but will they forever satisfy the public? When on one single railroad eighteen broken rails are taken up in one day; and on another the train stops four times in less than ninety miles to have broken rails replaced by whole ones; and when it is found that a boiler which exploded had ten out of fourteen head stays broken off for weeks before it blew up, it is about time that either intelligent mechanics and engineers be placed on these juries of inquest or the farce itself be omitted. Your paper has always denied the necessity of attributing boiler explosions to mysterious causes, and I sincerely hope you will continue as heretofore to expose the pretensions of self-sufficient charlatans. B. F. G.

New York city.

Onions and Epidemics.

MESSRS. EDITORS:—In the spring of 1849 I was in charge of one hundred men on shipboard, with the cholera among the men. We had onions, which a number of the men ate freely. Those who did so were soon attacked, and nearly all died. As soon as I made this discovery their use was forbidden. After mature reflection I came to the conclusion that onions should never be eaten during the prevalence of epidemics, for the reason that they absorb the virus and communicate the disease, and that the proper use for them is sliced and placed in the sick room, and replaced with fresh ones every few hours.

It is a well established fact that onions will extract the poison of snakes; this I personally know. Some kinds of mud will do the same.

After maintaining the foregoing opinion for eighteen years, I have found the following well attested: Onions placed in the room where there is small-pox will blister, and decompose with great rapidity; not only so, but will prevent the spread of the disease. I think as a disinfectant they have no equal, when properly used; but keep them out of the stomach.

If need be, the foregoing (which I have greatly abbreviated) can be attested on oath. Let us have all the facts bearing upon the subject. JOHN B. WOLFF.

BEMENT & DOUGHERTY'S STEAM HAMMERS.

The illustrations in this article represent three of the different styles of steam hammers built by Messrs. Bement & Dougherty, of Philadelphia. The hammers are rated or classified according to the effective weight of the piston and hammer head or drop, and range from 100 pounds up to 10 tuns.

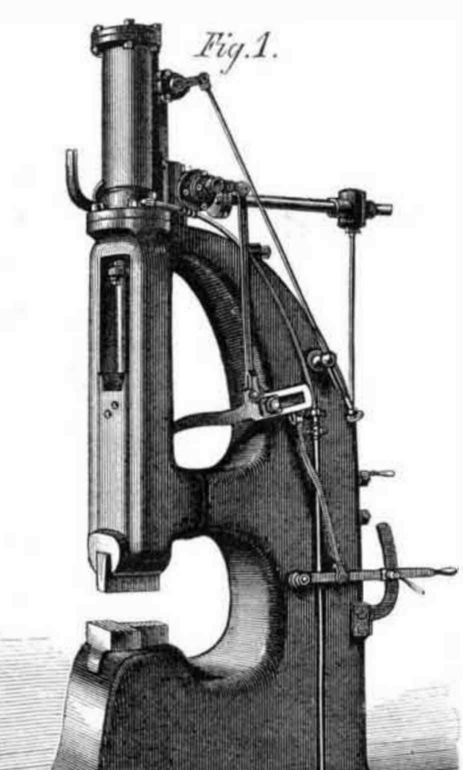


Fig. 1.

Fig. 1 is a perspective view of a 500-pound hammer whose anvil and frame are cast in one piece, to which are bolted the cylinder, guides, etc. It is fitted with an improved valve motion which can be worked at pleasure, single or double acting, adjusting itself to all variations in the thickness of the forging, controlling the admission of steam so as to produce at will a short and quick or a long and slow stroke, and graduating from the light-cushioned blow to the "dead blow," in which no steam is admitted beneath the piston until after the blow is struck, thus utilizing the *vis viva* of the falling weight impelled by the top steam. It can also be used as an ordinary hand-working hammer without altering the setting of the gear.

