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LIQUID AIR "SURPLUSAGE."

Now comes Mr. H. Gaylord Wilshire, editor and publisher of the The Philistine, a magazine "devoted to the demolition of preconceived ideas," who tells the Southern California Academy of Sciences that he can scientifically demonstrate the practicability of accomplishing perpetual motion by means of liquid air. Briefly stated, the demonstration is as follows: A given weight of liquid air will theoretically liquefy an equal weight of air without the aid of cooling water. If the resistance to compression of the air be reduced by passing it through cooling water, the liquid air will liquefy its own weight of air, plus an additional weight due to the cooling water. This is a "surplusage," and hence perpetual motion!

In detecting a fallacy it is sometimes as well, even at the risk of reiteration, to get down to first principles. If a given volume of air at atmospheric pressure and temperature be compressed to a smaller volume, it will have a pressure which is the result of its decrease in volume and the increase in its temperature due to its compression. The pressure due to reduction of volume is permanent at a given temperature, but the pressure due to the rise of temperature is transient, and will disappear as the heat of the compressed air radiates into the surrounding atmosphere. That part, then, of the energy expended in the compressor which appears as heat in the compressed air is a positive loss in all engines which make use of either compressed or liquid air as a motive power.

When air is compressed for power purposes, it is necessary to cool it during compression by passing it in a coil through water which is at atmospheric temperature. If it were not so cooled, and were delivered to the storage cylinders carrying all the heat of compression, it would suffer a subsequent fall of pressure which would amount to the same thing as if it were cooled at the compressor, and there would be a great loss of effect due to the heat so withdrawn. Every heat unit carried off in the cooling water of the original compression is a loss that must be charged against the compressed air or the liquid air, as the case may be, in every subsequent operation in which it plays a part; and when liquid air enters the lists in competition with steam, electricity, hydraulic or any other form of power, it starts with this heavy handicap against it.

In the lecture to which we have referred, Mr. Wilshire argues that in a theoretically perfect engine a given weight of liquid air would produce the same weight of compressed air, if both the liquid air cylinder and the compression cylinder were in free contact with the atmosphere. He then supposes the compressed air to be cooled with water during compression, and argues that such cooling would enable the liquid air to compress an additional volume of air, which he called a "surplusage." The fallacy of the argument lies in the fact that the liquid air itself has already been robbed of its own heat of compression, and the application of cooling water to the air which it is now compressing would merely enable it theoretically to produce by compression and expansion in a frictionless engine a weight of air just equal to itself.

There is no "surplusage" except in the exuberance of the lecturer's own imagination, and the cumbersome wit with which he rails at what he is pleased to call the "scientific Gradgrinds," who, be it said, have very effectually pricked the liquid air bubble. Mr. Wilshire's lecture, which is quite unique in its way, will be reviewed in the next issue of the SCIENTIFIC AMERICAN by President Morton, whose recent exposure of the liquid air fallacies has already attracted world-wide attention.

THE REASON WHY.

American master mechanics were the first to appreciate and prove the advantages of building express engines in which the center of the boiler is placed well above the driving wheels; and it is certainly late in the day for an American journal of the pretensions of Engineering News to be in ignorance of the excellent and obvious reasons for this modern practice. In a recent issue our esteemed contemporary, speaking of the new English express engines (illustrations of which appear in our SUPPLEMENT of the 3d inst.), informs its readers that these locomotives "are of a most peculiar appearance, as *in order to clear the crank axles the boiler is pitched so high* (the italics are ours) that its top is level with the roof of the cab, and this necessitates a little, dumpy smokestack which seems to have no relation to the boiler." As a matter of fact, the cranks have nothing whatever to do with the height of the boiler, there being no less than 15 inches clearance between the bottom of the boiler and the connecting rod ends at the highest point of their revolution. Engineering News evidently is not aware of or does not appreciate the fact that it was Mr. Buchanan, late master mechanic of the New York Central Railroad, who first had the courage to place the center of the boiler two feet above the top of a pair of 7-foot driving wheels, in order to allow the use of a boiler barrel that should be larger in diameter than the space between opposite wheels. As tried in No. 999, whose boiler centerline was a fraction less than 9 feet above the rails, the experiment was eminently successful; for not only was a large tube heating surface secured, but the high center of gravity was found to give an engine that was less destructive to track and roadbed. Inside cylinders may be answerable for many troubles, but a high center of gravity is certainly not one of them, any more than is "a little, dumpy smokestack." This last felicitously named deformity we must further inform our contemporary is due to the fact that the shallow loading-gage on English railways will not allow the smokestack to take on more æsthetic proportions. The same defect in appearance (if defect it be) is noticeable in the big Schenectady engines built some six or seven years ago for the New Haven road, which, we believe, is hampered by some bridges and tunnels that are lower than is common in American practice.

