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LIQUID AIR PROMOTION AGAIN.

We had occasion some months ago to refer to the unblushing attempts which were being made by so-called Liquid Air Companies to entice the public into the purchase of their stock. The storm of criticism which was leveled at these concerns by the technical press of the country caused the promoters to take to cover, with the welcome result that for the past few months the columns of the daily press have failed to be disfigured with the familiar liquid air advertisements.

It is evident, however, that "the snake was scotched, not killed," and that liquid air victims are as easily caught as liquid air profits are readily realized by the promoters. Not content with the Boston experience, the liquid air conspiracy has again taken the field, this time choosing New York city as the center of its operations. It is evident that the organizers of the latest "Company" are satisfied that the name of "Tripler" is one to conjure with in drawing the dollars from the pockets of the unsuspecting and all-too-little-informed investor. We have never hesitated to give Mr. Tripler every credit for his perseverance and mechanical ingenuity, and as the first gentleman to manufacture liquid air in commercial quantities in this country he deserves all praise. But when he lends his name to such a ridiculous and impossible statement of the uses to which liquid air may be put as appears in the latest advertisements of the company which bears his name, he is evidently tearing down with his left hand the reputation he has built up with his right.

We are compelled to take up this subject in our columns in order to answer the large number of correspondents who have written to this office asking for advice before they subscribe to the stock of a concern so full of alluring promises of profit. It is our conviction that liquid air has never made a dollar for its investors along the lines which are indicated in the advertisements of such companies as the one in question. We recommend any of our readers who are contemplating the purchase of liquid air stock to read carefully the contribution, on the accompanying page, from Mr. Hudson Maxim, who by the way, is quoted in the prospectus as one of the consulting engineers of the Tripler Liquid Air Company. Of the many claims made, there is one which is alone sufficient to stamp the whole scheme as being either of a very dubious character, or based upon a complete ignorance of the elementary laws of physics. In answer to the claim that "the use of liquid air in the generation of power on land and sea will reduce the cost to one-half of that now paid," Mr. Maxim shows that the "Teutonic" would have to carry for a seven-days' voyage more than enough liquid air to float the vessel itself, and that the cost for a single trip across the ocean would be a mere nominal sum of $174,560, this being the amount that it would cost to save about a half of the coal bill.

While it may be possible to find a commercial use for liquid air in the field of explosives along the lines indicated by Mr. Maxim, it would require a veritable boom in the sale of liquid-air cartridges to pay for the trip of one liquid-air-propelled "Teutonic." While it does not come within our province to advise correspondents who have written us whether they should or should not invest in liquid air companies, it is strictly within our province to warn them that many of the claims that are made by these companies are impossible and ridiculous.

THE CONSTRUCTION OF WARSHIPS AT GOVERNMENT NAVY YARDS.

A hearing on the question as to whether it is expedient that warships should be constructed at the Brooklyn Navy Yard is now being held before the House Committee on Naval Affairs. An influential committee of Brooklyn citizens, in which is included the former master machinist of the Brooklyn Navy Yard, is presenting a very strong case in favor of such construction, and there is no denying that the proposal thus put forward of the highest importance, touching as it does the whole question of the future growth and efficiency of our navy. Chief Naval Constructor Hichborn is favorable to the construction of naval vessels in the Government's yards, and in this he is earnestly seconded by Naval Constructor Bowles, who for many years past has been an earnest advocate of this policy. Mr. Bowles has had personal supervision of the building of some of our most important ships, and is particularly well qualified to judge of the somewhat complex question as to whether the Government yards can compete successfully with the well-equipped establishments at Philadelphia, Newport News, and San Francisco.

