by the researches of Professor Karmarsch, of Hanover. An ironmaster in the vicinity of that town had sent to the professor some samples of such drops of lead lying imbedded in the surface of a cast-iron block, and which had been produced in the manner above described. Professor Karmarsch found, upon close examination, that these drops of lead, instead of being solid globules, as was supposed at first sight, were all hollow, forming bubbles composed of a metallic skin, and apparently empty in the center, so far as his observation has been carried. He explains the whole by supposing that the molten lead, at the temperature to which it is raised by the contact with liquid iron, forms an incipient vapor of lead, which is prevented from escaping by the skin of solidifying metal which forms on the top. The lead vapor, according to this explantion, keeps the lead resting upon the surface of the iron. It seems that in large quantities the result is different, since it is known that lead is occasionally tapped from the bottom of blast furnaces, which smelt certain classes of ores containing lead, and in these cases the lead is found below the liquid iron, according to its greater specific gravity. —*Engineering*.

CAUSES OF STEAM BOILER EXPLOSIONS. UNSAFE CHARACTER OF TUBULAR BOILERS.

A correspondent of the Lancaster (Pa.) *Express* writes to that paper as follows:

"I have read the published testimony taken before the coroner's jury, and have been waiting anxiously to hear something said in regard to the recent explosions and disasters on our western rivers. No person seems to know or to remember that the Atlantic and Mississippi Steamship Company lost six of the finest Mississippi steamers that floated on those waters, by explosion, last spring (1866), all of which blew up in succession within a space of about three months; that this company caused an investigation into the cause of these almost simultaneous explosions. I have not seen any official report of the company's investigating corp of engineers; but I have talked with some of their captains and engineers on the subject. I talked with the captain of the steamer *Missouri*, a few hours after it blew up, six miles above Evansville, Ind., on the Ohio river; I have conversed at different times with their engineers and others posted in the investigations, and I have learned that the following is the substance of their investigations; although I would recommend that the coroner make an effort to get an official copy of their report:

"'That the tubular boilers are condemned as an unsafe and dangerous arrangement. That the tubular boilers are made with a view to economy in the saving of fuel, which is the real cause of their introduction; but the damage done by explosion is in no way equaled by the economy, say nothing of the loss of life; that steam is the decomposition of water, by being brought in contact with heat; that steam, if brought in contact with fire, is itself converted into an explosive gas, which no known substance can confine. That it requires a certain and fixed quantity of water to a given amount and intensity of heat, and a certain capacity of fire surface to prevent such a heat on the steam in the boilers as to produce this explosive gas. That it is impossible for a sound boiler to explode from the mere pressure of steam. That when the heat becomes so intense as to produce explosive gas, the water in the boiler is inadequate to prevent the accumulation of gas. That mere steam will not explode a sound boiler; that when a boiler is pressed by heat beyond its capacity, explosive gas is generated. That tubular boilers have a larger amount of fire surface, proportioned to the quantity of water they contain, than any other boilers; the amount of heating surface is too great to insure safety. That if the water by accident, negligence, or by being drawn from one boiler to another, falls below one or more tier of tubing, and a hot current of flame passes through the upper tubes, the steam is rapidly converted into gas, and if an explosion does not follow, it is because the process of generating gas is arrested by increasing the water, or cooling down the fire before a quantity of gas is generated to make a breach in the iron. During the last year, upward of thirty explosions have taken place, which were spontaneous explosions, and all of them that were heard from were tubular boilers, and in the same time in the United States, every locomotive boiler which has exploded spontaneously, was of the tubular arrangement. Locomotives having only a single boiler, the theory that the water was drawn from one boiler into another, will not apply. But the theory is that the amount of fire surface aided by the powerful draft of a locomotive in motion, capable of converting steam into gas exceeding the power of water to prevent generating such gas, will cause an explosion on the same principle. That before the invention of the safety valve, boiler explosions were so numerous that steam power was denounced as a failure, prohibited in some countries, and the machines destroyed by mobs in some places. But after the invention of the safety valve, and as long as the small single tube, cylinder boilers were used, explosions were rare, and unaccountable explosions seldom known; most of them could be traced to some neglect, carelessness, ignorance, inattention, incapacity, drunkenness, or design on the part of those having charge of an engine.'

"The same causes which exploded boilers in the early age of steam explode them now, for nature is always the same; no law has changed. But here in America, on water and land, are a succession of explosions falling fast one upon another during a single year, with a destruction of property amounting to millions, and a loss of thousands of human lives, and in no instance has it been shown that any of the duties of the engineer were neglected, or any of the ordinary causes in any way were connected with these mysterious explosions.

"The question here arises, what is the cause? If no law of nature has changed, if the law of explosion is the same now that it was when the small, single tube, cylinder boilers were in use, for a third of a century, what is the cause of this recent accumulation of explosions? Manifestly if no change has taken place in nature, then the change must be in the changed construction of boilers.

