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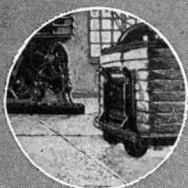
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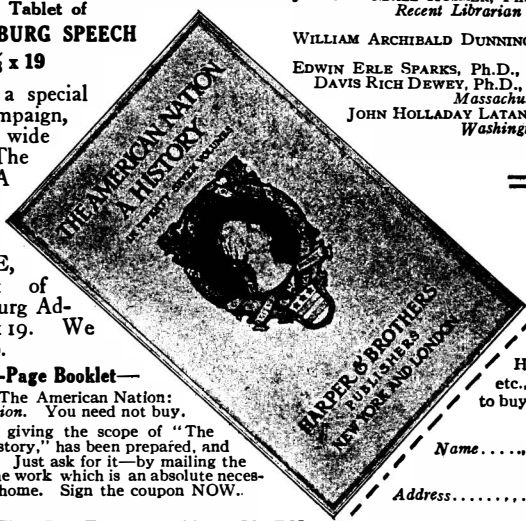
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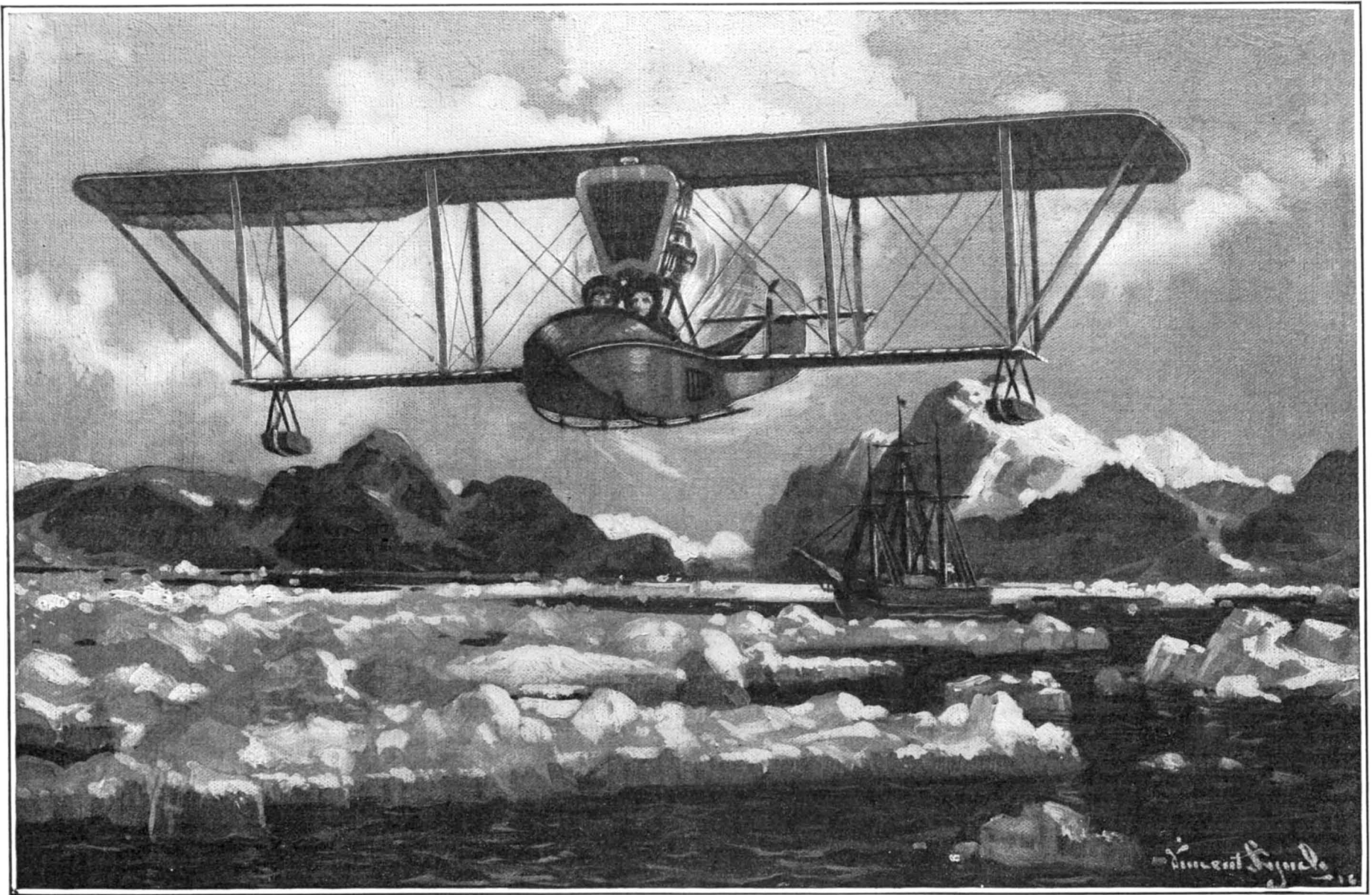
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The aeroplane vs. the steamer in polar exploration.

The Aeroplane in Arctic Exploration

By Burt M. McConnell, Canadian Arctic Expedition, 1913-14

IN September, 1915, Vilhjalmur Stefansson, Commander of the Canadian Antarctic Expedition, after having been "missing" for 18 months and almost universally given up for dead, surprised the world with a telegraphic announcement, from far within the Arctic Circle, that he had discovered land in the western Arctic Ocean northwest of Prince Patrick Land, and that he was going back to look for more. Those who know Stefansson realize that at any moment word may come that he has succeeded in this quest, and found a great Arctic continent.

It was the writer's good fortune, during the early stages of the work leading to last year's results, to be one of the supporting party that accompanied Stefansson and his two companions as far out on the sea ice as possible, carrying extra provisions and dog rations. Of the 65 miles thus covered, we were carried 40 by a southwest blizzard. The remaining 25 miles were achieved at the expense of 16 days of continuous and racking effort on the part of both men and dogs; and on our return over the rough, treacherous, drifting ice we encountered even greater difficulties. Ice fields half a mile wide consisting of solid masses as large as a house, tumbled about in confusion, could be crossed only by laboriously hacking trails up and down the steep slopes and hoisting and lowering the sleds with ropes. In one day of ten hours steady back-breaking labor we progressed but 500 yards.

Such conditions were enough to make the least imaginative wonder whether there were not a better way to explore the million square miles of unknown

area of the western Arctic. And it was then that the potential value of the aeroplane for this work was borne in upon me. Here we were, struggling along at the mercy of an adverse gale, and covering about as much area in a month of ceaseless effort as would an aeroplane in an hour!

The possibilities of the hydroaeroplane in Arctic exploration are indeed almost unbounded. During the winter of negligible daylight it would of course not be available. But in one long summer day of from 16 to 20 hours of brilliant atmospheric transparency, a single machine could cover as much territory as the most courageous and fortunate sledge driver could hope to cover in two months!

The development in the field of aerial navigation has been tremendous within the past three years. In 1913 there was no slightest possibility of Stefansson using the aeroplane to advantage; now all authorities are agreed that every objection to its employment has been removed. At the rate of exploration thus made possible, how long would it be before the one remaining unexplored area of great extent would be completely investigated—that lying north of Alaska and eastern Siberia, extending over 90 deg. of longitude from Prince Patrick Land to the New Siberian Islands, and bounded on the north by the Pole itself? Here it is that Stefansson is working; here it is that the old mode of exploration encounters the greatest hardships; here it is that the field of the aeroplane should be recognized to lie.

This field is a broad one. The western Arctic affords almost virgin territory for ethnologist and archaeologist, and at the same time presents a geographic problem of greatest interest. For geographers and students of

tidal phenomena long have contended that within the unknown area between Alaska and the Pole there lies a land mass of large proportions—either a continent of some 500,000 square miles, or an archipelago similar to the one lying north of western Canada. Upon the hypothesis of a deep and uninterrupted polar basin it is difficult to account for the fact that the range of the semi-daily tide along the north coast of Alaska is only about a quarter as great as that at Bennett Island, near the New Siberian group. Dr. R. A. Harris, of the U. S. Coast and Geodetic Survey, who for years has studied the problems connected with the tides of the Arctic, has even sketched an hypothetical continent within the unknown area. He has also shown that the diurnal tides along the north coast of Alaska have less than one half the rise and fall which the tidal forces acting over an uninterrupted basin would produce, and that the daily ebb and flow actually occurs earlier at Point Barrow than at Flaxman Island, 275 miles to the eastward, whereas with an open polar sea the reverse would be the case. On the other hand, Dr. Nansen, the Norwegian explorer, basing his belief upon soundings obtained during the drift of the "Fram," insists that the area in question is a deep open basin. This ship, however, in its remarkable drift, barely skirted the region under discussion. At any rate, the aeroplane stands preëminent as a means for testing the validity of these theories, for it is absolutely impossible for ships or dog teams to penetrate far into the interior of the Arctic ice pack.

