SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

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.

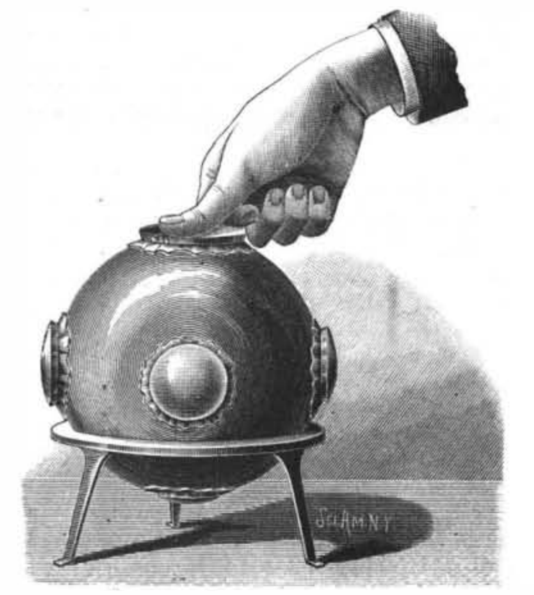

Fig. 1.—DEMONSTRATION OF PASCAL'S LAW.

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 converter, 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.

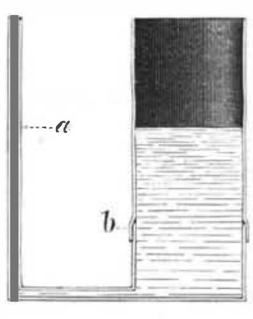

Fig. 3.

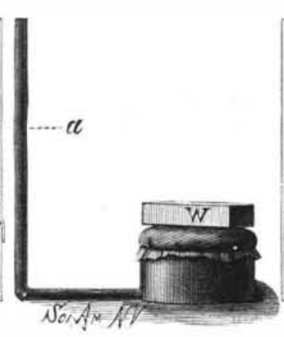

Fig. 4.

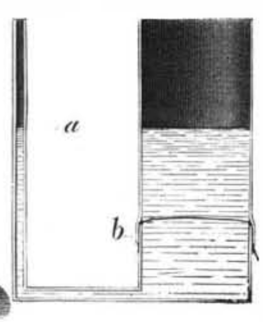

Fig. 5.

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.

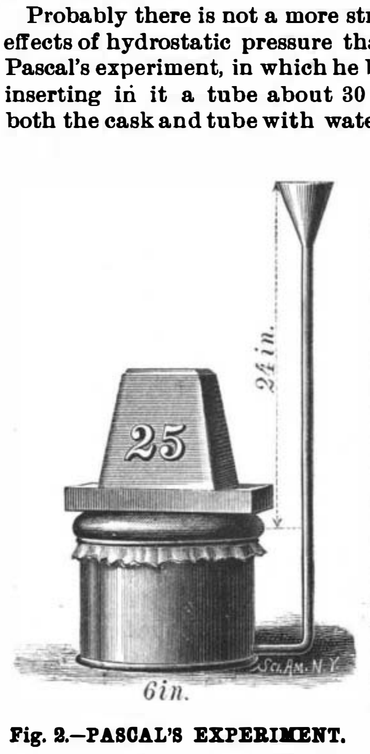

Fig. 2.—PASCAL'S EXPERIMENT.

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 inserted in a crosstee, to opposite sides of which are attached ordinary check valves. The tee

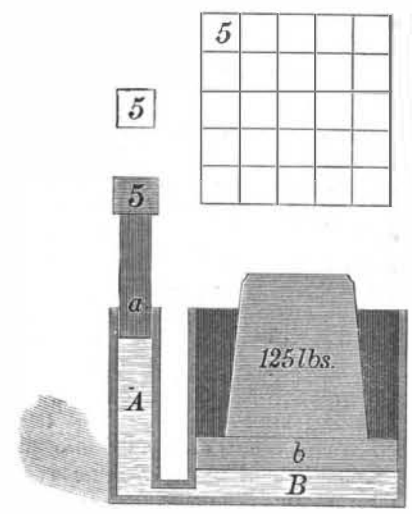

Fig. 6.—PRINCIPLE OF HYDRAULIC PRESS.

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 ¼ 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 reenforcing 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 ¼ 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.

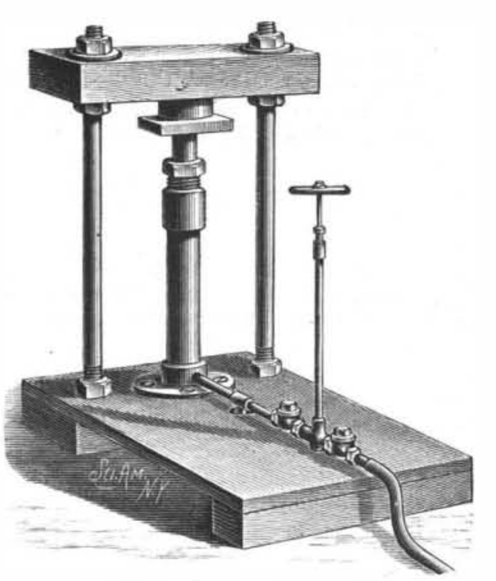

Fig. 7.—SIMPLE HYDRAULIC PRESS.

