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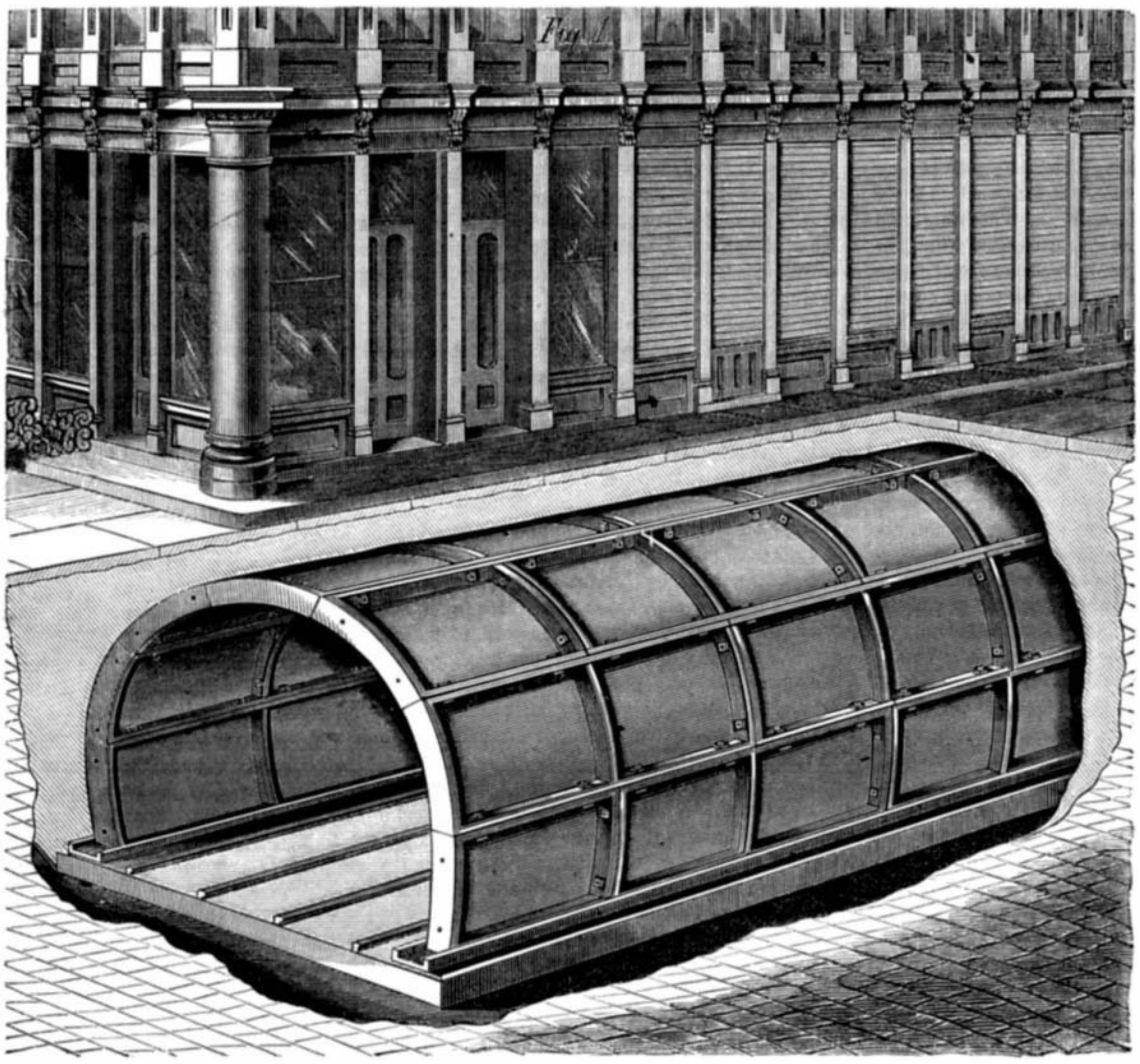
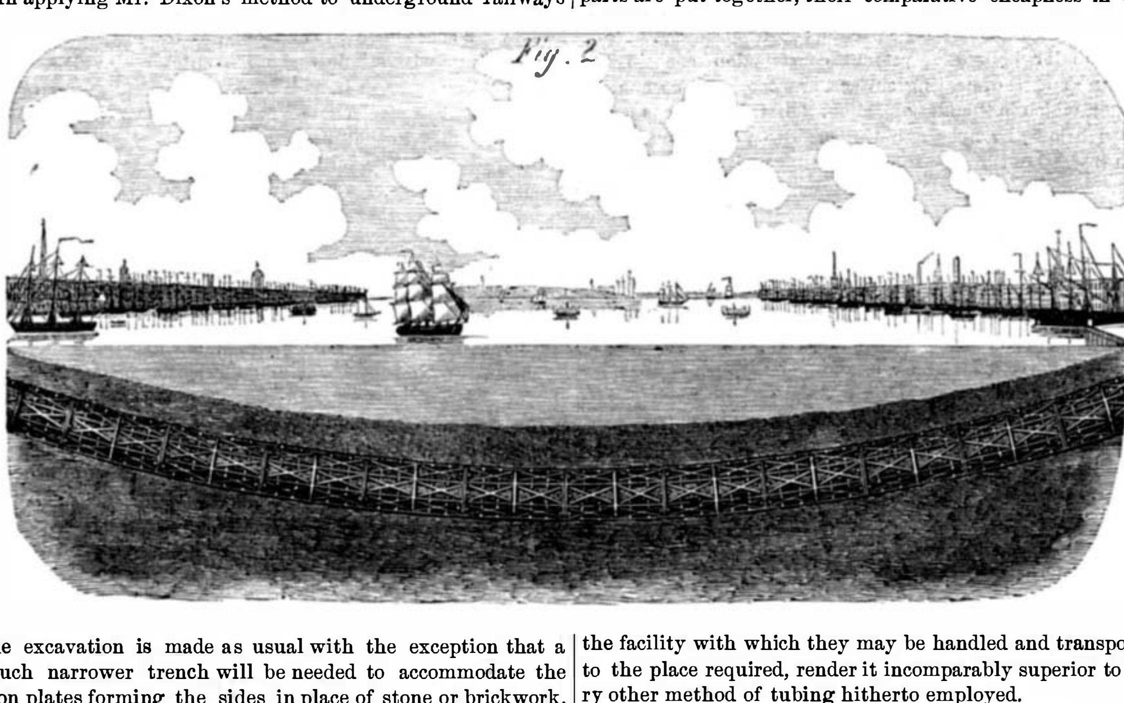
Method of Constructing Tunnels, Vaults, Etc.