"After the invention of the safety valve, the intelligent and cautious engineer trusted with confidence in the familiar sound of steam escaping from the safety valve to warn him of danger. But now the safety valve is unreliable. and even the water gage is treacherous. On the *Missouri*, which blew up in April, 1866, the engineer tried the water not five minutes before the explosion, and found it all right. All the ordinary means of guarding against explosions and assuring safety in the use of steam power, which for a quarter of a century or more were as reliable and safe as any means used to guard against accidents in the employment of any other dangerous and useful element have recently become uncertain, treacherous, and unreliable. Again we repeat the question, Why is this? and what is the cause?

"If we were to answer, we should say that mechanics, in the effort to construct a boiler to do the greatest amount of work with the least cost of fuel, have sacrificed safety to economy. When steam power was introduced the country abounded with wood, the best fuel for making steam; but as wood became scarce and high, fuel-saving machines were largely in demand. But no saving of fuel in generating steam can be accomplished except by increasing the fire surface in or around the boiler, with parallel flues through which a current of flame or heat passes several times over the water surface, thus retaining longer around the boiler the heat generated; while combustion is more perfect and the inflammable gas, the product of combustion, being longer retained within the reach of a flame, ignites and burns, where in a single flue it would pass unignited, without heating, out of the chimney. Even smoke is inflammable gas, and if this gas is all ignited, no smoke, nothing but a current of heated air would pass through the chimney.

"This principle of saving fuel, and still generating the required amount of heat, has proved a grand success in this country in stoves and heating furnaces. But it has proved a success in the generating of heat only, and not in generating steam.

"Boiler makers, when they applied this principle in generating steam, lost sight of the fact that when they increased the heating surface, the intensity and quantity of heat around a boiler, that they ought also to increase in an adequate proportion the quantity of water; instead of which, however, they have actually increased the power of the fiery element, and lessened the only power, water, capable of holding this fiery monster in subjection, which would be equivalent to running an ordinary one flue cylinder boiler on half water, with full heat.

"This, then, we conceive to be the true cause of the recent explosions in this country. Let it be understood by mechanics, that throughout all nature, in every element or living substance, organic or inorganic, a positive and a negative principle exists. That the positive is the active, moving, living power, while the negative is the passive power acted upon. That fire is a positive element, and water in a boiler becomes its negative, but when the water becomes sufficiently decomposed, a new element is created, which is a positive principle, and the atmosphere is its negative, and the attraction of this negative (the atmosphere) for the positive principle in the boiler when it becomes positive by decomposition of water, is so great, that no substance can hold it from escaping. The atmosphere cannot go into the boiler; if it could there would be no explosion, so the contents of the boiler seek the atmosphere.

"Hence it follows that there is always safety in the use of steam, provided that that only element of safety, *water*, shall exceed the heating power, *fire*, so as always to predominate, and that no fire shall pass over a steam surface to decompose the steam and convert it into explosive gas, which means a positive element whose negative is the atmosphere. Now, these tubular boilers of present construction contain too great an amount of heating surface, and too small a quantity of water, which is the first objection. That the water is liable to pass below the flues and the heat to pass through the steam instead of through the water, thus rarifying the steam and increasing its elasticity, is another and very serious objection. It is believed from various experiences, that boilers constructed of the same thickness of metal, one foot instead of four in diameter, will exceed the large boiler in resisting power fifty per cent. From the investigations of the Mississippi and Atlantic Steamship Company, I deduce the following conclusions: That the present arrangement of tubular boilers affords too great an amount of heating surface for their capacity for water; that by accident or neglect the water is liable to sink below the upper tier of tube flues, in which case the flues become hotter than they would if covered with water, and decompose or rarify the steam creating, if the tubes get hot enough and continue long enough out of water, and an explosive power, not steam, that iron is unable to confine. It is impossible to avoid explosions while the fire may, by accident or neglect, or by emptying one boiler into another, reach the steam surface, and rarify the steam.

"In making boilers, the engineer should enter into a mathematical calculation, ascertaining by experiment on a small scale the quantity of water to a given amount of heating surface, and intensity of heat necessary to prevent explosion; then when heating surface is increased by any arrangement of parallel flues, let the capacity for water be increased in a corresponding ratio. Let the boiler be so arranged as to render it absolutely impossible for the fire surface to reach the steam surface. With such an arrangement, with the steam gage, the water cock and safety valve, with sound and well-constructed boilers, with proper care and attention, it is the opinion of some of the most intelligent and best educated engineers in America, that there need be no explosions, at least spontaneous explosions.

No ship-builder on southwestern rivers will touch a tubular boiler any more, and insurance companies charge higher rates for insuring boats containing them. The object aimed at in tubular boilers being economy in fuel, and retention of heat around the boiler, need not be abandoned. I saw in the West a set of boilers, six in number, placed upright, twelve inches in diameter, and ten feet high, placed three on either side of a hollow fire chamber. The fire was allowed to pass to the hight of low water in the boilers, then down and under and up on the opposite side of the boilers, to the hight of low water, and out into the chimney flue. Through the hollow casing, around the fire chamber, a current of cold air was admitted at the bottom, and passing to the rear, and up into a jacket around the upper portion of the boilers, and then into the chimney. The object of the current of cold air is to prevent the destruction of the casing around the fire, and to keep the cold air from the boilers. There was no connection between the boilers by which steam or water could pass from one boiler to another; each boiler was supplied with water through a separate pipe. This arrangement has been in operation for two years, and the owner said he could make three times as much power with the same quantity of fuel as with his old style boilers. Abating something for zeal and confidence in one's own invention, I considered his machine a very economical one He told me he had no patent; if the world wanted it, let them have it.