Before presenting the arguments in favor of the construction of vessels in the Government's yards, it is necessary to consider the rather disconcerning fact that the warships already constructed at the navy yards have cost considerable more than those which were built by private firms. If we take the two battleships, "Texas" and "Indiana," we find that the former which was constructed at the Norfolk navy yard, cost per ton of finished vessel, $819.97, whereas the "Indiana," built by the Cramps, if we include a claim for damages due to delay in supply of armor of $483,000, cost $724 per ton. The increased cost of the government-built vessel is explained by the abnormal conditions under which she was constructed, conditions which were so adverse as to render it surprising, not that the difference in cost was so great, but that it was not greater. In the first place, when, in 1889, the "Texas" was ordered built at Norfolk, that navy yard was practically without tools to do the work. Not a single vessel had been constructed there for twenty-five years, and at no time in its history had a ship been built there of iron or steel. The existing plant was merely such as was necessary for the construction of wooden vessels, and anyone who has visited a shipbuilding yard of the latter type will understand how serious a task confronted the naval constructor who was told to go ahead and build an intricate modern battleship in such a place, and with such a "plentiful lack" of facilities. The problem was not merely to build a ship, but to build the necessary tools as well—a complication which enormously increased the cost of the vessel.

In the second place, to these technical difficulties were added others of a political nature. On the day on which the construction of the "Texas" was begun, the naval constructor in charge received notice that eleven new foremen had been appointed on the work and it was found that not one of these political heelers had the slightest knowledge of the art of shipbuilding. If matters were unfavorable at Norfolk, they were even worse at the Brooklyn yard, where in 1888, the construction of the "Maine" was commenced; for it was a hotbed of political corruption, and was even more devoid than Norfolk of facilities for the construction of a modern warship. At both these yards the creation of a shipbuilding plant and the education of a large body of mechanics and foremen, coupled with the exasperating delays of a cumbersome system of red tape in the administration of the yards, was answerable for costly delays in the completion of the two ships, seven years intervening in the case of the "Maine," from the date of laying her keel to the date of her first commission. In view of these facts it is surprising that the government-built vessels should have come as close in cost as they did to the ships built in private and well-equipped yards which were entirely free from the encumbrances above noted.

It is the unanimous opinion of our corps of naval constructors that if the yards at Brooklyn, Norfolk, and Mare Island always had one or more warships upon the stocks, it would be possible to turn them out at the same, and probably at somewhat less cost, than that of the ships which are built by contract in private yards. Granting then that the ships could be turned out merely at the same cost, the question arises as to what advantages are to be gained by construction in the Government's yards? The following are the chief advantages among many:

Firstly.—At present the yards are occupied merely with repairs and refitting. As this work is intermittent, the force at the yards is constantly changing, and during the slack seasons more or less of the costly plant is lying idle. To prevent this and to retain the services of skilled operators there is an instinctive tendency to prolong repairs and tide over to a busier season. If there were always two or three ships on the stocks, the whole plant would be regularly employed. It would then be possible to maintain a thoroughly efficient and permanent organization at the yard with considerable resulting economy. At the Brooklyn yard, for instance, it is possible to employ at present 4,000 men in the construction department alone, and with comparatively slight addition to the plant it would be possible to employ 6,000 men.

Secondly.—The construction of warships at the yards would offer a valuable opportunity for training a corps of efficient inspectors for overseeing the construction of government vessels that are built by contract. There is a great demand for young men who are competent to oversee contract work, and they would easily pick up in the government yards the necessary experience.

Thirdly.—The high class of work done in the government yards would act favorably in competition with private work by setting a high standard of workmanship. While it is true that in some of the government-built vessels, as in those constructed by private contract, there have been defects of design, there has never been any complaint of faulty workmanship in the government-built vessels, all of which has proved to be of first-class and thoroughly durable character.

Fourthly.—While it is the belief of naval constructors that ships could be built at least as cheaply under existing conditions, they are satisfied that if badly needed reforms were made in the cumbersome and expensive methods of administration of the yards, it would be possible to effect a still further and considerable reduction in the cost per ton of navy-built ships. One of the most expensive, and certainly the most exasperating of the present red-tape methods, is the regulation which requires that bids shall be asked for the supply of any material, even in small quantities, that may be required at the navy yards. This results in frequent and very costly interruptions and delays in the work. It is a well known fact that other things being equal the cost of a ship decreases in the exact ratio of the speed with which it can be built; in other words that it pays to "rush" the construction. The quickest built ship will be the cheapest.

