Scientific American.

ESTABLISHED 1845.

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

TERMS TO SUBSCRIBERS.

One copy, one year, for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) .... $3.00 a year.
Scientific American Supplement (Established 1876) .... 5.00 "
Scientific American Building Edition (Established 1885) .... 2.50 "
Scientific American Export Edition (Established 1878) .... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.

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MUNN & CO., 361 Broadway, corner Franklin Street, New York.

NEW YORK, SATURDAY, APRIL 22, 1899.

THE THIN END OF THE WEDGE.

Englishmen and Americans alike have been quick to realize the significance of the recent placing of orders in this country by England for locomotives and bridge work.

Outside of their splendid shipyards, there are probably no industrial establishments in which the English take greater or more justifiable pride than in the great locomotive shops from which the railroad system of England has been hitherto exclusively supplied with its motive power. To have first one and then another of its great trunk roads place an order for a score of first-class locomotives with a foreign firm has, therefore, produced a degree of surprise and misgiving which no subsequent explanations by the directors have been able to allay. The suspicion that foreign invasion of exclusive markets had commenced in earnest was deepened into conviction when, a few weeks later, the British government awarded to an American firm the contract for a bridge to be built on the line of the new railroad in the Soudan.

It is not enough to say that the sending of these orders abroad was due to the fact that English firms are crowded with work, some of which represents long-standing orders that were delayed by the great engineering strike, the rest being due to the remarkable era of prosperity in that country. This may have been the occasion, but it is not the cause. The cause lies deeper than any accidental shortage of locomotives on an English road or the military exigencies of the Soudan campaign. These may have hastened the insertion of the thin end of the wedge of competition, but they are not to be mistaken for the power which day by day will drive it home. The strength of American competition lies in the quality and low cost of our finished product, and in our ability and willingness to adapt it to the needs of the buyer, and to deliver it to him in so much less time than our competitors.

At the same time our success in foreign markets is not due merely to the fact that in many lines we can undersell our competitors. It was not the fact that our locomotives are from $2,000 to $3,000 cheaper than the English locomotives or that the Soudan bridge could be delivered at so many cents a pound less by an American firm that brought the orders here. We won those contracts because of our ability to promise prompt and early delivery, and this element of speed is only one among several which will give us a commanding position in every market of the world before many years pass by. The secrets of our success may be summed up categorically as follows:

1. We study the wants of each particular market and try to accommodate our products to the needs of the purchaser. On the other hand the English manufacturers demand that the market shall accommodate itself to the goods.

2. The design, manufacture, and finish of our commodities are governed by considerations of utility first and last. The finished article, whether it be a lock or a locomotive, must be pre-eminently useful. It must do its work quickly, and with the least possible care and expense to the user. If we secure these features of handiness and durability in the highest degree, we care very little how cheap a material is used, or how small an amount of finish for mere appearance sake is put upon the finished article. We realized long ago that cheap cost is not synonymous with weakness, nor mere weight with strength, nor polish with practical utility. We substitute wood for iron, cast iron for steel, and steel for the costly alloys when we are once satisfied that the cheaper material will serve the purpose equally well.

3. Capital and labor in America are both agreed that there is mutual profit in the substitution of the machine for the man wherever it is possible. Automatic and semi-automatic machinery cheapens the product, increases the demand, and so gives employment to five men for every one that it displaces. In England the operative, misled by the pernicious teachings of the trades unions, believes that the introduction of the labor-saving machine means the extinction of the mechanic. The result is that, while his American brother gets all he can, the English operative gets the least he can, out of the automatic machine.

If we were asked to name the cause which above all others is contributing to our success, we would point to the foregoing.

4. Our manufacturers realize the important economies which result from thoroughly systematized management. The clerical force, the draughting offices, and the shops are organized with a careful attention to detail, and are run in many cases with a strictness of discipline which is military in its order and method, and more than military in its accomplished results. The work is highly specialized, and its progress through the shops from the raw material to the finished product is so arranged as to avoid delay and enable it to pass from bench to bench and from department to department with the least amount of rehandling.