Fig. 2 shows a 1,000-pound hammer whose frame is keyed and bolted to a massive casting which forms the anvil and base, and expands below the level of the floor to such an extent and mass as to absorb the concussion and thus enables the foundation to be of the least expensive character. The piston rod and drop are of wrought iron forged in one piece. The piston head is of steel and also the guide, which is so arranged behind the drop as to leave the hammer face and dies entirely clear for convenient working. It has the same valve motion as that of Fig. 1, the details, however, not being seen on the side presented, they being sufficiently shown in Fig. 1. Messrs. Bement & Dougherty do not, however, restrict themselves to these designs, but are prepared to build these sizes of hammers with separate anvils if desired.

The 1,500-pound, 2,000-pound, and 3,000-pound hammers being similar in design and differing only in dimensions, are sufficiently illustrated by Fig. 3. They have separate anvils and double frames which form the guides for the drop and the supports for the cylinder, etc. They are fitted with

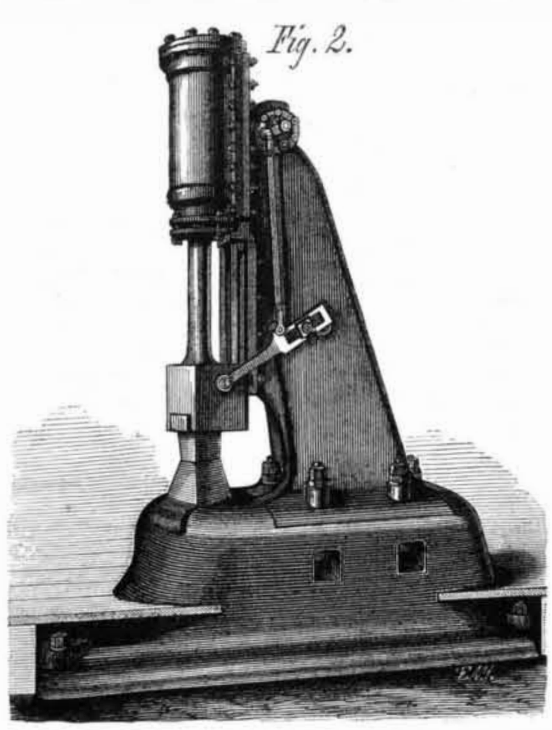


Fig. 2.

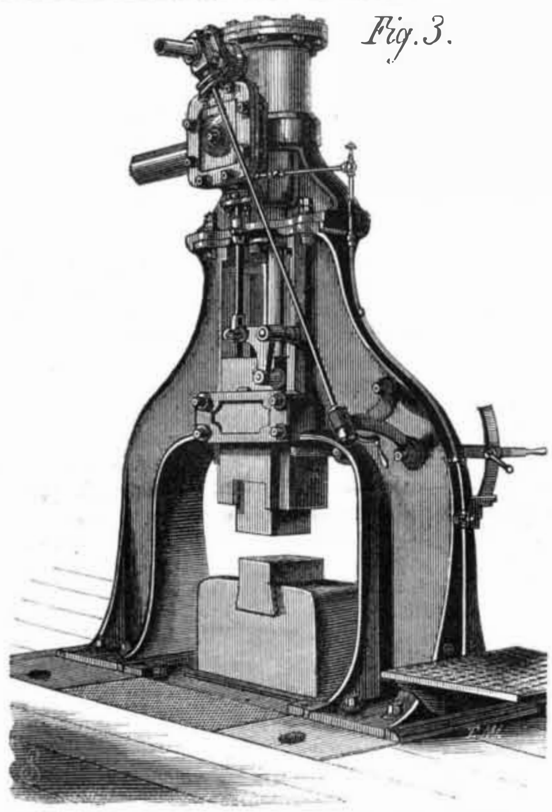


Fig. 3.

balanced slide valves of superior construction whose variable and self-acting motion is produced by the well-known expedient of a rock lever operated by an inclined slot or groove planed in the hammer drop.

Owing to the improvements made in many minor features since the photographs were taken from which these engravings were prepared, they can be said to give a correct idea only of the general style or design of these hammers. [See advertisement on another page.]

History of a Rail of Bessemer Steel.