In 1879 the "Jeanette," under Lieut. De Long, in an attempt to reach the Pole by way of Bering Strait was forced into the ice pack near Herald Island and

(Concluded on page 308)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Record Gunnery by the "Pennsylvania"

AT the opening of the European war, battle practice with our 12-inch guns was carried on at ranges of about 10,000 yards; and it was believed generally throughout the fleet that we were firing at ranges equal to and generally greater than those used by foreign navies. The naval engagements of the war quickly dissipated that delusion—the cruisers of Craddock's squadron being destroyed at 12,000 yards; those of von Spee's squadron at 15,000 yards, and the engagements on the Dogger Bank and off Jutland opening at ranges of from 18,000 to 20,000 yards. Our battleships, consequently, are now doing their shooting with the main battery at ranges equal to these, and under the new conditions our 14-inch guns have been achieving some notable successes. The battleship "Pennsylvania" firing at a range of 20,000 yards, and using the new director system, made five hits on a moving regulation target out of a salvo of twelve 14-inch guns. In the following 12-gun salvo she made three hits. Eight hits out of 24 shots must surely be a world's record. Moreover, this was done with the new 14-inch gun, mounted in the new 3-gun turret.

Now in view of the fact that rumors have been running around to the effect that the 3-gun-per-turret mounting is a failure, this feat of the "Pennsylvania" is certainly very timely and should serve to set at rest any doubt as to the efficiency of the system. When it was first tried out experimentally, the three guns were fired absolutely simultaneously by the closing of a switch. It was found however, that the air waves set up by the projectiles had a tendency to throw them out of their true line of flight. The difficulty was overcome by firing the two outside guns simultaneously, and arranging the electric firing connections so that the middle projectile left the muzzle a small fraction of a second after the other two, causing it to follow them at a distance at which the "bow wave" and other air disturbances were not sufficient to affect the flight of the shell. This very simple device completely solved the problem, and the recent astonishing results obtained on the "Pennsylvania" prove that the difficulty of interference has been completely eliminated.

Another very gratifying feature in this performance is the fact that these results were obtained with the new 14-inch gun, which fires a 1,400-pound shell with a muzzle velocity of 2,600 feet per second and a muzzle energy of 65,680-foot tons. The theoretical penetration with this gun is 15.9 inches of Krupp armor at a distance of 10,000 yards. Evidently, the United States Navy possesses in this piece one of the most accurate and effective naval weapons in existence; and we may be sure that the results obtained by the "Pennsylvania" will give a keener edge to the controversy, which is raging over the question as to whether our future ships shall carry a battery of twelve 14-inch guns firing a 1,400-pound shell or of eight 16-inch guns firing a 2,100-pound shell. With gunnery of equal efficiency, the number of hits secured, were the "Pennsylvania" to substitute a battery of 16-inch for her present battery of 14-inch guns, the number of hits secured would be 5.3 instead of 8 out of 24 shots. On the other hand, the destructive power of the 16-inch shell, whose muzzle energy is about 100,000-foot tons, would be far greater than that of the 14-inch shell.

Another element regarding the "Pennsylvania's" record, which is giving great satisfaction to our Ordnance Bureau, is the fact that the firing was done under our new director system, which has been developed during the past few years after lengthy and careful experimentation. In this system, into the details of which it is not expedient to go just now, the whole of the battery is controlled and the pointing is done

by a single officer chosen for his skill in holding the telescopic sights of the target. The system is so arranged that when the cross-hairs of his telescope are on the target, this officer knows that every gun throughout the battery is also on. It is evident that by this system those individual errors which must occur, when there is a gun-pointer for each gun, are eliminated.

Sleet—Glaze—Rime

AS recently noted in these columns, the United States Weather Bureau has been collecting information as to the various uses of the word "sleet" current in this country and elsewhere, with a view to formulating an official definition. This inquiry has now been completed and the results have just been published.

The history of the word "sleet" furnishes one of the most interesting examples on record of the fact that language (or, at any rate, the English language) was given to man to conceal his thoughts. The word has been applied to three different forms of atmospheric precipitation—and one of these is itself multifarious. It may mean either (1) a mixture of rain and snow, or (2) something more or less like hail, but without the structure of the true hailstone, or (3) a sheet of ice coating the branches of trees and other objects, and due to the freezing of rain. The second kind of "sleet" may again be subdivided into (a) frozen raindrops, or particles of clear ice, and (b) little white opaque pellets, like miniature snowballs. All these uses of the word "sleet" are found in America, though the first appears to be commoner in England than in this country. Moreover, various uses of the word are found in scientific and official publications, and this fact has given rise to much confusion.

Perhaps the most serious obstacle in the way of arriving at uniform usage is the practice, now almost universal in the United States and Canada among the wire-using industries, of applying the term "sleet" to the coating of ice formed by rain freezing as it falls, which does so much damage every winter to telegraph, telephone and electric transmission wires and poles. Other names for this ice deposit are known. In Great Britain it is called popularly, and also officially by the Meteorological Office, "glazed frost," but this name is quite unfamiliar in America. It has also been known in both continents as "silver thaw," though this name is also applied to an ice coating formed by fog, which is quite different in structure and appearance from that due to rain. The prevalence of the ice coating is often referred to as an "ice storm." A single short expression, easily assimilable into American speech, for the coating of frozen rain is obviously a desideratum. The connotations of the word "frost," as used in America, seem to make the British term "glazed frost" inappropriate. These considerations have led the Weather Bureau to coin the new term "glaze." It is hoped that the electrical and other industries which are practically interested in the phenomenon in question will take kindly to this term, and stop calling the formation by the ambiguous name "sleet."

The Weather Bureau has decided to restrict the term "sleet," for official purposes, to the small particles of clear ice which frequently fall in winter, with or without an admixture of rain. These particles have not the structure of hail—the attendant of summer thunderstorms—which consists of concentric layers of ice and compact snow. They also differ from those curious little balls, looking as though powdered with flour, which also sometimes fall in cold weather, and to which the technical name "soft hail" has been applied. This name is hardly a happy one, and many English-speaking meteorologists prefer to use the German name *Graupel*.

Lastly, the Weather Bureau has also adopted from the official vocabulary of the British Meteorological Office the term "rime," as the name for a coating of rough ice formed on terrestrial objects from fog; when the water droplets of the latter are undercooled, so that they turn to ice on coming in contact with solid bodies. Very striking examples of rime are seen in mountainous regions, where long feathery needles of ice form on the windward side of objects in a drifting fog. Rime is what the Germans call *Rauhreif*, and the French *givre*.

The Physiology of Labor

NATIONAL fortunes, according to the teachings of modern economists, comprise not only actual but potential assets, viz., the working capacities of citizens. The problem therefore arises of utilizing these assets to the best possible advantage, so that the whole social mechanism may work at maximum efficiency. One side of this has been mainly considered by American experts and constitutes what is called Scientific Management, viz., the organizing and coordinating of component movements so as to make the workers' labor as effective as possible. Another aspect will be studied in the Emperor William Institute for the Physiology of Labor, which has re-

cently been opened at Dahlem, near Berlin, and which makes part of those great laboratories of science, whose foundation has been from time to time discussed in this journal.

While being mainly intended for the study of professional and industrial hygiene, this Institute is likely also to assume importance for biological research in a wider sense.

It is well known that the trend of modern civilization is towards an increasing substitution of intellectual for physical work, the actual energy being supplied by machinery, whereas workmen are intrusted with the supervision of the latter and such operations as are mainly dependent upon skill, attention, thoroughness and endurance. The center of activity is thus shifted from the muscular to the nervous system and the brain, and is based on proper working of the senses, perceptive powers and will discipline. Only in this wider sense should labor be understood in reviewing the task of the new Institute.

It would, of course, be a hopeless task to investigate thousands of individual cases. The main principle of biological research, in fact, consists of realizing and choosing the typical, and thus reducing the multiplicity of phenomena to a limited number of cases.