The late A. M. Wellington himself was never friendly disposed to inside cylinders, and for the best of mechanical reasons; but to hear them thus maligned is enough surely to disturb the shades of that gifted and ever-to-be-lamented editor.

REPORT OF THE NICARAGUA CANAL COMMISSION.

The present Nicaragua Canal Commission, which was appointed under an Act of Congress of June 4, 1897, and is popularly known as the Walker commission, after Admiral J. G. Walker, retired, U. S. N., has submitted its full report to the President. A preliminary hearing was given last summer with a view to putting Congress in possession of sufficient data to enable it to legislate on the question during its late session; and while in the nature of things it was impossible, in the then incomplete state of the data, for the commission to give accurate information, it was evident that a serious disagreement existed among the members of the commission on certain fundamental questions relating to the feasibility and cost of the undertaking! The most serious divergence of opinion was on the question of cost, the ranking member and most distinguished engineer of the commission putting the possible cost at about $150,000,000; the Admiral placing it at about $125,000,000, and Prof. Haupt declaring that it could be done within $90,000,000.

In the report just presented, Admiral Walker and Prof. Haupt, who at the preliminary hearing were both ardently in favor of the immediate construction of the Nicaragua Canal, have compromised on a sum of $118,113,790 as representing the probable total cost. This is a jump on the part of the professor of over $28,000,000, or an increase of over 30 per cent on his original estimate of $90,000,000. As the latter gentleman has already said in committee, "the question of cost does not carry very much weight in my mind, even if it were $200,000,000," the astounding difference in his two estimates is easily explained. Col. Hains, who has always shown a conservatism becoming the stupendous nature of the undertaking, estimates the final cost as $134,818,308.

The commission was required to examine all routes heretofore proposed that had any merit, and any new routes that appeared to be feasible, so as to be in the position to present an exhaustive report on the entire region of canal possibilities. After mature deliberation the commission has recommended the Childs route from Brito on the Pacific to Lake Nicaragua, and the Lull route from the lake to Greytown on the Atlantic. The Childs survey was made as far back as 1852 by a distinguished canal and railway engineer of that name, and the Lull survey was carried through in 1873 by Commander Lull, U. S. A., who was sent to the isthmus by the government to re-survey the Childs route. All the members of the Walker commission, although at variance as to cost, are agreed in rejecting the unprecedented and perilous features of the Menocal surveys of 1887 to 1890, and returning to the original plans. As modified, these plans call for a single dam with regulating works at each end of the summit level. On the Pacific side the route follows the left bank of the Rio Grande, crosses the Western Divide to the valley of the Lajas, which river is followed to its entrance to Lake Nicaragua. From the lake the route lies in the bed of the San Juan River to near Boca San Carlos, where it leaves the river and follows its left bank in excavation to the San Juanillo, from which point it is cut across the alluvial land to Greytown. For a complete map and illustrations of the Nicaragua country, the reader is referred to articles published in the SCIENTIFIC AMERICAN of February 18, 1899, and the SUPPLEMENT of April 1, 1899. It is stated that the survey, which has been carried out by a strong force of about one hundred engineers, has brought to light more favorable physical conditions than were anticipated, particularly in the upper San Juan River, where the rock excavation is less than was indicated by the preliminary surveys.

