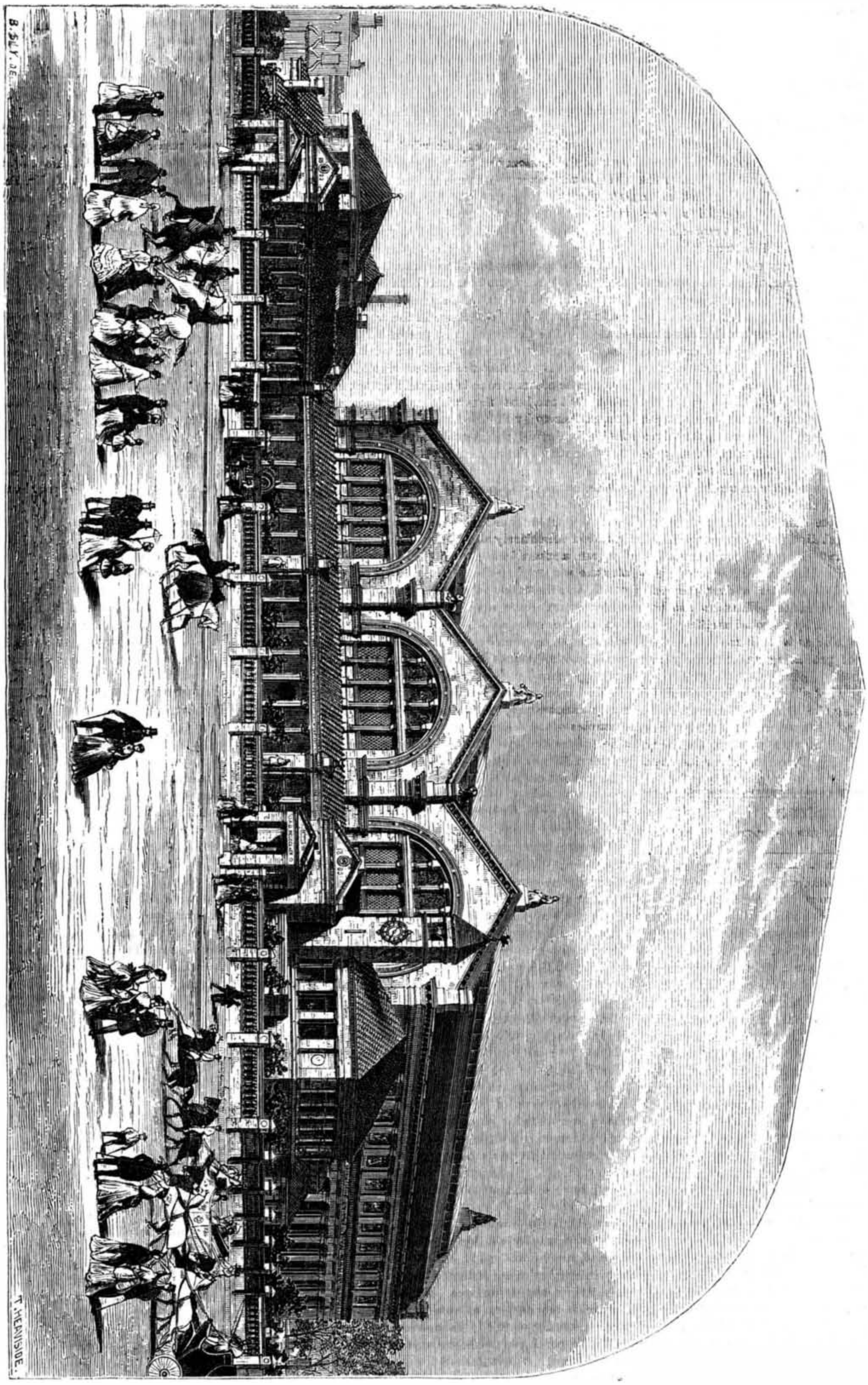
THE EAST LONDON MUSEUM OF SCIENCE AND ART.