Biological research can only hope to arrive at any suitable results by decomposing the complex phenomena of life into simple phenomena and gaging separately each effective factor. At the new Institute it is thus intended to investigate the output of the human organism, from a physical as well as a mental point of view, in connection with the various tasks of life, as well as according to sex, age, individual constitution and race. It will be ascertained how far this output depends on food, on the physical conditions of the surroundings,—air, temperature, atmospheric currents, moisture, noise, natural climate and the artificial climate of dwellings, factories and mines,—on dress and many other factors. In fact, all these influences are so far little known, and, generally speaking, we are more familiar with morbid than with normal circumstances in the life of the individual. However, even with regard to pathological lesions, much remains yet to be done. Deviation from normal life, as a consequence of professional accidents, will often take a long time to develop actual illness requiring medical help. In many cases there will even be no illness at all, but a general impairing of health, resulting in predisposition for bacterial infection or aggravation of an existing complaint.

Inasmuch as rational feeding will improve the general condition of any healthy individual, food may be considered the most important means of protecting man against noxious alterations as produced by overwork. On alimentary physiology devolves the task of stating the amount and kind of food materials required for yielding a given amount of work or improving the general condition of the organism. Much statistical material derived from practical life will, of course, have to be examined in this connection, e.g., the relative distribution of vegetable and animal food, provincial peculiarities, relations between country and town diets, the feeding of small and large families, etc.

Another problem studied at the Physiological Department is that of fatigue, on which much valuable material of an empirical character, that is, as yet devoid of any sound theoretical basis, has been obtained by the Taylor system. The circulation of the blood affords an objective standard for gaging bodily fatigue. In the case of intense physical work, the blood, in fact, flows from the abdominal organs into the body and limbs, thus widening their blood vessels; during fatigue the blood moves in an opposite direction, thus tightening the veins in the body and limbs and widening those of the abdominal organs. Observation of these phenomena has allowed two means to be devised for preventing or compensating fatigue, viz., a proper distribution of intervals and the inserting of what are called "auxiliary operations," viz., the activity of fresh groups of muscles. Actual tests at the Institute have resulted in a considerable increase of output. Scientific management is here studied independently of any economical or financial factors.

In a special department is investigated the pathology of work. The housing problem and endemic maladies, such as tuberculosis, caused most frequently by inadequate accommodation as well as alcoholism, the problem of female and infant labor, etc., are some of those coming within its province. Professional diseases are also considered in this part of the Institute.

The third department, that of Hygiene of Work, will ascertain the most satisfactory conditions for carrying out a given operation. This is mainly a question of logical deductions from investigations in other departments.

There will, of course, be close coöperation between the Institute and engineering practice, so that the results of scientific research may be of value in actual practice and contribute to the solution of the social problems engendered by our modern industrial system.

Naval and Military

The Gun Supreme in Battle.—The naval critic, J. B. Gautreau, writing from Paris for the *Naval and Military Record*, says that recent events tend to show that the instantaneous destruction of the most powerful battle unit can be effected more easily by the gun than by the torpedo. As proof of this he points to the fact that the British ship "Marlborough" of the "Queen Elizabeth" type received a torpedo hit without being disabled or disarmed; whereas some of the largest and best-protected units were seen to founder with tragic suddenness as the result of concentrated salvos by heavy guns. This striking proof of the superiority of the gun, he says, is considered in the French navy as being, so far, the most important lesson to be derived from the North Sea battle.

French View of the Big-Gun Controversy.—The same writer gives it as his opinion that the most reliable means of victory is provided by the concentration at the target at long range of the greatest number of efficient heavy guns. The best battle squadron will be the one having the most heavy guns on the shortest length of battle-line, and therefore best able to train its whole armament on a single target. In this respect he believes that four of the French Tourville, mounting among them 64 guns, would enjoy an uncontested tactical advantage over eight ships of the German Ersatz-Woerths type, carrying an armament numerically equal though superior in caliber.

Mobile Coast Defense.—The present war has demonstrated the value of mobility and the urgent need of changing the position of a battery as soon as it is located by the enemy's aerial scouts. Col. C. G. Morton, writing in the *Army and Navy Journal*, states that the difficulty of concealing the present big gun emplacements of our coast system and of providing additional cover for them has led to the consideration of making these elements mobile, either by the use of tractors over ordinary roads, or by the use of special railroad cars for the guns to be fired directly from the track. He is of the opinion that our present coast defenses, designed twenty years ago, lack concealment, lack cover against high angle and shrapnel fire, and lack mobility.

Admiral Fletcher on Target Practice.—In his examination before the House Naval Committee a few months ago, Admiral Fletcher, in referring to our practice at the long ranges, which we have adopted as the result of the teachings of the European war, stated that such has been the improvement in target practice that in recent long-range firing in Cuban waters the percentage of hits was in some cases as high at ranges of from 14,000 to 18,000 yards as at the shorter ranges of from 10,000 to 12,000 yards. This practice is not to be confused with the test of the guns of the "Pennsylvania" carried out a week or two ago, in which a record of eight hits out of twenty-four shots was obtained, as mentioned on our editorial page. The spring practice of the fleet was forty per cent better than that of the previous year.

Battleship Torpedo Nets.—Hitherto, the United States Navy has not favored the use of torpedo nets suspended from the boom and forming a crinoline, as it were, around the ship. An objection to these nets is that if they are to be effective when a ship is in motion its speed must be reduced to a few knots; for otherwise the rush of water would carry the nets well up toward the water surface, leaving the hull of the ship exposed. Used when the ship is at anchor, torpedo nets are an undoubted defense, but torpedo attack will very rarely be practicable under these conditions. The most feasible scheme is the construction of an outer false shell of steel plate which conforms to the model of the ship. The monitors built by the British were of this type, which seems to have proved an effective defense.

Superiority of 16" Guns.—The consideration which led the Navy Department to adopt the 16-inch gun for our future battleships and battle cruisers was the fact that they can pierce the armorplate of foreign battleships at a range of 17,000 yards, as against a penetrative range of 15,000 yards for the 14-inch gun. Our latest battleships carry twelve 14-inch; in place of this battery the new ships will mount eight 16-inch. Admiral Straus, Chief of the Ordnance Bureau of the Navy, believes that the greater volume of fire of the twelve 14-inch more than compensates for the greater penetrative range of the smaller number of 16-inch guns. However, the fact that the war has shown a continual increase in fighting ranges and that the foreign navies are going in the direction of 15 and 16-inch guns has determined the Department to adopt these big guns. It should be noted, furthermore, that the destructive effect of the burst of a shell weighing 2,100 pounds will be far greater than that of the 1,400-pound shell of the 14-inch guns.

Science

Mosquito Nuisance.—The residents of West Haddonfield were for years pestered and tormented by mosquitoes, which, it was learned upon investigation, were propagated in stagnant pools between the railroad and Haddon avenue. It was found practically impossible to drain these to the street gutters, hence another method had to be employed, and it was decided to sink the water into the ground. Under the supervision of L. Z. Lawrence, a heavy charge of dynamite was sunk and discharged about twenty feet under the surface. This caused the pools to disappear in short order, and no water has accumulated at this point up to the end of the year. It might help other infested places if the above method was tried.

Chemistry of Individuals.—The question of the chemistry of the species and of the individual is one that has a great interest in the field of biology. Between different individuals of the same species there are observed variations in anatomic and histologic structure, and in the same way there exist variations in chemical composition and reactions. Some noteworthy researches in this direction were made by M. Slovitzoff, of Petrograd, upon insects, and especially upon June bugs of a healthy and normal character and collected at the same time. He makes a great number of analyses and finds that taking the amounts of fats, chitine and nitrogen as a base, the specimens can be divided into several groups. About half the total number go to make up the average class, while the remainder show variations on both sides of the line, and he is able to make curves of variation analogous to what De Vries and others established for size, weight, color, etc., of different animals of a given species.

