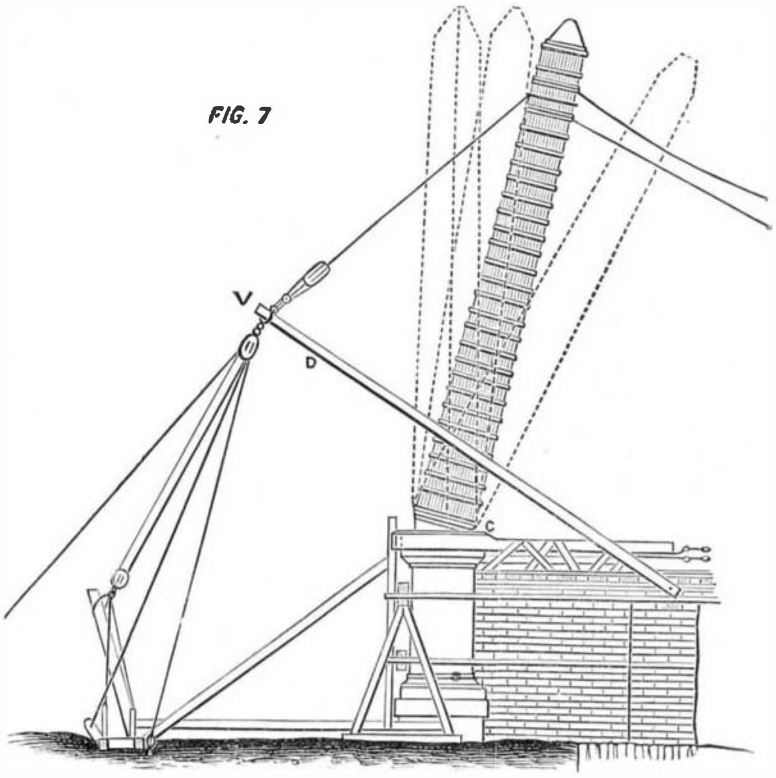
RAISING OBELISKS.

Now that New York is to possess an obelisk, it will soon become a question among engineers as to the best means of transporting and erecting the great mass of stone after it is landed at our docks. The most instructive examples of this class of work with which we are acquainted are supplied by the raising of the great obelisk in front of St. Peter's at Rome, by Domenico Fontana, and the putting in place of the Luxor obelisk in Paris. Both operations are thus described by Cresy:

The St. Peter's monolith was estimated to weigh 993,537 lbs.; the height is 180 palms, but without the apex, 77·2 English feet; the transverse section at the middle contains an area of 7·6 superficial feet; the solid content may, therefore, be taken at upwards of 166 cubic yards, weighing about 332 tons; if to this be added 4 tons for the weight of the apex, the whole weight of the obelisk raised is upwards of 336 tons. The length of each of the sides at bottom is 12¼ palms, and at top 8½ palms, the palm being equal to 2·7 English inches. Forty-six cranes, 600 men, and 140 horses were employed in removing it, and the timber, ropes, and iron made use of cost 20,000 crowns. The operations for removing it, which were conducted with the greatest skill, were as follows: A scaffold, called a castellum or shears. Fig. 1, was first constructed, 7 feet higher than the top of the obelisk when mounted on the pedestal. The eight principal timbers, four on each side, were 89 feet in height from the foundation; they were each built of oak and walnut, four beams in thickness, and banded at every 9 feet with strong iron hoops, and bolted together in several parts. The whole was so arranged that it could be easily put up or taken down, to suit the several positions in which the obelisks might be placed. Where this castellum was to be used, four holes 3 feet square were prepared in a platform of travertine stone, into which the four posts were dropped or secured. The obelisk was cased over with double mats to protect it from injury; was then covered with 2 inch planks, and longitudinal iron bars, 4 inches in breadth, were attached to it, three on each of the four sides: these, connected together by nine iron hoops, served to attach the tackle. This coating of mat, wood, and iron was estimated to weigh as much as one twelfth of the obelisk. Thus entirely covered the obelisk was lifted from the pedestal on which it stood by means of capstans and blocks attached to the iron hoops, and the blocks hanging to the cross beams of the shears; after it was lifted up 2 feet perpendicularly, a platform of timber was introduced beneath it, which rested on wooden rollers 9 inches in diameter, their ends being secured by iron hoops. The ropes of the blocks attached to the four lower angles of the obelisk being drawn, the platform which supported the weight moved on the rollers, and the ropes of the blocks attached to the upper part of the obelisk being slackened, the obelisk gradually descended, and was laid horizontally on the platform prepared to receive it; during its descent it was found necessary to support it in the middle by two shores, Fig. 5, made movable on an axis attached to its center, and which prevented any very great strain on the tackle. The inclined plane along which it was moved to its destination was formed of a mound of earth strengthened with timbers, and extended from the Circus of Caligula, afterwards called that of Nero, to the position where the obelisk now stands. Its former site is still marked by a stone in the passage leading from the sacristy to the choir of St. Peter's. After the obelisk had been moved along this plane upon wooden rollers, Fig. 6, the forty-six capstans placed round the mound of earth were prepared for their work of raising; they were fixed in the ground on each side, and each had four arms or handspikes; the first and third arms were worked by a horse, and the other two each by from six to ten men; four of the capstans acting upon as many blocks were used for drawing the foot of the obelisk forward, one block to each angle; the other capstans were employed to raise the obelisk into a vertical position. The whole operation is amply described in a work compiled by Fontana, and in which are engravings of the entire machinery. The foundations prepared to receive this enormous weight were carefully executed. An excavation 43 feet square, and to the depth of 24 feet, was made, and the bottom being found a clay, it was piled entirely over with oak and chestnut, with piles 18 feet in length and 9 inches in diameter, the bark being previously removed from them; upon these was laid a bed of concrete, composed of basalt broken into small fragments, and mortar composed of lime and puzzolana. The total cost of the entire removal was about $45,000. The arrangements are shown in the accompanying figures, 1, 2, 3, 4, 5, and 6, which we take from *The Engineer*.

FIG. 7



RAISING OBELISKS.

M. Lebas, an engineer of the Marine in France, was commissioned in 1831 to bring from Luxor, in Egypt, one of the granite obelisks, and raise it on a pedestal to ornament the city of Paris. It is 75 feet in height, containing about 3,000 cubic feet, and was estimated to weigh nearly 258 tons. The obelisk was cased with timber throughout its entire length; underneath its base, at the lower side, was placed a wooden roll or cylinder, C, Fig. 7, upon which the whole obelisk turned as upon a hinge during its movement; there were five stays on each side, formed of masts, one of which is shown at D; these were all united at their summit between two others laid at right angles with them, the whole being bound round with ropes. The ten masts rested on a level platform, and their ends being rounded, they worked in a hollow channel prepared to receive them, and together could be moved upwards or downwards, in the manner of a hinge, so that, when the ends at E were pulled down by the ropes of the windlass attached to them, the obelisk was advanced further into its perpendicular position; 480 artillerymen worked ten capstans, forty-eight being placed to each. Iron chains were placed around the top, and four others passed to capstans at the extremity of the inclined plane, for the purpose of holding the obelisk steady, and rendering its motion regular as it advanced. The whole of the operations were admirably conducted, and some improvements were adopted which we do not find made use of by Fontana; the application of the lever, D, is a decived advantage.