One of the conditions upon which the English Government agreed to appropriate money for this institution, was a freehold site, and this, through the exertions of Sir Antonio Brady, the Rev. Septimus Hansard, and others (the Corporation of London and the Fishmongers' Company being among the subscribers), was obtained in Bethnal Green; the title deeds being presented to the Government by a deputation in February, 1859. On this occasion the deputation repeated the views of the promoters as to the nature of the museum which they wished to secure for the East End of London; their leading idea rightly being that it should be educational, in the strictest and widest sense of the term. All the subscriptions had been asked for and given with that understanding; and in making over the land to the Government, the subscribers pressed these views on the consideration of the Government. As regards the study of art, they felt this to be a matter deeply affecting the trade and commerce of the country, and urged it as one of imperial necessity. What they desired was that the museum should be made subservient to technical education generally, and prove not only a blessing to the million at the East End, but a model educational institution for all provincial cities and centers of manufactures to imitate. Earl de Grey and Ripon, as President of the Council, in accepting the deeds, made it understood, that the museum is not a local but a national institution; that it will form, as it were, an outwork of the South Kensington establishment, and will be dealt with upon the principles on which the Committee of Council act with respect to the South Kensington Museum.

The site is a good one, some 4½ acres in extent, in the midst of a dense population, and thereon the building is being erected. The main body of it, about 185 feet long, and 730 feet wide, is now approaching completion. It has been built under the direction of Lieut. Colonel Scott; Mr. James Wild, architect, mainly assisting in the design. The building is wholly of brick, molded where necessary, and the arrangement of the front marks the tripartite plan. Within there are galleries in the two side divisions and at the end, lighted from the top. The central portion will have a mosaic pavement, made by the convicts at Woking and elsewhere.

Our illustration shows the complete design as proposed, with library on one side, refreshment room and house on the other, with corridors leading to the road; but, it is stated, that the Treasury has just now determined not to erect these—at any rate, at present, the amount granted, £20,000, being nearly expended; absolutely necessary accommodation for attendants and so forth, is therefore to be provided in the basement of the main building.



THE EAST LONDON MUSEUM OF SCIENCE AND ART.

ZANZIBAR gum is the most valuable for varnish making. Benguela gum stands next in value, and an inferior gum is known as kowrie.

WHAT IS STEEL?

The following is an abstract of a paper read at a meeting of the London Association of Foremen Engineers.

Steel is merely iron steeled or hardened, by being chemically impregnated with carbon, silicon, titanium, or any of those elements which possess more or less the hardening property; chemically impregnated, as the iron does not lose its special qualities, which it would do if the two elements were proportionately and chemically combined so as to form a new compound substance. There is, of course, a definite proportion of the chemically impregnating element, which confers the greatest amount of steeling or hardening property, entitling it so far to be called pre-eminently steel iron, or simply steel, variations from which proportion cause the metal to vary in respect of this property of hardness. According to this view we may regard ordinary cast iron as impregnated with too much, and wrought iron with too little, carbon, in both cases falling short of its strongest form, steel; or cast iron is a mixture of antagonistic steel and wrought iron, which is a very mild form of steel. Thus iron, which, in its pure, simple state, is comparatively soft, is chemically toned by carbon, silicon, or any one of the other elements used in forming steel. This toning may be underdone or overdone, or the different tonics may be all mixed up together, and to modify or neutralize each other's tonic influence. The same toning or hardening influence is to be found in the vegetable world, where we find silicon toning the strength of plants, as, for instance, in the straw of cereals, which is more or less stiff and hard, in proportion to the prevalence of silicious constituents in the soil on which it is grown; the length as well as the quality of the straw being influenced thereby.

