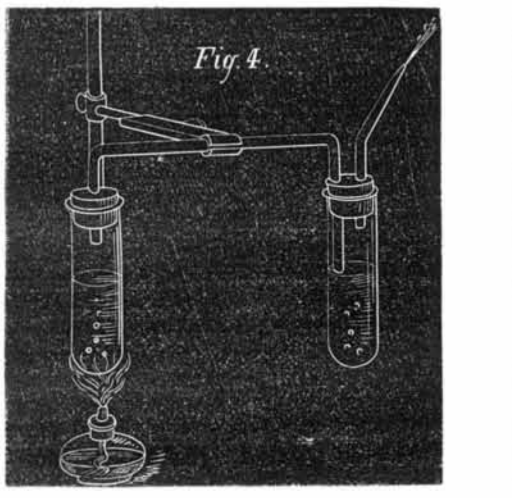
-hearers, that when ice freezes it is larger than the water from whence it comes, and that it cannot freeze without undergoing this change of bulk, which will burst almost anything.

Two cups were next made in the mold above described, and a piece of sealing wax being placed in one, the other was brought down upon it, so that their pieces met, when a momentary squeeze with the lecturer's hand joined them together into a hollow globe. Rings of ice, which had been molded before the lecture, were joined to form a chain; indeed, there is scarcely any limit to these experiments, if time would permit.

The effect of subjecting ice to strain and pressure, when below the melting point, was next demonstrated. This was done by crushing chilled ice in an iron mold; a series of loud cracks announced the rupture of the ice under these circumstances, and at the end it presented itself as a white powder, looking very much like rough salt.

You can now understand how a substance which so readily changes its form under pressure, and so readily re-unites itself when broken, can be forced through narrow gorges, and can accommodate itself to the bendings of the valley through which it moves. But there was another famous theory, which will lead me to say something about another property of ice. If you melt a quantity of ice, the water produced is not quite so big as the ice, and if you freeze water, the ice produced is somewhat bigger than the water; and as you have just now seen, the water swells in freezing, and the force with which it swells is enormous. It was this force that some eminent men thought to be the power which urged the glaciers continually downwards. But the glacier is not continually converting water into ice, as this theory supposes. This experiment leads me to think that you would like to see water frozen and a little bombshell burst in a red hot vessel. But you must first give me your attention while I explain the process.

Let us look at the still which, at the beginning of the lec-

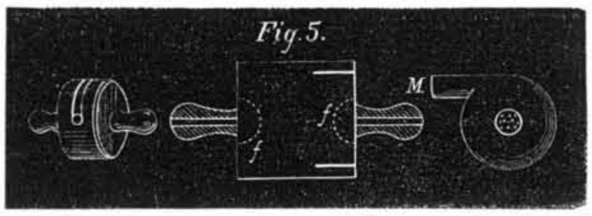


ture, I put in action. You see that in this space of time but a very small quantity of water has distilled; but look at the worm tub, and you see that a large quantity of water which was ice cold at starting has been made itself to steam—by what? By the heat which that small quantity of water contained when it was steam.

You can also boil water in one vessel by the steam generated in another, and thus actually measure the heating power of the steam. Two wide test tubes (Fig. 4), connected by a piece of quill tubing which, starting from the neck of one, goes to the bottom of the other, were about half filled with water; and a spirit lamp, placed under the first, in a short time created sufficient steam to pass into the second tube; but, however familiar the result, it was almost startling to see how very much more rapidly the second was made to boil, by the steam which was passed into it, than that had done which had been heated by the lamp, and also the minute increase in bulk of the liquid.

The rule is quite general that, when a liquid passes to the state of gas, heat is consumed, and if heat be not supplied, intense cold is produced. Ether poured on the hand produces an extreme feeling of coldness from the rapidity with which it evaporates. And the rule is just as general that when a solid is dissolved, heat is consumed and cold produced. This explains the coldness of the mixture of salt and pounded ice, or salt and snow—the salt causes the ice to melt, and thus produces great cold. Salts which dissolve with great rapidity produce a correspondingly great degree of cold. This has been taken advantage of by many persons who have invented different kinds of freezing machines. That which we have here is by Mr. Ash, and the ice which I turn out has been produced by the absorption of heat by liquefying certain saline substances, without the use of snow or ice.