FIG 1

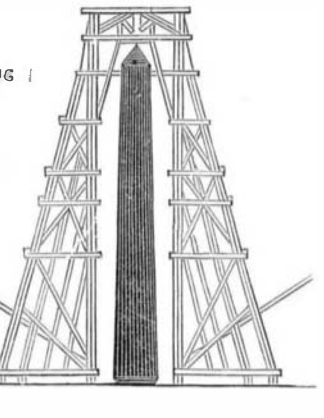


FIG. 3

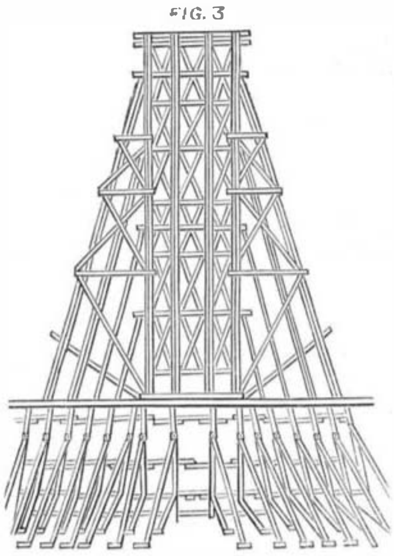


FIG. 4

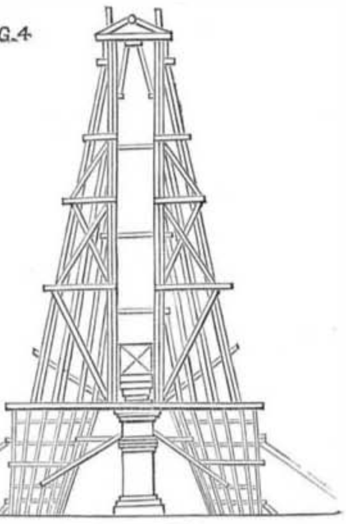


FIG. 2

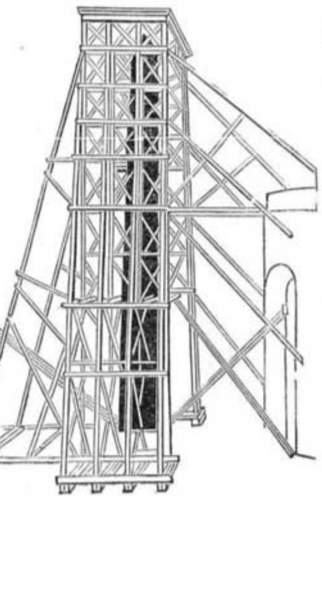


FIG. 6

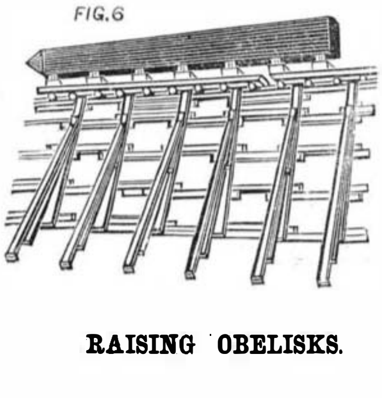
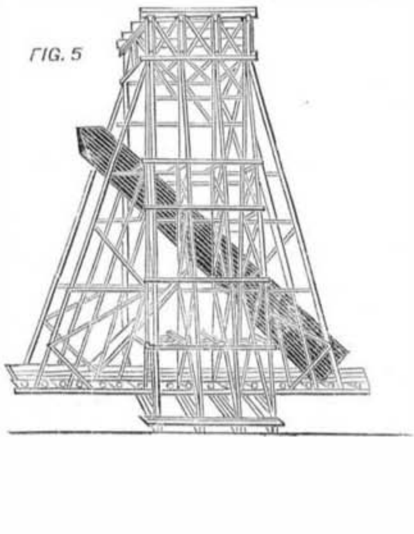


FIG. 5



RAISING OBELISKS.

* * *

The Cause of Putrefaction and Lactic Fermentation.

In delivering the recent inaugural address at King's College Medical School, Professor Lister adopted a novel course towards such an audience, and instead of occupying the time at his disposal with the usual recommendations to the students about to enter upon their medical curriculum, he preferred to treat of a special subject in the hope that he might be able to say something which should interest and possibly instruct his audience. The subject chosen by Professor Lister is one that has long been of deep interest to the cultivators of several branches of science, and his own efforts to make a practical application of the knowledge acquired by studying the phenomena of fermentation have given to that subject a wider significance than it had before.