In the early part of the year 1857 a steel bloom was made by melting in crucibles Bessemer metal with spiegeleisen. This bloom was rolled into a double-headed rail, and in the spring of 1857 it was laid down at Derby station. On the 21st of December, 1867, ten years and six months after it had been laid down, it was reported to be apparently little the worse for wear. Now the wear amounted to, on an average, 250 trains passing over it daily, and a like number of transits of engines and tenders. Reckoning now the weight of each train at 100 tuns average, and that of engines and tenders at 20 tuns, we have an amount of 30,000 tuns per diem passing over this rail, and this continued for, say 300 days per annum, 10½ years, gives a total of 94,500,000 tuns. Now on the Canadian railways the iron rails are worn out by a traffic ranging from 4 millions to 30 millions of tuns, according to the quality of the iron rails. The Derby rail, therefore, of Bessemer steel, has already sustained more than three times the amount of traffic which suffices to destroy the best iron rails, and, in spite of this, it is still "apparently little the worse for wear." The opponents of steel rails will argue, no doubt, that this rail is an exception, and was better than other Bessemer steel rails, because the metal was remelted. Such, however, is not the fact, for steel is always more or less deteriorated by remelting; and the rail ends from Bessemer steel rails, made at Crewe, and therefore, of course, the rails themselves, are of as good and as durable a quality of steel as this Derby rail. ROBERT MUSHET.

Science Familiarly Illustrated.

HEAT AND COLD.

BY JOHN TYNDALL, ESQ., LL. D., F.R.S.

Lecture IV---Continued.

I have now to say a few words upon another subject—the propagation of this thing we call heat—this curious quivering motion of the atoms of bodies; and in order to make this evident to you, I will, first of all, make an experiment or two on liquid bodies, or on gases. I want you to understand the manner in which heat distributes itself in gases, and, for that purpose, I have here placed a little piece of platinum wire—that metal which we raised to a bright white heat in our first lecture. It is a refractory metal, and bears a very large amount of heat. Now, we will have the room made dark, and Mr. Chapman will excite our electric lamp, and I will ask you to look at the shadow caused by this little platinum wire on the screen. I trust that even the most distant young philosopher now sees that shadow. We will heat the platinum wire by an electric current, and you will observe two things. You see, first of all, that the platinum wire gets longer—swags, sinks down—when I heat it. Observe also the air rising up from the surface of the heated wire. That wave-like motion is due to currents of heated air rising from the wire. The air, when heated, rises in that way. The same is true of liquids; I have here a glass cell containing cold water, which will enable you to see this. I will place it in front of the lamp, and cast an image of it upon the screen. There is a means of warming this spiral of platinum wire within the water, and I want you to observe that the same thing occurs in water as you saw taking place with the air just now. Mr. Cottrell will now make the circuit for the electric current to pass; and then the moment the circuit is made you will find that the water will be heated by this spiral of platinum wire and the heated particles of water will rise to the surface of the liquid. There, on the screen, you see the action of the hot wire upon the water, causing the water to rise in these *striæ*. The water goes up from the heated surface, and in time the heated particles will distribute themselves through the entire mass of the water. I make this experiment in order to fix upon your minds the difference between this action and another which resembles it at first sight. The action which I have shown you receives the name of *convection*, which I should like the elder boys to remember, and I want you to distinguish between this and another process, which is a very different one, and which is called *conduction*. In order to illustrate this subject of conduction, I have placed here before you an iron bar and a copper bar (Fig. 6), and I want to ask them which conducts heat best. Mr. Cottrell will now light a lamp, and place it underneath the bars, so as to heat the ends of them at the same time; and as they become hot they will liberate these little balls, which are fixed on with wax; and I think you will find that the heat will travel along the copper better than along the iron. Here is a similar apparatus, with bits of tallow candle fixed to it. The greater the number of these pieces of candle that drop away from either bar, the further and better the heat has traveled through that body. This is almost a better experiment than the more elaborate one, and it is one which you can make at home for yourselves. The copper will be able to melt away all its candles, while the iron will not be able to do so. The whole philosophy of the clothes you wear is, that they are bad conductors of heat. Your bodies are sources of heat. Through the burning up of the food you eat, within your bodies, warmth is produced; and the object of the woolen clothes which you wear at the present cold season of the year, is simply to prevent the passage of heat from the body to the