We are now prepared for an experiment. There is a gas, which is a very heavy one, often found in brewers' vats, at the bottom of deep wells, etc., a poisonous gas; accidents happen sometimes by the men, who go into these vats to clean them out, not taking sufficient care to see that this gas is first removed. It extinguishes flame, and has many more remarkable qualities. This gas is carbonic acid; now when this gas is subjected to very great pressure, its particles are squeezed closer and closer together, until at length it becomes a liquid. In doing this, the gas gives off a great quantity of heat, the vessels and the pumps becoming very hot. This you understand from what you saw and were told in the earlier lectures. I have some of this liquid gas in this iron bottle. When the cock is turned on, what takes place? Some of the liquid is immediately turned into gas, and takes up, in so doing, exactly the amount of heat it lost in being converted into liquid carbonic acid; but this is done with exceedingly great rapidity. Where is the heat, that it requires, to come from? All the tubes and vessels through which the liberated gas passes become intensely cold, the air in the immediate neighborhood is robbed of all its moisture which falls as snow, but even the heat from these sources is not enough, and it gets the remainder from itself. The total amount of heat, required for part of the liberated gas, is got at the expense of another part, which loses so much heat that it becomes converted, not into the liquid but actually into the solid state.



Dr. Tyndall then allowed some of the gas to blow through a suitable vessel (Fig. 5) for retaining the solidified gas, and in a few minutes exhibited the carbonic acid snow in considerable quantity.

The recipient for the solid carbonic acid is an ingeniously constructed draw out box, the contrivance of M. Thilorier. It consists of a brass cylindrical case, having tubular handles affixed to its ends. Plates of pierced brass are fixed before the outlet of each handle as shown by *f f*; these act as sieves, to keep back the solid acid and allow the gas to pass out. The box has a short tube joined to the side, as in the sectional drawing, so as to form a tangent to the inner circle of the case, and opposite to this tube is placed a bent piece of brass, in order to prevent the violence of the inrushing gas from blowing the solid matter into such fine particles as would enable it to pass through the perforated disks. For the purpose of taking out the solid, the box is made separable, by one end sliding over the other, and retainable together by two obliquely grooved holders placed on opposite sides of the joint. When being used, the tangent tube fits over the nozzle of the gas bottle.

Following out the rule we laid down, if we liquefy this solid, or dissolve it rapidly, the reduction of temperature is now something beyond what can possibly be borne by living creatures. Faraday proved this temperature to be nearly 140° below the freezing point of water, and he made it lower still, by putting it under the receiver of an air pump and exhausting; the temperature thus obtained was 166° below zero, or 198° below the freezing point of water.

If I hold this test tube with the mixture of ether and carbonic acid in it in the electric beam, you can see, not only the hoar frost upon it brilliantly illuminated, but also that the cold in its neighborhood is sufficient to condense and refrigerate the moisture dissolved in the warm air of this room, and in consequence, a miniature fall of snow is produced.

It is plain that a sufficient degree of cold is produced by this mixture to freeze the water in our little glass bomb as we proposed, but how can this be done in a red hot vessel?

Leidenfrost observed that if a sheet of metal, such as this silver basin, is made very hot, and that then a drop of water is allowed to fall upon its surface, the liquid does not boil, but instead of wetting the surface as usual and fizzing off in steam, it rolls about in a lively way in a spheroidal shaped mass (Fig. 6). The reason of this is that the temperature of the basin is so high that it immediately converts any liquid that touches it into vapor, upon which the liquid rests as on a cushion; in fact, the water is lifted up from contact with the hot metal by a spring of its own vapor; so that you see the possibility, at any rate, of a very hot and a very cold substance being very near together, so near as apparently to be touching each other, and that, nevertheless, the distance between them may be sufficient for each to maintain approximately its own temperature.