The particular kinds of fermentation which were the subject matter of Professor Lister's address were those which take place in blood and in milk, the question to which his attention had been directed having regard to the cause of the change which takes place when either of these liquids is kept for some time in contact with the air. In the case of blood the fermentation which ensues under these conditions is of the kind termed putrefaction; in the case of milk it is characterized by the formation of lactic acid, and is consequently termed lactic fermentation. In the experiments by which Professor Lister sought to illustrate the nature of the changes which took place in these liquids, care was taken to collect both the blood and milk in such a manner as to exclude the access to them of living organisms. It is unnecessary here to enter upon a description of the precautions observed to attain this result, the important fact being that blood so collected had been kept for six weeks without undergoing putrefaction, and that the air in contact with it was quite sweet. From this observation Professor Lister inferred not only that blood has no inherent tendency to putrefy, but also that atmospheric oxygen is not capable of causing it to putrefy, as has been supposed. Some kind of action was exercised by the oxygen upon the blood, as was indicated by the change of color from that peculiar to venous blood to the crimson color of arterial blood, but it was not until the blood thus preserved had been touched with an extremely minute quantity of putrescent blood on the point of a needle that putrefaction commenced.

The result in this case was exactly parallel to that which takes place in alcoholic fermentation, and the inference is that putrefaction is in fact a kind of fermentation characterized, like the alcoholic fermentation, by the reproduction of the ferment by which the change is produced.

As is well known, there is a conflict of opinion on the point whether the bacteria, which are unquestionably constant concomitants of certain kinds of fermentation, are also the cause of the change or merely accidental. It was suggested by Professor Lister that one of the causes of doubt as to the influence of bacteria in causing fermentation is the extreme minuteness of the organisms.

With the object of investigating this question more fully, experiments were made with another form of fermentation, that of milk, which, on exposure - to the air, turns sour and curdles: the sugar it contains being converted into lactic acid. At the same time microscopic observation always reveals the presence of minute organisms of the nature of bacteria in the coagulated milk. By collecting a number of samples of milk in separate glass vessels, with suitable precautions to prevent the access of organisms, the milk in a few of the glasses was found, after some weeks, to be entirely free from change, destitute of any acid reaction; and under the microscope, no indications of the presence of bacteria were to be found.

The next step in the investigation was to find evidence to decide whether the particular bacterium found in sour milk was or was not the cause of the lactic fermentation. For this purpose, Professor Lister endeavored to estimate the number of bacteria in a given quantity of sour milk, by placing one fiftieth of a minim of the milk on a slide, and counting the number of bacteria in the field; then by diluting the milk to such an extent that a single drop of the liquid would probably contain, on the average, one bacterium, a liquid was obtained, with which a number of separate quantities of boiled milk were inoculated, by adding a single drop of the liquid. The result was that out of five glasses of milk treated in this way only one was curdled, and on examination the one was found to contain the *bacterium lactis*, while the four others, which did not curdle, had no bacteria in them.

In another series of experiments, five specimens of milk were each inoculated with a drop of the liquid, calculated to contain two bacteria; other five specimens were inoculated with drops calculated to contain one bacterium; another set of five open glasses were inoculated with drops calculated to contain one bacterium; and one with a drop calculated to contain four bacteria. The result was that the last specimen curdled in a few days, and all those calculated to have two bacteria curdled in a few days. Of the five glasses calculated to have one bacterium, three remained liquid. On opening one of these glasses the milk was found to be perfectly sweet; it had a slight flavor of suet, similar to that which Pasteur has described as resulting from the oxidation of the oleaginous constituent of milk.