The Bessemer process demonstrates distinctly the fact that there is no definite boundary between the three forms; that the percentage of carbon can be very gradually decreased from 1·25 per cent to a percentage scarcely appreciable in practical analysis, without altering the essential properties of the steel, except in lessening the degree of hardness. As the greater the percentage of carbon, up to a certain point, the harder is the metal; so the substitution of a harder impregnating element may be expected to produce a still stronger quality of steel, as, for example, with silicon; or the substitution of a softer impregnating element may be expected to produce a weaker quality, as with phosphorus; and this really seems to be the case. Carbon steel, however, is the kind in general use, and the only one whose qualities have been subjected to practical investigation. It is not only the proportionate amount of the carbon with which it may be impregnated that determines the hardness of the steel; for the same metal can be tempered, or have its hardness moderated.

Crystallization plays a necessary part in imparting the steeling or hardening property.

This is obvious in the practice of hardening steel by plunging it suddenly into cold water, by which it can be rendered so hard as to be capable of scratching glass. So also, on the other hand, an extreme degree of hardness may be reduced to almost any degree of softness by heating the steel. All the gradations are beautifully marked on the bright steel in deepening rainbow tints, guiding the manipulator by visible signs as to the relaxing temper of the metal.

The first tinge of yellow indicates that the steel has barely begun to soften, though it has materially increased in toughness. As the yellow deepens towards orange, the color indicates the degree of temper required for such articles as razors, penknives, and tools for turning, planing, chipping, and boring.

As the orange deepens, the color indicates a temper suitable for joiners' edge tools and table cutlery. When the changing color runs into blue, a temper is indicated that fits the metal for springs, and when it has completed the revolution and arrived at the color from which it started the metal has become nearly as soft as before it was hardened.

It is pretty evident that the relaxing temper of the metal is associated with a chemical action of the heat on the crystalline molecules of the iron. This action is, as yet, not very well understood. It depends not only on the nature of the iron, but probably also on the determination of the axial direction in which the crystals are formed. Only the finest iron is used in making the good steel, and the purer the iron the larger the crystals, but the quality of the steel depends also greatly on the amount of carbon, and the chemical admixture of a foreign element reduces the size of the crystals.

The finer the steel the closer will be the grain of the fracture. This brings us to another phase of the question, what is steel? It may come before us in another form. How can steel be identified? How can its varying qualities be distinguished? This is the practical bearing of the question for those who have to realize it by inspection, and on correctness depend very important consequences. Supposing a piece of steel to be submitted for inspection, how can we test its character? If it be a steel rail it ought to contain one half per cent. of carbon. If it be a mild steel casting, it ought to contain about three quarters per cent., and if it be a piece of hard cutlery about a quarter to one-half per cent.

Of course the most correct estimate would be formed by analyzing the steel chemically, but that cannot be resorted to in the rapid turn-out of a factory, to any great extent. The nearest practical approximation to this is to dissolve a small piece of the steel in an acid, when the differing shades of brown will indicate the inherent proportions of carbon. Steel may also be tested as to its proportionate quantity of carbon by ascertaining its specific gravity, as the greater the proportion of carbon the less dense will it be found to be. The readiest method of testing the quality of steel is by examination of the fracture in a microscope. This requires considerable experience and a very powerful instrument. The unassisted eye may make a tolerable guess, but the result cannot be relied upon. Not so, however, where its power is multiplied by the powerful lens of a microscope. The crystals are found then to be octahedral, presenting the form of a double pyramid, joined base to base. As the carbon decreases the pyramids become flatter, from the cubical form in cast iron down to the flattened form in wrought iron, which confers upon it greater capacity of being welded, and thus producing fiber. Between these extremes may be found a graduated series of pyramidal forms more or less elevated, according to the quality of the metal. If the steel shows under the microscope a regular and parallel crystallization (which may be pretty accurately ascertained if the fractured metal be held against the light), flashing back to the eye an uniform luster, like evenly serried needle points, the steel is of good quality. In proportion as it departs from this standard and shows groups of crystals whose diskal directions are not parallel, causing the needle like fragments of crystals to reflect a luster, patched here and there with shade, imparting to one portion a bright silvery tone, and to another a dark grey one, the metal is of inferior quality or make. Fineness and parallelism of grain can be produced by repeated melting, heating, or hammering, when cold or at a dull red heat. Cold hammering has the effect of producing an extremely fine grain.