Solar Activity and Terrestrial Magnetism.—Although it has been recognized for years that a close relation exists between fluctuations in solar activity and in terrestrial magnetism, no criterion of solar activity has heretofore been found to synchronize precisely with any quantity used as an index of the earth's magnetic activity. In a recent paper by Dr. L. A. Bauer this fact is taken as the point of departure in an interesting development of the subject. Dr. Bauer points out that, for example, the maximum magnetic activity in 1892 preceded the maximum sunspot activity of that period by a year. Again, the recent minimum terrestrial magnetic activity seems to have occurred in 1912, while the sunspot minimum did not take place until a year later. Moreover, the amount of magnetic activity is not necessarily commensurate with that of solar activity, no matter what measure of the latter is used. If comparisons be made for shorter periods than a year—a month, for example—the lack of synchronism and proportionality becomes still more pronounced. However, since 1905 a new index of changes in solar activity has been available in the shape of solar-constant values, as determined by Abbot. As is well known, these values are subject to marked fluctuations, which may amount to as much as 10 per cent. Dr. Bauer has made a comparison between the annual changes in solar-constant values from 1905 to 1914 with the irregularities in the annual changes of the earth's magnetic constant, and the two sets of data are found to show generally similar fluctuations.

Sterilizing Grain by Chloride of Lime.—With a view of combating plant diseases which are propagated by means of the seeds, the necessity of employing antiseptics upon the seeds has been recognized for some time past. In the approved methods, the antiseptic is used for a long enough time to destroy the bacteria and the spores on the surface of the seed, but not sufficient to affect the germinative power. This method of proceeding is also used in laboratories of vegetable physiology, in which it is often indispensable to employ only such seeds as are quite free from micro-organisms. Up to the present, there have been employed as germicides only mercuric chloride, formic aldehyde, hydroxyl or alcohol; but experiments lately made by J. Wilson show that all these substances can be replaced to advantage by chloride of lime. The best solution for this purpose is obtained by using 100 parts chloride of lime (containing 28 per cent of chlorine) in 1,400 parts water. After standing for ten minutes, the clear liquid contains 2 per cent chlorine, and is ready for use. Seeds are dipped into this liquid, and unless in the case of a very long immersion, it is not found necessary to wash them to remove traces of the solution, for this does not appear to affect the germination. Experiments made with various seeds show that the time which is required for the surface sterilizing effect is always less by several hours than the time taken to affect the seed itself. The time of immersion is quite variable according to what seeds are used, for instance the surface of buckwheat becomes sterilized in six hours, while more than twelve hours are required for wheat grains. For this reason a large quantity of seeds should not be treated without making a laboratory test upon a small number. The volume of the solution should be at least five times that of the seeds.

Electricity

Harvard Stadium to Be Illuminated.—In order to make the stadium available for late afternoon and evening football practice, as well as to make it possible to play longer periods in the October games without being handicapped by darkness, the Harvard authorities are presently considering the installation of a lighting system.

An Electric Truck That Carries Its Own Charging Set is in use by the line crew of the Benton Harbor-St. Joseph Railway & Light Company of Michigan. The electric truck, a one-ton vehicle, carries a motor-generator set in order that the battery may be recharged at any transformer station. Otherwise it would not be possible for the truck to be recharged in the country districts where no facilities are afforded for the handling of electric vehicle batteries.

A New Refillable Cartridge Fuse has recently been introduced, having for one of its features a sealed fuse link. A number of the links, protected in a glass tube, are carried in the pocket, and when one of the new fuses blows it may be renewed by simply unscrewing one end of the cartridge case, removing the glass container of the burnt link, and substituting a new fuse member. The new cartridge fuse is constructed in compliance with the National Electrical Code.

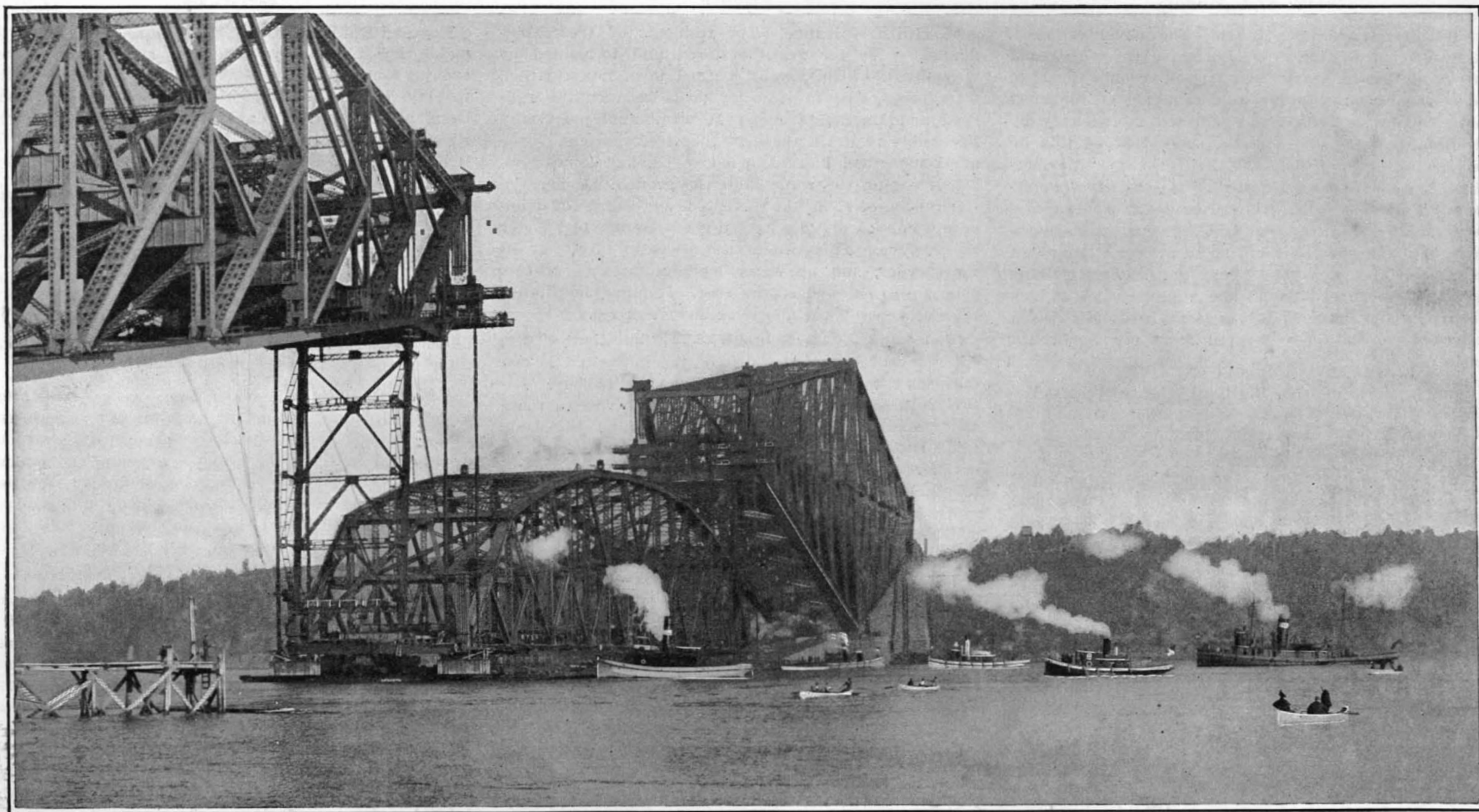
Copper-Clad Steel Wire is finding its way into the electrical industries for certain purposes where wire cost and wire strength are important considerations. The new wire, consisting of a steel wire core with a welded copper jacket, costs less per pound than copper wire; is 7 per cent lighter, size for size; is 60 per cent stronger, and therefore can be used in smaller sizes, giving better service; averages 126 per cent greater elastic limit, and does not reach a "yield point" under extremely heavy snow and ice storms; and, lastly, costs less to maintain. These are the claims set forth by manufacturers of such wire.

Novel Electric Connector.—Simple but efficient is the electrical conductor recently patented by Johann G. Peterson of Jersey City, N. J., consisting of two spring arms with apertured plates. The normal state of the present connector is with the spring arms sprung, so that the apertures of the end plates are not in alignment. Thus if the two plates are placed on a binding post of any kind, no matter whether the fastening nut should work loose, a good contact is established by the shearing action of the connector. To place or remove a connector from a binding post, the spring arms are pressed together in order to align the apertures of the plates.

Contemplated Electrically-Heated Hotel.—A local electric company of Rupert, Idaho, states the *Electrical World*, is figuring on heating a 50-room hotel through an electric boiler and indirect radiation. Such an installation will have to be made to compete with coal, but owing to the elimination of a fireman, as well as the upkeep of the equipment, it is believed that no trouble will be encountered by the company in securing the contract. A maximum demand of 300 kilowatts is being figured on. The electric heating of the high school of Rupert, Idaho, has attracted wide attention. Energy is bought cheaply from the Minidoka reclamation plant.

