue was to be found in the grossly defective cesspool, with its foul exhalations, completely shut in from lateral air currents, and pouring through open doors and windows into the kitchen and dining room, to be inspired by the inmates, or, worse still, to be absorbed by the food in course of preparation for the table, and thus brought in contact with the alimentary mucous membrane. "It is proper to state in conclusion," he adds, "that the dangerous character of this particular cesspool cannot be abated or removed by any amount of cleansing or emptying, however frequently performed. Its complete abolition alone can bring safety to the household."

THE COURSE OF THE CONTAGION.

"Into this house, with its history of fever and its foul environment, late in December, 1884, came David Jones, fresh from his mountain home, overlooking the vale of Wyoming, to visit his city brother and spend his Christmas holidays. Forth from this house, early in January, 1885, again he went, but went not as he came. A poisoned blood now coursed through his veins, and shortly after returning to his home he was prostrated with what his physician soon pronounced typhoid fever, and lay on his back for many weeks in his cottage on the banks of a little stream which supplies the reservoir of the town at the foot of the mountain.

"This little town at the foot of the mountain was Plymouth, a mining town of some 8,000 or 9,000 inhabitants, situated on the right bank of the Susquehanna River, three miles below Wilkesbarre. As a large part of the town is upon a side hill, the surface water readily finds its way into the Susquehanna.

"No system of sewers and no effect at systematic drainage have ever been introduced, and the borough council seem singularly apathetic in the matter of sanitary reform. The drainage from each house is into cesspools situated in the back yard, or, in some cases, it is even into the streets themselves, which, in parts of the town, have not a proper arrangement of gutters for disposal of this drainage.

"It was found, on further investigation, that the house in which the young man lay with typhoid fever he had contracted at his brother's house in Philadelphia was situated so near the stream supplying the water reservoir at Plymouth that, as soon as the weather permitted a sufficient thaw to allow the frozen accumulations of weeks of dejection from this one case to reach this stream, only a few yards distant, with the conformation of the ground favoring its course to this water supply, a local epidemic of such magnitude ensued during the following April and May of 1885, and continued until the following September, that it is scarcely paralleled in modern history, and at the same time making this 'one of the most instructive as well as one of the most terrible instances which ignorance and negligence have contributed to the records of disease.'"

THE FEVER FOLLOWS DRY SEASONS.

Professor Vaughan, in speaking of the Iron Mountain epidemic, to which I have already referred in this paper, says: "It is well known that typhoid fever follows dry seasons, and is coincident with low water in wells. They are, on an average, 1,000 deaths and 10,000 cases of sickness from this disease annually in Michigan. These figures can be greatly reduced if people will cease polluting the soil about their houses with slops, garbage, cesspools, and privy vaults, and will see that their drinking water is pure beyond all question. When there is any doubt, the water should be boiled and kept uncontaminated afterward. While the germ most frequently finds its way into the body with the drinking water, it may be taken in with any food, and even with the air. The earth, air, and water about our homes must be pure, if we escape this disease altogether. When cases of typhoid fever occur, all discharges should be thoroughly disinfected."

THE EFFECT OF PURE WATER IN MANSFIELD.

Since Mansfield has practically ceased the use of water from wel s throughout our city and adopted the use of water supplied by the powerful artesian wells drilled just north of our city, and which have been given the flowery title of "wonderful artificial geysers," a chemical analysis of which was made by Professor C. C. Howard, of Columbus, and showed the water to be unusually pure (and more recently pronounced by the Professor, in a private letter to the writer the purest water that he has examined for any city in the State of Ohio), the prevalence of typhoid fever in our city has greatly dimishe l only one death from this disease having been reported during the summer and fall, and but a few cases having occurred in the city and they were all in persons who used well water, which is all more or less contaminated with organic filth throughout the principal part of our city, which certainly demonstrates to any unbaised mind that typhoid fever is a preventable disease, and can be prevented by the use of pure water.

SIX FACTS TO BEAR IN MIND.

Before closing this paper, allow me to call your special attention to a few facts:

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*From a paper read at the sixth annual meeting of the Ohio State Sanitary Association, held at Canton, Ohio, November 14 and 15, 1888.