5. While our manufacturers aim to meet the demands of particular localities, they endeavor, as far as possible, to standardize their work, with a view to building for stock and keeping a surplus on hand to meet a sudden demand. We have carried this practice into fields in which our European competitors have never attempted to apply it. There is no valid reason why locomotives and (in the smaller sizes) bridges should not be sold out of stock, as well as lathes, reaping machines, or bicycles. They vary in size, shape, and capacity, and in proportion as the trade of our great industrial establishments extends, the risk of keeping such costly material in stock is lessened, while its value from a competitive point of view is immeasurable.

One of the English firms whose bid on the Soudan bridge was rejected on the ground of delay, declared that only a bridge-building firm that kept bridges in stock could guarantee delivery in the time proposed by the successful American firm. While this is not true, our excellent system of building to standard designs and with standard shapes gives us an unquestionable advantage in competitive bidding.

The performance of these American locomotives on the Midland and Great Northern railways will be watched with keen interest by the English master mechanics, or locomotive superintendents, as they are called over there. If they are only approximately as economical in fuel and durable under hard service as English locomotives of equal hauling power, their cheap cost and the rapidity with which they can be delivered will either make them the pioneers of many more to follow, or produce a radical change in the appearance and cost of the home-made English locomotives.

ECHOES OF THE WINDSOR HOTEL FIRE.

It is characteristic of the rush and ready forgetfulness of the times that the horrors of the Windsor Hotel fire should already have ceased to occupy the public mind. There are three or four thousand guests in similar fire traps (there are many of them) in this city, who are living contentedly in brick and timber hotels that would probably immolate a large proportion of their inmates if they should once become well ablaze by day or by night. It is impossible to believe that these people are conscious of the hourly risk they run, or the simplest instincts of self-preservation would cause an early emigration to the modern fireproof buildings, which, while they might not live fully up to their name, would at least be so far slow-burning as to afford time for the escape of the guests.

But although the inmates of these older hotels may have forgotten the awful object-lesson of the Windsor fire, there are others, such as the hotel proprietors and the members of the fire and building departments, who do not forget, and surely will not be so criminal as to ignore this latest warning. If "the life of a man is worth more than that of a sheep," we shall surely see some early steps taken to protect the inmates of the many non-fireproof hotels referred to. The least that can be done is to provide some speedy and reliable means of escape from the building, for it may as well be taken for granted at once that a six or eight story hotel with hollow wooden floors opening into hollow wooden partitions, when once ablaze, will burn like kindling wood or a Fourth of July tar barrel.

The late fire has shown once more the inadequacy of the stereotyped means of escape. It takes an athlete to descend a rope, and the aged and sick are helpless on balconies and fire escapes; internal stairways and elevator shafts are so many great flues impassable for smoke, if not for flame; and smoke and fire belching from outside windows frequently render the ordinary outside fire escape impassable. It is probable that more victims are overcome by smoke than by flames. It is the all-pervading smoke that so quickly renders useless the various means of escape both within and without the building.

What is needed is some independent stairway or elevator shaft, external to the building, and having no direct connection with the building through which fire and smoke can enter. This emergency shaft could be built either within or outside of the main walls of the building, provided that the openings at the different floors led out on to balconies on the outside of the building and there was from cellar to roof absolutely no direct opening from the building to the shaft. If this shaft were constructed of fireproof brick and with hollow walls, the elevators and stairways within it could be used even while the interior of the building was a seething furnace. At each floor there should be a door through the side walls of the building, if the shaft were on the inside, or through the wall of the shaft remote from the building, if it were on the outside, each door leading onto a balcony communicating with each of the rooms or passageways on that side of the house. In the case of new buildings, the designs should be so drawn that the walls in the immediate neighborhood of the emergency shaft should be windowless. At the ground floor a fireproof passageway should communicate directly with the street.