In 1853, when the question of saving fuel in making steam was being experimented upon, the chief engineer of the Collins' Steamship Line, in a conversation with me, remarked, "If they increase the heating surface and power without a corresponding increase of water, they will blow their machines to the *devil*." He was a rough-spoken Englishman, about fifty, and had helped to build the first locomotive ever made in England."

[The tubular boiler in this section is deemed as safe, if not safer, than any other. The cause of its failure on the Western waters is, that the tubes fill with mud so solid that water cannot touch them; hence they burn, collapse, and play other inconvenient and uncomfortable tricks.—Eds.]

Correspondence.

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

The Acceleration o Shot.

Messrs. Editors:—In your paper (Sept. 14th), Seth Boyden refers to a mode of starting shot from a fowling piece, by having a long, narrow chamber in the breech of the gun, and lighting the powder in this chamber at the top, next to the shot, and remarks that he thinks for an accelerating cannon this mode would be preferable to having the powder chambers along the bore of the gun.

I tried the long narrow chambers as accelerators for a cannon eleven years ago. The bore of the cannon was 2½ inches diameter; the two chambers of steel each 1½ inches diameter and 30 inches deep. They were a complete failure.

Suppose the bore of the gun is six inches in diameter and the narrow chamber 3 inches, it must be four feet deep to hold as much powder as would fill the bore of the gun one foot deep, which is less than the Whitworth gun uses safely. If we fire this charge at the top, it will burn down perhaps two feet, and ram the rest of the column into a cake as solid as any rocket is packed and into which the fire can not enter. It burns only on its end, and most of it after the shot has left the gun. It will be found that instead of burning six or eight times as much powder as a Whitworth gun of the same bore and giving six or eight times as much power, it has not given half so much power.

If to overcome the difficulty of the packing of the powder, he leaves a space filled with air only, at the breech, or makes his cartridge with a hole down its center, and puts a string of gun cotton through it, as I finally did, I think he will blow his long narrow steel chambers to fiinders, as I did with the first shot I tried in that manner.

If Mr. B. will increase the length of the long, narrow chamber which he uses with his shot gun, from two to three inches, which is probably its present depth, till it will hold enough to fill the bore of the gun one foot, he will probably find his chamber several feet in length. He will certainly find that the narrower his chamber the less will be his penetration. Now if he tries a steel shot on a wrought-iron target, he may throw his shot through one quarter inch, possibly through three eighths of an inch, but never through one sixteenth as much iron as can be penetrated, or one eighth as much as has been penetrated by a shot from a barrel of half-inch bore with accelerators placed under it.

H. S. Whitfield also in the same number says he "has concluded that this thing of acceleration could be accomplished in another way much more simple and quite as effective by a cartridge with partitions, each partition containing a full charge of powder, and so divided that when fired from the front they will explode in succession." If this cartridge is made of the strongest metal, and so heavy that the valves wil not give way backward from the explosion of the first charge, it would require a cartridge ten or twelve feet long to hold sufficient powder to fill the bore of a six-inch cannon even four feet deep. The accelerator 18 feet long must then be increased to 28 or 30 feet long. But the valves would probably leak and all the charges be lighted at once and his gun blown to fragments. If it did not, this long, heavy cartridge would

be so swedged in that it would not be removed the same day the gun was fired.

The objections most frequently urged against the accelerators under the bore of the cannon are; First, "They can not be cleaned." Ans.—It is found that even the small accelerators of the hunting rifles that had been fired five hundred or one thousand times during two or three years without being cleaned, on examination appear as clean as when they have been fired but five times, and as no shot ever slide along their surfaces, they do not need cleaning. Still even these accelerators under the bore of the cannon can and have been cleaned, dried, and oiled in a few minutes with a very simple apparatus.

Second objection—"The powder used in them is not in cartridges, and the exposure of such quantities of loose powder to the open air is dangerous." Ans.—The powder is in strong tin canisters, each containing the charge of, and numbered for, its particular accelerator, and so arranged that it is turned in without exposing a particle of it to the open air.

It would require no extra hands to load half a dozen accelerators for a large gun. The ordinary gun's crew required to move and aim it are sufficient. One of these men to each chamber charges it in half the time occupied by those engaged in loading the breech.

Several articles have appeared on the subject of a vacuum in the barrel for increasing the force; the last by Mr. Whitfield. In May, 1851, you filed a caveat for me in the Patent Office for a vacuum in front of the charge. I had tested it before, but the patent was not applied for till five years after, with the accelerator. The vacuum in front of the charge is the second claim. A. S. LYMAN.

No. 212 Second avenue, New York city.

The Inutility of Levees on the Mississippi.

MESSRS. EDITORS:—The subject of controlling or directing the waters of the Mississippi, which has been repeatedly treated in your journalis one of the gravest importance both on account of the interests involved and the immense sums of money and amount of labor expended on the levee system in the past, and because of the recommendations and attempts now being made to involve the Federal Goverement in the system, which, if successful will cause millions of dollars to flow from the treasury.