The problem how to relieve the city of its over-crowded population, how to extend its cramped proportions to the upper end of the island of Manhattan, how to connect it by rapid and low-priced means of communication with the neighboring shores of Long Island and New Jersey, and how to provide comfortable and cheap homes in its vicinity for its myriad sons of toil, who labor ceaselessly to enrich grasping landlords, and who pass their hours of rest in dwellings which are a disgrace to a civilized age, is one which interests every humanitarian, every capitalist, and every lover of the city's prosperity, almost as deeply as the numerous class which is more immediately benefited by its solution.



DIXON'S MODE OF CONSTRUCTING TUNNELS, VAULTS, ETC.

Railroads—aerial, pneumatic, and underground—to supersede the tedious horse cars, and bridges as a substitute for ferryboats have been proposed. A commission, consisting of three Senators, the Mayor of the city, the State Engineer, and the Engineer of the Croton Aqueduct Board was appointed to sit during the recess of 1866, and inquire into the best means of affording the much-needed rapid transportation. They advertised largely and received a great number of plans and suggestions embracing every description of railroad. After giving the matter a thorough investigation they reported to the Legislature last January recommending, unanimously, the underground railroad as superior to all other methods for this island. Notwithstanding this report and the numerous petitions of owners and lessees of property in favor of the measure, the Legislature refused to grant a charter to any of the numerous applicants owing to dissensions among the parties applying—the only measure of relief (?) granted was the authority given to construct two bridges across the East River, which cannot be completed in several years. The time, however, will come when public opinion will demand the adoption of all the methods that can be made available and then the plan recently patented by Mr. Joseph Dixon, and illustrated in the accompanying engravings, will undoubtedly meet with the success its simplicity, economy, and adaptability for the underground and pneumatic systems deserve.