A more correct estimate of what steel really is has had the effect of materially shortening the process of manufacture. The material itself has been made for upwards of 2,000 years, but only now, in the latter part of this wonderful century, has its manufacture been developed so as to show its capabilities.

Correspondence.

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

Compound Engines---Mr. Emery's Reply.

To the Editor of the Scientific American:

I have but just found leisure to pen a reply to the pointed, but courteous, editorial inquiries contained in the SCIENTIFIC AMERICAN of June 3, and relating to a paper I had previously read on the subject of compound engines.

The communication to which your article refers, namely, that of Mr. Harrison in the previous number of May 27, is a valuable one, as it acquaints your readers with facts difficult to obtain; and the example of Mr. Harrison in publishing his observations might be followed with advantage by many of your readers. Allow me, however, to take up the discussion of the facts where he leaves it, to do which, understandingly, and avoid repetition, I must request your readers to again examine the numbers of your paper of the dates above mentioned.

Mr. Harrison concludes, from calculations founded on the indicator diagrams, that if the steam supplied to the two cylinders of the "Magellan" had been used in the smaller of the two, and exhausted directly to the condenser, the addition of the large cylinder would have produced a gain of 19 per cent in power after deducting the estimated loss by additional friction.

This is doubtless true, but is foreign to the subject; for, let us suppose the steam to be used only in the larger cylinder, with the same initial pressure and measure of expansion as in the two cylinders. From the diagrams we find that the mean initial pressure was 47 pounds, and that the steam was expanded 1·29 times by wire drawing, and 2·2 times by the cut off on the small cylinder; also, that this expanded steam was again expanded 2·57 times by the difference in volume of the two cylinders, so the total expansion was $1·29 \times 2·2 \times 2·57 = 7·29$ times. [It will be observed, however, that the terminal pressure is lower than is due to the measure of expansion].

Now, if the steam used were let directly into the large cylinder and expanded 7·29 times, the mean total pressure by the usual rules would be 25·3 pounds, and deducting 4·3 pounds as ample for back and friction pressures, the remaining pressure, namely, 21 lbs., would be effective, and the power would be (using Mr. Harrison's figures) $\frac{21 \times 7224 \times 7·50 \times 56}{33000} =$ 1930·8 horse power, or (1930·8 — 1659·8 =) 271 horse power greater with the single cylinder than when both were used. This difference would, however, in practice, be much less as, with similar valve gear, the diagrams would be similarly rounded and modified in both cases, and the only difference would be that due to the loss of pressure required to transfer the steam from one cylinder to the other, or roughly about 75 horse power by the diagrams shown.

This review exemplifies the statement in my paper that "there is no gain in power by the addition of the small high pressure cylinder of the compound engine, for the effective pressure upon its piston is only the difference between that of the entering steam and that admitted to the second cylinder. There is, in fact, a little power lost in transferring the steam from one cylinder to the other." This loss in the case of the "Magellan" was about 75 horse power, or 4½ per cent of the net power exerted.

The indicator has heretofore been considered a faithful guide, but in this case it shows a loss of 4½ per cent against the compound engine when, in fact, such engine was actually saving fully one third the fuel as compared with the performances of other engines.

I do not think I can explain what I consider the true reasons of the economy of the compound engine in fewer words than in the paper you have referred to, and I trust you will consider the subject of sufficient importance to publish such paper in full in your journal.

In reply to the question asked in yours of June 3, I will say, first, that the glass and iron cylinders experimented with were both carefully felted to eliminate all condensation due to external refrigeration, and both cylinders being of the same size, and operated in precisely the same way, there could be no possible difference in the work done except that caused by the different quantities of steam in motion on account of the internal changes of temperature.