Now, with regard to the older fire-trap hotels existing in this and other cities, it is evident that these fire escape shafts could now be built against the rear walls in positions where they would not mar the architectural appearance of the buildings. Two such additions to the Windsor Hotel, with connecting balconies on three sides at every floor, would probably have enabled every victim that was shut out by fire and smoke from the interior elevators and stairways to escape. There is certainly every reason why shafts should be built against the rear walls of every important hotel of the older class and the necessary connecting balconies added.

It is true the inconvenience and cost would be considerable, and the balconies would be somewhat unsightly—though it would not be necessary to use them on the main front—but we have yet to learn that the buildings in question have so much architectural beauty that an iron balcony more or less would materially alter the effect.

We commend this suggestion, which comes to us from Mr. C. Baillairge, a civil engineer of Quebec, who has devoted many years to the advocacy of better means of escape from fire, to the notice of the building and fire departments of this city. If "the life of a man is worth more than that of a sheep"—which many people seem to doubt—it is surely well worth while to enforce the erection of this, or, if such can be found, some better way of escape from fire, in connection with the older hotels with which our large cities abound.

NAMING THE NEW WARSHIPS.

The warships authorized by the recent naval appropriation bill have been named by the Secretary of the Navy as follows: The three battleships, which are to be of 13,500 tons displacement and 18½ knots speed, are to be known as the "Pennsylvania," the "New Jersey" and the "Georgia;" the 12,000-ton cruisers will bear the names of "West Virginia," "Nebraska," and "California," while the six 3,000-ton protected cruisers will be known as the "Denver," "Des Moines," "Chattanooga," "Galveston," "Tacoma," and "Cleveland."

It is provided by law that the battleships shall be called after States, and the cruisers after towns. It was in accordance with this provision that our first two armored cruisers, the "Brooklyn" and the "New York," were named after cities; but it will be noticed that the new cruisers of this class are to take the names of States. This is more agreeable to the size and fighting power of these vessels, which actually have more in common with the battleship than with the cruiser. It is certainly proper that the names carried by our warships should be representative of their size and importance, and the trend of later designs shows that the battleship and the cruiser are destined before long to merge into a common type.

In this connection we think the selection of the names of States for the three little monitors "Florida," "Wyoming," and "Connecticut" is greatly to be regretted, particularly in view of the fact that giving the names of States to armored cruisers as well as to battleships will so much the sooner exhaust the list of available names, of which twenty-one out of a total of forty-five have already been appropriated. It would have been better, we think, to have named our monitors after famous admirals, particularly as there is a historical fitness in giving the names of Farragut, Porter, and others of their day to a type which originated in the stirring times which made these men famous; but inasmuch as these names have been given to the torpedo boats, would it not be well to continue to name this class after famous Indian chieftains or tribes, as was done in the case of the early monitors? Such names as Miantonomoh, Monadnock, and Canonicus appeal to us both for their euphony and strong historic interest.

A RECORD TORPEDO BOAT TRIAL.

The builders of the new cup challenger, the "Shamrock," have just completed a torpedo boat which has broken all records for an official trial trip by making a speed of 33 knots an hour. The "Albatros" is one of five sister vessels completing for the British government, whose contract speed is set down at 32 knots. She is of 360 tons displacement and her engines are designed to develop 7,500 horse power. In our own navy the vessel that most approximates to her is the torpedo boat "Stringham," of 340 tons displacement, 7,200 horse power, and an estimated speed of 30 knots. Thirty-three knots, while it is the highest speed attained at an official trial, is not the highest speed ever attained, the "Turbinia" having steamed 35 knots, and the "Hai Lung," a torpedo boat built by Schichau for the Chinese government, 35·2 knots an hour in private trials, the last named standing as the fastest speed ever made by any type of vessel.

LIQUID AIR AS A NEW SOURCE OF POWER—ANOTHER ENGINEERING FALLACY.

BY PRESIDENT HENRY MORTON, PH.D., LL.D., SC.D.

