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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE "CASUALTY LIST" OF AMERICAN INDUSTRIES.

Statistics are "dry"; but sometimes they are wonderfully illuminating, and occasionally, by means of a tabulated list, a fact will be brought home to the public with a convincing force, which could be gained in no other way. At the dinner held in New York to inaugurate the opening in this city of the First International Exposition of Safety Devices and Industrial Hygiene, Gov. Hughes made the startling announcement that the number of people killed or wounded in the various industries of the United States, amounts to 500,000 every year! And yet, if we bear in mind what a large number of people fall victims annually to the carelessness with which our railroads are operated, it should not surprise us that in the whole range of our industrial activity the total number of accidents should reach the stupendous figure of half a million.

It is characteristic of the shortsightedness, the absence of perspective, the lack of a sense of proportion, which marks the average individual, that there should be such a wild outcry against the slaughter of a great war—an event which may occur once in ten years—when, as a matter of fact the killings and woundings of battle are insignificant compared to the day-by-day carnage and mutilation which occur in the prosecution of the so-called peaceful arts.

And this tragedy is rendered all the more terrible when we learn that by the outlay of a certain amount of money and the expenditure of a reasonable amount of well-timed forethought and protective provision, most of our industrial accidents could be absolutely prevented.

That the subject has never excited its proper amount of shame and pity, is due to the fact that the accidents are scattered throughout the year and spread over a territory as wide as the United States. The killing of a few industrial workers in Seattle will arouse local pity and indignation in the State of Washington; but it will be read with only a passing glance in the daily dispatches of a Florida newspaper. Yet if all the accidents of the year should take place on one particular day and in one particular city, say in New York, and if, on the first of January of each year, we should learn that, on the day preceding, half a million people had been killed or wounded in this city in the pursuit of their peaceful avocations, we would then realize the full horror of the situation.

As is usual in matters affecting the safety of life and limb of the individual citizen, we in the United States are, in respect of this matter of preventing industrial accidents, far behind European nations. It is in the endeavor to educate the public to an appreciation of the gravity of the situation and show them how much can be done, and is being done elsewhere, to safeguard the industrial classes, that the present International Exposition is being held in the Museum of Natural History in this city, where a wide variety of appliances for the protection of the artisan are being exhibited. Many, if not the majority of the devices, consist of comparatively inexpensive attachments for preventing contact of the operative with the more dangerous parts of the machine. Of such kind are the shields which cover swiftly-revolving emery wheels, to catch the flying fragments in case the wheels should burst under the high speed at which they are run; the casings built around the gears and pulleys of lathes and other geared machines, with which accidents have been so shockingly frequent in the past; and safety shields and stops which, while they do not prevent the operative from properly observing the action of the machine, render it absolutely impossible for the hands to be caught and maimed by the moving parts.

The fact that such lavish sums are given in this country for charitable purposes proves that our large industrial casualty list is not due to lack of kindliness of heart. It is rather to be explained by the fact that we are in a general way too careless of life and limb, and that, for the lack of properly advertised statistics on the subject, we have never realized how widespread and pitiful is this tragedy of our modern industrial life. Prevention is ever better than cure, and the promoters of the present exposition of safety devices are inaugurating one of the most commendable philanthropic works in the history of the country. To a certain extent the evil can be remedied by legislation; but a quicker remedy can be found in the voluntary adoption on the part of our industrial concerns of those inexpensive means by which our annual casualty list would be immediately reduced.

SATISFACTORY FOUNDATIONS FOR PANAMA DAMS AND LOCKS.