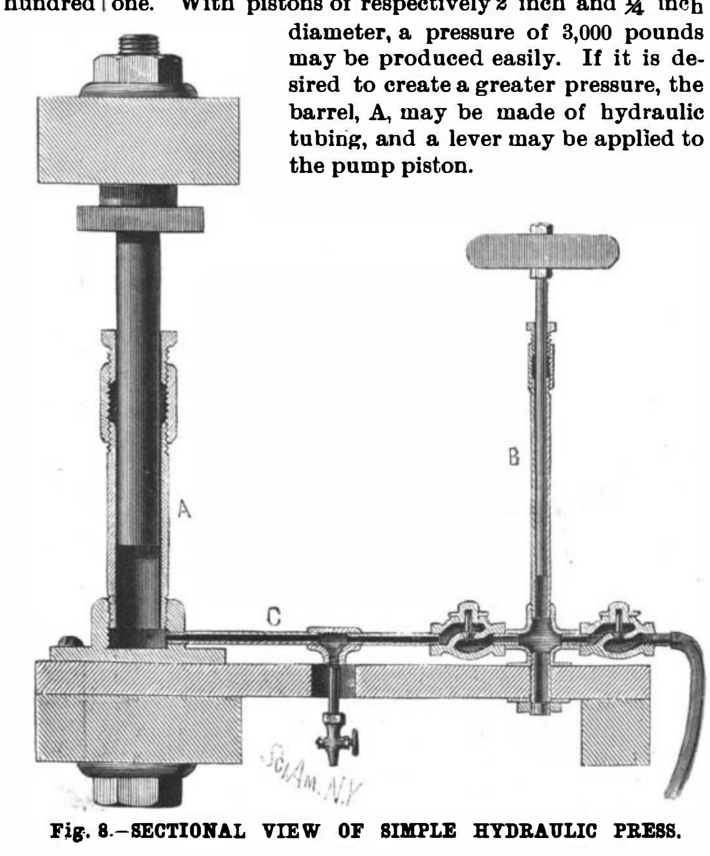

Fig. 8.—SECTIONAL VIEW OF SIMPLE HYDRAULIC PRESS.

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 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*).

Endurance of Wood Posts in Fires.

The contents of a building, says E. M. Shaw, in the *Architect* (London), have undoubtedly much to do with its safety or danger, but, in estimating the whole risk, the materials of which the building is constructed must never be put out of consideration. Every building cannot be erected with brick columns and groined arches, but there is a vast range between these and the miserable cast iron posts too commonly to be seen, many of which have been put in without having been tested for strength even at the ordinary temperature of the atmosphere, much less at that of a fire. The following illustration may be given of a fact well known to all firemen of experience, but seldom proved to demonstration for those not specially interested.

A fire occurred in a warehouse of enormous proportions, and raged with great fury for five hours, at the end of which time it was extinguished, and a very large proportion of the building and its contents saved. The warehouse was constructed of brick walls, it had wooden floors supported on wooden beams, which in their turn were carried on wooden story posts about 12 inches thick, and, although serious damage was done, not one portion of the heavy woodwork was destroyed. After the fire the proprietors allowed the chief of the fire brigade to remove one of the story posts, with a section of the beams and other parts surrounding it above and below.

This post had been subjected to the full action of the fire during the whole of its duration, as already mentioned, or, making full allowance for everything, including the delay of the fire attacking the particular spot on which it stood, and the time at which the cooling process commenced, certainly not less than four and a half hours. As large quantities of water had been used, and it was probable that everything had been saturated, the wood was carefully dried before a strong fire until not a trace of moisture remained in it.

It was then set on end in an open yard, exactly as it had stood in the warehouse, with the pedestal underneath, the cap above, and the beam across the cap, more than a ton of shavings, light wood, and heavy wood were placed round it, and after the whole heap was saturated with petroleum a light was applied to it, and, after this, large quantities of petroleum and turpentine were pumped on it. At the end of two and a half hours the post, beam, and other parts were withdrawn from the fire, and within a few minutes from the time they were withdrawn they ceased to burn. A few feet were then sawn off horizontally, at that part which had suffered most from the flames, and afterward the same piece was split longitudinally with steel wedges, in order to examine its condition.

