

RULES TO FIND PROPER VALVE DIMENSIONS REQUIRED FOR GIVEN STEAM DISTRIBUTION.

1. Given Pre-admission to find Angle of Lead:

Find the desired point of pre-admission on the proper piston-stroke scale, and the point opposite this on the scale of angle-degrees. The angle between this point and the end of the stroke is the Angle of Lead. The sum of the Angle of Lead and of Angle of Lap is the angular advance.

2. Given Pre-admission and Cut-off to find Outside Lap:

Find Angle of Lead by Rule 1, and set it forward from point of cut-off found on proper piston-stroke scale. Half the remaining angle between the point so got and the end of the stroke is the Angle of Lap.

3. Given Pre-admission, Cut-off, and Release to find Inside Lap:

Find angular advance by Rules 1 and 2. Set the angular advance back from end of stroke. The angular difference between the point so got and the desired point of release as found on the proper piston-stroke scale is the Angle of Inside Lap, or of clearance if release is further back than point first got.

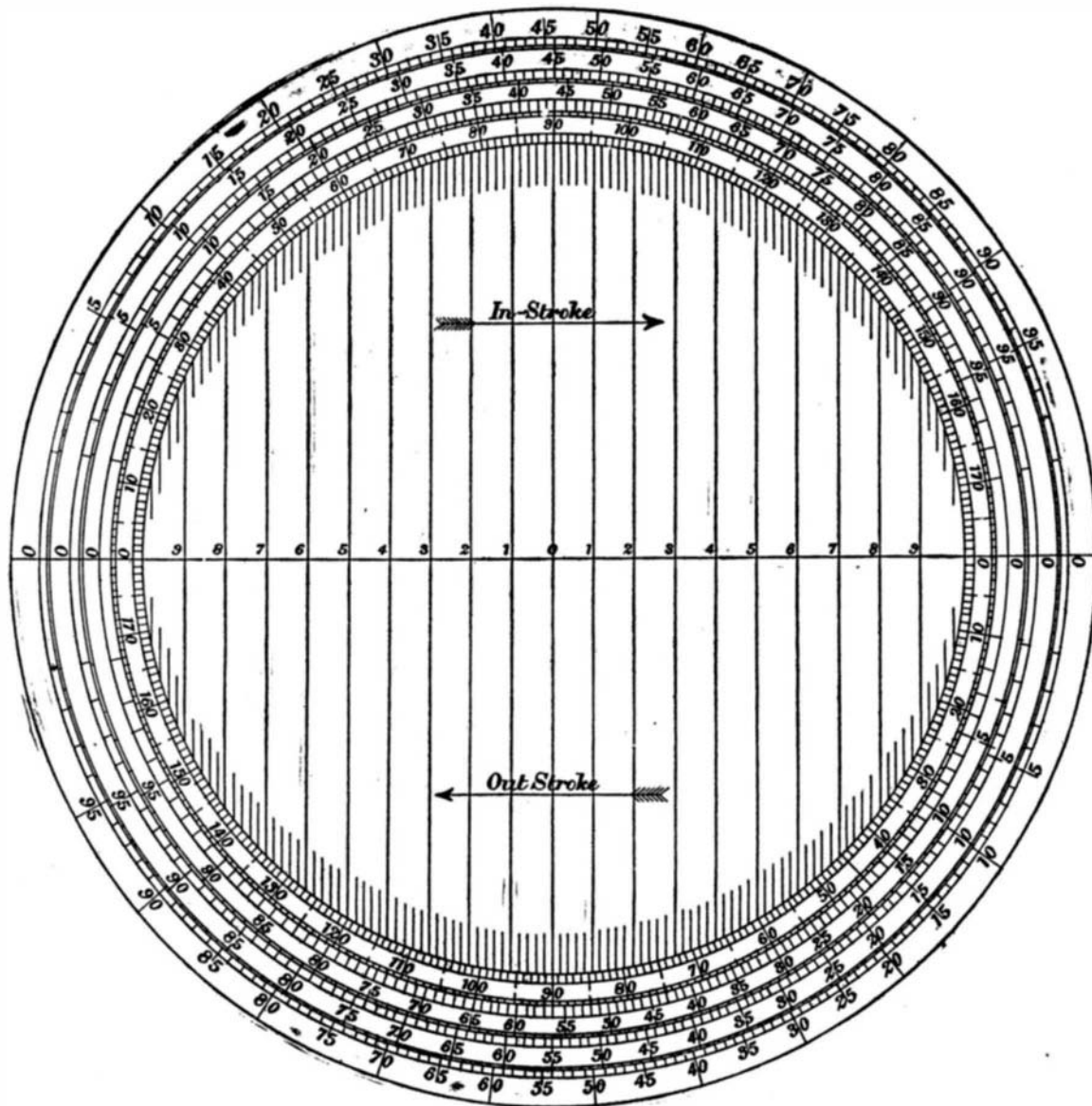
4. Given Pre-admission, Cut-off, and Compression to find Inside Lap:

Find angular advance by Rules 1 and 2. Set the angular advance back from the beginning of the stroke. The angular difference between the point so got and the desired point of compression as found on the proper piston-stroke scale is the Angle of Inside Lap or of clearance if the point of compression is further forward than the point first got.

5. Given Cut-off and Angular Advance to find Outside Lap:

From point of cut-off as found on proper piston-stroke scale, set forward the angular advance. The angle from point so got to end of stroke is the Angle of Outside Lap.

SLIDE VALVE DIAGRAM.



Scale on Diameter.—Valve travel; each half-travel divided into 50 equal parts. (These divisions being projected on 1st circle.)

Scale on 1st Circle.—Equal degrees of Angle; each semicircle divided into 180 degrees.

Scale on 2d Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = 2 Strokes. (Showing positions of Crank Pin for simultaneous positions of Piston.)

Scale on 3d Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = $2\frac{1}{2}$ Strokes.

Scale on 4th Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = 3 Strokes.

RULES TO FIND STEAM DISTRIBUTION DUE TO GIVEN VALVE DIMENSIONS.

1. Given Lap and Angular Advance to find Pre-admission:

Subtract from Angle of Lap and Lead, i. e., the angular advance, the Angle of Lap. Set the difference of these angles back from the beginning of the stroke. The point so got is the point of Pre-admission.

2. Given Lap and Angular Advance to find Cut-off:

Add the angular advance to the Angle of Lap. Set the sum of these angles back from the end of the stroke. The point so obtained is the point of Cut-off.

3. Given Inside Lap and Angular Advance to find Release or Exhaust:

Subtract from angular advance the Angle of Inside Lap. Set the difference of these angles back from the end of the stroke. The point so got is the point of Release.

4. Given Inside Lap and Angular Advance to find Compression:

Add the angular Advance to the Angle of Inside Lap. Set the sum of these angles back from the beginning of the stroke. The point so got is the point of Compression.

DEFINITIONS.

The "Angular Advance" is the angle between crank and eccentric, less 90 deg.

The "Angle of Lap" is the angle whose sine is the outside lap divided by the half-travel.

of circular arcs of connecting rod radius, instead of by perpendicular straight lines. In the diagram attached to this article this is done for three standard ratios of connecting rod length to crank throw. The connecting rod lengths chosen are 2, $2\frac{1}{2}$, and 3 strokes. The stroke is divided into 100 equal parts, and the corresponding positions of the crank pin are shown on the three outer circular scales for the above three connecting rod lengths. The actual connecting rod length in steam engines is never so much different from one or other of these as to make any appreciable difference in the slide valve calculation.

The inner circle is taken as 5 in. in diameter, and represents to different scales the paths of both crank pin and eccentric center. The horizontal diameter represents to the same two scales the strokes of piston and of valve. It is divided into 100 parts, only every fifth division being indicated by a vertical cross line. Considering it as the valve stroke, the corresponding positions of the eccentric center are projected on the circle by vertical straight lines, because the obliquity of the eccentric rod may be taken as practically nil. In slide valve design, all dimensions have to be considered in ratio to the half travel of the valve. Therefore, the half travel is conveniently divided into ten parts, each of these being subdivided into five. The one-fiftieths of the half travel are large, and easily divisible by eye, so that there is no difficulty in reading off the ratios to 1 per cent. of half travel.