I have known the Mississippi for over thirty years, have lived on its banks, and now own lands washed annually and inundated by its overflows, and would greatly rejoice to see some effective system adopted by which its overflows and the caving of its banks could be prevented; but I unhesitatingly pronounce the levee system in the past, and however much improved upon in the future, inadequate to the task; that it is both radically wrong, and unphilosophical in principle; that, even if successful for a series of years, in the course of time it would become the greatest and most alarming curse; for notwithstanding it is a law of all flowing waters to cut out a channel deep and broad enough to contain their volume of waters (which law, in a state of nature, that is, before its water-shed is denuded of its flora, is more certain and less subject to be broken in upon by heavy rains and snows than in a contrary condition), yet these channels are liable to be filled or choked up by the sand, gravel, and dirt brought down by the streams. This filling or choking up and consequent overflows and changes of beds, is less when their water-sheds are covered with their natural flora than when denuded by man or otherwise, because the detrition of the earth's surface is in a great measure prevented by the shade, stems, boughs leaves, and roots, standing or fallen, of the flora of the water-shed drained by the stream; but when the water-shed of the stream is cleared of its natural flora, and subjected to cultivation, especially to our superficial cultivation of 6 or 8 inches, greater quantities of sand, gravel, and dirt are detached from their sites, swelling the volume of the stream, and increasing the quantity of deposition of these materials upon the bottom of the channel; for as they are specifically heavier than the water they are constantly seeking a lodgment and rest; and as in all large and deep streams like the Mississippi River, the current near the bed is more sluggish (owing, I suppose, to the greater friction and possibly of the superincumbent weight of waters, etc.), than the surface current, this deposition upon its bed takes place, gradually filling it up, and causing it periodically to overflow its banks. Now I have before said that, even if the levee system could be made successful for a series of years (and it could only with the greatest outlay of money be made so for a few years at a time), it would in the course of time become the greatest and most alarming curse. Now why do I say so? Because if my views be correct, and if I am not misinformed, the levee system in Europe and elsewhere demonstrates the fact that the dirt must be piled up and the levees raised higher and higher every year, with the raising of the bed of the river, until in the course of time the levees will become several hundred feet higher than the original banks of the river, and the bed of the stream also higher than the banks; the levee, liable at any moment to give way, and the mad waters carrying havoc and destruction in their course. Who can estimate the destruction of life and property in such a catastrophe? Even under the system as it existed before the war the thoughtful citizens living behind the levees as they then existed, rarely exceeding twenty feet in hight, during the time of high water lived in constant dread of such a catastrophe, and such did often then occur. But who can estimate the cost and labor required to build and keep up such a system for a hundred years or so?

But is there no remedy for this great evil of annual overflows? I answer that I know of none, but I think it may be greatly mitigated, and perhaps eventually prevented, by opening all outlets to the ocean and to the interior; widening and deepening their channels, and intersecting the whole valley with wide and deep canals, instead of railroads whenever and wherever needed for commerce, etc.; diffusion and shorter passages to the ocean, and deep cultivation, say to the depth of two or three feet, which is to my mind the only lasting and philosophical remedy; thus, when the whole water-shed drained by the Mississippi River and its tributaries is cleared and brought into a high state of cultivation, absorption, use, and evaporation will consume the excess of waters, and the now uncontrollable force of the Mississippi River will be measurably if not entirely brought under man's control. Until then we had better endure the ills we cannot avert than increase the evil and be met with constant and inevitable failures. THOS. Y. BERRY.

Port Gibson, Miss.

[We hardly agree with our correspondent in his deprecation of the government devoting its money and energies to the great improvement mentioned. It is as much a subject of national importance as many other projects which have received the aid and been taken under the control of the National Government. But his suggestions relative to canals which might be available for purposes of irrigation and intercommunication, seem to be worthy attention.—EDS.

The Compensation Balance.

MESSRS. EDITORS:—I am prepared to make the following favorable statement concerning the compensation balance, as a principle. I have found that since I could remove the variation consequent upon variable resistances to the balance of a watch, that the compensation balance has fewer of those eccentricities so generally attributed to this principle by the best chronometer makers. The effect of variable temperature on the very best oil, seems to have a large share in the trouble. I say this in justice to the principle in question. The compensation balance may be defective from one band being thinner than the other, and have more action; but the material does not necessarily lose its elasticity. The smaller the scale consistent with perfection in the bands, the harder and tougher (the best word I have) is the material, in effect (I say, in effect, because the forces which are perpetually at work reduce with the scale of construction); I never could make a good compensation balance on the usual marine chronometer scale and always blamed myself for the failure.

J. MUMA.

Hanover, Pa.

P. S.—My challenge—page 147, current volume—has not yet been taken, as I told you it would not be. I have not received one letter concerning it. The world has been humbugged with the watch long enough. I make no allusion to low-priced watches; they are, as a general thing, a prodigy of production for the price. J. M.

Fish Culture--A Good Suggestion.