Battery Light for Manhole Work.—Weighing but 40 pounds complete, the storage battery lighting equipment recently introduced by the Commonwealth Edison Company of Chicago is proving of great assistance to manhole workers in splicing cables and other tasks. The main reason for adopting an electric lighting equipment is obviously to eliminate the danger that would arise if an open flame were taken into a manhole containing gas. A black-japanned pressed-steel battery box is used to carry the manhole lighting outfit about, the equipment consisting of a six-volt, 80 ampere-hour storage battery, and two 25-foot lengths of cord, with plugs, lamps and shields attached.

"The International System of Electric and Magnetic Units" is the subject of Scientific Paper No. 292, which has just been published by the United States Bureau of Standards. The paper gives full descriptions of the existing methods of measurement and those which have been proposed, and states the advantages of the methods already approved. All electrical measurements in the various countries are based on certain standards, kept at bureaus of standards. These standards represent the units, such as the volt and ampere, in terms of which measurements are expressed. Several different systems of electric and magnetic units have been proposed from time to time. These systems have been put forward as having noteworthy advantages in a theoretical way over the units which are ordinarily used. A careful study, however, has shown that the advantages of the proposed systems are not such as to justify a general change of units. In fact, the present paper shows that the ordinary units are in many ways superior to those proposed.



Suspended span, connected up to hoisting links, but with load of span still carried by the scows

Further Light on the Quebec Bridge Disaster

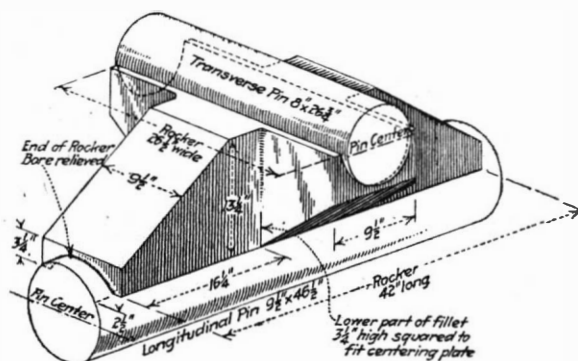
A Minute Examination of the Structure Discloses Internal Evidence of the Cause of the Collapse

IN our issue of last week, containing an account of the fall of the suspended span of the Quebec Bridge, we gave details as to the size, weight, and method of lifting into position of the central suspended span of the Quebec Bridge. It will be remembered that the span was 640 feet long, 88 feet wide and 110 feet deep, and that it weighed over 5,000 tons. It was towed to the bridge upon the scows upon which it had been erected, and it rested at its four corners upon four lifting-girders, between each of which and the end of the truss above was interposed a cast-steel rocker-bearing, capable of universal movement, placed there to prevent any inequality in the speed of the lifting, or any movement of the truss due to temperature and wind, from setting up abnormal stresses in the span itself or the lifting gear.

Last week, in the absence of any close professional examination at the site, we offered a possible theory as to the cause of the span's slipping off its lifting girders, suggesting that there might have been rotation of the southwest girder (where the first drop occurred) about the pins, by which the girder was attached to the lifting chains,—the girder thus kicking away from under the truss, leaving the span supported on only three points and setting up stresses in the cross-bracing which caused it to collapse and allow the whole truss to fall from its supports into the river.

Since that article was written, *Engineering News*, with the assistance of the officers of the St. Lawrence Bridge Company, has made on the spot a very thorough investigation of the disaster. The Bridge Company asked the editors of that journal to extend to the other technical journals the courtesy of advance proofs of its article, with a view to securing accuracy and thorough detail in other technical publications. Our photographs were taken by the Bridge Company, and the follow-

ing analysis of the conditions which led to the disaster is based upon the advance proofs above referred to. Briefly stated, the primary cause of the disaster



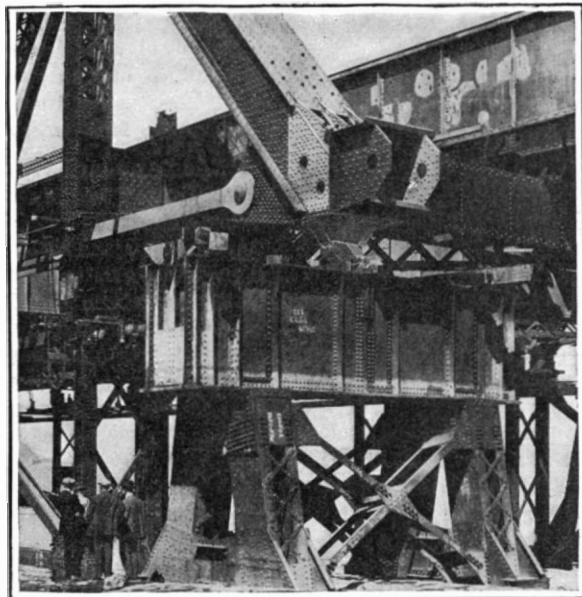
The rocker bracket which broke and precipitated the fall

was the fracture and breaking down of the cast-steel rocker-bearing interposed between the bottom of the southwest corner of the span and the lifting girder

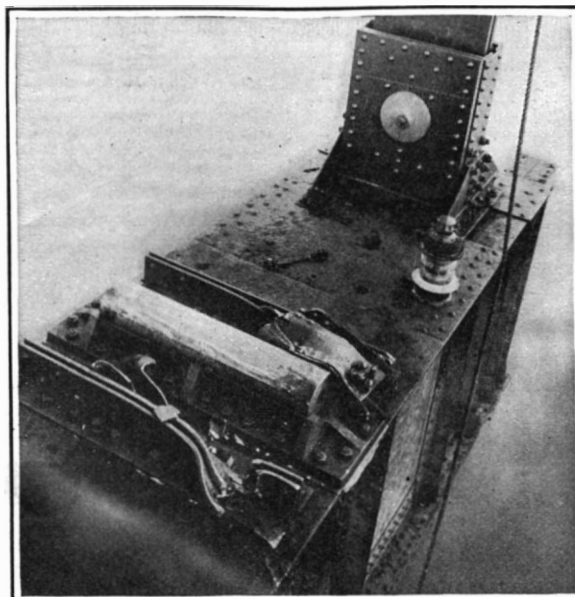
upon which it rested. The proof of this was found in the condition of the lifting girders after the span had disappeared, particularly as regards the crushing down, bending, scoring, etc., of certain details of the girders themselves, the condition of the lifting chains attached to them and of what was left of the rocker-bearings. The work of making a minute examination started a few hours after the collapse. Engineers of the St. Lawrence Bridge Company, outside engineers retained by them, as well as members of the Board of Engineers, took part in these examinations; and on invitation, a separate survey of the conditions was made by one of the editors of *Engineering News*. Hence we feel justified in accepting the unanimous conclusions arrived at as representing the true cause of the disaster.

The rocker-bearing so often referred to was built up as follows: On the top of the girder was a steel shoe casting with a longitudinal pin groove, which carried a pin $9\frac{1}{2}$ inches in diameter and $46\frac{1}{2}$ inches in length, which lay parallel to the longitudinal axis of the bridge. On this pin rested the steel rocker-casting, which is believed by the engineers to have broken, and this casting in turn carried a short transverse pin, 8 inches in diameter by $26\frac{1}{4}$ inches long. The upper shoe, which was attached to the base of the end post of the span, rested on this transverse pin. To keep the castings in proper central bearing when the hangers picked up the lifting girders, four centering plates were bolted to the bottom casting and fitted into the inner corners of the cruciform rocker.

When a descent was made down the southwest hanger after the accident, the top of the lifting girder showed the conditions revealed in the photograph which accompanies this article. It was immediately noted that of the four centering plates the northwest plate was in place, but crushed down vertically. Beside it was the girder



A corner of the span in position on lifting girder during erection



Courtesy of Engineering News

Photograph showing the shoe of the southwest rocker and the hanger after the fall of span

suspension bridle, also crushed vertically. The southwest centering plate was gone, but its bolts had been sheared off vertically, which indicated the descent of some vertical load upon it.