In using the diagram, careful distinction must be made between the out and in strokes. The upper semicircle must be used in dealing with the in stroke, the lower with the out stroke. The diagram must be so used, whatever be the actual direction of rotation of the engine. The diagram can be used for the solution of two classes of converse problems—first, given the valve and port dimensions and the setting of the valve, to find the resulting steam distribution; secondly, given the desired steam distribution and the ratio of connecting rod length to stroke, to find the required valve dimensions and eccentric setting. In conjunction with the diagram, two sets of rules are given—first, four for the first class of problems, and second, five for the converse problems. These rules are so easily proved to be correct by a little careful consideration that it is hardly worth while to give demonstrations of their truth here. It will be sufficient to make one or two explanations as to the phraseology used and as to the general mode of procedure.

In the rules, the phrase "set off" such an angle is constantly used. This setting off is not to be performed with dividers. By help of the scale of angle degrees all the angles used are obtained in degrees, and the simplest mental addition and subtraction of degrees are alone needed for the plotting off of the angles from any of the points mentioned in the rules. If the mental arithmetical faculty be not developed in the operator, he can make his additions and subtractions on paper, but he should not substitute the use of the dividers for this arithmetic, because the prickings of the divider points

would rapidly destroy the diagram for all accurate purposes. The "angle of lead" is to be understood as the angle at which the crank stands before the dead point when steam admission takes place. The "angle of lap" is the angle beyond 90 deg. at which the eccentric stands when steam admission takes place. The "angular advance," is the sum of these two angles.

It is to be distinctly understood that the diagram enables one to calculate only angles and ratios of the valve dimensions. Evidently, any standard diagram could not give directly absolute dimensions. The port breadth has to be found from the required area of port. Call it b . Say that a ratio, q , has been calculated by help of the diagram for outside lap divided by half travel. Then from this we find the half travel = $\frac{b}{1-q}$

and therefore the outside lap = $b \frac{q}{1-q}$

If we wish to make the cut-off the same on out and in stroke, we find two different values of q for the two strokes, i. e., for the two outside laps. That obtained for the out stroke is always the larger of the two if the two angles of lead be taken the same. For example, if the connecting rod were two strokes in length, and the

cut off — were desired for both out and in strokes, and

an angle of lead of 10 deg. were wished, then for in stroke we would have "angle of lap" = $\frac{1}{2}(180-129-10 \text{ deg.}) = 25 \text{ deg.}$, and consequently $q = 0.42$. For the out stroke we find "angle of lap" = $\frac{1}{2}(180-106\frac{1}{2}-10) = 31\frac{1}{4} \text{ deg.}$, and therefore $q = 0.53$. If now b were taken the same for both ports, the half travel as calculated

from the first figure, $0.42, \left(\frac{b}{1-0.42} = \frac{b}{0.58}\right)$ would be less

than that from the second, $0.53, \left(\frac{b}{1-0.53} = \frac{b}{0.47}\right)$

Now the two half travels cannot be unequal. We must therefore have either unequal cut-offs, or unequal port openings for the two ends of the cylinder. It will generally be preferable to have unequal port openings. We must then calculate the half travel from one of the two ratios, q , obtained, and from the q obtained for the other end of the valve calculate the port opening and lap from this half travel. Thus, suppose that in the above example it has been reckoned that $\frac{3}{4}$ in. steam port opening was required. If we calculate half travel from the 0.42 for in stroke, we would have half

travel $\frac{0.75}{0.58} = 1.29$, and lap = $1.29 - 0.75 = 0.54$. Then for

out stroke we would have lap = $1.29 \times 0.53 = 0.68$, and therefore port opening $1.29 - 0.68 = 0.61$. But this port opening is less than has been settled as necessary. We must therefore proceed in the other order, and calculate the half travel from the 0.53 obtained for the out

stroke; thus half travel = $\frac{0.75}{1-0.53} = 1.60$, and there-

fore lap = $1.60 - 0.75 = 0.85$. For in stroke we then obtain lap = $1.60 \times 0.42 = 0.67$, and therefore steam port opening = $1.60 - 0.67 = 0.93$. This is in excess of the required opening, but so far as simple steam admission is concerned, this excess is no evil, whereas the deficiency obtained by the previous dimensions is a decided evil. The larger valve travel of course involves more waste of frictional work in driving the valves, and in some cases this evil may be considered to overbalance the evil of deficient opening of the steam port at one end. But this cannot be considered the standard case, and therefore we should generally follow the rule to design the half travel by help of the ratio, q , obtained for the cut-off on out stroke. We then from this half travel calculate the lap for in stroke, and we will find that the steam port opening for in stroke is in excess of what is absolutely required.—*The Engineer.*