Fifthly.—That navy yard construction of warships would have distinct advantages in economy over that carried on in private yards, is due to the fact that there would be no charges for depreciation or interest on the money invested, and that there would be no charges for administration, professional oversight, drafting and clerical work, the expenses of which are carried by other appropriations. Again, the navy yards do not have to reckon in profits, and it would not be necessary for them to add the large percentage which a constructor must include his total estimate of cost.

Sixthly.—By keeping in check any tendency for a combination among the constructors to place their bids at unreasonable figures, the continual turning out of government-built ships, at a reasonable cost per ton, would constitute an excellent safeguard of the interests of the nation.

Lastly, if the proposed measure is carried out, not merely with regard to the Brooklyn yard, but to the others mentioned, the total warship-building capacity would be doubled at a stroke—a consideration which of itself should be sufficient to induce Congress to take favorable action on the question. The enormous increase which is being made in the navies of the Continental powers, whose interests in the great commercial war of the day are bound to come into violent conflict with our own, should be a warning to us to stand ready to double, if necessary, our present rate of output of war vessels. At a comparatively slight expense it would be possible to add the navy yards at Brooklyn, Norfolk and Mare Island to our all too small list of available warship-building yards.

THE WORK OF THE DIVISON OF CHEMISTRY OF THE DEPARTMENT OF AGRICULTURE.

The work of the Division of Chemistry of the Department of Agriculture, which is under the direction of Dr. H. W. Wiley, is of great importance. The old quarters of the division have been found to be totally inadequate for its increasing labors, the old building was vacated and temporary quarters were found for the force, and much of the material and apparatus as was necessary for the work was transferred to Columbian University during the summer, and the laboratory work was even carried on after the regular laboratories had to be turned over to the students. In spite of the inadequate laboratory facilities for and delay in getting into the new building, a great deal of work was done during the fiscal year ending January 30, 1899. The association known as the Association of Official Agricultural Chemists has been in existence for about fifteen years and is composed primarily of chemists of agricultural experiment stations and agricultural colleges and it also admits to memberships all chemists employed in the control of food products by any State or municipality. The meetings of the association are held under the auspices of the Department of Agriculture and its work has thus assumed a degree of authority which may be regarded as official. The methods of analysis adopted by this association have been legalized by the courts in various parts of the country. The Division of Chemistry co-operates with the association in its valuable work. The reports of the association are issued as bulletins of the Division of Chemistry. The chief work of this kind which is accomplished during the past year was the revision of the entire methods of analyses of the association on all of its subjects, and this bulletin has been recognized as an authority in all parts of the world, and its contents has been reprinted in most of the languages of science. The effect of this organized effort on the part of agricultural chemists has been so pronounced as to induce other nations to follow the example which this country has set. It is to be hoped that Congress will see its way clear to acknowledge the association to be an official advisor of the government, or by recognizing it in some way as by a vote for supplies. At present it has neither treasurer nor funds.

The study of soils under identical conditions, as illustrated and described in the SCIENTIFIC AMERICAN for December 3, 1898, has been carried on, and the results may be regarded as important. By far the greater part of the force of the division during the past fiscal year has been employed in the investigation of food products. The particular subject of food study which has been investigated is the preservation of meat by sterilization, otherwise known to commerce as "canned corn beef" and "canned roast beef." The scope of the investigation has been twofold. In the first place, the chemical composition and nutritive value of the meats have been determined. The results of this investigation has been to supply us with a definite idea of the food value of all the various products which have been examined carefully, and systematic research has been made for preservatives of all kinds which may have been used in or on these meats. Investigations have been also carried on in the culture of sugar beets and the production of beet sugar. Many thousands of samples have been received and careful analyses have been made, the results of which work were valuable in defining with greater accuracy the lines of the most successful beet culture in the country.