In view of the attack which is being made in more than one quarter against the selection of the Gatun location for the construction of a dam and locks of unprecedented size, it is gratifying to learn from the report of the Isthmian Canal Commission in relation to the new borings of the Gatun dam that the latest investigation shows the foundation both for the dam and for the locks to be satisfactory. The report states that one hundred and twenty-seven holes have been bored at Gatun lock site, covering an area of 1,200 by 5,000 feet. All were carried well below the lock walls, and sixty-six to a depth of fifty feet or more below sea level; and they all show that lock walls will rest on firm and suitable soft rock. Thirty-six borings made, covering an area of controlling gates for spillway, all show safe foundation in soft rock. Three lines of borings, sixty-three in number, all extending to rock, have been made across Valley Chagres, covering the dam site. Pervious material is found in only four holes, and these below the 200-foot level. Ten borings have been made below the foundations of the Pedro Miguel lock walls, all showing rock suitable for foundations. Test pits at Gatun and Pedro Miguel so far all show harder material than cores from borings.

The investigation which the commission has continued has thus far led to no disclosure of extraordinary difficulties, requiring changes of previous plans. The continuation of surveys has for its object the complete adaptation of the design of locks and other features of the plan to the existing surface and subsurface conditions. There is nothing in the later examinations made affecting the practicability or permanence of the Gatun dam.

The borings show below the surface soil what is termed "indurated clay" or "chopped sand and clay." The chopped material is, however, different from the indurated clay and "seems to be a sort of hardpan or conglomerate, either of which will make a good foundation." "The borings and exposures of the material in the French work at the drydock at Cristobal establish" that the indurated clay "makes an entirely satisfactory foundation for the proposed lock structures."

Mr. Stevens, the chief engineer of the canal, states that besides indurated clay, there is what is called blue clay and sand, clay, gravel and fine sand, etc. This is not so hard as the indurated clay, but is in every respect an equally good and sufficient foundation for locks, etc. Mr. Stevens believes that this material is "as good as the indurated clay and good enough in any case" to form a satisfactory foundation.

THE PANAMA CANAL CONTRACT.

The two most important events that have happened in connection with the construction of the Panama Canal since the recent visit of President Roosevelt to the Isthmus, have been the opening of the bids for the construction of the canal and the recent presentation of the report of the Isthmian Canal Commission in relation to the new borings which have been made along the site of the Gatun dam and locks. The most surprising fact developed at the opening of the bids was the wide disparity between the percentages for which the contractors offered to do the work. It will be remembered that under the terms of the contract the present plant of the government will be taken over by the contractor, who will act practically as the agent of the government, and that the contract is to be given to the firm which offers to do the whole work at the smallest percentage of the estimated cost of the canal, always presupposing that the contractors are otherwise satisfactory to the government. The bidders offered to do the work for a percentage which varied from 6.75 to as high as 28 per cent of the total cost. The remarkably low bid of 6.75 per cent was made by a firm of which the junior member is not considered to be acceptable to the government, and, as matters now stand, the senior partner is seeking to associate with him one or more individuals or firms that will meet the government requirements. At the same time, in a statement recently issued from the White House, the public is informed that the President is highly gratified with the rapid progress which is being made under existing conditions, about half a million cubic yards having been taken out of the Culebra cut during the past month, while the amount of excavation is steadily increasing.

It is evident that the government is even at this late day considering the construction of the canal under its own supervision by the engineers of the United States army, as an alternative to its being built by contractors under the present chief engineer of the commission. We have always felt, and do still strongly believe, that contract construction will be found to be the most speedy and economical, in spite of the fact that an amount equal to at least 6.75 per cent of the cost of the canal must be paid to the contractor. The advantage of contract construction is shown in the statement from the White House above referred to when it says: "The real object in contracting the work is to have assembled a large number of the best specialists in each class of work." It is this advantage which has led to the placing of all great engineering works, whether for State or municipal improvement, or the extension and improvement of railroads, with responsible contracting firms. There is every reason to believe that the economies in time and cost usually secured in carrying through these great works will be also secured if the same policy is followed at Panama. There is no reason why the considerations which render it expedient for New York city to build its $160,000,000 water supply system by contract should not hold good for the construction of the $140,000,000 canal at the Isthmus. We do not advocate construction by contract because of any doubt of the ability of the army engineers to handle the work successfully; for we doubt if, anywhere in the world, there is to be found a body of men so well qualified by technical training and wide experience as this fine body of professional men. It is through no fault of theirs that work done by the government is, or at least is popularly supposed to be, usually more expensive than work done by contractors under the supervision of civilian engineers.