Again, it is true that the heat abstracted from the cylinder during the steam stroke is utilized as work in the expanding steam, but the heat thus withdrawn from the metal is returned thereto by the condensation of the entering steam at the beginning of the next stroke; and this condensed water, together with that resulting from the work done, is what is partially evaporated during the expansive portion of the stroke, but is more completely evaporated at the moment of the exhaust and throughout the return stroke, when all the heat abstracted from the metal to produce such evaporation is, of course, entirely wasted.

Again, a steam jacket produces economy because it evaporates the water from the interior surfaces as fast as it deposits, and therefore no water is left to be boiled by actual contact when the exhaust takes place. The losses by radiation at the moment of exhaust will still obtain, however, when the expansion is carried so far that more water is suspended in the steam inside the cylinder than the jacket can evaporate during the expansive stroke.

All discussions on the subject of the compound engine are really unnecessary, as the results obtained with the better examples of this class of engine show them to have remarkable superiority, and of this fact I trust ere long to convince you, Mr. Editor, with some compound engines of my design.

New York city. CHAS. E. EMERY.

Mr. Paine and his Detractors.

To the Editor of the Scientific American:

The great inventor, whose engine was so long in operation at Newark, N. J., whose achievements have satisfied so many of our greatest scientists, and for whom still greater successes are waiting in the future, has suffered the usual fate of the pioneer of invention, namely, detraction and calumny. Mr. Rowland more than hints at a surreptitious connection between the Paine motor and a steam engine in the same building. I think this insinuation is unworthy of a scientific investigator, and it is not to be wondered at that Mr. Paine has passed it by, no doubt thinking it beneath his notice.

Dr. Vander Weyde, another scoffer, has demonstrated that all Mr. Paine's results amount to the discovery of the perpetual motion; and although the Dr. intended to show a *reductio ad absurdam*, Mr. Paine's disciples will consider that Mr. Paine has as much right as anybody else to solve the tremendous problem of building a machine that shall create more power than is required to drive it. Now, while your readers are engrossed in the controversy, and are straining their attention to the coming demonstration, the newly discovered force of psychic power comes upon us. May not this agency have something to do with the motion of Mr. Paine's apparatus?

Even Mr. Paine's warmest admirers, knowing how logically and systematically all his experiments and reasonings are pursued, may hesitate to claim for him the honor of inventing the perpetual motion; indeed, with characteristic modesty, he himself deprecates the idea. But then the question arises, how is the mechanism operated? "How," as the boys say, "does the thing work?" I am driven to the conclusion that Mr. Paine, perhaps unconsciously, is the real discoverer of the psychic force, and that the results, the remarkability of which no one can deny, are to be credited to the mental power, courage, and indomitable will of the great inventor of Newark. I am strengthened in this belief by the visible fact that Mr. Paine's power augmentor (for that is the proper name for his invention) must be driven by some such agency. Mr. Home does more with a slight touch of his finger tips than strong men can do with the whole strength of the muscles. And a similar phenomenon must cause the motion of the Newark engine, whose running powers are otherwise inexplicable, and which must have considerably startled Mr. Paine when the machine first ran away at an unexpected pace.

The unfortunate persons called spiritualists are now about to receive the reward of their patience and long suffering. They have been taunted with the uselessness of their manifestations, and asked, if it be possible that spiritual power can find no better employment than turning hats and upsetting tables. These sneers will now cease, as a direct mechanical force, available for all purposes, has been demonstrated by Mr. Home, in the presence of witnesses of acknowledged honesty as well as intelligence, to exist in the mind of a highly gifted spiritualistic medium. If Mr. Paine's motor be the great want of the future, the apparatus that shall allow us to utilize, to direct, and to govern this omnipresent power, he will have obtained a reward for the years of patient investigation he has devoted to his invention. A far greater renown than that of discovering the self-moving machine will be his; and the sarcasms of all Vander Weydes, Rowlands, Smiths, and other extraneous and superfluous persons, will be silenced for ever. B. D.

Jersey city.