The result of these experiments proves conclusively that the ferment which caused the curdling of the milk was not in solution but in the state of suspended particles, otherwise every drop of the inoculating liquid should have produced the same result. Again, the fact that some drops were destitute of the ferment proves in like manner that it was not in solution.—*Pharmaceutical Journal.*

The Ancestry of Insects.

In his new work on "Our Common Insects," Mr. A. S. Packard gives an excellent chapter under the above caption. He considers that the natural system is the genealogy of organized forms; and when we can trace the latter we establish the former; and he concludes that there is a strong genetic bond uniting the worms, insects and crustacea in one grand sub kingdom. Many of the most interesting facts pointed out by Mr. Packard are presented in condensed form below.

The lowest form of insect life is the parasitic mite, the highest is the hive bee. Between these two there is an ascending scale of being, a continuity of improving organizations, which affords strong arguments for the theory of evolution. The mite is called the pentastoma, and lives in the manner of the tape worm a parasitic life in the higher animals. It is found in the nostrils of dogs, sheep, and horses. It is a little higher than some worms but lower than others. Young mites when hatched have but three pairs of feet, while their parents have four. If these early stages of mites and myropods are compared with these of the true six-footed insects as the cicada, or dragon fly, it will be seen quite plainly that they all share a common form. By simple modifications of parts here and there, by the addition of wings and other organs in these simple creatures, Nature has rung numberless changes on the elemental form. Starting from the simplest kinds, such as the poduras, spiders, grasshoppers, and May flies, allied creatures which we know were the first to appear in the earlier geologic ages, we rise to the highest, the bees with their complex forms, their diversified economy and wonderful instincts. In this progress upwards the beetles are higher than the bugs and grasshoppers, and the butterflies and moths more highly organized than the flies. In the egg nearly all insects agree most strikingly in their mode of growth. The earlier stages of the germ of a bee, fly or beetle bear a remarkable resemblance to each other, and suggest that a common design or pattern at first pervades all. At a certain period in the life of the embryo, we notice that all agree in having the head large, and bearing from two to four pairs of mouth organs resembling the legs; the thorax is merged with the abdomen and the general form of the embryo is ovate. The first to discuss the subject of the ancestry of insects was Fritz Muller, who suggested that the larva of crabs, zoëa, was the common ancestor. Haeckel and Friedriech Brauer have partially sustained this idea. The latter declared his belief that, though it seemed premature after the discovery of highly organized winged insects in rocks so ancient as the Devonian, to even guess as to the ancestry of insects, yet he would suggest that, instead of being derived from some zoëa, "the ancestors of insects must have been worm-like and aquatic." Mr. Packard rejects the zoëa origin of insects, and says the only refuge is in the worms. But how to account for the transmutation of any worm into a form like the leptus, with its mandibulated mouth and jointed legs, seems at first well nigh impossible. We have the faintest possible indication in the structure of some mites, and of the tardigrades and petastoma, where there is a striking recurrence to a worm-like form, readily noticeable. In the demodex we see a tendency of the mite to assume, under peculiar circumstances, an elongated, worm-like form. The mouth-parts are aborted, while the eight legs are not jointed and form simple tubercles. In the tardigrades, a long step lower, we have unjointed fleshy legs armed with from two to four claws, but the mouth-parts are essentially mite in character. A decided worm feature is the fact that they are hermaphrodites, each individual having ovaries and spermaries, as is the case with many worms. When we come to the singular creatures of which pentastoma and linguatula are the type, we have the most striking approximation to the worms in external form. They lose the rudimentary jointed limbs, which some have well marked in the embryo, and from being oval, rudely mite-like in form, they elongate, and only the claws remain to indicate the original presence of true jointed legs.