1. Typhoid fever is caused by the introduction of a specfic germ into the alimentary canal.

2. That this specific germ multiplies in the alimentary canal, and in turn is thrown off in the stools of the patient.

3. That its vitality is much greater than at first supposed, resisting a variation of temperature ranging from even below the freezing point to 133° Fah., with out being destroyed.

4. That the germ may be communicated from one person to another by water, milk, foods and air, in the manner illustrated in the cases cited in this paper.

5. To prevent its spread, all the dejacta should either be burned at once (which is perferable) or thoroughly disinfected, by throwing them into a pot of boiling water and thoroughly cooking them, or use some effective germicide, such as a strong solution of the bichloride or mercury, in sufficient quantities as to insure their destruction before they are buried, which should be at a sufficient distance from any neighboring water supplies as to insure their freedom from contamination.

6. If the water supply is of a suspicious character, thoroughly boil it before using, and then place it where there is no possibility of its becoming infected. If ice is to be used to cool the drinking water, keep it of the water, only packing it around the water vessel, but not putting ice into the vessel or allowing the melted ice in any way to enter your drinking water, and thus take the chances on its contamination.

By the strict observation and practical application of these few simple hints, I am certain you will soon be led to believe that typhoid fever is a preventable disease.

ADMISSION OF AIR TO ROOMS.

Air should be introduced and removed at those parts of the room where it would not cause a sensible draught. Air flowing against the body at, or even somewhat above, the temperature of the air of a room will cause an inconvenient draught, from the fact that, as it removes the moisture of the body, it causes evaporation, or a sensation of cold. Air should never, as a rule, be introduced at or close to the floor level. The openings would be liable to be fouled with sweepings and dirt. The air, unless very much above the temperature of the air of the room, would produce a sensation of cold to the feet. It may be regarded as an axiom in ventilating and warming that the feet should be kept warm and the head be kept cool.

The orifices at which air is admitted should be above the level of the heads of persons occupying the room. The current of inflowing air should be directed toward the ceiling, and should be either as much subdivided as possible by means of numerous orifices, or be admitted through conical openings, with the smaller openings toward the outer air and the larger openings toward the room, by which means the air of the entering current is very rapidly dispersed. Air admitted near the ceiling very soon ceases to exist as a distinct current, and will be found at a very short distance from the inlet to have mingled with the general mass of the air, and to have attained the temperature of the room, partly owing to the larger mass of air in the room with which the inflowing current mingles, partly to the action of gravity in cases where the inflowing air is colder than the air in the room.—D. GALTON, in the *Architect*, London.

The number of gallons of water required for a boiler per horse power per hour may be safely estimated by adding 15 to the pressure per square inch in pounds; divide the sum by 18, and multiply the quotient by 24.

WHOLESALE DRAINAGE.

BY O. M. CROSBY.

A glance at any recent Government map of the Florida Peninsula shows a large tract of country surrounding a great lake yet unsurveyed, and all but unexplored, known as "The Everglades," a name suggestive of alligators, snakes, and Seminole Indians. North of this lake also is an immense tract of perfectly flat country; at times during the wet summer season covered from a few inches to several feet by water, but for the most part barren of trees, and when dry, in winter, exposing black soil of great fertility, the most desirable known for sugar and vegetable culture, if only drained.

A few years ago a syndicate of Philadelphia capitalists was formed, who first bought outright 4,000,000 acres of land from the State of Florida, then entered into a contract with the State to drain this region, having half the lands so improved deeded to them as their reward, thus owning or controlling a territory much larger than the State of Connecticut. Of course, such a gigantic undertaking requires many years to carry out to complete success, but it may be interesting to note at this time, about five years from the beginning of operations, what has already been accomplished. Beginning at the northernmost of a chain of lakes, whose outlet flows into Lake Okeechobee, though nearly one hundred miles above, a powerful steam dredge cut a navigable canal from one lake for four miles into the next, 8 or 9 feet below it, thus draining a vast tract of wet lands, over some of which steamers used to pass, but which are now being cultivated with sugar-cane and garden truck. In this region cane was grown and exhibited at the New Orleans Exposition that was the wonder of the old Louisiana planters, yielding at least one-third more sugar per acre than ever before produced. Subsequently one of their largest sugar mills was moved to South Florida, and is now in operation there.

A busy town or "city" of 1,500 inhabitants is built upon the shore of this lake, on land that was once practically worthless, yet statistics prove it to be far from unhealthful.