MESSRS. EDITORS:—On page 114 of No. 8, Vol. XVII of the SCIENTIFIC AMERICAN, I find a very interesting article on fish culture, and it seems to me an important subject. I have closely observed the habits of many of the fishes that inhabit our Southern streams, and among others the trout. Here they are migratory, or at least they leave the small streams in October, and return to them in March. They spawn in April, and the young brood are hatched out in a few days. Now my object in writing this is to suggest that the eggs of the trout and other fishes might be protected in their natural bed where deposited by the mother, by placing over it a frame of fine wire net or cloth. But little attention is needed to find the nest of the trout or other fish; then as soon as the eggs are all deposited you have only to put the wire net over the nest and it will keep off nearly all of the fish and insects that prey on the eggs. In this way I think you may be sure of 75 per cent of the eggs producing young trout, and as these remain near the nest till old enough to escape from most of the dangers of their infant state, the wire net will save nearly all of them. A. C. STEEDE.

Americus, Miss., Sept., 1867.

Nitro Glycerin.

MESSRS. EDITORS:—In your issue of the 7th Sept., you insert on page 153 an article, not very friendly to this new agency in the useful arts. The sad accidents that occurred at San Francisco, Aspinwall, Sidney and the Wyoming hotel will never cease to be lamented by any one having the least concern for humanity. Similar calamities are not likely to occur again.

Nitro glycerin is less dangerous than gun powder, and no more intelligence is required to employ the former for blasting purposes, than the latter. Upwards of ten thousand blasts have been made under my directions, and I have handled thousands of pounds, and there never has been on my works a life lost. At Oswego, between five and six thousands of blasts have been made and no accident. Besides these, many gentlemen in different parts of the country have been using large quantities for blasting and no accidents have transpired. We hear of the explosions of gun powder mills, of the killing of people by premature explosions and however sad the destruction may be, it creates no especial wonder!

Practically there has been found considerable difficulty to explode nitro glycerin. An ordinary fuse that will ignite gun powder, will not explode nitro glycerin. I have discharged tin cartridges loaded with 2 ozs. of powder in a pint of nitro glycerin and failed to explode it. This and similar experiments I have made many times. I have ignited a pint of it and seen it burn with a red blaze until the whole was consumed, and no explosion. I have carried it in a wagon, on several occasions, over rough roads and at a speed of four miles per hour, and I am still alive.

For blasting purposes nitro glycerin has excelled all other explosive substances. At the Hoosac tunnel, on the Baltimore and Ohio Railroad, at Oswego and many other places it has proved to surpass gun powder for disrupting rock. It is being rapidly appreciated throughout the country and many thousands of pounds are required to supply the demand. In the copper, iron and other mineral regions the demand is greater than the facilities to supply. It fragmentizes rock, rends assunder cast and wrought iron, and upheaves the sunken wrecks and strong barriers in harbors.

The gases of nitro glycerin are sufficient to give an explosive force of 169,000 lbs. per cubic inch, and the whole of this is effective as the detonation is sufficiently rapid to produce a complete explosion. Not so with gun powder. Its explosive force is about 13,000 lbs. per cubic inch, but of this only 32 parts out of 100 explode, the remainder, 68 parts, burns or is wasted.

All explosive substances are more or less dangerous. Gun powder, gun cotton, nitrated sawdust, gambia, bark, pulp, etc., are all to be handled with care. When these are compounded with chlorate of potassa the hazard becomes vastly increased

You have styled nitro glycerin a "demon," which means the devil. If you are correct I have had a curious associate, nevertheless I admire his or its potency. The Christian is cursed by the Mahomedan. The Jews, who despised the Christians for centuries, are not even now permitted to shelter in Christian Moscow. As the light of intelligence dispels the darkness of ignorance, prejudice passes away. Truth will prevail and science will command admiration!

T. P. SHAFFNER.

New York, Sept. 1867.

The Light of Comets.

MESSRS. EDITORS.—In some recent communications for your columns from Prof. Ramsey, and Prof. Wilhelm, concerning the tails of comets I have been much interested. But in the discussion the question has arisen to my mind "how are we able to see these tails, admitting the theory of either of the gentlemen to be correct?" *i. e.* whether they be composed of reflected light as supposed by the one, or of refracted light as by the other, in either case it is light only that forms the tail so far as their explanations indicate. Now it is certain that in vacuity light is never originated or detected; that mere space can neither become luminous nor be illuminated. Light, either as a cause or an effect must be connected with matter. The light then whether reflected from, or refracted by the nuclues of the comet must fall upon some material substance that it may become visible to us. What is this substance which must be there in order to reflect to us the solar rays? Dr. R. would perhaps think to solve the problem by saying that this light is not simple but "electrified" by impringement and reflection from the opaque nucleus. Electricity however cannot pass through a vacuum; does he say that these two forces which singly are unable to traverse a void are yet able to make the trip in company? *Credat Judaeus non ego!*" I believe that the most interesting point in this investigation will prove to be the establishment of the existence of the heretofore hypothetical interstellar medium, the "all-pervading ether" of the physicists which is a *sine qua non* of the undulation theory of transmission, and which is doubtless the "resisting medium" by which Encke accounted for the secular acceleration of his comet. This medium, illuminated gives to our vision that most remarkable of heavenly phenomena the comet's tail. H. S. FULLERTON, M. D.

How far a Suction Pump can Lift Water. The Egyptian Lotus.