The presence and condition of these two centering plates proves that conditions remained normal up to the moment when some vertical blow was delivered to the west centering plates of the southwest hanger. These plates are the only points on any of the hangers at the four corners of the span where direct vertical or shearing action is indicated—all else shows a combination of turning, twisting and sliding. The vertical injury to these plates must

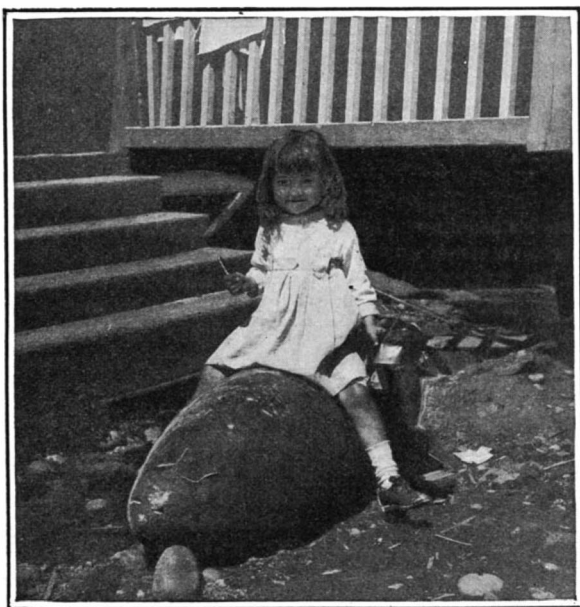
have preceded all other effects noted elsewhere. The two other centering plates of this southwest corner showed the bolts sheared downward and forward (that is, toward the suspended span, at 45°; the southeast centering plate was free and the northeast one was missing. These conditions indicate that backward movement of the girder occurred on the east side of the pin simultaneously with the dropping of the truss shoe. The lower pin was in place, but was rotated 1½ inches and scored spirally, indicating backward movement of the girder and crosswise movement of some superimposed burden.

The fracture which caused all the mischief probably occurred near the root of the front, lower pin-bracket of this rocker, which put the bearing on the lower pin out of service. Probably the fracture entered the upper pin seat and one of the upper brackets also.

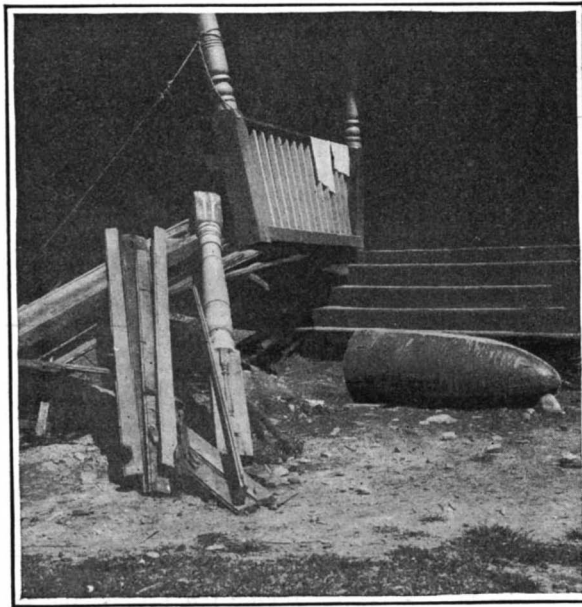
Concentration of the enormous 1250-ton load on the fracture edges must have caused crushing, tipping of what was left of the rocker, and some backward movement of the lower shoe and lifting girder. It was incidental to this quickly-passed stage of the catastrophe that the westerly fragment of the rocker bore down on the two west centering plates, curling one of them over and forcing the other off by downward shear. In the same action the fragments of the broken rocker were ejected from between the two pins like a smooth, wet orange seed, and, the impulse kicking back the entire swinging lifting girder, the corner of the suspended span fell free, merely grazing the pin and the girder cover-plate as it went off.

These events, written in the markings on the southwest girder, make all the other actions subsidiary. Indeed, the examination of the other three hangers shows the very sequence of movements which must inevitably have followed from the starting of the fall of the span as above outlined.

We are entirely in agreement with *Engineering News* and the
(Concluded on page 310)



Test of a 16-inch naval shell against 13-inch armor. The child acts as a scale to show the enormous dimensions of the shell



This 16-inch shell passed through 13 inches of armor, 35 feet of sand, covered three-quarters of a mile, and went through this cottage

Sixteen-Inch Naval Gun Penetrates Thirteen-Inch Armor Plate

THE new 45-caliber, 16-inch type gun built for the Navy has been undergoing a series of very thorough tests, and so far with gratifying results. It is 60 feet in length, weighs about 80 tons, and fires a projectile weighing 2100 pounds, with a muzzle energy of approximately 100,000-foot tons. Up to the present time the tests have been of a general character; but last week the gun was tried out with an armor-piercing shell against a 13-inch Krupp plate. The plate had behind it the usual heavy backing of timber and sand, there being a mass of sand banked up against the backing and extending for some 30 or 40 feet behind it.

The shell made a clean perforation of the armor, timber and sand backing, was deflected, and traveled about three quarters of a mile farther, finally passing through the cottage of a Government employee at the Indian Head proving ground. Fortunately, no one was injured. The shell doing the enormous amount of work involved in the perforation of armor, backing and sand-bank came to rest, it will be noticed, fairly intact; although the photograph shows incipient signs of heavy flaking near the tip of the nose of the projectile.

to expose several of the methods actually practiced, but they also serve to indicate the great amount of ingenuity possessed by these thieves.

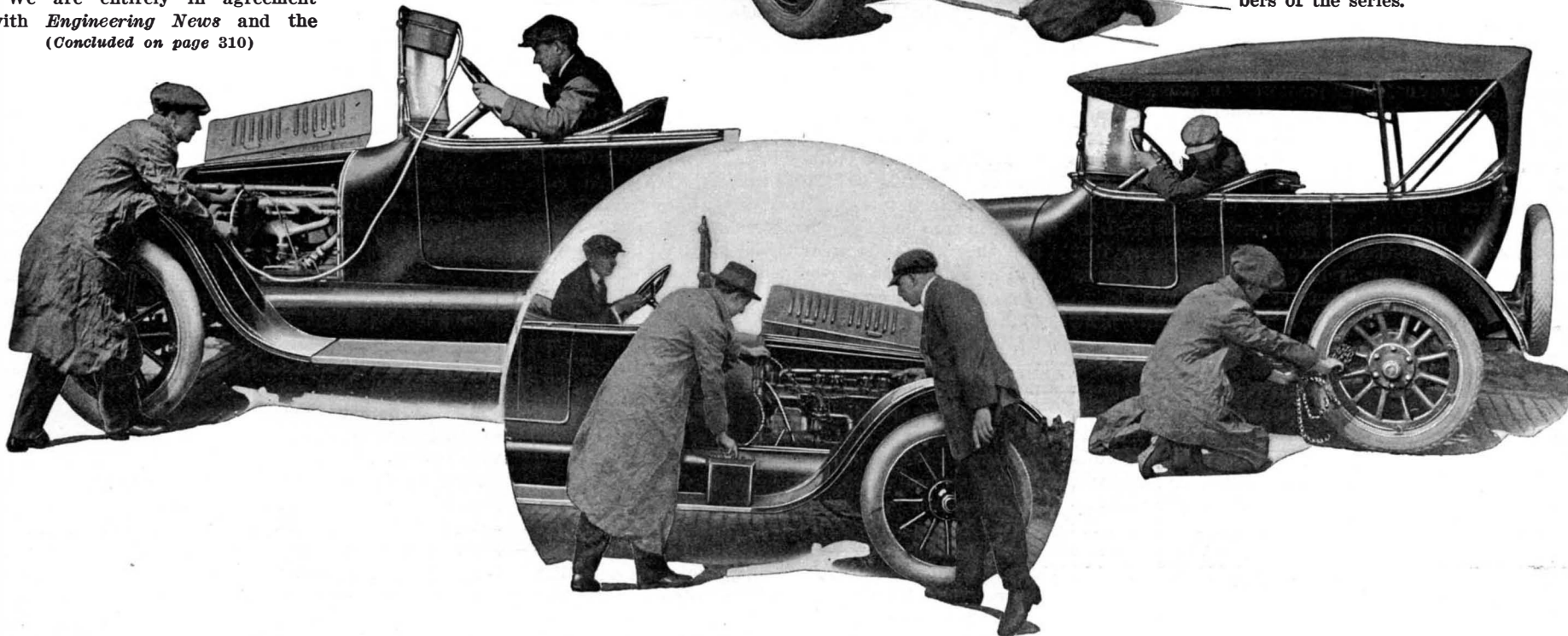
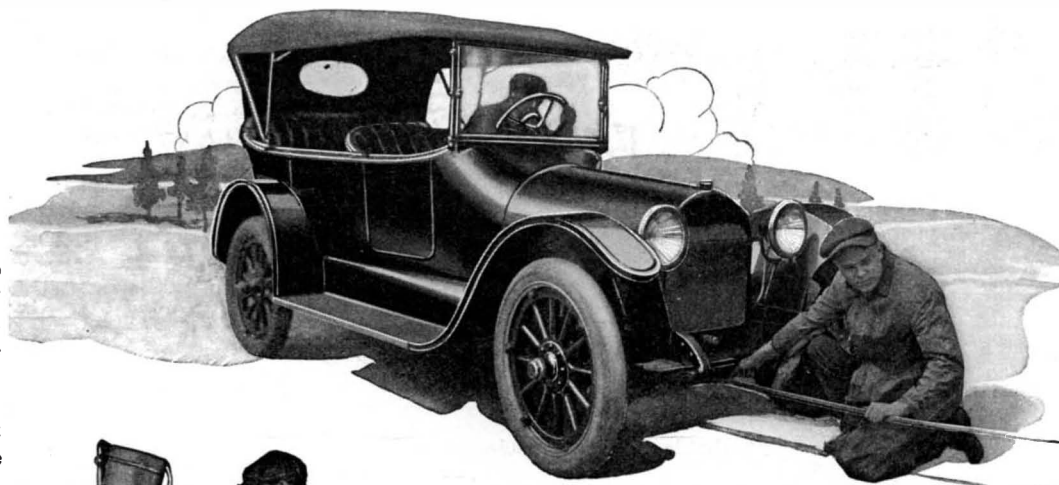
One of the favorite tricks of the automobile thieves is to dress as repair men from a garage, drive up to a stationary car, fasten a tow line to it and chug away, ostensibly to the repair shop.