ON THE REMARKABLE EFFECTS OF ADDING SACCHARINE MATTER TO MORTARS.

By SAMUEL CROMPTON.

A LETTER from Mr. Thomson Hankey "On a New Use of Sugar"—*London Times*, October 13—has given rise to wide discussion and inquiry. At a time when the price of sugar is so low, and, as I shall show, when the use of a very small quantity of it, or of treacle, adds largely to the strength of mortar, and makes Portland cement itself set with great rapidity, it seems to me that I may do a service to engineers by laying before them the scientific grounds on which I was led to experiment on the subject, and the remarkable results which have been obtained.

The practical importance of this addition of saccharine matter to mortar I will state briefly to begin with, and will give a few illustrations:

I mixed in a small jar some Portland cement and brown sugar, adding water and stirring. I took out a little of the cement for an experiment, and when I tried an hour after to take out more, I found that the remainder had already set.

My neighbor, Mr. Rowland, weighed carefully Portland cement and sand into four small jars. To two he added different sugars, to the third treacle, but to the fourth no saccharine matter. On the day following the cement had set—we do not know how much earlier, for it was not examined—in all the jars with saccharine matter. Mr. Holden, Jr., the foreman of a builder, examined all of them on the Monday following the Friday on which they had been mixed. On pressing the cement to which the treacle had been added, he said, "I might press the bottom of the jar out before I can make impression on this." He then put his finger into the jar in which there was no saccharine matter, and stirred up the cement, which had not set at all, and which did not set till a day or two after. It may be objected that it

might not be an advantage that it should set so quickly. This objection will be answered by and by, as I proceed, by showing that it is highly probable that the strength of Portland cement will be greatly increased by this addition of saccharine matter.

Mr. Thomson Hankey had experiments made, first by his own brickmaker and secondly by a house builder. Both reported that the addition of sugar made a common lime equal to Portland cement.

The bearing of these facts will be plain to every engineer, but I cannot forbear mentioning here a startling incident. The Ecclesiastical Commissioners built for the late Bishop Fraser, of Manchester, on his coming into the diocese, a lodge like that at Lambeth, with a lofty archway set in Portland cement. A clerk of the works appointed by the architect of the commissioners superintended it. After a due time the scaffolding was removed. One day—perhaps that day—the Bishop walked through and had just got beyond danger when the whole of the archway fell. If he had been under it, he would have been killed, and his grand career as a bishop would have been cut short at the outset. Your readers, as I proceed with my statement, will judge for themselves whether the addition of a few shillings' worth of treacle would not have made all secure, and have saved the expense of doing this work over again.

I have to explain how it is that sugar, or rather saccharine matter of any kind, produces this remarkable effect on lime. Here I ought to mention that I am a retired physician, and that the idea of putting the matter to the proof arose in the following manner: In medicine we have two kinds of lime water; one, the common lime water that can be got by mixing lime and water. It is to be particularly noted that, add as much lime as you like, it is impossible to get water to dissolve more than half a grain of lime in one ounce, or about two small tablespoonfuls, of water. But by adding two parts of white sugar to one part of lime, we obtain a solution containing about $14\frac{1}{2}$ times more lime in the same quantity of water.

Here it is to be observed—and it is a most important point—that there are hot limes, such as Buxton lime, which, if the sugar be incautiously mixed with them, will *burn* the sugar, make it a deep brown color, and convert it into other chemical forms, and possibly, and I think probably, will destroy its value in mortar. The way to use sugar with such limes is to dissolve it first in the water. I dwell particularly upon this, because a gentleman referred to me by Mr. Thomson Hankey, in writing to thank me for the information I had given him, casually observed that his cement had turned nearly black by the addition of the sugar. Probably many other experimenters with sugar and hot limes have had the same result, and are in the belief that all is right. Our strong medical saccharated lime water looks like water.