MESSRS. EDITORS.—In answer to your correspondent, A. T., of Kansas, page 167, current volume, who proposes to raise water 31 feet by setting his pump "eight feet below the surface of the ground which gives it *twenty-three feet to suck the water* and eight feet to lift it to the heater," you say, "The plan will not work." Surely this is an error. A pump in such a situation even if 1,800 feet above the ocean level will suck water considerably more than twenty-three feet, while it will lift it any distance according to the strength of the pipe and the power applied.

I notice, also a slight error in what is said of the "Egyptian Lotus on page 166 of the same paper. The flower referred to is of the same family (*Nelumbium*) with the Egyptian lotus, but of a different species and though a very magnificent plant is by no means so uncommon as would be inferred from your article. It is found in the Southern and Western states where it is known as the Water Chinquepin and in the Delaware below Philadelphia. How it got into the Connecticut is a mystery. Mr. Gray suggests that it was introduced by the Indians. The roots and seeds are both said to be nutritious.

The roots can be easily obtained at low water and said to grow readily when transplanted. A large number have been taken up this year by various gentlemen with the hope of introducing it into new localities. WM. EDWARDS.

Middletown, Sept., 1867.

[We are still quite content with our answer to A. T., of Kansas, and find in it no error. Will Mr. Edwards please read it again and observe that he does not fairly represent it in his criticism,—EDS.

FLEXIBLE SANDSTONE.—Dr. C. M. Wetherell, of Philadelphia, has recently investigated this singular mineral substance known as Itacolumite, so called from Itacolumi, a mountain of Brazil. It is of particular interest from its almost universal occurrence in gold regions where diamonds are found. Its peculiar flexibility, whereby without breaking, sheets of it can be bent back and forth through a considerable curve, this gentleman has found to be due to small and innumerable ball and socket joints existing through the mass of the stone, each joint permitting a slight degree of motion.

by the researches of Professor Karmarsch, of Hanover. An ironmaster in the vicinity of that town had sent to the professor some samples of such drops of lead lying imbedded in the surface of a cast-iron block, and which had been produced in the manner above described. Professor Karmarsch found, upon close examination, that these drops of lead, instead of being solid globules, as was supposed at first sight, were all hollow, forming bubbles composed of a metallic skin, and apparently empty in the center, so far as his observation has been carried. He explains the whole by supposing that the molten lead, at the temperature to which it is raised by the contact with liquid iron, forms an incipient vapor of lead, which is prevented from escaping by the skin of solidifying metal which forms on the top. The lead vapor, according to this explantion, keeps the lead resting upon the surface of the iron. It seems that in large quantities the result is different, since it is known that lead is occasionally tapped from the bottom of blast furnaces, which smelt certain classes of ores containing lead, and in these cases the lead is found below the liquid iron, according to its greater specific gravity. —*Engineering*.

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A correspondent of the Lancaster (Pa.) *Express* writes to that paper as follows:

"I have read the published testimony taken before the coroner's jury, and have been waiting anxiously to hear something said in regard to the recent explosions and disasters on our western rivers. No person seems to know or to remember that the Atlantic and Mississippi Steamship Company lost six of the finest Mississippi steamers that floated on those waters, by explosion, last spring (1866), all of which blew up in succession within a space of about three months; that this company caused an investigation into the cause of these almost simultaneous explosions. I have not seen any official report of the company's investigating corp of engineers; but I have talked with some of their captains and engineers on the subject. I talked with the captain of the steamer *Missouri*, a few hours after it blew up, six miles above Evansville, Ind., on the Ohio river; I have conversed at different times with their engineers and others posted in the investigations, and I have learned that the following is the substance of their investigations; although I would recommend that the coroner make an effort to get an official copy of their report:

"'That the tubular boilers are condemned as an unsafe and dangerous arrangement. That the tubular boilers are made with a view to economy in the saving of fuel, which is the real cause of their introduction; but the damage done by explosion is in no way equaled by the economy, say nothing of the loss of life; that steam is the decomposition of water, by being brought in contact with heat; that steam, if brought in contact with fire, is itself converted into an explosive gas, which no known substance can confine. That it requires a certain and fixed quantity of water to a given amount and intensity of heat, and a certain capacity of fire surface to prevent such a heat on the steam in the boilers as to produce this explosive gas. That it is impossible for a sound boiler to explode from the mere pressure of steam. That when the heat becomes so intense as to produce explosive gas, the water in the boiler is inadequate to prevent the accumulation of gas. That mere steam will not explode a sound boiler; that when a boiler is pressed by heat beyond its capacity, explosive gas is generated. That tubular boilers have a larger amount of fire surface, proportioned to the quantity of water they contain, than any other boilers; the amount of heating surface is too great to insure safety. That if the water by accident, negligence, or by being drawn from one boiler to another, falls below one or more tier of tubing, and a hot current of flame passes through the upper tubes, the steam is rapidly converted into gas, and if an explosion does not follow, it is because the process of generating gas is arrested by increasing the water, or cooling down the fire before a quantity of gas is generated to make a breach in the iron. During the last year, upward of thirty explosions have taken place, which were spontaneous explosions, and all of them that were heard from were tubular boilers, and in the same time in the United States, every locomotive boiler which has exploded spontaneously, was of the tubular arrangement. Locomotives having only a single boiler, the theory that the water was drawn from one boiler into another, will not apply. But the theory is that the amount of fire surface aided by the powerful draft of a locomotive in motion, capable of converting steam into gas exceeding the power of water to prevent generating such gas, will cause an explosion on the same principle. That before the invention of the safety valve, boiler explosions were so numerous that steam power was denounced as a failure, prohibited in some countries, and the machines destroyed by mobs in some places. But after the invention of the safety valve, and as long as the small single tube, cylinder boilers were used, explosions were rare, and unaccountable explosions seldom known; most of them could be traced to some neglect, carelessness, ignorance, inattention, incapacity, drunkenness, or design on the part of those having charge of an engine.'