Sharp nippers make car thieves superior to steel chain locks on the wheels. Too many car owners rely on chains to prevent theft, only to find to their loss that these offer but scant protection.

Devices for locking the fuel system of a car do not baffle the automobile thieves. When they find the gasoline tank locked, the adepts bring into use their own portable fuel tanks, which they mount on the windshield, or some other convenient support, and pipe the gasoline through a rubber hose from bucket to carburetor. Again, devices for locking the ignition system are of no avail; by carrying their independent ignition system the thieves can soon have the engine operating as efficiently as if it were employing its own magneto and distributing devices.

A New Deluge Tablet

IT is reported from the Smithsonian Museum that there has been found among the museum's large stores of uncollated Mesopotamian texts a small tablet containing an account of the Deluge, substantially in accord with other items of a similar nature already known. The tablet just discovered is in an extremely early Accadian or Sumerian tongue, and dates back to at least 2250 B. C., being thus notably earlier than most of the Deluge inscriptions. It appears to be a continuation of a similar tablet found in the museum and translated some time ago. The Smithsonian Assyriologists are now employed in a thorough search for some further members of the series.



A few of the methods practiced by automobile thieves in the theft of cars

Above, using the tow-line; left, using the portable gasoline tank; right, cutting wheel chains with powerful pliers; below, installing an auxiliary ignition system

Strategic Moves of the War, September 22nd, 1916

By Our Military Expert

THE general aspect of the European war at the present time suggests the lull before the storm. There are no spectacular movements to record, from any front; yet there has been inaction nowhere. Each battlefield seems to be held in force, Western, Eastern, Italian, Southern and Asiatic, while the lines are dented and bruised here and there without any achievements of note resulting therefrom.

But it is believed by many observers that affairs of moment are pending, gigantic movements in course of preparation, where, nobody knows. The time which has elapsed since the war entered the newest phase, brought about by the introduction of Roumania into the fray, has scarcely been sufficient to allow troop concentration following the declaration of war, especially as general reserves as well as troop bodies from various fronts must be redistributed to back up the movement; and the direction in which Roumania would jump was so uncertainly indicated that the Entente could not with any degree of surety assume alliance on its side and make pre-actional disposition for immediate use.

There seems to be a disposition on the part of public and press to give undue prominence to Mackensen's operation in the Dobrudja. As a matter of fact this movement is but a sort of counterbalance to that which took place when Roumania swept into Transylvania; a glance at the map will show why.

Roumania's line of defense from the south and southeast is formed by the line of the Danube. Fifty miles northeast of Rustchuk, the Roumanian frontier ceases to be limned by this river, which then pursues a northeasterly course until it reaches the heart of the division between Dobrudja and Wallachia, the principal province of the Roumanian kingdom, from whence the Danube thrusts due north to the Bessarabian border, thence southeast to the Black Sea. It is clear, then, that all Dobrudja lies without Roumania's line of defense, and, in consequence of the long line to be defended, there are insufficient troops at first available for the defense of the outlying position. In Transylvania, the Austrians are shortening their lines by slowly giving up portions of this province, falling back toward the chord of the Transylvanian peninsula.

There is a limit, however, to the amount of Dobrudjan territory which can readily be conceded to invasion. Mackensen's advance must proceed on a decreasing front as though his men were marching into the mouth of a funnel, for the northeasterly trend of the Danube and the shore line of the Black Sea combine to produce this geographical situation. At the narrowest part of the funnel runs the railway from Constanza to Cernavoda, the former on the Black Sea, the latter on the Danube, and this line must be held by the Entente, lest a way be opened for a Teutonic advance upon the flank.

It is axiomatic that in modern warfare swift movement and ample supply can be accomplished only by the use of railway facilities properly placed. Mackensen's northward advance through the Dobrudja has possessed an artery of supply in the railway from Varna. Should the Constanza-Cernavoda line be gained and held, the Teutonic forces would then be able to turn westward and begin their battering at the Cernavoda bridgehead, which, once carried, even at a tremendous cost, would open up an entrance into Roumania on the home side of the Danube defenses. For these reasons it is necessary that this east-and-west railway in the Dobrudja be held by the Entente; and the dispatches indicate that retirement has ceased. It is by far the most logical point to defend in the entire province. Here the front is most restricted and can be held by the fewest men. Only a limited number of men can occupy a given space; therefore, if the Entente holds this line with an adequate force, three times their number should not be able to dislodge them. And if the combined Roumanian-Russian advance into Bulgaria, a movement generally forecast, takes place in the vicinity of Rustchuk, Mackensen's men will have to come tumbling out of the Dobrudja at breakneck speed, or be trapped like rats in the Dobrudja and northeastern Bulgaria.

Meantime, serious preliminary action has developed along the southern line. French, English, Serbs, Italians and Russians have begun their poundings upon the forbidding mountain barriers which hold them from Serbia and Bulgaria. Already the local Bulgarian successes

which marked the opening of the Macedonian offensive have been, to a great measure, overcome, and the Entente has advanced its line on the west until, it is reported, Monastir is threatened with immediate recapture. With the fall of Monastir, the line of the Cerna, a general line of Teutonic defense, will be turned and the way opened for general advance toward the redemption of Serbian soil and, indirectly, against Austria.

In eastern Macedonia several villages near the Struma line have been retaken by the Bulgars, a part of their defensive operations which have come to be marked by offensive-defensive methods, although these successes have so far accomplished nothing toward retaking the Struma line behind which the Entente is preparing for advance.

Before leaving the subject of operations in the Balkans it may be well to consider for a moment the conditions now existing in Greece. When the Bulgarians occupied Kavala, a considerable force of Greek troops, estimated at something less than an army corps, were held technically as armed neutrals, really as prisoners of war, and they were sent into Germany.

after all, an even more powerful weapon than Force.

In France, the Somme sector still marks the center of interest. Gradually the British and French are biting away nibbles at point after point in the attempt to so undermine supporting positions that the entire structure of defense must eventually crumble and fall. While the ceaseless hammering continues along the general Somme front, the French have begun to turn some of their attention to broadening the section won since the beginning of the attack. The old line and the new meet to the southward in the vicinity of Chaulnes. About three miles north of this point the Entente is already in position to cut downward and isolate the town. East of Chaulnes are important railway junctions, the main line from Laon to Amiens being here, as well as the branch which springs northeast to Perrone, forming thereby one of the principal lateral lines of supply. Possession of this junction by the French would seriously handicap the Germans, and one of the most sanguinary battles of the war will probably be registered here, once the operations are undertaken. There are several indications that such a movement is in course of preparation, and any day now may witness the beginning of the major attack.

Russia seems merely holding on throughout her line; something is going on behind the curtain of inaction, and it will probably be raised within a reasonably short time.