This is also a railroad centre, and now a "sugar railroad" is being constructed through the rich bottom lands to transport the abundant crops. Thus far more than 2,000,000 acres have been reclaimed and the enterprise, that was once considered visionary and impracticable, seems an assured success. It is proposed to continue this system of dredging and draining from lake to lake and river to ocean, some 200 miles, when the whole distance will be navigated by steamboats, and the entire route become dotted with settlements. The high pine lands a few miles back of this valley are rapidly being settled upon; one new township alone this coming winter will see an influx of one hundred families.

The Queen of Great Britain is now sovereign over a continent, 100 peninsulas, 500 promontories, 1,000 lakes, 2,000 rivers and 10,000 islands. She waves her hand and 900,000 warriors march to battle to conquer or die. She bends her head and at the signal 1,000 ships of war, and 100,000 sailors perform her bidding on the ocean. She walks upon the earth and 300,000,000 of human beings feel the slightest pressure of her foot. The Assyrian Empire was not so populous. The Persian Empire was not so extensive. The Arabian Empire was not so powerful. The Carthagenian Empire was not so much dreaded. The Spanish Empire was not so widely diffused. The Roman power was weak in comparison, and Greece was but as a small village. No nation or combination of nations ever before reached the supremacy that the *tight little island* has attained by her efforts in peace and in war.—*Exchange.*

THE TRIALS OF AN ARCHITECT.

A writer in the *Ohio Valley Manufacturer*, who is evidently an architect, depicts some of the trials one of his profession has to endure from his client.

He enters an architect's office and starts the conversation by stating his wants, desires, etc., in regard to the future house. His greatest want invariably is to get the house for about one-half what it will surely cost him.

His next want is to design the house from within, and in this he has an able second in the person of his wife or daughter, as the case may be, and oftentimes several persons more. He proceeds by jumps of one room at a time, without any general or definite idea of the whole. He wants the hall like Mr. Some-one-else's hall, the dining-room like that of some other house, and so on, utterly regardless of anything else but to have them just so, and nine times out of ten, when he gets it that way, it is not what he wants at all, it is but a taking fancy of the moment, and he allows it to mislead him without thinking it seriously, for when completed, Mr. Some-one-else's hall and Mr. Some-other-house's dining-room are entirely of a different plan and feeling from each other, and so on through the house. They are all designed by different minds upon different principles, probably the hall from a seaside cottage and the dining-room from some city house, but no matter, he pays his money and he must have it. Thus the architect receives his idea of the future house, from basement to roof, and he makes his plan accordingly.

Then he is confronted with one of the meanest tasks that can be imposed upon a designer who takes pride in his work at all, namely, to design an exterior to fit the plan as laid out, a scheme as ridiculous in principle as to make the window frames to fit some old sash that may be on hand.

The whole house has been designed without reference to the exterior, and hence the public is confronted with a flat, featureless building which is an eyesore to the beholder; or else the building is covered with an excess of meaningless ornamentation put on to hide the defects of a plan designed without due and proper thought, but to please Mr. Must-have-it.

Moral: Leave the full designs and surroundings to the more experienced and better judgment of the architect.

HINTS FOR BUILDERS.

The *Builder and Woodworker* gives the following advice to builders and to those who have not had much experience in working up old materials. The suggestions will be found valuable:—

Never compete with a "botch," if you know he is favoured by the person about to build. He will undercut and beat you everytime.

In tearing down old work be as careful as in putting up new.

It costs about 15 per cent extra to work up old material, and this fact should be borne in mind, as I have known several contractors who paid dearly for their "whistle" in estimating on working up second-hand material.

These remarks apply to woodwork only. In using old bricks, stone, slate, and other miscellaneous materials, it is as well to add double price for working up.

Workmen do not care to handle old material, and justly so. It is ruinous to tools, painful to handle, and very destructive to clothing.

In my experience I always found it pay to advance the wages of workmen—skilled mechanics—while working up old material. This encouraged the men, and spurred them to better efforts.

Sash frames, with sash weights, locks, and trim complete, may be taken out of old buildings that are being taken down and preserved just as good as new by screwing slats and braces on them, which not only keeps the frame square, but prevents the glass from being broken. Doors, frames, and trims may also be kept in good order until used by taking the same precautions as in window frames.

Old scantlings and joists should have all nails drawn or hammered in before piling away.