SHOULD THE STEEL MAKERS SUBSIDIZE OUR SHIPBUILDERS?

There is much good sense in the suggestion made by Mr. Alexander R. Smith, in a recent pamphlet on American shipping, that the powerful corporations engaged in the manufacture of steel and iron should combine for the purpose of offering for a fixed period a substantial bounty for the construction in the United States of ships built of American steel. It is suggested that such action should be taken simultaneously with the passage by the government of the Merchant Marine Commission's Shipping Bill, or of some other measure of equal effectiveness; and the author believes that upon the passage of such a measure by Congress, coincidently with the announcement of such a bounty to be paid by the steel concerns on steel ships built in this country, the rapidity of the increase of our foreign-going tonnage would be immediate, and so great in its proportions as to practically create a new industry.

The suggestion is not by any means novel or untried. For many years German syndicates have paid large bounties on exports of manufactures, with such success that the policy has recently been discontinued, only because it had operated so successfully as to be no longer necessary for the encouragement of the manufacturer or the advancement of trade. If our American steel concerns should take the initiative, and announce the institution of a system of bounties, it is believed that such a step would stimulate Congress to pass the pending shipping bill.

The considerations upon which the above suggestion is made are that in the United States there are probably half a dozen steel-manufacturing corporations whose aggregate capital exceeds $2,000,000,000, and whose net earnings probably now exceed $200,000,000 annually. During the fiscal year ending June 30, 1906, the value of our exports of iron and steel was over $160,000,000, and it is admitted that in many cases the articles of export were sold at a reduction considerably below the prices obtained for the same articles in the United States. This, it is claimed, is tantamount to a bounty paid by the producers of those articles for the purpose of securing and holding a foreign trade regarded as of value and benefit to such producers. It is considered that the amount of that bounty, or lower price, is considerably in excess of the bonus of from $3,000,000 to $5,000,000 a year, which it is suggested should be offered for a period of ten years by a combination of the steel and iron manufacturers. Such a bonus, based upon the tonnage of steel ships built in the United States for our foreign trade, would establish an industry in the United States which might conceivably raise our merchant marine to that leading position which it held in the middle of the last century.

WHY THE BIG ONE-CALIBER-GUN BATTLESHIPS ARE BEST.

In a letter recently written by President Roosevelt to the chairman of the House Committee on Naval Affairs, advocating the construction of two 20,000-ton battleships of the "Dreadnought" type, the President presents a powerful and convincing argument in favor of big ships, and offers much valuable information upon a greatly misunderstood question. The facts and arguments of his letter are based upon a masterly discussion of the subject in a recent report by Lieutenant-

Commander William S. Sims, who has been mainly responsible for the recent remarkable development of the marksmanship of the United States navy. The report is published in its entirety in the current issue of the SUPPLEMENT for the benefit of those of our readers who wish for a more complete statement of the arguments in favor of the high-speed, all-big-gun, uniform-caliber, battleship than it is possible to give in the present article.

The report is based upon recently acquired information regarding the events of the battle of the Sea of Japan, which Lieutenant-Commander Sims considers to be absolutely reliable. We may summarize his deductions by saying that he favors the "Dreadnought" type of battleship in respect of its size, of its high speed, and of its use of large guns of uniform caliber. Furthermore, he proves that not only is a battleship of this type more efficient per unit of displacement, but that it costs considerably less per unit of fighting power and is considerably more economical to maintain.