A mixture of solid carbonic acid and ether was then placed in a red hot platinum crucible, fixed in a circular hole in a large plate, to avoid firing the ether vapor by the flame of the lamp, and a glass tube, having a bulb filled with water at its end, was used to stir about the freezing mixture; in a few minutes a solid lump of ice was produced as it were from the center of a fiery furnace.

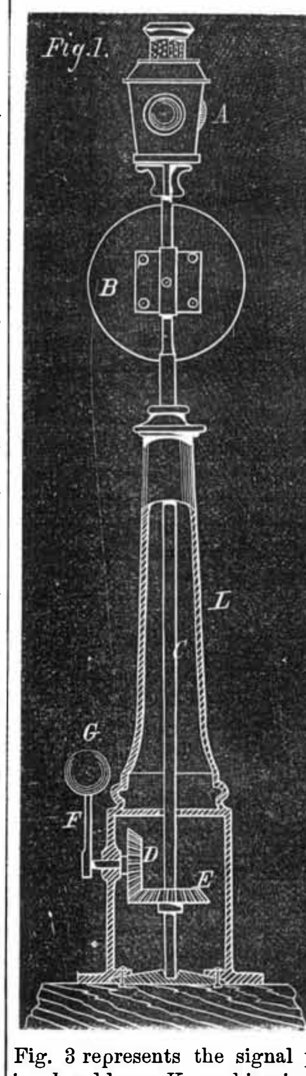
Some of the peculiarities attending cleavage were then touched upon. The little atomic bricks which form crystals often arrange themselves in layers which are perfectly parallel to each other, and which can be separated by mechanical means. Rock salt can thus be cut up into layers, and these layers may again be divided in certain other definite directions. There are, however, other phenomena to which the term cleavage is applied, and in some of these the cleavage only takes place in one direction. Sandstone cleaves in planes parallel to its bedding lines. Among the substances capable of cleavage, slate ranks very high; the blocks in which it is quarried cleave with the utmost facility into thin laminæ, which can be split up again almost indefinitely if the instruments be fine enough. Many theories explaining this peculiarity of slate have been promulgated, but at last it was found that the lamination of the mass was produced by pressure, and that these planes of cleavage were invariably at right angles to the direction of the pressure.

The flattening out of fossils in the slate forms an additional proof of the correctness of the conclusion. Some specimens were exhibited, showing the distortion of trilobites and shells.

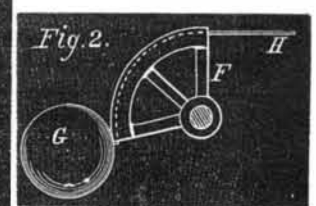
The same cause, which produces the cleavage planes of slate rock, also produces the veined structure of the glaciers. The ice of the higher regions is whitish, through the diffusion of small air bubbles within it. At the sides of the glaciers and at the bottoms of cascades, this ice is sometimes subjected to enormous pressure. It yields laterally as the slate mud has yielded, and a laminated structure is the consequence. On the surface of the glacier, under the medial moraines, and on the sides of the crevasses, the lamination reveals itself as clear blue veins or streaks drawn through the whiter ice.

NEW DEVICE FOR RAILWAY SIGNALS.

Our engraving illustrates a new form of railway signal which is now being introduced along the line of the New York Central and Hudson River Railroad.



In Fig. 1, A—the lamp in which bull's eye lenses of white and red glass are arranged—and B—the target—are attached to the rod, C, which passes through the ornamental iron post, L. The rod is arranged so as to be easily revolved by the action of the miter wheels, D and E. To the wheel, D, by means of a rod passing through the post, the lever, F, is attached, at the end of one arm of which is a solid weight, G. The form and arrangement of the lever and weight are shown in Fig. 2.