Professor Ganin, a Russian naturalist, made some remarkable discoveries in regard to the early stages of the platygaster, a parasite on a gall fly. He established facts which bear strongly on the theory of evolution by "acceleration and retardation." In the history of many early larval stages we see a remarkable acceleration in the growth of the embryo. A simple sac of unorganized cells, with a half-made intestine, so to speak, is hatched, and made to perform the duty of an ordinary, quite highly organized larva. Even the formation of the "primitive band," usually the first indication of the germ, is postponed to a comparatively late period in larval life. The different anatomical systems appear at longer or shorter intervals, while in one genus the respiratory organs are not developed at all. Thus some portions of the animal are accelerated in their development more than others, while others are retarded and in some species certain organs not developed at all.

That the cylindrical form of the bee grub and caterpillar is the result of modification through descent is evident in the caterpillar-like form of the immature caddis fly. In like manner the caterpillar form is probably the result of the leaf-eating life of a primitive larva, and the soft-bodied maggot of the weevil is evidently the result of its living habitually in cavities in nuts and fruits. So the organs of special sense in insects are in most cases simply altered hairs, which are themselves modified epithelial cells.

NEW ARRANGEMENT OF THE AIR RESERVOIRS IN PUMPS.

The object of the air reservoir in pumps and hydraulic machines is to equalize the movement of the water and to deaden shocks. Its action will be more efficacious in proportion as (1) the head of water is low; (2) the movement slow; (3) the section of pipe and valves large; (4) it is itself large, and (5) as the mass of water is small. Given the pressure and dimensions of the pump in order that the reservoir may operate to best advantage, it is further necessary that it contain as much air as possible, that the water pipes be completely isolated, and that it be disposed as near as possible to the point where shocks and other disorders are most likely to occur. We illustrate herewith a new arrangement of air reservoir which we extract from *Dingler's Journal.* P is the section of the pump, V the valve box, *w* the reservoir of aspirated air, and *w'* that of compressed air. The dotted lines indicate the highest levels, full lines the minimum normal level. The entry pipes, *e e'*, are placed exactly above the maximum level, and escape pipes, *a a'*, are situated as low down as possible.

Fig. 1.

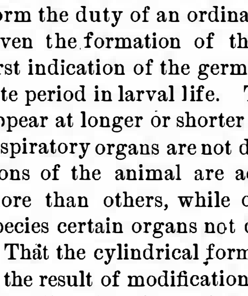
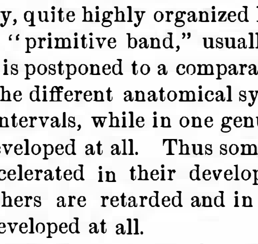


Fig. 2.



By this arrangement it is claimed that sudden shocks are impossible. Even if the valve, S, be opened suddenly, so as to allow of the escape of considerable water at once, the perturbation affects immediately only the small column of water comprised between the air reservoir and the escape orifice. The water in the tube remains as before, as it is only after the air pressure in the reservoir, K, is diminished that the flow progressively becomes more rapid.

The Melting Point.