The post was of pitch pine, about the most inflammable wood known, and yet after exposure for seven hours to fires, the fury of which could not be exceeded except in blast furnaces, it contained within it a quantity of perfectly uninjured and apparently fresh wood, probably capable of supporting the whole weight which the original post was designed to carry. Immediately after the saw cut, and again after the cleaving with steel wedges, the center was carefully examined, and found to be just perceptibly warm to the touch, but nothing more, thus proving that the fiber, in which the strength lay, was quite uninjured.

[PHOTOGRAPHIC TIMES.]

Bleaching Blue Prints.

An original method of procuring a beautiful tone and detail with the ordinary blue prints is certainly an accessory to the amateur photographer.

I hardly expect to go into an explanation of the preparation of the paper—it is not necessary in this case; suffice to say that almost any solution that you may make up and spread on the paper for blue prints can be treated by this bleaching process with the same effect as the ordinary stock paper that is sold at the stationers' or photographers' stock houses.

To get the prettiest tone in the blue print it is necessary to overprint—that is, to expose the print much longer than in making an ordinary blue print—and, after a thorough washing in running water, procure a tray, say 8×10, for small (4×5 or 5×7) prints, and put in eight ounces of the following bleaching mixture:

Aqua ammonia	1 drachm.
Water	8 oz.

Lift the blue prints from the water and place in the bleaching solution carefully, so as to cover the entire print. The action is rapid, and the print on immersion immediately takes on a purplish hue, which is very beautiful for certain effects. The print will then gradually fade away, changing to almost the original coloring, and if allowed to remain in the solution the blue will bleach out entirely, leaving no trace of the blue solution on the paper.

The operator must use his own judgment as to the proper time to stop the bleaching, and he can readily judge that by watching the print fading away, and remove it immediately when he has procured the proper tint.

I would advise overprinting for the reason that the half tones and the beautiful detail so often found in the shadows of a silver print are not to be had on an ordinary blue print unless it is overprinted. This gives the operator an opportunity to judge, by actual observation during the bleaching process, the proper time to remove the print. Immediately after taking it out of the bleaching solution, place the print back into the running water and wash for a short time, so as to remove any trace of the ammonia.

If this solution bleaches your prints too quick, add a little more water, or if it acts too slow, add a few drops of ammonia.

I would advise the use of the weak solution, as it gives one an opportunity to handle the prints better, and it seems to have a better effect on the prints.

In special cases, where you wish to remove a blue spot or blemish of any kind, take a small brush and paint over the blemish with a mixture of ammonia and water. High lights can be readily brought out in this manner, which, if properly handled, has a very desirable effect.

For the use of photo-engravers a very cheap and desirable method to obtain correct drawings is as follows:

After the blue print has been washed and toned down to the proper coloring, take a drawing pen or brush and with indelible drawing ink draw the necessary lines for the engraving on the print, and after the ink is well dried, place the print in the bleaching solution and allow it to remain until the blue tint is entirely removed.

This will give you a pure white paper and clean black lines. The bleaching solution will have no effect on the indelible ink.

Oxalic acid or cyanide of potassium in solution will bleach blue prints, but usually leaves a yellow tint on the white parts, which is undesirable, let alone the danger of handling or using these poisonous chemicals. —*John E. McCrickart.*

Electric Railways and Motors.

The electric street railway in the city of Boston, being built under the Bentley-Knight and Sprague patents, is nearly completed. It will be ready for operation soon, in time to test the feasibility of those systems amid the ice and snow of the Boston climate, which is particularly bad for subways, owing to the rapid variations in temperature, which give rise to large quantities of slush and sleet—the two evils against which electric railways will have to contend. If this road operates successfully in Boston this winter, the feasibility of the devices with which it is fitted will be well established.

The electric street railway to be built in Fulton Street, New York City, is progressing slowly. The street is broken, and the details of construction are lying around in great confusion. The delay is probably caused by the proverbial wire pulling with which New Yorkers are so well acquainted.

We notice an increase in the demand for electric motors to be used in driving isolated machinery. Among the recent orders is another for driving transfer tables. This makes the third electric application of this nature now in successful operation.

There is a complaint against the use of dynamos run by separate engines in the front car of passenger trains for the purpose of lighting the cars with electric light. It is stated that the vibrations of such dynamos and engines shake the cars considerably, and by some it is further stated that the pulsations can be perceived at the rear of the train. There is a demand for a well balanced engine and dynamo connected directly together, for the purpose of lighting passenger cars, and it is wholly inexcusable that such machinery should be so badly out of balance as to shake the train. In this connection it may be well to state that so far the systems adopted for electric lighting in our through trains have been such as to require the use of the small stationary engine during the whole day and night, in order to store sufficient current for use during the short time the lights are lighted. It does seem that our electricians should offer something better than this.—*The Railway Review.*

A PINT of warm water taken on an empty stomach in the morning is the safest and surest of all remedies for habitual constipation. It dissolves the fecal matter and stimulates peristaltic action, thereby giving a normal action without pain. If the tongue is coated, squeeze a lemon into the water and drink without sweetening.