No definite action can be taken by Congress at this time, as it must now await the report of a new commission, authorized at the close of the last Congress, which is empowered to investigate not only the Nicaragua but the Panama and any other possible route, and report as to which is the most feasible to construct and operate. It will probably be a couple of years before the final report of this commission can be made the subject of legislation.

BRASSEY'S NAVAL ANNUAL.

The stirring events of our late war have lent a special interest to the annual publications which deal with the development and statistics of the world's navies, and the recently issued volume of Brassey's Naval Annual, the thirteenth of its kind to appear, devotes two lengthy chapters to the Spanish-American war and the United States Navy. The present volume is somewhat larger than its predecessors, the rapid growth of the various navies causing the tables and diagrams of the ships steadily to increase in volume. There are thirteen very good plates from wash drawings of notable battleships and cruisers interspersed through the reading matter, the "Iowa" being chosen from our own navy for reproduction. There are also nine charts and diagrams, seven of which are explanatory of the naval operations of the war. About one hundred pages are given up to tabular lists of all the warships of the world, and these are followed by ninety plates containing plans of practically every important type of warship in the world at the present time. These plans are line drawings, prepared as far as obtainable from working plans, which show only the armor, armament and leading offensive and defensive features of the ships. We take this opportunity of expressing our indebtedness to this portion of the Annual for many of the small diagrams which have accompanied our articles on the navies of the world.

While upon this subject we would suggest that as the plates in the later editions of the Annual (to save space) are being produced in two sizes, full page and half page, it would be better to reduce the older ships to half page size and reserve the full page plates for the later and more important vessels. Thus among the plates of our own navy we find that while the "Texas," which is rated in this Annual as a third class battleship, is allowed a whole page with five drawings, our latest first-class battleships of the "Alabama" and the "Maine" classes are confined to two drawings of half page size. The same thing is noticeable in the British navy, where the old armored cruiser "Imperieuse" occupies as much space as the two cuts representing the powerful modern ships of the "Cressy" and "Formidable" classes.

From the opening review by Lord Brassey and the tables of comparative strength given in a later chapter, we find that Great Britain has 41 battleships built and 16 building, a total of 57, as against 32 built and 4 building for France, and 15 built and 6 building for Russia. The United States have 5 built and 8 building, all but one of which are of the first class; and it is a gratifying fact that we have more first-class battleships built and building than any other power but England. Of these the latter country has 34 building; France, 11; Russia, 10; Italy, 7; Germany, 9; and Japan 6. Of cruisers England has 137 built and building; France, 52; Russia, 28; Italy, 21; Germany, 24; the United States, 20; and Japan 18. Construction of huge battleships and cruisers whose displacement, speed, and fighting qualities steadily increase, goes on apace. If any one is disposed to doubt the necessity for making regular additions to our own navy, we would draw his attention to a statement which has recently issued from the office of Naval Intelligence, Washington, to the effect that the total tonnage of all the vessels now building or authorized for the British navy exceeds the total tonnage of all the war vessels of the United States navy, built and building, by more than 100,000 tons. We commend this statement of the Navy Department to the attention of those Senators who recently delayed for at least another year the modest addition which our last Congress proposed to make to the navy—modest in comparison with the wealth and responsibilities of a nation which is rapidly moving to the leading position among the great commercial nations of the world.

In reading the chapter upon the "Progress of Foreign Navies," one is impressed with the marked decrease in the number of unprotected cruisers which are being built, all the new tonnage being put into ships of the armored class, either battleships or cruisers. Japan indeed is the only nation that is building protected cruisers on any considerable scale; a fact which may be largely explained by the excellent work which was accomplished by this type of vessel in her war with China. The rapid growth of the Japanese navy is one of the most remarkable naval events of the last decade of the century. The new shipbuilding programme provides for four battleships, six first-class and three second-class cruisers together with several smaller vessels, and all of the ships are being pushed to completion with as little delay as possible. The progress of the United States navy is described under a separate chapter written by Lieut.-Commander W. H. Beehler, of the navy, which will naturally be of extreme interest to all Americans. Lieutenant Beehler traces the growth of the navy from the time of the Civil War to the present day. The administration is outlined at considerable length; then follows a description of the personnel, with tables giving the rank and total numbers of the various officers with their rates of pay, whether at sea or shore duty, or on leave or waiting orders. The same is done with regard to the chief petty officers and the various grades of seamen and other subordinates.