FACTS VERSUS CLAIMS FOR LIQUID AIR.

BY HUDSON MAXIM.

Liquid air is such a strange substance and so readily lends itself as a plaything for the imagination as well as for the hands, that many have been ready to believe the most absurd things concerning it. When it was first discovered that air could be liquefied, it was so very expensive as to preclude any serious considerations of its usefulness except as a scientific curiosity. But when Tripler showed that it could be produced by the gallon, and at low expense when compared with its cost by earlier methods, the question naturally arose concerning its commercial value.

So extraordinary are some of the claims which have been made for liquid air as a motive fluid, that the public eye is beginning to look askance at its mere mention in connection with any commercial application. This is unfortunate, both for the public and for the promoters.

Ignoring propositions for the production of perpetual motion by liquid air, which have been made and exploded, let us consider claims which are now being made by advertisers in the public press, from which I quote the following:

> "The use of liquid air in the generation of power on land and sea will reduce the cost to one-half of that now paid for steam power. This statement carries its own argument, and needs no elaboration."

> "In the production of motive power, liquid air has a wonderful future as a fuel saver. Liquid air, after a short exposure, loses most of its nitrogen (the chief obstacle to combustion), and the resultant oxygen used in connection with carbon (coal, coke, etc.) produces perfect smokeless combustion, avoiding the large percentage of loss now incurred in the use of fuel."

Liquid air is not a magic wand by which miracles may be wrought, and yet it is hard to see how, without the enlistment of the miraculous, such results can be accomplished.

Examining the first of these claims, let us compare liquid air with steam as a motive fluid, under like conditions, in a triple expansion marine engine. It is common for such an engine, with 250 pounds steam, to produce a horse power hour for every 1½ pounds of coal consumed. Now, suppose we were to substitute liquid air for the water. We should still require boilers for its evaporation, and to make it as economical as possible, let us assume that we heat it to the temperature of steam at 250 pounds pressure; in other words, to 406° F. It must be assumed that the air is to be expanded 4½ times, which is the average ratio of expansion in compound triple expansion engines at the present time. To determine the weight of any motive fluid required for 1-horse power hour, we have the following formula:

$$W = 183{\cdot}45\ T \left(1 - \left(\frac{T''}{T'} \times \frac{T'}{T}\right)\right),$$

in which W is the work in foot-pounds, T is the initial temperature, T′ is the temperature after expanding to do work, and T″ is the temperature after expanding from the last temperature to atmospheric pressure. (Clarke's Manual of Rules, Tables, and Data, page 909.)

Solving the above formula, the result obtained is 78,607·6 foot-pounds, as the energy in 1 pound of air at 250·3 pounds pressure, and 406·2° F. temperature.

Therefore, 1-horse power hour would consume 1,980,000 ÷ 78,607·6 (foot-pounds in 1 pound of air) = 25·19 pounds of liquid air. It would take 0·7 of a pound of coal to evaporate this amount of air and superheat it to the temperature of saturated steam at 250·3 pounds pressure (406° F.). Hence, we should need nearly half as much coal per horse-power hour for the air as for water. By any means now known which could be employed on shipboard, the amount of heat which could be absorbed from the air and water and utilized would in practice be a negligible quantity. As air could not be re-condensed like water, we should be obliged to load up with enough liquid air to last the whole voyage without re-condensation.

The engines of the "Teutonic" develop about 20,000 horse power. This would require 242 tons of liquid air per hour, 5,829 tons per day, and 40,807 tons for a seven-days' voyage, considerably more than enough to float the vessel.

Some have made the claim that liquid air can be made as cheap as 2 cents per gallon. Let us assume, for argument sake, that such be the cost. This would be $4.28 per ton, and liquid air enough to take the "Teutonic" across the ocean would cost $174,560. In other words, it would cost this sum to save about half the coal bill.