"The same causes which exploded boilers in the early age of steam explode them now, for nature is always the same; no law has changed. But here in America, on water and land, are a succession of explosions falling fast one upon another during a single year, with a destruction of property amounting to millions, and a loss of thousands of human lives, and in no instance has it been shown that any of the duties of the engineer were neglected, or any of the ordinary causes in any way were connected with these mysterious explosions.

"The question here arises, what is the cause? If no law of nature has changed, if the law of explosion is the same now that it was when the small, single tube, cylinder boilers were in use, for a third of a century, what is the cause of this recent accumulation of explosions? Manifestly if no change has taken place in nature, then the change must be in the changed construction of boilers.

"After the invention of the safety valve, the intelligent and cautious engineer trusted with confidence in the familiar sound of steam escaping from the safety valve to warn him of danger. But now the safety valve is unreliable. and even the water gage is treacherous. On the *Missouri*, which blew up in April, 1866, the engineer tried the water not five minutes before the explosion, and found it all right. All the ordinary means of guarding against explosions and assuring safety in the use of steam power, which for a quarter of a century or more were as reliable and safe as any means used to guard against accidents in the employment of any other dangerous and useful element have recently become uncertain, treacherous, and unreliable. Again we repeat the question, Why is this? and what is the cause?

"If we were to answer, we should say that mechanics, in the effort to construct a boiler to do the greatest amount of work with the least cost of fuel, have sacrificed safety to economy. When steam power was introduced the country abounded with wood, the best fuel for making steam; but as wood became scarce and high, fuel-saving machines were largely in demand. But no saving of fuel in generating steam can be accomplished except by increasing the fire surface in or around the boiler, with parallel flues through which a current of flame or heat passes several times over the water surface, thus retaining longer around the boiler the heat generated; while combustion is more perfect and the inflammable gas, the product of combustion, being longer retained within the reach of a flame, ignites and burns, where in a single flue it would pass unignited, without heating, out of the chimney. Even smoke is inflammable gas, and if this gas is all ignited, no smoke, nothing but a current of heated air would pass through the chimney.

"This principle of saving fuel, and still generating the required amount of heat, has proved a grand success in this country in stoves and heating furnaces. But it has proved a success in the generating of heat only, and not in generating steam.

"Boiler makers, when they applied this principle in generating steam, lost sight of the fact that when they increased the heating surface, the intensity and quantity of heat around a boiler, that they ought also to increase in an adequate proportion the quantity of water; instead of which, however, they have actually increased the power of the fiery element, and lessened the only power, water, capable of holding this fiery monster in subjection, which would be equivalent to running an ordinary one flue cylinder boiler on half water, with full heat.

"This, then, we conceive to be the true cause of the recent explosions in this country. Let it be understood by mechanics, that throughout all nature, in every element or living substance, organic or inorganic, a positive and a negative principle exists. That the positive is the active, moving, living power, while the negative is the passive power acted upon. That fire is a positive element, and water in a boiler becomes its negative, but when the water becomes sufficiently decomposed, a new element is created, which is a positive principle, and the atmosphere is its negative, and the attraction of this negative (the atmosphere) for the positive principle in the boiler when it becomes positive by decomposition of water, is so great, that no substance can hold it from escaping. The atmosphere cannot go into the boiler; if it could there would be no explosion, so the contents of the boiler seek the atmosphere.

"Hence it follows that there is always safety in the use of steam, provided that that only element of safety, *water*, shall exceed the heating power, *fire*, so as always to predominate, and that no fire shall pass over a steam surface to decompose the steam and convert it into explosive gas, which means a positive element whose negative is the atmosphere. Now, these tubular boilers of present construction contain too great an amount of heating surface, and too small a quantity of water, which is the first objection. That the water is liable to pass below the flues and the heat to pass through the steam instead of through the water, thus rarifying the steam and increasing its elasticity, is another and very serious objection. It is believed from various experiences, that boilers constructed of the same thickness of metal, one foot instead of four in diameter, will exceed the large boiler in resisting power fifty per cent. From the investigations of the Mississippi and Atlantic Steamship Company, I deduce the following conclusions: That the present arrangement of tubular boilers affords too great an amount of heating surface for their capacity for water; that by accident or neglect the water is liable to sink below the upper tier of tube flues, in which case the flues become hotter than they would if covered with water, and decompose or rarify the steam creating, if the tubes get hot enough and continue long enough out of water, and an explosive power, not steam, that iron is unable to confine. It is impossible to avoid explosions while the fire may, by accident or neglect, or by emptying one boiler into another, reach the steam surface, and rarify the steam.