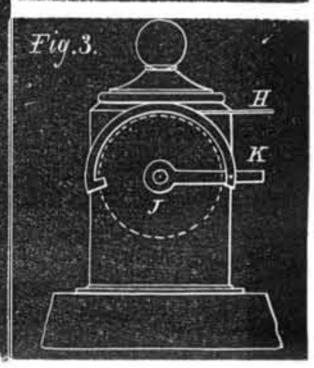


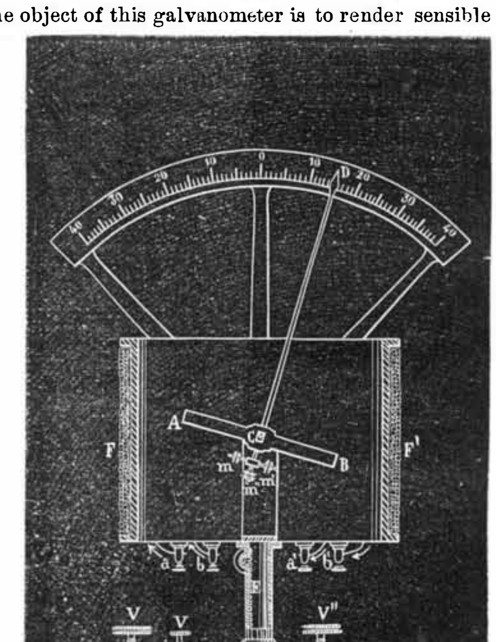
Fig. 3 represents the signal post, on the exterior of which is a hand lever, K, working in a semicircular guide and turning the sheave, J, within the post. To the circumference of this sheave, the wire, H, is fastened, passing therefrom over other sheaves for a distance of from 1,000 to 2,000 feet, until it reaches the lever, described on Fig. 1, to which it is attached, as shown on Fig. 2.

By raising the hand lever, K, the sheave is turned, and the force communicated to the wire raises the lever, F, and weight, G, which, by the action of the miter wheels, revolve the rod, C. By this means, the red or danger side of the target and the red light are displayed. On returning the lever, K, to its former position, the wire is loosened, and the weight, G, falls, turning back the lamp and target.

The apparatus was devised by Mr. J. M. Toucey, the superintendent of the road, and is now in successful operation at many points along the route.

VERTICAL BALANCE GALVANOMETER.

The object of this galvanometer is to render sensible to a



large audience the existence of weak as well as strong currents of electricity, without the necessity of employing any expensive or cumbersome accessories, such as a lantern to project a magnified image of the galvanometer needle and scale on a screen, in order to render the deflections more evident.

The chief part of this apparatus is a balance beam, A B, of magnetised steel poised on knife edges, as in a common weighing balance. At right angles to this beam is fixed a long pointer, D, the point of which can be adjusted at zero by means of two thumb screw weights m, m^1. The sensibility to motion of the beam can be rendered greater or less by screwing up or down the weight m^2.

The magnetized beam is placed in the center of a bobbin ring, F F^1, of dimensions sufficiently large to render the action of the current on the beam practically the same at whatever angle the beam may have turned through. The sensibility of this instrument will be seen when it is mentioned that the current produced by merely bringing the hand near a thermopile will give a very large deflection. The beam of the instrument can be removed and remagnetized with great facility if its polarity by any means becomes destroyed or reversed. It is necessary, in setting up the instrument, to place it in such a position that the vertical plane passing through the beam may cut the magnetic meridian. It is sufficient if the part of this plane which contains the south pole of the beam makes, with the south pole of the dipping needle, a less angle than 90°.—*Mechanic's Magazine.*

Telegraphy without Insulation.