This is, of course, without taking into account the additional horse power which would be required to carry the enormous cargo of liquid air necessary.

Referring to the second of the claims above quoted, it requires about 2⅔ pounds of oxygen to burn 1 pound of carbon. Air contains 22·92 per cent, or, roughly, 23 per cent of oxygen. A gallon of liquid air weighs about 9·351 pounds, 2·143 pounds of which is oxygen. If the nitrogen were separated so that all of the oxygen were saved, and if this could be done without expense, and if liquid air could be produced for 2 cents a gallon, then the oxygen would cost 0·9333 cents per pound, or $18.67 per ton. Now, let us assume that the coal costs $3 per ton. It would, therefore, cost $49·80 to save $3 worth of coal.

In regard to the value of liquid air for refrigerating purposes, of course much will depend upon the cost of its production. The latent heat of liquid air as calculated from data given by Sloane is 140 heat-units. As the specific heat of air is 0·2377, it would require 81·91 heat-units to raise 1 pound of air from its boiling point to the freezing point of water, or to the temperature of melting ice: 81·91 heat-units added to 140 heat-units = 221·91 heat-units. As the latent heat of ice is 144 heat-units, liquid air has a frigorific value above ice of 77·91 heat-units per pound. Yet, ice has many advantages above liquid air, not the least of which is its power to maintain adjacent bodies at the freezing point without actually freezing them.

For the preservation in transportation of substances which would not be injured by freezing, and by reduction to an exceedingly low temperature, liquid air might have an especial value in the saving of freight on ice, particularly when such substances contain a very high percentage of water. This is a proposition which I have never seen discussed, and it may, perhaps, be worthy of consideration. Let us take, for example, beef, which contains such a high percentage of water that we may consider its specific heat when frozen, as that of ice. The meat could be placed in a bath of liquid air before packing for shipment, and its temperature reduced to 313° below zero Fah. The specific heat of ice being 0·504, and the temperature of liquid air below zero Centigrade being 344·6° F., we have 344·6 × 0·504 = 174 heat-units. It would, therefore, require about 20 per cent more heat to raise the temperature of a pound of beef up to the melting point of ice than would be required for melting a pound of ice. Hence, the beef could be made to carry its own cold, as it were, and without the use of additional ice. This might be a means of saving considerable freight, as I have said. Yet, we must take into account that the rapidity with which heat is radiated or lost is as the square of the difference in temperature of bodies, and it would be necessary to carefully insulate articles so refrigerated for shipment.

With regard to the use of liquid air for internal combustion engines or explosion motors, it is estimated that in the Diesel motor, which is one of the most economical, both for the fuel and air consumed, it requires about 10 pounds of air to produce 1-horse power hour. This would require about 1 gallon of liquid air per horse-power hour; and if liquid air can be produced at 2 cents a gallon, then it would cost, in addition to the fuel, 2 cents per horse-power hour.

The contingent loss of liquid air by evaporation in transportation and handling, and while motors in which it is employed are standing idle, would certainly counterbalance any advantages which might exist from having the air in concentrated or liquid form.

Liquid air will be chiefly valuable as a source of oxygen for other purposes than the production of motive power.

If liquid air can be produced cheaply enough, even at, say, 5 cents per gallon, it may be destined to find its most useful application as an ingredient of blasting agents, especially for mining purposes.

I am aware of the many difficulties which would attend such use of it, yet I believe that if it can be produced at the above price most of the difficulties in the way of its practical application in blasting agents may be overcome. I have given this matter considerable thought, and have ascertained from calculations and experiments that explosives may be made from liquid oxygen and combustibles which will rank among the most powerful known to science. Liquid air, slightly enriched in oxygen by letting a portion of the nitrogen distill off, would produce, with a suitable combustible element, a high explosive comparable with dynamite.