In proving the superiority of the 12-inch gun, Lieutenant-Commander Sims states that experience has shown that the percentage of hits per round is greater with large than with small guns. The danger zone, or the space within which a ship will be hit, is, at 6,000 yards range, 100 per cent greater for the 12-inch than for the 6-inch gun. The latest reports of Japanese fire in the battle of the Sea of Japan state that 19.6 hits per cent of rounds fired were made by the 12-inch guns, and that this was twice as great as the percentage obtained with the smaller guns. The Japanese fired 50 pounds of small-caliber projectiles for every pound that reached the enemy; but they fired only 5 pounds of 12-inch shell, for every pound that got home. Add to this the fact the 12-inch shell has a bursting charge of 38 pounds as against a bursting charge of 4 pounds for the 6-inch shell, and the superiority of the 12-inch gun is strongly established. Another powerful argument in favor of using only one caliber of gun is the modern system of fire control, with which such accurate shooting has been obtained in our own and the British navy. Accuracy of gun fire has come to be regarded as the most vital element of all in the fighting efficiency of a warship. At the longer ranges it is necessary to have an observing party for each caliber of gun, whose duty it is to check the accuracy of the sighting bar by observing the splash of the projectiles. If the ship carries two or more calibers of gun, there must be a duplication both of the observation party and of the fire-controlling apparatus. A most important point brought out by this report is that "interference," of which we have heard so much recently, is not a question of the influence of the flash of the guns so much as of the disturbance of the atmosphere, or "the refraction of the lines of sight by heated gases." Before a gun, adjacent to another gun which has just been fired, is discharged, it becomes necessary to wait until the hot gases of the first discharge have cleared away, and hence, the frequent firing of a numerous battery of small, rapid-fire guns seriously interferes, by the heating of the atmosphere, with the fire of the more important large-caliber guns. This is especially true of the after pair of 12-inch guns, across whose line of sight the heated gases will pass as the ship moves forward. Hence, there is bound to be a decided advantage in mounting a smaller number of high-powered guns of uniform caliber; since the ultimate object of warship design is accuracy of fire, or the getting home of a maximum number of hits of maximum destructive effect within a given time.

Another important advantage of the "Dreadnought" type of ship established by Lieutenant-Commander Sims is the fact that in the case of two fleets of equal total displacement, in one of which that total is made up of ten 20,000-ton battleships, and in the other of twenty 10,000-ton battleships, the advantage of concentration of broadside fire would lie altogether with the fleet of "Dreadnoughts." For the fleet of ten big ten-gun ships, which would be strung out in a comparatively short line of battle, would be able to offer a broadside of thirty-eight 12-inch guns per mile, as compared with a broadside of only twenty-one 12-inch guns per mile, offered by the longer line of ships of the mixed-battery type, carrying only four 12-inch guns apiece. The effect of this would be that the portion of the four 12-inch gun, old-type battleship line, which was immediately opposite the fleet of ten 12-inch gun, modern battleships, would be enormously overmatched, at a range of 6,000 yards, by the superior number of 12-inch guns opposing it, and its higher speed would enable the big-ship fleet to maintain that range indefinitely.

Compared on the basis of comparative cost, the all-big-gun, one-caliber battleship costs less than the four-big-gun, multiple-caliber, smaller ship, when both are compared on the same unit basis. Thus, although the big battleship can concentrate 80 per cent more guns within a given length of line of battle, the first cost is only 50 per cent greater per unit of concentration, while, measured on the same basis, the size of the crew required to fight the big ships is about 50 per cent less. Another important economy is secured in respect of the annual cost of maintenance; for the cost of maintaining ten 20,000-ton ships would be less by about $10,000,000 per annum than that of maintaining twenty 10,000-ton ships mounting the same total number of 12-inch guns.

Upon no question affecting modern tactics do the results of the battle of the Sea of Japan speak with greater emphasis than that of the value of high speed; for it now appears that the Japanese ships had an advantage of speed of between 6 and 7 miles an hour, the Russian fleet maneuvering at about 9 knots, and the Japanese at between 15 and 16 knots. This enabled Admiral Togo to place himself at that range (about 6,000 yards) at which he found that he could inflict a maximum amount of damage on the enemy, while yet keeping outside the extreme range at which the Russians were able to do any effective shooting.