Counters, shelving, drawers, and other store fittings, should be kindly dealt with. They will be wanted sooner or later.

Take care of the locks, hinges, bolts, keys, and other hardware. Each individual piece represents money in a greater or lesser sum.

Sinks, wash-basins, bath-tubs, traps, heating appliances, grates, mantels, and hearth-stones should be moved with care. They are always worth money, and may be used in many places as substitutes for more inferior fixings.

Marble mantels require the most careful handling.

Rails, balusters, and newels may be utilized much readier than stairs, as the rail may be lengthened or shortened to suit variable conditions.

Gas fixtures should be cared for, and stowed away in some dry place. They can often be made available, and are not easily renovated if soiled or tarnished.

It is not wise to employ men who have nothing but their strength to recommend them. As a rule, they are like bears—have more strength than knowledge; and lack of the latter is often an expensive desideratum. Employ, for taking down the work, good, careful mechanics, and do not have the work "rushed through." Rushers of this sort are expensive.

Have some mercy for the workman's tools. If it can be avoided, do not work up old stuff into fine work. If not avoidable, pay the workman something extra, because of injury to tools.

Don't grumble if you don't get as good results from the use of old material as from new. The workman has much to contend with while working up old nail-speckled, sand-covered material.

PAINTED RESIDENCES.

Statistics show that people live longer in brick houses than in stone, and that wooden houses are the healthiest. This suggests the idea of using paint on masonary. An authority stated that a hundred years ago it was fashionable to paint brick buildings white, and many charming old structures remain to attest the value of the coat of paint in preserving the masonry, and its pleasant homelike effort is to foil the vines and shrubs with which even city houses are now commonly adorned. If it should prove, as might be easily ascertained, that the painted brick-houses preserve their inhabitants more effectually from sickness and premature death than the unpainted ones, it would be worth while to revive the ancient fashion, and, with our greater resources in the way of materials and ideas, exterior coloring might become as important an accessory to the architecture of the twentieth century as it was to that of the twelfth or thirteenth. Painters who, when bidding for jobs are expected to be responsible for the safety of the glass work, do not like the plan. Years ago the custom of holding painters responsible for glass work was much more general than it is at present. The presumption is that painters are unnecessarily careless, but this has but little foundation to stand upon. Following are a few lines concerning the painting that ought to be kept in mind: The best time to paint the outside of a house is early in the winter or in spring, when the air is dry and no dust is flying. Knots in boards may be killed before painting by several methods. The surest and best in fine work is to cover the knot with an oil size and lay silver leaf over it. Glue size mixed with red lead, or gutta-percha dissolved with ether, will satisfactorily cover knots not exposed to sunshine. The heat of the sun draws the pitch in the knot to the surface through the paint. If woods to be painted are soiled by smoke or grease, those parts are to be washed with a solution of saltpetre in water, or with very thin lime whitewash. If soap suds be used to wash off smoke or grease, the wood should be thoroughly rinsed with clean water, or the paint will not harden. The first, second and third coats of paint on the outside of buildings should be prepared by mixing the white lead with boiled linseed oil, and allowing each coat to dry before applying the next.—*Exchange.*

USE OF VANILLIN.

Commercial vanillin is not made from vanilla, but from the cambium sap of the pine, which contains coniferin or coniferyl-alcohol. The latter is converted into the former by a process of oxidation. The discoverers of the chemical constitution and of the method of artificial preparation of vanillin, Messrs. Tiemann & Haarmann, have gradually improved the process; so that the commercial product is fully equal in aroma to the natural vanillin contained in vanillia beans. And the vanillin is now sold at a price which makes it decidedly more economical to use it than an equivalent amount of the beans themselves. There are several manufactories in Europe which do not seem to have as yet combined to a "trust." In consequence, the price has been depressed more and more.

At one time it was supposed that artificial vanillin would ruin the vanilla industry and trade, just as artificial alizarin has practically ruined the madder industry. But, curiously enough, this has not been the case. Vanilla holds its own extremely well. In fact, there is much more vanilla grown and sold at the present time than before vanillin was known as a commercial product. And yet, the latter is also consumed in constantly increasing quantities.