The chapter explains in detail the means by which apprentices enter the navy and the course of training which they subsequently undergo, and this part of the article renders in condensed form a considerable amount of information which is not easily accessible to the public. Considerable attention is paid to the navy yards and stations and the private shipbuilding yards, while the last few pages of the article are devoted to description of the latest ships that are now being constructed for the navy.

The succeeding chapter, by G. S. Clarke, is devoted to the Spanish-American war. It contains excellent plates of Manila Bay, the island of Cuba, Santiago Harbor, and of the coast to the westward of Santiago, along which the running fight between the Spanish and American ships took place. There are also plates showing the number and location of the hits made on Admiral Cervera's fleet, and a few small diagrams illustrating the method of disposing our warships during the blockade of Santiago. The whole chapter of over fifty pages forms one of the best compendiums of the Spanish-American war that has yet appeared, and the lessons of the war as drawn by the author are conservative and just and in the main agreeable to the expert estimate of these events as generally made throughout the world.

The chapter on recent warship construction, written by the editor, assisted by Captain Orde Browne, is perhaps one of the most valuable in the whole work, and the table published on page 176, showing the comparative qualities of eight of the latest first-class battleships in the world, will form a subject of interesting study for every one who follows closely the subject of warship construction. The battleships taken are the "Formidable" and the "Duncan," of 15,000 and 14,000 tons displacement respectively, of the British navy; the "Iéna," 11,870 tons displacement, of the French navy; "Kaiser Friederich III.," 11,130 tons, of the German navy; the Russian "Petropavlovsk," of 10,960 tons displacement; the Italian "Benedetto Brin," of 12,564 tons; the United States "Maine," 12,500 tons; and the Japanese "Shikishima," of 14,850 tons displacement. Accompanying this table is another showing the energy of gun-fire per minute for each ship. The largest vessel in point of dimensions is the "Benedetto Brin," which is 413½ feet long, by 27 feet draught, and has the enormous beam of 78 feet. Evidently her model must be exceedingly fine, as she displaces only 12,564 tons as against 15,000 for the shorter and narrower and shallower British ship "Formidable." The Italian ship has the thinnest armor, only 6 inches on the belt; she has the most powerful fire energy, the total amount being 600,745 foot-tons per minute. The "Iéna" has the smallest energy, 431,423 foot-tons. With new guns and smokeless powder, the "Maine" is estimated at 560,513 foot-tons, or about the same as the Japanese "Shikishima." The fire energy of the British ships is, as usual, relatively less than that of the others, being for the "Duncan" class 489,706 foot-tons per minute. This is compensated, however, by the high speed of 19 knots with natural draught, which would be equivalent to about 21½ knots with forced draught.

There is a marked tendency in the latest ships to reduce the thickness of the armor and spread it over a larger area of the ship's side. In the British vessels of the "Formidable" class the belt is 9 inches, and the side armor above the belt is 9 inches. In the "Duncan" class it has been reduced to 7 inches; in the "Iéna" the belt is 13¾ inches, and the side armor 4¾ to 3 inches thickness. The "Kaiser Friederich III." has a maximum thickness of 11¾ inches in the belt; it has no side armor above the belt. The "Petropavlovsk" has a 15¾-inch belt; the "Benedetto Brin" has a 6-inch belt and 6-inch side armor above it; the "Maine" a 12-inch belt, with 7-inch side armor; and the "Shikishima" has a 9-inch belt and 6-inch side armor. All the ships carry 6 inches of armor for the protection of the secondary battery, except the "Maine" and the "Iéna," the former having 5½ inches for this battery, and the French no protection beyond that afforded by shields. The 5½-inch side armor of the "Maine" is, however, continuous, while the 6-inch armor on many of the other vessels is placed only upon the casemates. Looking the comparison over carefully, we have every reason to be satisfied with our own "Maine," which we think stands as the best all-round fighting ship in the table. We cannot but feel, however, that she would be greatly improved if Krupp steel was substituted for the Harveyized armor, and the weight so saved were allotted to a battery of four 8-inch rapid-fire guns, these four to take the place of four of the 6-inch rapid-firers in the present battery.