Ten or fifteen years ago I had been experimenting with lime and sugar, but not in reference to mortar, and I spoke about that time to my friend, the late E. W. Binney, F.R.S., about this property of sugar. He said that it was very curious, and that it was new to him; and he told me this anecdote, that in his grandfather's time an Italian architect came down to Work-sop to erect a building for a nobleman, and insisted on being supplied with malt to make his mortar with; the malt was supplied and used. Many years afterward, this building had to be taken down; but, said Binney, "they could not pull it down, do what they would, and they had to use gunpowder." I said it would be the saccharine matter in the malt that produced this result. He agreed with me.

A few months ago I was at Peterborough, and went to see the progress of the restoration of the cathedral, where I made the acquaintance of Mr. Irvine, Mr. Pearson's clerk of the works. Mr. Irvine was for more than a quarter of a century with Sir Gilbert Scott, and possesses a greater knowledge of architecture, and antiquity bearing on English architecture, than any one I ever met with. One day I said to him that I had been to Fotheringhay. He replied that he had seen every other church than that in the neighborhood of Peterborough. I asked him to go with me on his Saturday's half-holiday, as my visit to the church had been a hurried one, and I wished to make some further inquiries. Besides, I was glad to have the companionship of one who was so thorough a master of the subject. The chancel of this fine church, built before the nave, and so late as 1410, has entirely perished; and it had been so badly built even that in the time of Queen Elizabeth it had fallen in and was then in ruins. The chancel and tower exist, but the tower is unsafe, and if the church be not soon restored, this grand historical monument may suffer or be destroyed. As Mr. Irvine and I walked to the railway station, I asked him whether he was aware of the chemical fact that the addition of sugar to water makes it take up about sixteen times more lime than water by itself does—I might have said a little more than fourteen times. He replied that he did not know this fact, and that he had never heard of it, and that he did not believe that it had been so used in mortars. I then told him what Mr. Binney had told me regarding the building erected by the Italian architect near Work-sop. He said that he had been clerk of the works in the restoration of several cathedrals, in the books of which he had met with old entries of payments, "For beer for the masons," and that he had found one entry where it was written, "For beer to mix with the mortar." I said that that would be for the saccharine matter in it; and I added that a few years ago I had seen in a newspaper that the vintage in Spain had been so abundant that the people had not casks enough, and were using the wine to mix with their mortar. It flashed across my mind that this traditional use of saccharine matter was probably the explanation of the exceptional hardness of the old Roman mortar, and had been handed down from generation to generation, and had at length been forgotten, in England at any rate. A few days afterward I was pondering as I walked along the street in Peterborough on this matter, when suddenly I said to myself, "Why not try the experiment?" I went into a grocer's shop and bought a pound of exceedingly finely powdered loaf sugar and some beeswax—of the wax I will speak some other time. I took the sugar to the hut in the cathedral yard, where I found the foreman of the contractor and Mr. Irvine. Laughing, I said, "I have come to teach you to suck eggs." After explaining to the intelligent foreman my views, he and Mr. Irvine kindly agreed to try the experiment.

Some powdered lias lime and some of the sugar were being mixed together in an iron basin. Water was added, and Mr. Irvine began to stir them with a trowel. No sooner had he done so than he exclaimed, "Look, look! It is beginning to set already." I said, "Is not that usual?" He replied, "No; something very uncommon." The mortar was poured out on the end of a beam, where it set.