During 1894-95 the present writer prepared two articles under the title of "Engineering Fallacies," which were published in the Stevens Institute Indicator, vol. xi., pp. 273-294, and vol. xii., p. 125.

Since that time, though several new forms of what might be termed in a general way "Perpetual Motion Schemes" have appeared, none of them has seemed of sufficient importance to warrant any special notice, but in the March number of McClure's Magazine there is published an article entitled "Liquid Air—a new substance that promises to do the work of coal and ice and gunpowder, at next to no cost," which is so eminently calculated to mislead the general reader and even to become the basis of financial frauds, like that of the Keely Motor, that it would seem a duty to draw attention to the fundamental errors in scientific principles and in statement of facts which this article contains.

This McClure article may be fairly considered as made up of two prominent elements or parts, one of which is the statement of certain things as facts which, as I shall presently show, cannot possibly exist and are inconsistent with other facts stated in the same article and known from other sources to exist as so stated; while the other main element consists of rather vague statements concerning general principles which, though in a general sense true, yet as here used are calculated to cover up or befog the too obvious inconsistencies of the statements of facts with the established principles of science.

As an example of the first element, we find on page 400 as follows: "I have actually made about ten gallons of liquid air in my liquefier by the use of three gallons in my engine." This I shall presently show is simply impossible and inconsistent with data given elsewhere in this article and known to be substantially correct.

A sample of the other element is found on page 399, in the following:

"That is perpetual motion, you object. 'No,' says Mr. Tripler sharply; 'no perpetual motion about it. The heat of the atmosphere is boiling the liquid air in my engine and producing power exactly as the heat of coal boils water and drives off steam. I simply use another form of heat. I get my power from the heat of the sun; so does every other producer of power.'"

This, while true as a general statement of what might be done on an impractical scale, is not correct as here used to imply that in his experiments Mr. Tripler actually derives or can derive any adequate amount of energy from the heat of the atmosphere or in that sense directly from the sun. This I shall show later, but will first take up the statement that three gallons of liquid air have supplied or can supply the power to liquefy ten gallons.

On pages 402 and 403 of the McClure article we are told that Mr. Tripler uses to make his liquid air a steam engine of 50 horse power and that with this he can make liquid air at the rate of 50 gallons a day. This I know, from other sources, is substantially correct, and means that each horse power in a day (say 10 hours) makes 1 gallon of liquid air. In other words, 1 gallon for 10 horse power hours.

It is again stated in this article on page 405 that a cubic foot of liquid air contains 800 cubic feet of air at ordinary atmospheric temperature and pressure, or, in other words, any volume of liquid air, if adequately heated, will expand 800 times in reaching atmospheric temperature and pressure. This also is substantially correct.

We may remark in passing that this is nothing wonderful; for water, when expanded into steam at atmospheric pressure, increases about 1,700 times in volume, or more than twice as much as liquid air.

Now if we apply to the above data the well known and universally accepted formula for the maximum work done by air when expanded at constant temperature,

$$W = p_2 v_2 \text{ hyp log} \frac{v_2}{v_1}$$

we find that a pound of liquid air in expanding 800 times would develop about 190,000 foot-pounds of work. As a gallon of liquid air weighs about 8 pounds, this would give eight times as many foot-pounds, or 1,520,000. If this work were accomplished in an hour, it would represent almost exactly three-fourths of a horse power, because one horse power means 1,980,000 foot-pounds of work per hour, and 1,520,000 is only a trifle over three-fourths of this.

From the above it follows as a matter of absolute certainty that the maximum power which liquid air could develop in an ideally perfect engine without any loss from friction or other cause would be three-fourths of a horse power for an hour for each gallon of liquid air expended.

We have seen, however, that with his 50 horse power plant, which on account of its size should operate with considerable efficiency, Mr. Tripler makes only 1 gallon of liquid air with 10 horse power hours. In other words, he requires to make a gallon of liquid air twelve times as much power as a gallon of liquid air could possibly develop in an ideally perfect engine.