The theory that iron in a cupola is melted all up through the stock is wrong, for every cupola has a certain point at which the iron is melted, and there is not a pound of iron melted in any cupola until it comes down to the melting point. The melting point in a cupola is generally from six to eighteen inches above the tuyeres, but it may be raised or lowered a little by increasing or diminishing the amount of fuel in the bed; but if we get the bed too high it throws the melting point too high, and the result will be slow melting. If we get the bed too low, it will allow the iron to get below the melting point, and the result will be dull iron; and in order to do good melting in any cupola, it is very essential that the melter should know the melting point of his particular cupola. The melting point of a cupola is at the point at which the most intense heat is created by the action of the blast upon the fuel. This intense heat at the melting point will cut the lining more than at any other place in the cupola, and the lining will generally be found to be cut out more just above the tuyeres than at any other point, which indicates the melting point of the cupola. If the tuyeres are put in so as to distribute the blast evenly through the stock, and the changes of iron and fuel are put in evenly, and every charge leveled up properly, the heat will be even all through the cupola, and the lining will be cut out in a regular belt at the melting point all around the cupola. On the other hand, if the tuyeres are not put in so as to distribute the blast evenly through the stock, or the charges of iron and fuel are not put in even and level, or if the fire is all on one side of the cupola, the heat will not be even through the cupola, and the lining will not be cut out in a regular belt at the melting point, but will be cut full of holes, which shows that the cupola is not melting all around, but is only melting in spots. By this irregular charging and melting in spots, the cupola may be reduced to half its melting capacity, which accounts for a cupola melting fast on one day and slow on another day. As before intimated, the melting point in a cupola is the point at which the most intense heat is created by the action of the blast upon the fuel. When the blast enters the cupola it is cold, and as it passes through the heated fuel it becomes hot, and as it becomes hot it creates heat by combination with the fuel, and makes an intense heat. If we have a very strong blast it will travel fast and will pass through the fuel rapidly, and it will have to pass through more fuel before it becomes heated sufficiently to make an intense heat by combination with the fuel. On the other hand, if we have a mild blast, the blast will pass through the heated fuel slowly, and is more heated, so that it does not have to pass through so much fuel before it becomes sufficiently heated to make an intense heat by combination with the fuel; so that when we have a strong blast the melting point of a cupola is higher than when we have a mild or weak blast; and the bed has to be put in higher in a cupola with a high melting point than in a cupola with a low melting point, which accounts for one cupola requiring more fuel in the bed than another cupola does. When the cupola is in blast, the bed or fuel in the bottom of the cupola is constantly burning up, and the unmelted iron will get down below the melting point. To prevent this, the melter has recourse to charges of fuel between the charges of iron, and as the charges of iron are melted and drawn out at the tap hole, the charges of fuel come down and replenish the bed and again raise the melting point; the next charge of iron comes down and is melted and drawn out; the bed is reduced and is again replenished by the next charge of fuel, and so on through the whole heat. If we supply too much or too little fuel between the charges of iron, the melting point will be raised too high or reduced too low, or in other words, if we have a melting point of ten or twelve inches in height in our cupola, and we supply twenty or twenty-five inches of fuel, this extra fuel must all be burned up before the iron can come down to the melting point; and we will not have a continuous melting, but will have a delay between each charge of iron. If, on the other hand, we have only five or six inches of fuel between the charges of iron, when we should have ten or twelve inches, this small amount will not more than half replenish the bed, and the unmelted iron will get down too low and will not make hot iron, and the iron may not be melted at all; and in order to do either fast or economical melting, we must not use either too much or too little fuel, and we must have the fuel distributed so as to suit the particular cupola in which it is used; for, as before explained, there are scarcely two cupolas that will melt exactly alike on account of the melting point being higher or lower, which is caused by a stronger or weaker blast, or by more or less draft; and in order to do good melting, the melter should not charge his cupola just the same as some other cupola of the same size is charged because that cupola does good melting charged in that way; but he should vary the height of the bed and the amount of fuel between the charges of iron, and the amount of iron on the bed and on each charge of fuel, until he finds the exact proportions that will do the best melting in that particular cupola.

Melters, in changing from one cupola to another, will generally have trouble in making hot iron, and they will often make a complete failure of melting in a strange cupola. This is simply because they undertake to charge that cupola the same as some other cupola that they have been melting in, and they never pay any attention to the draft, blast, or the melting point of the cupola, which is the cause of their failure in melting in a strange cupola. When a melter takes charge of a strange cupola, his first object should be to study the draft of the cupola, the nature of the blast, and to ascertain the melting point of the cupola. He can generally tell where the melting point is by noticing where the lining is cut out the most, and he can tell whether the cupola is melting evenly, or is only melting in spots, by noticing whether the lining is cut out in a regular belt all around the cupola, or is only cut out in holes, as before explained. He can tell whether the bed is too high or too low by noticing how the cupola melts. He can tell whether he is using too much fuel between the charges of iron, or if he is putting in the charges of iron too heavy, by noticing whether the cupola melts regularly or not, and by noticing if it