COMPARATIVE TEST OF ALCOHOL, KEROSENE AND GASOLINE AS AUTOMOBILE FUELS.

The first practical demonstration of the use of denatured alcohol as a fuel for automobile use was made last week by a Maxwell touring car, which was run from New York city to Boston on 40¾ gallons of the new tax-free alcohol. In order to make a direct comparison, two identical cars, the motors of which were run on kerosene and gasoline respectively, accompanied the alcohol-driven machine. The test was made under the supervision of the Automobile Editor of this journal and representatives of the Automobile Club of America and the American Automobile Association. It yielded considerable interesting data as to the consumption of gasoline, kerosene, and alcohol in an ordinary two-cylinder, opposed-type engine when used to drive a car at an average speed of about 15 miles an hour over roads covered with snow of from 4 to 10 inches depth.

The start was made from New York at 9:10 A. M., January 28, and the cars reached Boston together at 1:15 P. M. January 30. The trip was thus made comfortably in two and one half days, despite the fact that the weather was rather cold and the ground was covered with about a foot of snow.

As is well known, the Maxwell engine is of the double-opposed-cylinder type, having a bore and stroke of 5 inches and a compression of about 60 pounds. It drives the live rear axle through the usual 3-speed sliding gear transmission, propeller shaft, and bevel gears. Individual spark coils with vibrators, fed by six cells of dry battery, supply the high-tension ignition current. All valves are mechanically operated; the cooling water is circulated without a pump on the thermo-siphon principle; and the entire engine and gear box form a unit, suspended at three points. On account of the low compression, it was not expected to show much efficiency with denatured alcohol as a fuel, for this substance requires a compression three or four times as great as does gasoline, in order to equal or surpass it in thermal efficiency. Used in an engine with the proper compression and having a long stroke, a thermal efficiency of 31 per cent has been obtained as against 20 to 23 per cent with gasoline. The main object of the test was to demonstrate that a modern gasoline car can be run successfully on alcohol or kerosene if necessary, and to bring out the relative cost of operating it on either of the three fuels. In order to start the engines, when cold, it was found necessary to prime with gasoline. The one that was run on kerosene was provided for this purpose with a special pipe extending from the dashboard to the inlet pipe, and at first it was necessary to run it a couple of minutes in this way, until it had become warm. In the case of alcohol, by squirting a little gasoline into the hot-air jacket around the cylinder, to which is connected the air inlet pipe of the carbureter, the engine could be readily started and would continue to run on alcohol. The power developed by the engine, when running on the new fuel, seemed fully equal to that developed when it was run on gasoline, and the pulling qualities of the engine when its speed diminished under load were remarkable, being the nearest approach to a steam engine that we have thus far observed. Despite the fact that it was the most heavily loaded (weighing 2,750 pounds, as against 2,520 and 2,270 of the kerosene and gasoline cars), the alcohol machine opened the way through the snow and kept well ahead of the other cars. There seemed to be nothing lacking in power and speed. The kerosene car, too, showed good power and speed, especially the first day. Later on the heavy carbon deposit which undoubtedly formed in the cylinders owing to incomplete combustion, caused the engine of this car to knock badly under a load, apparently from pre-ignition. The spark plugs on this car were provided with spark gaps, as a result of which they operated with little or no trouble. That the kerosene was not vaporized properly but was burned in excess in the raw state could readily be seen from the heavy, ill-smelling smoke that was emitted. Because of the lubricating qualities of the kerosene, the driver was able to run his car half of the distance without the use of lubricating oil in the cylinders. On account of its low cost and other desirable features, kerosene would no doubt come into wide use, especially for commercial work, if some form of carbureter were introduced that would thoroughly gasify the liquid. Even with a greatly increased consumption, on account of its low cost, it was the cheapest of the three fuels used. The car running on this fuel averaged 7.4 miles per gallon, as against 6.13 of the alcohol car and 10.1 of that run on gasoline.