In face of this, how supremely absurd is the statement that with a little engine such as the pictures and descriptions in the McClure article show, lacking all conditions for efficient working, Mr. Tripler can make 10 gallons of liquid air by the use of three.

Turning next to the statement about using the heat of the atmosphere to develop mechanical energy or work, let us put this to the test of a quantitative example.

Assume the temperature of Mr. Tripler's laboratory to be 70° F. and that he has an abundant supply of water at 50° F. These will be of necessity the limits of work he can get out of the atmosphere, because any lower temperature is only secured by doing work and so expending energy which will be at least equal to the power obtainable from the use of such lower temperature. All the work that can be obtained for nothing is that which nature will freely give in the warm air and cool water, supposing both to be supplied freely without charge.

The 20° F. which we may assume as being possibly taken out of the air by the cool water will represent the maximum gift of nature in this shape of "power costing nothing." Now, 42 British thermal units or pounds of water changed 1° F. per minute will represent one horse power, and as the specific heat of air is about one-quarter that of water, we should need four times as many pounds of air to produce the same effect. This would call for 168 pounds of air changed 1° F. If, however, the air is changed 20° F. in place of 1° F., we need but $\frac{1}{20}$ or 8·4 pounds of air parting with 20° F. each minute, to give us 1 horse power at 70° F. For "round numbers," let us say 8 pounds. Now, a pound of air has a volume of about 13·3 cubic feet. Call this also, for "round numbers," 13 cubic feet, then 8 pounds of air would be about 104 cubic feet, and this volume of air would have to part with its 20° F. heat each minute to the apparatus, in order to develop one horse power. For a 50 horse power engine fifty times as much air would be required, or 5,200 cubic feet each minute; this would be the contents of a room 26 × 20 feet on the floor and 10 feet high, which would have to be drawn through the apparatus each minute in such a way as to completely yield its 20° F. between 70° F. and 50° F. What sort of a boiler or heat-absorbing apparatus can we imagine which would absorb from air at 70° F., 20° F. of its temperature while the said air was passing through it at the rate of 5,200 cubic feet a minute?

It would surely need to be "as big as a house," to use a familiar phrase.

This also, be it remembered, makes no allowance for loss by friction, eddy currents, and the like, which would be enormous, nor for the power to put this air in motion.

Obviously, such a machine would be simply huge in size, and, indeed, the friction involved in it would probably use up a large part of the power it could develop.

Suppose, however, that it could be built and operated in place of Mr. Tripler's 50 horse power steam plant. Its entire output would be 50 gallons of liquid air a day, and this, as we have seen, could only develop in an ideally perfect engine ¾ horse power for an hour for each gallon or 3¾ horse power for a day of 10 hours.

This does not look as if heat obtained from the atmosphere and operating an engine by aid of liquid air is likely to become a dangerous rival to the coal mine.

On page 402 of the McClure article it is stated that Mr. Tripler makes his liquid air at a cost of twenty cents a gallon.

We have shown above that the maximum power obtainable from this liquid air, by heating it to ordinary atmospheric temperature, is ¾ of a horse power hour. This, at twenty cents, would be vastly more expensive than power derived from an ordinary steam engine, whose cost ranges from less than one cent per horse power hour under the best conditions to three or four cents, where a profit is included, or the conditions are less favorable.

The really difficult thing to explain in connection with this McClure article on Mr. Tripler and his liquid air, is how those concerned in its publication (being as I do not doubt honest men) can be deceived or have so deceived themselves as to make and repeat such obviously impossible statements.

In this connection, however, I will make a suggestion founded on experience.

Some years ago I was called upon to examine an engine operated with liquid carbonic acid, which was said to have ten times the efficiency of an ordinary steam engine.