Mr. H. Highton recently read a paper on this subject at the meeting of the Society of Arts in London. He showed by experiment that water itself is for electricity of low tension so perfect an insulator, that a long wire on a plate of copper charged with electricity of low tension will retain the charge even for hours; indeed quite as obstinately as the glass of a Leyden jar retains a charge of high tension. The instrument he proposed to use for submarine telegraphy is a light slip of gold leaf, weighing from one 500th to one 2000th part of a grain, acted on by a powerful electric magnet, and with its motions optically magnified. The delicacy of this is so great that simply looking at a thermopile will transmit a visible signal through the resistance of the Atlantic cable, and a kiss or grasp of the hand a very strong signal. So that a modern Pyramus and Thisbe might exchange salutations not through a hole in the wall, but through the breadth of all the waves of the Atlantic. The use of this instrument gives an opportunity of using electricity of the very lowest tension which, besides its other advantages, has a much less tendency to escape by faults in the wire. It was shown that a fault which caused the disappearance of all visible signals through Thomson's speaking galvanometer, with a resistance of 500 units, or about 125 miles of the Atlantic cable, would still allow intelligible signals to be transmitted on this instrument with 10,000 units, or 2,500 miles of resistance. The other advantages were the absence of all swing, such as there is in a needle, and an instantaneous movement, in spite of electrostatic induction. Where it requires two or three seconds for the wire to accumulate sufficient charge, to overcome the initial friction in any instrument where there is any friction, however slight, it moves at intervals of seconds by jumps, but the gold leaf, having no friction, begins to move instantaneously and proceeds by an equable motion. Again, where increased sensitiveness is required, the only thing necessary is to increase the force of the electro magnet at the receiving end. The conclusion the author drew from his experiments was that, instead of the hundreds of thousands of units of insulation of the present cables, it would be quite feasible to work through a cable having only a single unit of insulation; or if greater insulation were desirable, a wire might be used presenting much more resistance to the currents, such as a steel wire, possessing more strength and cheaper than copper, and that electrostatic induction being less injurious, much cheaper, with less gutta percha, cables might be used costing some fifth or sixth of the present prices, and that thus telegraphy might be made much cheaper and more available for hundreds of thousands of poor emigrants, instead of being the luxury of rich merchants, or speculators, or government officials. £50 a mile ought to provide a wire, sufficient for all purposes, of any required length.

Vitrified Marble.

The material itself results from the admixture, and melting together in a furnace, of equal parts of certain vitreous and silicious substances in about equal proportions, to which are added, at a suitable stage and in the requisite quantities, such coloring materials as will produce the desired effects, either as a plain body color equally diffused throughout the mass, or in veins of one or more colors with or without ground. When in a semi-fluid state, while yet hot, small or large masses of this plastic matter are cut off and pressed into iron or steel molds carefully formed to the desired shape. In this manner decorative objects of any size, shape, or appearance can be produced with the utmost facility and rapidity of execution.

The manner in which natural materials of all kinds can be imitatively reproduced is extraordinary; ordinary marbles, veined and other, porphyry and malachite, jade, lapis lazuli, etc., thus prepared are, if anything, more real than the genuine objects themselves, and have the advantage of being in forms that could only be obtained out of the originals with great labor, waste, and cost. They can also be obtained and applied in bulk and solid masses, as for vases paper weights, inkstands, table tops, etc., or in minuter portions, such as pateræ and tesseræ, or amorphous pieces for mosaic work in every variety, suitable for dadoes, pavements, etc. For the latter purpose, the vitrified marble paving possesses an important advantage over marble and encaustic tiles, in relation to the surface, which is rougher and more safe and pleasant to tread upon, giving good foothold and equable wear, while lending itself to every pattern, regular or the reverse. And it is not only in respect of mere surface patterns, but also of raised designs and molded forms of every species, that this material is susceptible of adaptation. Indeed, the sharpness of definition and accuracy of detail, of which it admits, are alike noteworthy.

It cannot, moreover, be said of this invention, as of so many others, that the fairness of its promise in conception is marred or belied in practical application. On the contrary, it is sufficient to say that the most eminent architects of the day have given their testimony, in evidence of its merits, by adopting it in leading works, which are alike monuments of their skill and of national objects. Mr. G. Gilbert Scott, for example, has made use of it largely in the bosses and gems for the decorative work of the Royal Albert Memorial in Hyde Park; and nearly 2,000 of these ornaments have been introduced therein, studding and decorating the work with equal brilliancy and effect. Jesse Rust, of 15 Coleman street E. C., London, England, is the patentee of the above material.

Correspondence.

The Editors are not responsible for the opinions expressed by their Correspondents.

Petroleum and Coal.