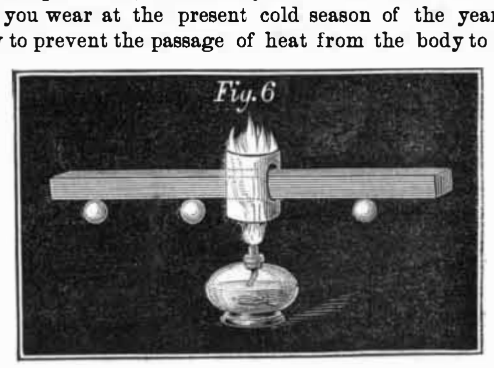
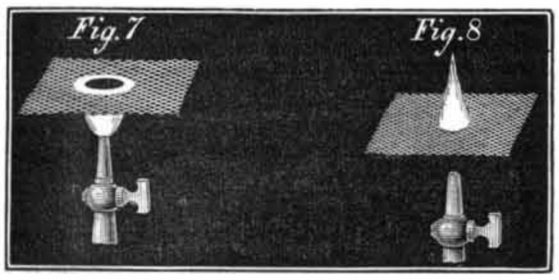


Fig. 6

air. For this reason we clothe the body with woolen cloth, that being one of the worst conductors of heat in nature. But the cloth has no warmth in itself; if I want to keep ice cool, as I did in a former lecture, I wrap my ice in flannel, which prevents the heat from without coming to the ice. Thus the woolen cloth simply prevents the transfer of heat in either direction, and hence the value of these non conductors as articles of clothing.

The experiment with the pieces of candle sufficiently illustrates the fact that different materials differ in their power of conducting heat. I might also show you this in another way. If I warm this piece of iron by putting it into warm water, and then place it upon a cylinder of glass which stands on the face of the thermo-electric pile, that glass does not allow the heat to pass through to the pile, and the needle still remains on the side of cold. It would be a long time before the heat of this iron passed through the glass and reached the face of the pile. I will now remove the glass and place a cylinder of copper on the face of the pile, and then put the warm iron on the copper. I suppose that not more than two or three seconds will elapse before the heat will pass by the conduction of the copper to the face of the pile, and the moment it does so you will see that the needle will come to the other side of the middle line, showing heat. Now, in this case, instead of having the heat transferred, as in liquids or gases, by the passage of hot masses through the remaining bulk, we have a transmission of heat from atom to atom of the copper; and this process, as I have said, is called *conduction* of heat, in contradistinction to the other process, which is called *convection*.

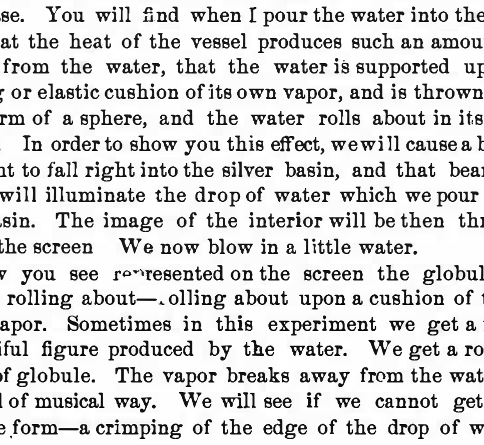
And now I have to go on to another subject of a somewhat different character; but in passing I must say a word upon a very useful piece of apparatus, the safety lamp, which, unfortunately, is not always wisely used. I will state the problem which the inventor of this simple, but very wonderful apparatus placed before him. You must know that in our coal mines the miners are prevented from using a candle to light them while at their work, in consequence of the quantity of gas which is in the air of the mines. In former times they used to employ a flint and steel, and work by the feeble light of the sparks. The problem which Sir Humphry Davy, the inventor of the safety lamp, set before him was this: "How can I give the miner light, and still preserve him from this explosive gas?" and he thought, "Can I put a light in any way within an apparatus so that, although the light shall shine through the apparatus, the gas outside will be prevented from exploding?" He found out that a flame could not pass through a piece of ordinary iron gauze. In fact, the flame is so much cooled by the wire gauze, in consequence of iron being a good conductor of heat and carrying the heat away from the flame, that the flame cannot get through. You see that when this iron gauze (Fig. 7) is placed over the