The total fuel consumption of the three cars—gasoline, kerosene, and alcohol—for the 250-mile journey was 24¾, 33¾, and 40¾ gallons respectively. At the prevailing prices of these three fuels, viz., 20, 13, and 37 cents per gallon, the total fuel expense of each car was $4.95, $4.39, and $15.07. This would make the cost per car mile $0.019, $0.0175, and $0.0603 in the order named, and the cost per ton-mile $0.0169, $0.0139, and $0.0448. From the latter figures it is seen that at the present time the use of denatured alcohol as fuel in an ordinary gasoline automobile engine fitted with the regular carbureter costs nearly two and one-half times as much as the use of gasoline, and over three times as much as the use of kerosene. In order to be on a par with gasoline at 20 cents a gallon, alcohol must be purchasable at 22 cents a gallon and must be used in a specially constructed engine giving 10 per cent more thermal efficiency than does the gasoline engine. Already, one month after the new alcohol law has gone into effect, the denatured spirit made by the addition of 10 parts (by weight) of wood alcohol and ½ part of benzine to every 100 parts of 90 per cent grain (ethyl) alcohol, can be purchased through dealers in this city for $0.36 a gallon in 5-barrel lots. A decided increased demand has already occurred for the spirit for use in the varnish and similar industries, and when once it begins to come into use as a motor fuel, with the largely increased demand that will then occur, the price will no doubt drop to approximately the same figure as that at which gasoline can be purchased to-day. Because it lacks the dangerous and ill-smelling qualities of gasoline, wealthy automobilists may yet prefer it to this fuel even though the expense be greater.

A description of some of the foreign carbureters which have been designed for alcohol motors, as well as much information regarding the theory and practice of this type of engine, will be found in the new book "Industrial Alcohol," which we will publish during the present month.

THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1623, opens with an article by William Mayner on the Rudolf Virchow Hospital, which is, perhaps, the finest institution of its kind in Europe. Something of the size of the institution may be gathered from the fact that it numbers fifty-seven buildings. Following the publication of the plans and specifications for constructing a 100-mile wireless telegraph set in SCIENTIFIC AMERICAN SUPPLEMENT No. 1605, and the location and erection of a suitable station for housing and operating this installation, printed in SCIENTIFIC AMERICAN SUPPLEMENT No. 1622, Mr. A. Frederick Collins, in the current SUPPLEMENT, describes how the set may be installed in the station to the best advantage, and finally, how the instruments may be properly adjusted and tested. An historical account of the eolipile, an ancient steam generator, is given by Mr. S. J. Berard. The epoch-making paper on the art of cutting metals read by Mr. Frederick W. Taylor before the American Society of Mechanical Engineers contains no more important chapter than that on the "Chatter of the Tool." This chapter will be found published in the current SUPPLEMENT. The English correspondent of the SCIENTIFIC AMERICAN writes on a novel engineering achievement in burying a river to a depth of 120 feet. Mr. W. H. Dugdale writes instructively on some early vicissitudes in engineering. Some practical hints for concrete constructors are given. The third installment on new incandescent electric lamps is published. The well-known aeronaut Carl E. Myers writes on the progress in airships and on forms of gas bags. A very good article is that on the tactical value of the "Dreadnought" type of battleship, the arguments being based upon the results of the battle of the Sea of Japan.

TELEPHONE STATISTICS.

Figures of the amount of business connected with telephones made public to-day, indicate that there were 5,071,500,000 exchange telephone talks and 133,600,000 long-distance or toll communications in the year 1906 in this country. On December 31 there were 7,107,835 instruments in use, 1,436,236 miles of toll wire, 2,385,742 miles of underground wire, 11,373 miles of submarine wire, and an aggregate of 6,080,282 miles of wire devoted to telephone service. The stations number 2,715,367, the total circuits 1,407,900, and the employees 90,000. These figures show a growth in six years of 171 per cent in number of employees, of 239 per cent in the number of stations, and of 349 per cent in the total number of miles of wire.