There is one reason for this. It is well known that an extract of vanilla made from the bean contains other matters besides the vanillin, among them what is usually termed "extractive" and a good deal of coloring matter. Now these substances have the power of binding or holding the odor of vanilla much more energetically than a simple neutral solvent would. Therefore, if two liquids are made of as near equal strength in odor and taste of vanillin as possible, one from vanilla bean and the other from vanillin, and if these two liquids are used, in equal proportions, to flavor equal amounts of any inert or insipid mixture, it will be found that the one flavoured with the extract of the bean will retain its odor longest. But this property is not always required of the flavoring. When used for culinary purposes, it is seldom required to preserve the odor or taste of some flavored delicacy more than 48 hours. On the other hand, when chocolate or other confectionary is made on the large scale for the market, it is necessary to insure the stability of the odor and taste for as long a time as possible. Hence while artificial vanillin is perfectly satisfactory in the former case, the natural bean is perferred in the latter. It is usually considered that 1 oz. of vanillan is equivalent to 40 oz. of good vanilla beans.—*American Druggist.*

THE YOUTHFUL ELECTRICAL ENGINEER.

"The youthful aspirant to the honourable profession of electrical engineering," says Sir William Thomson, "ought to learn mathematics and dynamics; after having the elements of a good general education, he ought to learn a good deal of chemistry and regular mechanical and civil engineering *besides electricity.*" We quite agree with Sir William when he asserts that "engineering" must form an important part of the modern electrician's curriculum, but we would warn the youthful aspirant against the idea that "electricity" can be learned in a few months. Indeed, we have now specialists in "electricity" who are devoting their entire attention to a single branch of electrical science, and with all their industry and application they find it difficult to keep in the front ranks, and among these are men who had a thorough engineering education to begin with. There is no danger in learning too much, but in these days of close competition there is the danger of learning things which are not absolutely necessary, and of neglecting studies which are specially useful in some branch of the profession. Take mathematics, for instance. Here we find that different branches of mathematics demand different efforts for their comprehension, and even call into activity different intellectual faculties. "Mathematics" and "engineering" are broad terms, and unless the youthful aspirant is guided by practical men he may grow mad over the immensity of the task before him.

The average electrical engineer requires but an elementary knowledge of mathematics, and even if he has mastered the higher branches, he will seldom find time to apply them, though the desire of doing so may be frequent and tempting. The creative minds of Watt, Stephenson, Telford and Whitworth, although never trained to the study of mathematics, have given us our steam engines, our railways, and our canals, and it must be conceded that there is a vast field of useful mechanical and electrical knowledge in which a man may work successfully for the good of his profession without being competent to follow the symbolical reasoning of a mathematical treatise. There are numbers of men who will when endowed with common sense comprehend many a complicated piece of mechanism with no further aid than that derived from patient thought upon the principles involved and a careful comparison of the successful steps which have led previous inventors to some complete and final result. Such men will, when mathematical analysis is requisite, consult competent mathematicians who make this branch of study a profession. We do not depreciate the value of universal knowledge or learning,, but we know from experience that the great majority of electrical engineers cannot approach the ideal of Sir William Thomson, yet they are doing the bulk of the good work in the most efficient manner when guided by a gifted and particularly developed mind. We would advise the youthful aspirant to learn all he can about the special subject he wishes to excel in first, and to employ spare time in the study of subjects more remotely connected with his calling.—*Electrical Review.*

The engine that runs smoothly, does its work silently and economically, is almost invariably a clean engine; the engine room is clean, and where you find a clean engine you will generally find a competent engineer.

The engine that pounds and groans as it does its work is nearly always dirty—in fact, filthy—is expensive, a nuisance, and is usually to be found in charge of a person whose chief concern is quitting time and the weekly envelope.—*Safety Valve.*

ELECTRO-PHYSIOLOGY.