"In making boilers, the engineer should enter into a mathematical calculation, ascertaining by experiment on a small scale the quantity of water to a given amount of heating surface, and intensity of heat necessary to prevent explosion; then when heating surface is increased by any arrangement of parallel flues, let the capacity for water be increased in a corresponding ratio. Let the boiler be so arranged as to render it absolutely impossible for the fire surface to reach the steam surface. With such an arrangement, with the steam gage, the water cock and safety valve, with sound and well-constructed boilers, with proper care and attention, it is the opinion of some of the most intelligent and best educated engineers in America, that there need be no explosions, at least spontaneous explosions.

No ship-builder on southwestern rivers will touch a tubular boiler any more, and insurance companies charge higher rates for insuring boats containing them. The object aimed at in tubular boilers being economy in fuel, and retention of heat around the boiler, need not be abandoned. I saw in the West a set of boilers, six in number, placed upright, twelve inches in diameter, and ten feet high, placed three on either side of a hollow fire chamber. The fire was allowed to pass to the hight of low water in the boilers, then down and under and up on the opposite side of the boilers, to the hight of low water, and out into the chimney flue. Through the hollow casing, around the fire chamber, a current of cold air was admitted at the bottom, and passing to the rear, and up into a jacket around the upper portion of the boilers, and then into the chimney. The object of the current of cold air is to prevent the destruction of the casing around the fire, and to keep the cold air from the boilers. There was no connection between the boilers by which steam or water could pass from one boiler to another; each boiler was supplied with water through a separate pipe. This arrangement has been in operation for two years, and the owner said he could make three times as much power with the same quantity of fuel as with his old style boilers. Abating something for zeal and confidence in one's own invention, I considered his machine a very economical one He told me he had no patent; if the world wanted it, let them have it.

In 1853, when the question of saving fuel in making steam was being experimented upon, the chief engineer of the Collins' Steamship Line, in a conversation with me, remarked, "If they increase the heating surface and power without a corresponding increase of water, they will blow their machines to the *devil*." He was a rough-spoken Englishman, about fifty, and had helped to build the first locomotive ever made in England."

[The tubular boiler in this section is deemed as safe, if not safer, than any other. The cause of its failure on the Western waters is, that the tubes fill with mud so solid that water cannot touch them; hence they burn, collapse, and play other inconvenient and uncomfortable tricks.—Eds.]

Correspondence.

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

The Acceleration o Shot.

Messrs. Editors:—In your paper (Sept. 14th), Seth Boyden refers to a mode of starting shot from a fowling piece, by having a long, narrow chamber in the breech of the gun, and lighting the powder in this chamber at the top, next to the shot, and remarks that he thinks for an accelerating cannon this mode would be preferable to having the powder chambers along the bore of the gun.

I tried the long narrow chambers as accelerators for a cannon eleven years ago. The bore of the cannon was 2½ inches diameter; the two chambers of steel each 1½ inches diameter and 30 inches deep. They were a complete failure.

Suppose the bore of the gun is six inches in diameter and the narrow chamber 3 inches, it must be four feet deep to hold as much powder as would fill the bore of the gun one foot deep, which is less than the Whitworth gun uses safely. If we fire this charge at the top, it will burn down perhaps two feet, and ram the rest of the column into a cake as solid as any rocket is packed and into which the fire can not enter. It burns only on its end, and most of it after the shot has left the gun. It will be found that instead of burning six or eight times as much powder as a Whitworth gun of the same bore and giving six or eight times as much power, it has not given half so much power.

If to overcome the difficulty of the packing of the powder, he leaves a space filled with air only, at the breech, or makes his cartridge with a hole down its center, and puts a string of gun cotton through it, as I finally did, I think he will blow his long narrow steel chambers to fiinders, as I did with the first shot I tried in that manner.

If Mr. B. will increase the length of the long, narrow chamber which he uses with his shot gun, from two to three inches, which is probably its present depth, till it will hold enough to fill the bore of the gun one foot, he will probably find his chamber several feet in length. He will certainly find that the narrower his chamber the less will be his penetration. Now if he tries a steel shot on a wrought-iron target, he may throw his shot through one quarter inch, possibly through three eighths of an inch, but never through one sixteenth as much iron as can be penetrated, or one eighth as much as has been penetrated by a shot from a barrel of half-inch bore with accelerators placed under it.

H. S. Whitfield also in the same number says he "has concluded that this thing of acceleration could be accomplished in another way much more simple and quite as effective by a cartridge with partitions, each partition containing a full charge of powder, and so divided that when fired from the front they will explode in succession." If this cartridge is made of the strongest metal, and so heavy that the valves wil not give way backward from the explosion of the first charge, it would require a cartridge ten or twelve feet long to hold sufficient powder to fill the bore of a six-inch cannon even four feet deep. The accelerator 18 feet long must then be increased to 28 or 30 feet long. But the valves would probably leak and all the charges be lighted at once and his gun blown to fragments. If it did not, this long, heavy cartridge would