flame, the flame is entirely cut off, and cannot pass through; and if we light the gas above the gauze it will burn there, but the flame is prevented from reaching the gas below the gauze. (See Fig. 8). Now, Sir Humphry Davy, when he made the miner's safety lamp, surrounded the candle wick or the oil wick with a wire gauze; and, although the light can pass through the meshes of the gauze, you might have an explosive mixture within and without the lamp, but the flame inside could not propagate itself to the gas outside, being unable to pass through the gauze.

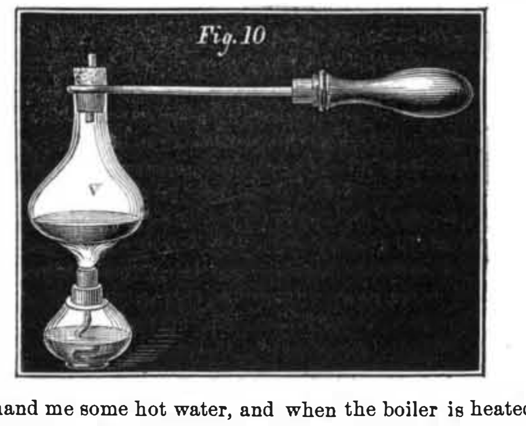
I come now to another subject, and a very interesting one. I will ask Mr. Cottrell to heat a silver crucible, or dish, almost to redness; and supposing I then pour water into it, what do you think will occur? You might at first say, "Well, the water will be converted into steam." That is not quite the case. You will find when I pour the water into the vessel that the heat of the vessel produces such an amount of vapor from the water, that the water is supported upon a spring or elastic cushion of its own vapor, and is thrown into the form of a sphere, and the water rolls about in its own vapor. In order to show you this effect, we will cause a beam of light to fall right into the silver basin, and that beam of light will illuminate the drop of water which we pour into the basin. The image of the interior will be then thrown upon the screen We now blow in a little water.

Now you see represented on the screen the globules of water rolling about—rolling about upon a cushion of their own vapor. Sometimes in this experiment we get a most beautiful figure produced by the water. We get a rosette form of globule. The vapor breaks away from the water in a kind of musical way. We will see if we cannot get the rosette form—a crimping of the edge of the drop of water.



[After a few seconds the rosette form occurred. See Fig. 9]. When the basin is not very hot, at first these little crimpings arise, and then, when the vapor is not sufficiently strong to lift the water out of contact with the basin, the water will come into contact with the basin, and will suddenly boil. There it is. [At this moment the spherical form ceased, and the water boiled up and immediately disappeared with a hissing sound]

I must now send Mr. Cottrell down stairs to prepare something of very great interest and beauty; but as I do not know whether the experiment will succeed or not. I do not wish to raise your expectation. If, however, it succeeds, the experiment will be a very useful and a very important one. In the meantime I want to show you what may occur in consequence of this spheroidal condition of water on a hot surface. I have here a little copper boiler (Fig. 10). I will cork this boiler up, but I intend first of all to heat it very highly indeed, and then I will place a little drop of water into the boiler. I now heat the boiler, and Mr. Chapman



will hand me some hot water, and when the boiler is heated I will pour a little into it, and that water will roll about as a spheroid. Vapor will be given off, but being small in amount, while the water is rolling about it will escape through a small hole in the cork. I will then withdraw the boiler from the source of heat, and the drop of water will then come into contact with the hot boiler; steam will be generated, and I think that that steam will be sufficient to expel the cork into the atmosphere. [The experiment was performed with the result anticipated.] There you see the steam drives out the cork the moment the water becomes changed into vapor by contact with the hot surface of the boiler. In this way we may have very serious explosions, but that is a subject into which I cannot go at present.