It must be borne in mind that liquid air as a blasting agent, especially in mines, possesses some great advantages to offset its disadvantages. For instance, there would be no thawing out required in cold weather, with attendant inconvenience and danger, and the products of combustion would be smokeless. There would be no nitrous fumes, and the gases would be far less noxious than those produced by other explosives.

It has occurred to me that some of the difficulties which lie in the way of its practical application in the manufacture of explosives might be surmounted in the following manner:

In many mining districts very cheap water power, and in others very cheap coal may be obtained. If, by these means, liquid air can be produced at the prices I have suggested, then we might, perhaps, by a specially constructed centrifugal machine separate the oxygen from the nitrogen without much additional cost. We could then use the oxygen in making explosive cartridges, and these could be packed and immersed in a bath of liquid nitrogen. As the nitrogen is more volatile than the oxygen, there would be practically no loss of oxygen from the cartridges. In this way the cartridges could be shipped for a considerable distance, or kept for a considerable time before use; but, as the material could be put up at the mine, or in the mining district, it would not be necessary that many hours intervene between its production and its use. In charging holes, they could first be chilled by a jet of liquid nitrogen, and their temperature so lowered that the oxygen would not be very rapidly driven off for some time after loading. To further protect the cartridges, they could be covered with a combustible non-conductor of heat, which would form part of the explosive.

The explosive would be so quick in its action that the holes would need only to be tamped by simply filling them with water, or by pouring sand into them, instead of ramming them in the usual way, and, in many cases, no tamping at all would be required.

To prevent tamping being blown out by the evaporating oxygen, a small and very thin copper tube could be inserted into each hole when loading, which would serve both to vent the hole and to conduct electricity to an exploder to fire the charge.

In order to allow for some evaporation, we might use 3 pounds of oxygen to a pound of carbonaceous matter in producing explosives. Three-quarters of a pound of oxygen, and a quarter of a pound of carbonaceous matter would, therefore, produce 1 pound of explosive. Oxygen, at 20 cents per gallon, would cost about 2 cents per pound. The carbonaceous matter would not cost more than half a cent per pound. We would need, therefore, 1½ cents worth of oxygen, and ½ cent worth of combustible matter. Hence, our explosive would cost 2 cents per pound. Now, if we double this cost to make allowance for incidentals, labor and interest on capital, and add another cent per pound for loss in weight by evaporation, we would still have a powerful explosive at a cost of 5 cents per pound, and one which would have some obvious advantages above dynamite, at less than half its cost.

At any rate, if liquid air can be made at a sufficiently low cost the question of its application in the manufacture of explosives for mining purposes is worthy of consideration.

A BILLION DOLLAR COUNTRY.

Every year's developments seem to justify the assertion that this is a "Billion Dollar Country." The year 1899 brought our foreign commerce for the first time past the $2,000,000,000 line, and the month of February, 1900, shows our money in circulation for the first time as more than $2,000,000,000. Thus, by a peculiar coincidence, the announcement of $2,000,000,000 of foreign commerce and the $2,000,000,000 of money in circulation are made within a single month, the totals indicating that the $2,000,000,000 line had been crossed in our commerce for 1899, the figures being official, having been compiled by the Treasury Bureau Statistics, and the Treasury Bureau of Loans and Currency. The total foreign commerce for the year 1899 was $2,074,345,242, while the total money in circulation on February 1 was $2,003,149,355. The use of figures carried out to ten places with which to show the business conditions of the country is indeed becoming surprisingly frequent. For example, the total resources of the national banks is $4,475,343,924. The latest report of the Comptroller of the Currency shows that the deposit in savings banks amount to $2,230,366,954. The total resources of all banks in the United States are given as $5,196,177,381. The amount of money for each individual is greater to-day than ever before. The actuary's estimate that the population shows that on February 1, 1900, it amounted to 77,116,000, the money in circulation being $2,003,149,355, the circulation per capita is $25.98. This gives a larger per capita than in any previous month in the history of the country.