I of course told the applicant that such a thing was physically impossible and did not deserve investigation, but, finding that a number of substantial people had been so impressed by what had been shown them that they would not be satisfied without an investigation, I consented to make one. This proved an easy piece of work. I found that the promoters and others were under the impression that a horse power was measured by the raising of 33,000 pounds one foot high irrespective of time, and in their demonstrations were contented with showing that their engine did this amount of work in ten minutes. As, however, a horse power involves the raising of 33,000 pounds one foot high in one minute, it was obvious that the power shown by the carbonic acid engine was $\frac{1}{10}$ of a horse power and not one horse power, as those exhibiting the engine claimed.

This, of course, explained the situation. An engine developing $\frac{1}{10}$ of a horse power might easily require only $\frac{1}{10}$ as much fuel as an ordinary steam engine developing 1 horse power, without violating any of the established laws bearing on this subject. The curious thing was that such people as were concerned in this matter should have been misled on such a simple and elementary subject; but if they were, as I personally know, so misled, why may not Mr. Tripler and his friends be in a similar case?

I could give from my own personal experience many like examples, but have said enough for the present to make it evident that what is claimed in this McClure article as a new source of "power which costs nothing" is not founded on fact, but is probably the result of some oversight in observation or calculation not inconsistent with honesty of intention.

THE NEW SATELLITE OF SATURN.

Prof. William H. Pickering, as the discoverer of the new satellite of Saturn, suggests that the name "Phœbe," a sister of Saturn, be given to the new satellite. Three of the satellites, Tethys, Dione, and Rhea, have already been named for Saturn's sisters, and two, Hyperion and Iapetus, for his brothers. The direction of the motion, which is toward Saturn, shows that the apparent orbit is a very elongated ellipse and that it lies nearly in the plane of the ecliptic. Prof. Asaph Hall has pointed out that this is to be expected in a body so distant from Saturn. The attraction of the latter only slightly exceeds that of the sun. Hyperion appears as a conspicuous object on the plates which have been taken by direction of Harvard College Observatory, and the new satellite appears about a magnitude and a half fainter on each. As seen from Saturn it would appear as a faint star of about the sixth magnitude. Assuming that its reflecting power is the same as that of Titan, its diameter may be about 200 miles. It will, therefore, be noticed that while it is probably the faintest body yet found in the solar system, it is also the latest discovered since the inner satellites of Uranus in 1851. Prof. James E. Keeler, director of the Lick Observatory, says: "Considering the extreme faintness of the satellite and its great distance from Saturn, it is not surprising that this discovery was not made by visual observation. With a great telescope directed to Saturn the satellites would be far beyond the limits of the field."

The last discovery of a satellite of Saturn was made in September, 1848, by Prof. W. C. Bond, then director of Harvard College Observatory, and his son, Prof. George P. Bond. The satellite Hyperion was seen by his son September 16 and 18, but its true character was first recognized on December 19, when its position was measured by both father and son. Soon after it was discovered independently by Laselle at Liverpool.

PROGRESS OF THE ZOOLOGICAL PARK.

Two new buildings are rapidly nearing completion in the grounds of the new Zoological Park. These are the reptile house and the winter house for birds. The Park Department is also constructing walks and roads and is laying sewer and water pipes. Much work has also been accomplished upon the various outdoor animal dens. In a hollow in the park is a body of water which will be utilized for aquatic rodents. The beaver pond is also ready, while up on the elevated portions among the rocks work on the bear dens is well under way. Owing to the configuration of the park, many of the outdoor inclosures need but little changing beyond fencing in. The work on the buffalo house is rapidly progressing.

THE English Society for Checking the Abuse of Public Advertising, or "Scapa" as it is called for short, has approached the Chancellor of the Exchequer with the suggestion that exposed advertisements should be taxed, contending that a moderate impost would tend to greatly reduce the volume of displayed advertisements without causing any real loss or hindrance to legitimate forms of advertising. The Chancellor replied that he could only regard the matter from the point of view for revenue, and he could not see on what ground the tax on advertisements could be defended unless newspaper advertisements were included.