In the chapter on coast fortifications the author divides the ports of the British empire into three classes: commercial ports, naval or dockyard ports, and supply ports or coaling stations. He does not believe in the extensive fortification of commercial ports as such, and would confine the erection of strong fixed defenses to the naval dockyards and the coaling stations. Regarding commercial ports, defended by mine fields, protected by rapid-fire batteries, with the fields so arranged that the mines could be kept permanently in place, or so that whole system of mines could be laid down in a short time, the author considers that the former method would be impossible because intolerable, as shown by the inconvenience experienced by New York in the late Spanish American war. It is considered that to carry out the second of the above named methods would "require an amount of time which would more than suffice to assemble the armed defenders whose presence would secure the place against hostile molestation far better than obstructed channels or fixed batteries." Whatever may be the case with regard to Great Britain, the writer is mistaken in his estimate of the situation at New York, where a very effective system of mines was laid down in a comparatively short period of time and would, we believe, have proved an effective safeguard to the city had we confronted a more energetic and formidable foe. Moreover, the mines were laid long before our volunteer army was in a position to take the field. Under our present system it is evident that submarine mines must constitute for many years to come the most effective defense available for our maritime cities.

THE AUTOMOBILE TRIP FROM CLEVELAND TO NEW YORK.

The first attempt in this country to use a standard automobile carriage on a continuous high speed trip of several hundred miles must certainly be considered a triumph for the new form of locomotion. The Winton carriage which left Cleveland on Monday, May 22, reached New York at 5:30 P. M. on Saturday, May 27, having covered the whole distance of 707·4 miles in the actual running time of 40 hours and 4 minutes. This is an average running speed of 17½ miles an hour, and in view of the fact that long stretches of the road were in a poor condition, and that some sections are spoken of as being disgraceful in the extreme, this is a highly creditable performance. The fastest average for a continuous run was made between Cleveland and Buffalo, where the distance of 218 miles was covered in 11 hours at the rate of a fraction under 20 miles an hour. The carriage weighs 1,700 pounds, and is driven by a 6 horse power motor. It is made in three different sizes; and good illustrations of the type appeared in the recent automobile number of the SCIENTIFIC AMERICAN.

The fastest speed for a long-distance journey was that accomplished by the winning carriage in the recent automobile race from Paris to Bordeaux, when a petroleum-driven carriage covered the distance of 353 miles in 11 hours 43 minutes and 20 seconds, an average speed of thirty miles an hour. This was a truly sensational performance, but there are circumstances which bring it within the limits of comparison with the Cleveland-New York journey. For it must be borne in mind that the Paris-Bordeaux roads are of the very finest surface throughout, and the vehicle, unlike the Winton carriage, was a special racing machine equipped with a fourteen horse power engine.

By sacrificing everything to power it is quite possible to build an automobile that will cover a straight-away mile at the rate of 60 miles an hour; and it has recently been reported from Europe that this speed has been attained more than once. These sensational speeds however do not interest the public so much as the question of maintaining a high average speed with motor-carriages of the standard make. The recent trip from Cleveland to the eastern seaboard proves that economical and speedy long distance automobolism will be within the reach of the public in the near future.

PHOTOGRAPHY IN RELIEF.