To the Editor of the Scientific American:

I find, in your paper of May 25th, an article copied from the *Petroleum Monthly*, in which the statement is made that no coal beds, capable of being worked, are to be found within fifty miles of the oil producing territory. This, to the oil men of West Virginia, is indeed a startling assertion, as we obtain all our fuel from the same hills on which the wells are located; and, within the present month, an instance occurred wherein a party engaged in boring struck, as they supposed, a crevice of five feet, and knew no better until a miner came up and informed them that their auger had come through and, barely missing the mule, had disabled their car by falling through it; in another instance, a well, deserted as non-paying prior to the introduction of torpedoes, was leased by other parties; and in attempting to tube it, the hole was found obstructed and a man was sent into the coal bank about 100 feet below; and it was found covered with a pile of slates. In both these cases, the vein was about five feet thick and of a very good quality of bituminous coal. All the wells located on the hills pass through at least one vein of coal, and most of them through two veins; in some cases these amount in all to nine feet in thickness. It seems incredible that any one should undertake to write on a subject in which he is so lost as to assert that "in boring for oil, no coal has ever been found even in the smallest quantities." Again, the writer asserts that there is no evidence that petroleum is not derived from bituminous coal by distillation. If such were the case, could we not reasonably expect to find at least a trace of petroleum in the rocks adjacent to the coal? But the facts are that at least one hundred feet of strata intervene before we reach the first rock in the least impregnated with petroleum. Nor do we have any reason to believe that it is derived from the limestone, as we have the best authority that limestone under high pressure does not part with its carbon on being heated, no matter how intense the heat; and we do not find the oil in the limestone, but above it, in the sand rock. He admits, also, that carbon does enter into the composition of petroleum; but does hydrogen, to any extent, enter into the composition of coal or limestone? And if not, whence is derived the hydrogen to constitute the hydrocarbon? He then asserts that "petroleum is certainly a mineral oil," an assertion which the facts do not warrant, as geologists agree that oil is of vegetable origin. Again, as to the reproductive power of wells; if he will take into account the increased experience and facilities, added to the fact that, in all territory where surface water is not allowed to flood the wells, the salt water is becoming exhausted, and oil which was held back is allowed to flow down to the bed rock and reach the wells, also the fact that much of the oil is not in crevices but merely confined in the porous sand rock, and, as the cavities are emptied, it oozes out where it reaches the pump, he can readily account for this "reproductive power." I am not in the habit of catching folks on pin hooks, but when I see an article going the rounds of the scientific papers, so at variance with the plain facts of the case, I feel called upon to refute it, as my idea of science is that it is "truth demonstrated."

As one who has spent years in the oil regions and tried to arrive at the facts, I might say much that would at least have the merit of being scientifically correct, but I defer for the present, being firm in the conviction that enough has not been said to arrive at the "Origin of Petroleum," a knowledge of which would assist, as well in the location as in the working of the wells. G. W. S.

The Rubber Tip Pencil Case.

To the Editor of the Scientific American:

My attention having been called to-day to your editorial on the decision of Judge Benedict in case of the Rubber Tip Pencil Company *vs.* S. D. Hovey *et al.*, I desire to correct several errors therein contained. First, this case is wrongly reported both in your paper and the Patent Office *Official Gazette.* Judge Benedict declined to hear the above case, and it came before Judge Blatchford in April, who dismissed the bill with costs. The only case heard or decided by Judge Benedict was the case of the Rubber Tip Pencil Company *vs.* Howard, Sauger & Co., which was materially different from the case against Hovey, as it contained no question of estoppel and was decided nearly two months prior to Judge Blatchford's decision. Your most serious error, however, is in construing Judge Benedict's decision into an opinion that attaching rubber to a pencil for erasing purposes, for convenience, is not patentable; for the learned Judge says nothing which can possibly be construed into such an opinion. Blair did not claim to be the inventor of attaching rubber to pencils for erasing purposes, but only claimed to be the first inventor of a rubber cap or tube (or as Judge Benedict describes it, "a piece of rubber with a hole in it") which could be applied to a pencil. If Blair had contented himself with claiming rubber on a pencil, the result might have been different, but in claiming it broadly, off or on, he claims nipples and every style of rubber with a hole in.