Paine's Electro-Motor.

To the Editor of the Scientific American:

I have read with a great deal of interest the articles in your paper on Mr. Paine's electro-motor, and rather impatiently await the settlement of the whole question by the production, on the part of Mr. Paine, of a machine actually performing the work he claims for it, or its partial settlement by his failure to do so. I say *partial* settlement, for it seems to me that the question, whether such a machine as he claims to have knowledge of is or is not among the possibilities, would still press for solution, even should he totally fail to produce it. In the absence of a machine doing the work, the controversy must remain unsettled just so long as one palpable fact obstinately persists in existing. Allow me to explain by giving an example:

Place an electromagnet in the circuit of a current just sufficient to suspend, say, ten pounds in actual contact. Now break the circuit, and complete it again by placing in it another magnet precisely like the first, and either the current will suspend twenty pounds with no increase, or with only a very trifling increase. I know of no analogous fact outside of the phenomenon of magnetism. It is like getting one hundred horse power out of a fifty horse power engine by throwing an extra shovelful of coal in the furnace. It is like making a water wheel which operates a fifty horse power mill operate two such mills by throwing an extra bucketful of water into the mill dam. It is like a man who could resist the pull of an equally strong man being able to resist the pull of two such men by eating an oyster. The theory of the conservation of force is much talked of, and I have a profound respect for that theory, and for the processes of critical investigation which have been employed to produce it. But that theory is in no way interfered with in the electromagnetic phenomenon, unless it is insisted that the electric current produces the magnetic force, in which case the theory of the conservation of force would be overthrown. My mind can make nothing else out of it. If the electric current is the cause of the magnetic force, if it is changed into it by any imaginable process, then the facts in the case disprove the the theory. But it is a gratuitous assumption to insist upon any such transformation. Why may not the force or forces of magnetism always exist in the bar of soft iron, totally independent of the electric current, but in a state of equilibrium which that current disturbs? and while so disturbed, force be manifested which overcomes other forces, gravitation for instance, and which can be used for mechanical effect? The magnetic force in such bar of soft iron might be aptly likened to a train of loaded cars on an inclined road, with a stone resting on the track and blocking one of the wheels, and which stone had a tendency to always get under the wheel and stop the train unless forcibly prevented. Now the electric current knocks out that stone, and the train moves with a force entirely disproportioned to that which was required to move the "scotch," and it keeps moving as long as the stone is held out. If we now suppose an indefinitely long track, the breaking of the current merely stops the train. If we suppose a limited track, and the current be broken when the train had reached the lower end, then not only is the train stopped, but returned by great Nature to its starting point, ready to perform once again its work. It is like an infant pulling the "trigger" of a cannon, with Nature to replace the load. If the character of the magnetic force be ever understood, there may be known the breservoir from which its vitality is replenished. Whether there be such reservoir is now hidden in impenetrable darkness; at least, so it seems to me.

I am totally unacquainted with Mr. Paine; he may be a perfect charlatan, so far as I know; but is not the above mentioned fact of electromagnetism basis enough to sustain his wildest assertions? A very little reflection will show that this force makes possible a practically unlimited and costless mechanical power, so far as the destruction of values is concerned, in obtaining the initial current of electricity. Whether it is or is not a perpetual motion has nothing to do with it, so far as I can see, and the conservation of force is in no way disturbed by it, in our present condition of ignorance. To obtain millions of foot pounds from the consumption of grains of zinc may be Utopian, but in this case the foot pounds are obtained from the magnetic force. The grains of zinc pull the trigger, while Nature tends to the reloading.

I once heard Professor Smith, of the University of Virginia declare—and he performed an experiment before my eyes to prove it—that a small block of platinum, the densest of metals, had the power of stowing away within its own body, while under the influence of the electric current, a prodigious quantity of hydrogen gas, a quantity so great that no known mechanical force could succeed in compressing it into an equally small compass. This metal, he declared, seized the hydrogen and forcibly stowed it away within the