I want now to make an experiment or two which shall illustrate the character of a certain substance with which I am now going to operate. I have had occasion to mention gases several times in these lectures. Now, gases and, in fact, the very air we breathe, are nothing more than the vapors of substances possessing very low boiling points. For instance, Mr. Faraday, to whom we are indebted for the very finest investigations upon this subject, succeeded in squeezing together the particles of the gas which is contained in this vessel, and forming it into a liquid; and there are other gases which have been liquefied by Mr. Faraday. One of them is a gas called carbonic acid, which we breathe out of our lungs. I want to generate a quantity of carbonic acid gas in this large round glass vessel. We have at the bottom of the vessel some bicarbonate of soda, and I have here an acid. If I pour the acid into the vessel it attacks the bicarbonate of soda, and we get this carbonic acid gas liberated. I dare say we shall presently have accumulated enough for our purpose. [After an interval]—Now let me see whether the gas which has been liberated has not the power of putting out a candle. This will show whether the gas exists in this vessel or not. [A lighted taper wa lowered into the vessel, and was immediately extinguished by the carbonic acid gas therein contained.] Yes: there is the gas. You see it is incompetent to support the combustion of the candle. The vessel is very nearly full. Now I will show you that this gas is very much heavier than ordinary air. I might ladle it out or dip it out in a bucket, and if I did so in front of the screen you would see it fall like water from a vessel, although under ordinary circumstances it is quite invisible. But I want to show you its heaviness by means of a soap bubble. I will blow a bubble from this clay pipe, and allow that bubble to fall upon this invisible gas. You will find that the bubble will float about upon the surface of the gas as if it were floating upon the surface of a visible liquid. [Successive soap bubbles were then produced, and on being detached from the tobacco pipe, were gently dropped on the surface of the carbonic acid gas, and while floating there, were illuminated with electric light.]

Let me now tell you what I have sent Mr. Cottrell to do. Down stairs in the laboratory we have two very strong iron bottles, and these two bottles are filled with this carbonic acid. The gas in those bottles has been liquefied, and at the present moment he is turning a cock and allowing the liquid carbonic acid to turn into gas. What I want you to understand is that when the liquid carbonic acid turns into vapor it generates enormous cold, just as our vapor of water did on its production, only the cold generated by the carbonic acid is far greater. The consequence is, that when this liquid is turned into a gas and generates this cold, a portion of the vapor is turned into snow, and we thus obtain carbonic acid snow. I am almost afraid to speak to you about this matter, lest we should fail to get this wonderful substance. If I do get it I intend to put it into this vessel and make a few experiments with it which will both delight and surprise you. If we get the solid carbonic acid we shall be able to freeze water and produce ice in a crucible when it is actually heated to redness. First of all the carbonic acid snow is itself very cold, but in order to make it still colder I pour a little ether upon it. This turns it into a paste; and this mixture of carbonic acid and ether gives us nearly the greatest cold which has ever yet been produced. If we put that paste of carbonic acid and ether into the hot crucible, what occurs? The carbonic acid and the ether evaporate, and they so evaporate as to produce a protecting coating of vapor of carbonic acid between the red hot crucible and the pasty mass within it. In point of fact the pasty mass does not touch the crucible at all. It remains intensely cold within the crucible. If we are successful in getting the solid ca bonic acid, I shall dip this small brass sphere containing water into the mixture of ether and carbonic acid in the hot crucible; and I have no doubt that the water will freeze and will burst the brass sphere, and we shall then be able to take from the red hot crucible a sphere of solid ice. Mr. Cottrell is a long time bringing the solid carbonic acid. I am afraid he is not successful. Allow me simply to walk down stairs and see that the matter is going on rightly. [The lecturer then went in quest of the carbonic acid. On returning to the theater he resumed as follows]—I am sorry to say that my worst anticipations have been realized. The experiment below has has not succeeded. Here, however, is a little of this wonderful carbonic acid snow—solid carbonic acid. I will put a little in my mouth, and breathe against a candle. If I inhaled it I should kill myself; but I do not intend to inhale it. I intend simply to *exhale*. [The candle flame was then extinguished by the gas exhaled from the lecturer's mouth.]