As I fully agree with your views as to the patentability and importance of the invention of combining rubber with a pencil for convenience in erasing, and as I believe Judge Benedict has the same views, I deem it but justice to him to correct these errors, into which almost every casual reader of this decision has fallen. SAMUEL D. HOVEY,

President of Goodyear's Rubber Head Pencil Company, 205 Broadway, New York.

Novel Method of Indicating a Hot Journal.

To the Editor of the Scientific American:

My ingenious and able colleague, Dr. Mayer, has recently been experimenting, during the course of an interesting investigation, upon a number of substances which change color on raising their temperature and regain their original hue when cooled.

Iodide of mercury is one of these substances, and he suggests that if a bearing, to which access is difficult while machinery is in motion, or which, for other reasons, cannot be conveniently reached by the hand and its condition thus known be painted with iodide of mercury or some such material of changeable color, its darkening when the journal heats, may make it a valuable indicator. Its change—from bright red to black at about 70° C.—would attract attention from a considerable distance.

I have sent you this suggestion, as I have no doubt that it may prove very useful to some of the readers of the SCIENTIFIC AMERICAN. R. H. THURSTON.

Stevens' Institute of Technology, Department of Engineering, Hoboken, N. J.

Sea Sickness.

To the Editor of the Scientific American:

In your issue of May 18th, you have an article on sea sickness which attempts to give a philosophical explanation of the phenomenon, namely, pressure of blood upon the brain during the forward pitch of the vessel. Sickness from swinging is referred to the same cause. The proper position to lie on board a pitching vessel is given as being with the head toward the bows, etc. In all the cases referred to, the motion was either rising and falling, or gyrating.

I was a witness and a sufferer in a case of sea sickness, wherein the conditions were so different from all other cases I ever heard of that I thought them worth the consideration of those who wish to account for sea sickness, especially as I could not see how the above explanation could account for this case.

Some time ago, while riding in the cars between Cleveland and Columbus in Ohio, one side of the engine became disabled and all the work fell upon one cylinder. All went well enough till we came to an up grade, when the engine stopped with piston at the dead point. The engineer contrived to start again, but the motion, for every revolution of the drivers, was alternately fast and slow, being almost nothing at the dead point, *crescendo e diminnendo*. In a few minutes I began to feel sick, and as the train did not move faster than I could conveniently walk, I got out and kept along with it. I was soon joined by others who said they were sea sick, and I suppose that half the passengers in the car I was in felt the symptoms of sea sickness, which lasted as long as the irregular motion. Now this motion was straightforward, no pitching, rolling, swinging, or turning, and no position that could be assumed would avail against its unpleasantness. There was nothing about it to determine the blood to the head rather than anywhere else, as far as I see. I submit the case to those whose business it is to explain it. A. E. DOLBEAR.

ANOMALOUS SPECTRA.—A recent number of Poggendorff's *Annalen* contains a short but interesting paper by Christiansen of Copenhagen, in which he states that a hollow prism filled with the alcoholic solution of fuchsin produces a highly anomalous spectrum, which, instead of proceeding regularly from the red to the violet, like the ordinary solar spectrum, stops at a certain point, returns backward, then stops again, and resumes a direct course to the end. Kundt finds that anomalous spectra are given by all the anilin colors, and by permanganate of potash. Such spectra generally turn back upon themselves, having the green at one extremity, the blue being situated between the green and the red.

PUBLIC CLOCK REGULATORS AT PARIS.—In the various squares and public places of Paris, instruments are being put up for the regulation of clocks and time pieces. This little invention of M. Detouche, the well known clockmaker, called the equatorial quadrant, appears to be a complete epitome of practical astronomy, as by it the true mean solar time can readily be determined anywhere, on the spot. M. Detouche has supplied numerous models of his invention, adapted for a variety of situations, and the little instrument is said to be coming into very general use.