In applying Mr. Dixon's method to underground railways the excavation is made as usual with the exception that a much narrower trench will be needed to accommodate the iron plates forming the sides in place of stone or brickwork. A foundation of stone is then placed to which the side plates are bolted, and the plates forming the arch are first placed on a movable framework and bolted to each other. The framework being made so as to be raised or lowered by means of a screw jack, will be raised slightly above the sides while the flanges of the arch plates are being bolted together, and when ready the framework will be lowered till the arch rests in its place on the sides. A section is now complete, the center plate acting as the key, and every joint answering as a powerful strengthening rib, and being tongued and grooved and packed with cast iron or other cement, will be perfectly water-tight. The means of ventilation will be through iron air shafts rising in the form of an obelisk or column of open lattice work and surmounted by lamps to be used in place of the present street lamps.

For constructing the pneumatic railway Mr. Dixon's method will equally well apply where the tube is of sufficient diameter to contain the carriages and in which they are propelled by the direct expansion of the air, the ease with which the parts are put together, their comparative cheapness in cost, the facility with which they may be handled and transported to the place required, render it incomparably superior to every other method of tubing hitherto employed.

For a submarine tunnel this method stands pre-eminent. As before remarked, the bridges about to be constructed across the East River will take several years to complete, one of them at an estimated cost of $8,000,000; for this sum several tunnels, each affording as much facility for traffic as a bridge, could be laid across the East and North Rivers, and not one of them need occupy over a year in constructing.

For vaults under sidewalks, such as are used by the large newspaper establishments, and by dry-goods stores, breweries, etc., this system can be advantageously applied and the size of the vaults largely increased by substituting the iron plates for the thick stonework and brickwork generally used

In the construction of tunnels where the engineer is forced to drift through a loose soil, the advantages of arches formed of these iron plates with the joint inside, are too apparent to require any thing more than a mere mention.

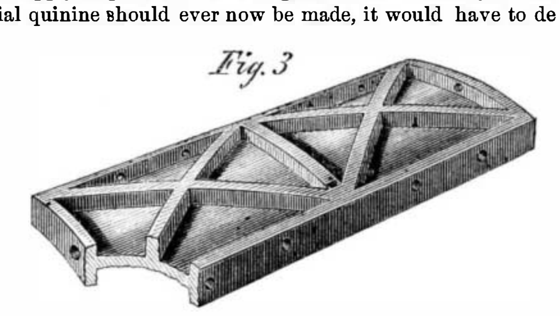
This device was patented August 20, 1867, through the SCIENTIFIC AMERICAN office, by Joseph Dixon, 119 Broadway (Rooms 34 and 35), who will give further information.

Quinine.

Among the many remedial agents which organic chemistry has afforded us, quinine occupies the first place, chloroform the second. Without quinine, large tracts, indeed whole countries, would be simply uninhabitable for Europeans. To the backwoodsman a supply of quinine is as important as gunpowder. The "quinine famine' in the Mauritius demonstrated to thousands how small a thing even gold itself might become in comparison with this life-saving salt.

If the search for artificial quinine has been as unsuccessful as that for the Philosopher's Stone, it has at least resulted also in some great discoveries. It does not appear to be generally known that the first of the analine colors was discovered during a search for artificial quinine! But, tired of waiting for that which did not come, finding that chemists could not produce quinine, it struck certain minds that it would be a surer plan to assist Nature a little, and Nature, as she always does when properly called upon, responded liberally. In effect, owing to the wasteful and ignorant manner in which bark was collected in its old habitat, it was, especially in the finer and richer varieties, getting scarcer. This circumstance has induced certain enterprising men to cause the cinchonas to be introduced into India, and it has not only been found that the change of habitat does not prevent the developement of quinine, but the valuable discovery has been made by McIvor, and confirmed by DeVrij, that covering the bark during its growth with moss increases the percentage of alkaloids. The cinchona plantations in India are now so flourishing that there need be no apprehension of the supply of quinine ever failing, and if the discovery of artificial quinine should ever now be made, it would have to depend upon its cheapness for its value. We are aware that the discovery of artificial quinine has more than once been announced, but up to the present time such announcements have never been supported by positive evidence.—*Chemical News.*

Fig. 3



Lead Floating on Molten Iron.

Some experiments have been made in Germany which seem to show that molten lead when dropped upon liquid iron remains floating on the surface of the latter. As the specific gravity of lead (11.5) is more than one half greater than that of cast iron (7), there arose some discussion on this subject which has been recently closed in a very satisfactory manner 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 an other 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 $2\frac{1}{2}$ inches diameter; the two chambers of steel each $1\frac{1}{2}$ 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 finders, 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