A new method for producing reliefs by the aid of photography has been devised by M. Lemac, who in this manner has produced fine medallions from living persons. His process has been described at a meeting of the Société Française de Photographie as follows:

The model, which it is not necessary to powder or treat specially, is placed in front of a black background, presenting the profile to the camera. Two plates are successively taken, avoiding all displacement of the model between the two exposures. For these the source of light should have as small dimensions as possible, a cartridge of powdered magnesium being preferred; this should be maintained in a plane perpendicular to the axis of the objective and slightly nearer the latter than it is to the model. During one of the poses the model is lighted about three-quarters in front, and for the second, three-quarters to the side. Negatives are obtained on films, which are then placed exactly over one another. In this way the most salient points of the face are represented by an intense black, these having received the maximum of light in one or the other exposure; the less lighted portions are gray, and the hollows, having been each time more or less in shadow, appear as transparent places in the negative. With this combination a print is made upon a paper which permits of easy retouching, such as platinum paper. This print is then retouched in order to bring out the hair and drapery. If letters are desired on the medallion, these are drawn with Chinese white or India ink, according to whether they are to be raised or depressed in the medallion.

The outline of the plaque or medallion is traced in India ink, according to the shape desired. This proof in black and white is then reproduced to the desired size, giving a negative from which are made the proofs in relief.

For low reliefs, proofs are made on a sheet of bichromated gelatin in the usual way, but to obtain high relief, one proceeds in the following manner: A thin layer of gelatin is flowed upon a sheet of a spongy substance which swells easily in water. The gelatin is sensitized with bichromate, and after drying, is exposed under the negative last obtained, and then submitted to the action of water, which washes out the portions shielded from the action of light, causing depressions, while the unexposed and impermeable parts are swelled out by the action of the water, thus producing a high relief, which corresponds to that of the model. Upon the relief so obtained fine plaster of Paris is flowed, and the hollow mould obtained is retouched. This constitutes the final mould for the reproduction of proofs. This process is not difficult to carry out by one accustomed to photographic manipulation; the time occupied in retouching the black-and-white print as well as the plastic mould is not more than one hour for a medallion-head of natural size.

THE BIRTH-RATE IN EUROPE.

Scientists and statisticians of France have been for some time occupied with the question of the decrease of the birth-rate in that country. This naturally leads to the investigation of the birth-rate of the other countries of Europe, in order to find out whether France is the only country going down the scale. For this purpose the tables published by Signor Bodis, a prominent statistician of Italy, are of value; these tables have in fact been made the base of various investigations as to the movement of population. Below is the order in which the countries of Europe are classed in decreasing series, according to their mean birth-rate:

1. Russia in Europe	12. England and Wales
2. Hungary	13. Scotland
3. Servia	14. Denmark
4. Roumania	15. Norway
5. Austria	16. Belgium
6. German Empire	17. Sweden
7. Italy	18. Switzerland
8. Spain	19. Greece
9. Finland	20. France
10. Portugal	21. Ireland
11. Holland	

Thus we find that Russia has the largest percentage of births, and France and Ireland the smallest.

To find out whether in any of these countries the birth-rate is on the increase or decrease, the figures for each for different years are examined, and we thus find that in all except five the movement of natality is on a decrease more or less rapid. M. Vauthier, analyzing the figures obtained by Signor Bodis, draws the following conclusion as to the diminution of the number of births:

The country of Europe in which the decrease is most striking is England, including Wales, whose coefficient of decrease is 0·306 per 100; Scotland, whose mean birth-rate is nearly the same, decreases but 0·027 per 100; and Ireland, whose birth-rate is much smaller, decreases only 0·0233 per 100. Somewhat after England and Scotland, but before Ireland, are found Holland and Germany, having a coefficient of decrease of 0·0244 per 100, followed closely by Belgium (0·0239). Then, passing by Greece (0·0209), one reaches France, whose natality decreases annually by 0·0179 per 100. After France comes Russia (0·0158), Sweden (0·0147), Switzerland (0·0128). Last are found, having less than 0·01 per 100, Denmark (0·0078), Austria (0·0077), Pomerania (0·0033) and Hungary (0·0024).

As to the countries in which the birth-rate is on the increase, we find the following series: Italy, by 0·0083 per 100; Spain, by 0·0040; and lastly Servia and Norway, with coefficients of 0·0017 and 0·0012 per 100, being thus nearly stationary.