At Owens College, Manchester, Professor Stirling lately delivered a lecture on the electrical properties of the tissues, but especially of those composing the nervous system. There are about fifty species of fishes which are known to have specially modified organs for the generation and discharge of electricity. These organs when at rest do not discharge their electricity; but if the animal be irritated, electrical shocks are discharged, which in some fishes are very powerful indeed. By means of electrical discharges these animals not only stun their prey, but they ward off the attacks of their enemies. The animal may discharge its batteries voluntarily, but after having done so for a considerable number of times the electrical organs become fatigued, just as muscles after severe exercise are fatigued. At first sight it might seem remarkable that certain animals are provided with structures which evolve powerful discharges of electricity. This, however, is not by any means the most remarkable fact. When we know that the whole of the body of the animal is traversed by the electrical current at the moment it is discharged, it does seem far more wonderful that the tissues of the animal itself are not thereby affected; not even a muscle is caused to contract, although the discharge must necessarily traverse the nervous system as well as the muscles. The animals, therefore, have an immunity from the effects of their own shocks. Darwin admitted that the presence of these organs in a limited number of fishes was a fact not easily explained on the evolution hypothesis. Recent researches, however, have shown that the electrical organs are really modified muscular organs, or the terminations of nervous structures in muscles. This fact greatly simplifies the problem. Muscles and nerve, however, evolve electricity in the living condition; and a variation of the electrical conditions of a muscle, a nerve, or even of protoplasm, generally is one of the best signs of the vital activity of these structures. With Galvani's experiments on the twitchings of the limbs of frogs, there commenced the investigation of electrical phenomena, which have led to such splendid results, not only in physiology, but to the development of new means of producing electricity and its numerous applications in the arts. The lecturer demonstrated the classical experiments of Galvani, Volta, Noboli, Du Bois Reymond, and others, showing historically on what lines our present knowledge of animal electricity had been reached.

THE TELEPHONE AND LIGHTNING.

Whilst research and statistics on one side, says the journal *Assecuranz*, have demonstrated that the number of thunderstorms, accompanied by severe strokes of lightning, have increased during the last 10 years, it has, on the other side, been proved that in larger towns both the number and effects of the same have considerably decreased. To the latter fact, no doubt, several of the inventions and discoveries of recent years contribute, among which the telephone nets now spread over the roofs of houses in towns are, we consider, one of the principal causes.

A large telephone installation, consisting of numerous wires of steel, suspended in the air over the houses like a huge steel net, each wire of which is connected either at the stations or in other places with the earth, where they again touch a network of gas and water pipes of iron, forms, with the latter, a kind of electrical safety wire fence above the city. For a city so enveloped is but a reality of Faraday's famous physical theory that a body completely encased in metal cannot become electrified through an electric current outside the metal case.

However, telephone installations do not act as lightning conductors alone by the wires at each end being connected with the earth, but also by most of the poles supporting the wires being of metal, and connected with the lightning conductors, if any, or by acting as such themselves.

The amount of protection which a telephone net affords to the buildings below it depends, in the first instance, on the local distribution of the wires, an area being the better protected by such a steel wire net the heavier and the more uniformly the metal is distributed over the same. Therefore that part of a city situated near a telephone station is the best protected as the metal net is there thickest.

As regards the metal supporters on the roofs, those nearest stations afford the best protection, and next, those bearing the most wires. Those supporters, whence wires of any length emanate, should advantageously be connected with the lightning conductor, if any, or otherwise by points and earth conductors be converted into such, which will afford a still bette protection for the buildings in question.

That a telephone net affords the protection here claimed for it, statistics from late years go to prove beyond a doubt, as for instance, those relating to the town of Munich, where in spite of numerous severe thunderstorms, no severe casualty through lightning has occurred since the city became enveloped in a telephone net. In suburbs and the country, however, where the factors described are absent, the cases have in no way diminished.

RESULTS OF GOOD PATENTS.

W. P. Proctor, vice-president of the Singer Sewing Machine Company, lives at the Fifth Avenue Hotel, and has the best horses and carriages in the city, but never rides. His own exercise is walking, and the carriages are for his family. He was a mechanic when he first met Singer. They went into partnership to make rock drills on Cherry Street. The drills worked with a hand ratchet. Their factory blew up, and Singer walked all the way to Boston in the hope of interesting Boston people to start a factory there. While in Boston he was asked to go around the corner to see a wonder—it was a sewing machine. He came back to New York, and said he could make a better sewing machine than the one he saw. They raked together $50, and the machine was made, and in thirty-five years this $50 of capital grew to be $30,000,000. Proctor married Singer's daughter, and is probably worth $25,000,000. He owns a third of the stock of the Singer company. It is amusing to hear him tell at times how, in the early days of his sewing machine experience, he and Singer used to dream of the time when they could make 2,000 machines a year, which they were certain would yield them a fortune. To-day they make 2,000 a day.—*Daily Paper*.