TURNING A MOVABLE WHEEL AROUND A FIXED WHEEL.

"How many revolutions on its own axis will a movable wheel make in rolling once around a fixed wheel of the same diameter?"

This discussion continues with unabated interest and we are in receipt of a great variety of additional communications, with models and curious diagrams. Examination of the subject leads to study of the laws of motion, which becomes more interesting the further it is carried and is undoubtedly of benefit to the participants.

The two revolution philosophers may rejoice in the accession to their cause of Dr. Vander Weyde, late Professor of Mathematics and Chemistry, Gerard College, whose letter follows.

The editor of the Newburyport, Mass., *Daily Herald*, also appears as a two-revolution champion, and winds up a leading editorial as follows:—If the editor of the SCIENTIFIC AMERICAN "really needs any further light on the subject let him stand up face to face with another man of about his size—or a good looking woman—and revolve around him or her, and he will see that he will face the same side of the room *twice*, before he returns to his original position.

"The reason of the apparent discrepancy between a wheel revolving once to measure off its circumference on a plane and twice on a circle, is simply that in the latter case half of the motion is constantly wasted in space, so to speak, in getting round to the surface on which it is to revolve—' that's what's the matter.' "

Clear as mud that. If our cotemporary cannot do better the two-revolutionists will disown him. We would say to correspondents that we are always glad to hear f om them; but of course we cannot publish every letter. We shall however endeavor to give every side a representation, and if a direct reply is not always given, correspondents will find their answer in some parallel representative case.

We still adhere to "one" and the majority of our correspondents coincide with us. We however take pleasure in giving a full and fair hearing to those who say "two," and for this reason make perhaps the most numerous selections from their letters.

MESSRS. EDITORS:—Let us suppose fixed wheels of different diameters and the case will become clear. First, let the fixed wheel be very small, commence with one infinitely small, a point; then a movable wheel turning around a point will have made exactly one revolution around its own axis when it has returned to its first position, no matter where this point is situated, it may be near the axis or near the circumference, inside, or even far outside the wheel. In the same manner the moon makes one revolution around its own axis when it turns once around the center of the earth. (In regard to the earth the moon makes, of course, no revolution at all around its own axis but she does so in regard to sun, stars and the rest of the universe.)

But when a wheel rolls in the same time around another wheel the effect of this rolling is added to its own rotation; however small this fixed wheel may be the moving wheel will make more than one revolution around its own axis; the number of these revolutions will depend on the relative size of the movable and fixed wheels; so when the fixed wheel is half the size of the movable it will make one and one half revolutions; if the wheels are equal the movable will make two revolutions, if the fixed wheel is twice the size the movable will make three revolutions, if three times the size four revolutions, and, in short, the movable wheel will always make one revolution more than the number expressing how often the size of the movable wheel may be divided into that of the fixed wheel.

It is scarcely worth while to exhibit wood cuts to illustrate these truths. Let any one who is not clear on the subject make the wheels out of disks of cardboard and rotate them rolling one along the other; it will serve him at the same time for a mental, geometrical and mechanical exercise, taking for his model the figure, page 67 (which is perfctly correct and demonstrates clearly the two revolutions), and making the wheels of different relative diameters the above-mentioned number of revolutions will be found to take place when rolling one around the other. P. H. VANDER WEYDE, M D.

MESSRS. EDITORS:—I have just tried the experiment of a movable wheel revolving round a fixed wheel of the same diameter, and find it makes one revolution. I cut two wheels out of a thin piece of wood, made one fast, and f om a given point on each rolled one around the other and one revolution is all I could make. It is astonishing what an amount of figures have been indulged in to prove the contrary while by a simple experiment they might prove "one" to be correct.

Camden, N. J HENRY M. TEST.

MESSRS. EDITORS:—About the wheel question: I would like to ask L. M. how many times the arrow head points to