Some more was then made much thinner, and a little sand added to it. With this, which was about the consistency of cream, two largish fragments of the broken stone tracery of an old window were joined, and so were two bricks, two pieces of glass, and two slates. It would be about five o'clock in the evening. As I was going to leave Peterborough about noon on the following day, I called at the cathedral about ten in the morning to see the results. Mr. Irvine said it was too early to judge. He felt at the stone tracery very tenderly. Holding the upper fragment, he then tilted the tracery sideways, and as the stones held together, he then took hold of the upper fragment with both hands and lifted the whole stone without the lower fragment falling off. In like manner, in lifting both bricks the lower brick did not fall off. The slate and the glass seemed also set. So that the experiments seemed to confirm remarkably the view I had formed, on theoretical and chemical grounds chiefly, that saccharine matter added to mortar would be of great value, and that an important discovery had been made. I wrote to my brother-in-law, Mr. Guildford Molesworth, engineer-in-chief to the State railways in India, and author of "The Engineer's Pocket Book,"

if not by one-half. But I must leave the matter in the hands of scientific engineers. I think it is very probable that this use of sugar with lime is of extreme antiquity, and that a knowledge of it passed from India to Egypt and Rome; and that these nations used malt for its saccharine matter as a substitute for sugar. I have shown that the mediæval builders used beer in building our cathedrals, and beer is still used with plaster of Paris. These I take to be the remnants of ancient tradition. It is said that in the cold winter when Bess of Hardwicke died, her masons had to "melt the beer which they mixed with their mortar." They would have acted more wisely if they had used infusion of malt only, for most of the sugar must have been converted into alcohol, and lost for the purposes of mortar making. Antiquarians may be able, from old documents, to throw light upon this subject; but I strongly suspect that the old Roman mortar had saccharine matter added to it; and I am of opinion that in all engineering works requiring great strength it would be wrong not to take advantage of facts confirmed by the experience of ages.

Cranley, Surrey, November 30, 1886.

—The Engineer.

IMPROVED DARK ROOM LAMP.

By F. C. BEACH.

THE object sought to be accomplished by this lamp is to provide a diffused but strong non-actinic light for the convenience of the photographer, with a view of preventing any injurious effect upon the eyes. It is a

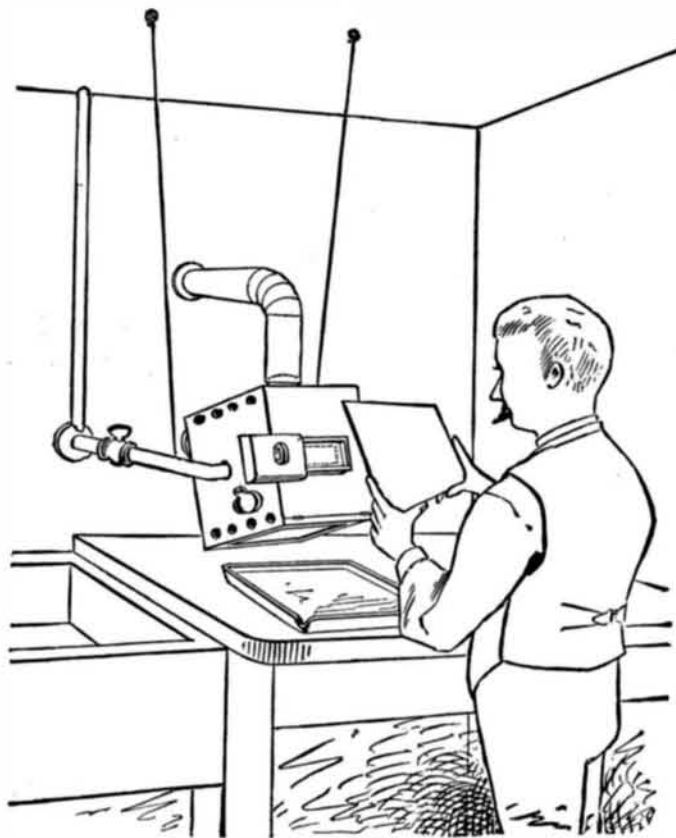


FIG. 1.

telling him what we had done. From him I received a letter dated Simla, August 28, 1886, giving me the following interesting particulars: "With regard to your addition of sugar to mortar, it is a practice that has been in use in the Madras Presidency from time immemorial." The following is an extract from the Roorha (?) "Treatise on Civil Engineering," vol. i., page 150, third edition: "It is common in this country to mix a small quantity of the coarsest sugar—'goor' or 'jaghery,' as it is termed in India—with the water used for working up mortar. Where fat limes alone can be procured, their bad qualities may in some degree be corrected by it, as its influence is very great in the first solidification of mortar. Captain Smith attributes the fact that mortars made of shell lime have stood the action of the weather for centuries to this mixture of jaghery in their composition. He made experiments on bricks joined together by mortar consisting of 1 part of common shell lime to $1\frac{1}{2}$ of sand. One pound of jaghery was mixed with each gallon of water with which the mortar was mixed. The bricks were left for thirteen hours, and after that time the average breaking weight of the joints in twenty trials was $6\frac{1}{2}$ lb. per square inch. In twenty-one specimens joined with the same mortar, but without jaghery, the breaking weight was $4\frac{1}{2}$ lb. per square inch."

Mr. Molesworth then adds: "The use of sugar or jaghery was known to me when I was in Ceylon twenty years ago. The masons who came over from Madras used to make most beautiful plaster work, almost like enameled tiles, of shell lime mixed with jaghery. The surface took a fine polish, and was as hard as marble; but it required a good deal of patient manipulation well suited to the national character."

This intelligence from India supplies proof of the most positive kind of the enormous strengthening power of sugar when mixed with mortar. It may be argued that some of our limes and cements are of themselves good enough without it. It is for engineers to judge whether they might not be made much better by it, or whether the facts I have brought forward do not show plainly that there should be an inquiry instituted by scientific men to investigate the actual numerical value of sugar, and the various conditions under which it acts, whether for better or worse. For the worse it cannot act, except such an insane use of it be made by adding too much, as to expect sugar to be itself mortar. The jaghery sugar used in India is sold in the London market at, I think, less than a penny a pound, and is used for feeding cattle. Treacle seems to me to be a most promising form of saccharine matter. I would shirk beetroot sugar. There is a rough, unrefined treacle which is very cheap, and I should suppose would be excellent. A halfpenny worth of treacle and water added to a hod of mortar would, I conjecture, increase its strength by one-third,

gas lamp, and has been in practical use in the large dark room at the quarters of the Society of Amateur Photographers in this city.

The construction of the lamp is readily seen in the accompanying engravings. As shown in Fig. 1, it is a sheet iron box, about a foot square, suspended by wires from the ceiling, and connected by a stove pipe

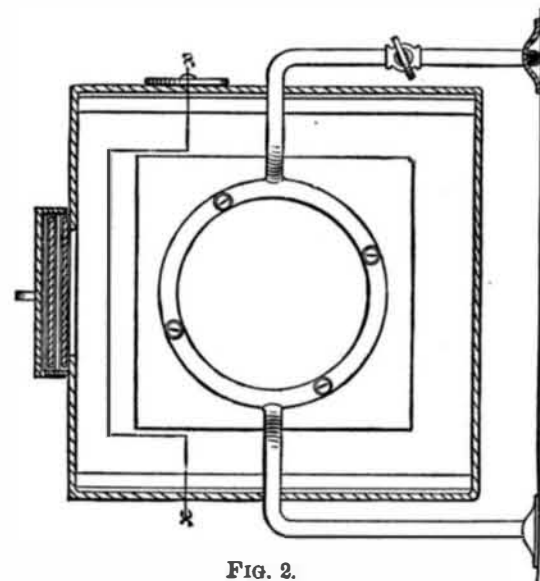


FIG. 2.

at the top to a chimney, for conducting off the waste heat.

Perforations are shown on each side, shielded by L-shaped strips of metal on the inside (see Fig. 3), for permitting the free ingress of air, and preventing any escape of light.

The bottom of the lamp is closed with two panes of glass, one a cathedral green, the other a cathedral orange, having a sheet of canary yellow tissue paper between the two. Special grooves are made in the sides to allow the sheets of glass to be slid in or out (see Fig. 3).

There is also a small window of double glass on the front of the lantern, 4×5 inches in size, covered by a metal slide, the latter being pushed to one side, as shown in Fig. 1, when the operator wishes to examine a plate by transmitted light. A pivoted metal slide, round in shape, allows the lighting taper to be inserted for igniting the gas.

As shown in Fig. 2, the gas supply pipe enters one