The Current Supplement

AN exceptionally interesting article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2126, September 30th, is *The Relation of Muscular Activity to the Mental Processes*, treating of the energy that directs the movements that represent consciousness. *A New Explanation of Sound Phenomena Accompanying Disruptive Electrical Discharges in Air* suggests a new theory of thunder, and is accompanied by a number of original illustrations. *Volume Changes During the Hardening of Steel* discusses conditions that affect a troublesome technical problem. *Aeronautics of the Great War* tells of the valuable work of the captive balloon in the operations on the battle front in Europe, and is accompanied by several excellent photographs. *The Indian Jute Industry* speaks of the history, cultivation and manufacture of a textile that is used throughout the world. *A Comparative Color Photometer* gives a general description of an instrument, and of a new system for standardizing and charting colors and also for scientific color synthesis. The subject is most interesting and valuable in its scope, and is illustrated by many diagrams. *The Metallurgy of the Rarer Metals* calls attention to an attractive field of research for the chemist, and gives brief summaries of methods of extracting a number of little known metals, their qualities, and, as far as known, their practical applications. The paper on *The Movements of the Moon* is concluded. Other articles in this issue include *The Fan Dynamometer*, with drawings and formulae for its use and *Propeller Immersion* treating of a problem in ship propulsion.

Use of Lime and Fertilizers in New Zealand

THE agricultural interests of New Zealand, backed by the New Zealand government, are devoting much attention to the study of the treatment of various soils in order to get the best possible results. The soils of New Zealand vary materially in different parts of the country. Some lack sufficient quantities of lime, containing too much acid, and must be treated before some of the more attractive crops can be grown. For liming the soil large limestone-grinding plants are located in many sections. The soils demanding it are treated by spreading from 500 pounds to 4 tons per acre, according to the quality of the soil. This is done by machinery with excellent results.

Fertilizers are extensively used, the imports for the year ended March 31st, 1916, amounting to 134,002 tons, against 130,599 tons for the year ended March 31st, 1915. Imports of fertilizers of various sorts during these two years, from the chief sources of supply, in tons of 2,240 pounds, were: Bone dust, 9,424 in 1914 and 11,688 in the year ended March 31st, 1916; superphosphates, 50,743 and 58,088; rock phosphate, 23,934 and 51,510; basic slag, 29,165 and 10,279; nitrate of soda, 33 and 50; iron sulphate, 21 and 155.



The battle regions of southeastern Europe

The general situation in Greece has been a disturbed one, with the main sentiment of the country distinctly hostile to Bulgaria and somewhat in favor of espousing actively the Allied cause. Pro-Teutonic sentiment of the Throne has been the principal reason why Greece has not ere this become involved. The Greeks and Bulgars are natural enemies; and the action of Bulgaria in spiriting away an army corps of Greeks, dazed and uncertain as to what action to take, due to political muddling, has increased the feeling of displeasure. Greece has sent an ultimatum of sorts to the Teutonic authorities demanding the return of these soldiers. There is scarcely a chance that the men will be returned—and the chances are exactly equal that if Germany holds the Greek troops, Greece will declare war within a very few days.

Greek entrance into the war would place a force of at least 300,000 men available within a reasonable time, at the service of the Southern High Command—an ample number to take over enough of the general line to enable General Sarrail to detach troops to bridge the gap in the line between his left and the Italian forces before Avalona, thereby forming one continuous line of operations from the Aegean Sea to the Adriatic, and render possible a more speedy reclamation of the Albanian and Serbian territory. Political developments in Greece, within the next few days, should be watched with a great deal of interest. Diplomacy is,

Armor-Plating an Aeroplane

By Ladislav d'Orcy

ALONGSIDE with the steady development of the military aeroplane for scouting and offensive purposes, there has loomed up the problem of providing such aircraft with adequate protection against both anti-aircraft guns and the newly developed aerial artillery, which the battle aeroplanes carry in form of machine guns and small caliber semi-automatic guns.

The means of protection are varied in form, according to the class an aeroplane belongs to. Speed scouts—to use the term employed by the United States Army—generally rely upon their speed, both translational and ascensional, to escape the fire of the enemy; and whereas this class of aircraft must be particularly fast and possessed with great excess of power, these requisites can be attained only in a "light weight" machine, which almost precludes the employment of armor-plating.

It is by no means easy to foretell whether the practice of relying solely upon speed for the protection of the speed scout is going to prevail in the near future; in fact, one can already record several attempts, made chiefly in France, at producing armored high-speed scouts, but this development has been far from becoming general.

In the spring of 1914 the Nieuport Company of Paris, France, built an armored scout which has achieved brilliant results. This machine, a monoplane of 24 square meters surface and fitted with a 100 horse-power Gnome engine, has flown at the rate of 145 kilometers per hour, risen at the rate of 500 meters in 3 minutes, 45 seconds, and made its get-away and landing within an enclosure of 150 square meters. The armor consisted of a 3.5 millimeter nickel steel belt covering the cockpit of the two occupants and the engine hood. The machine weighed complete, with its pilot, gunner, machine gun and three and one half hours' fuel supply, 1,000 kg.

Other French concerns have turned out experimental machines whose performances have more or less equalled the ones just mentioned.

It is generally agreed to-day that the military aircraft which mostly need armor protection, are the battle aeroplane and the bombing aeroplane, but more so the latter. Both types of machines have the task of carrying out long distance raids into enemy territory; but while the battle aeroplane may rely upon its superior artillery to fight off enemy aircraft, the case of the bombing aeroplane is entirely different. While the battle aeroplane may be soaring at a height of 2,000 meters, watching the skies for the aerial enemy unmolested, except for high-angle guns, the bombing aeroplane cannot remain at such a height if it is to fulfill its mission.

For instance, the pilots of the Royal (British) Naval Air Service have strict orders to come down within 300 feet of the target to be bombed; and the results of the daring raids upon Friedrichshafen, Diesseldorf, Cuxhaven, Evere, etc., constitute a forceful justification of this seemingly draconic measure.

In the French Aeronautic Service the rules regarding the "bombing altitude" are, chiefly on account of a superior equipment, less stringent; but while a maximum height of about 600 meters is considered sufficient for such attacks, the individual bravery of French airmen is apt to reduce greatly this range, such as was the case at Carlsruhe, Colmar, Ludwigshafen, etc.

Assuming 600 meters to be the maximum height at which bombing operations can successfully be conducted from an aeroplane, the adoption of armor-plating becomes imperative if the lives of the airmen are to be safeguarded to some extent.

Unfortunately the present status of aerodynamics limits, on account of the weight involved, the use of armor-plating to the protection of the vital organs of the aeroplane and only against small arms fire. Protection against high-angle guns, which throw projectiles weighing from 8 to 40 pounds to an average altitude of 20,000 feet, is beyond the possibilities of the present moment.

Exhaustive tests show that a nickel-steel belt of 3 to 4 mm. thickness effectually stops the most powerful modern rifle bullet, the Mauser *Spitzgeschoss*, at a range of 600 meters. By armoring the aeroplane's most vital part, the cockpit, with plates of said thickness, the constructor insures the safety of its occupants and of the navigating instruments—in short, the aeroplane's "brains." But the protection of the "nerves" of the aeroplane, i. e., of the cables controlling the warp, the elevator and the rubber constitutes a far more difficult problem to resolve.

It is true, absolute protection could be obtained by leading the control cables to the steering organs through armored beams carrying the same amount of protection as the cockpit; but the weight of such armor-plating seems almost prohibitive, and, in fact, this solution has not thus far been put into practice.

In case the constructor chooses not to armor the leads of the control cables—which is the habitual pro-

cedure—the only actual protection consists in duplicating said organs.

But the problem of providing an aeroplane with adequate protection against small arms fire does not stop at the protection of its vital parts. The remaining parts also require a careful study; and whereas these cannot be armored, they should be "so designed that bullets will pass through without doing more than local injury and without serious effect on the strength or flying power of the machine as a whole; in certain cases components will require to be duplicated. It is important to understand clearly that any intermediate course is fatal. Either the bullet must be definitely resisted and stopped, or it must be let through with the least possible resistance." (Lanchester.)

In this respect attention must also be paid to the structural features of the aeroplane that is to be armored. From a purely military standpoint the pusher type is far superior to the tractor type on account of the former's greater range of vision; but if the question of aerodynamic efficiency and structural strength is raised, the judgment must unhesitatingly be reversed.

Most pushers carry the steering organs on "outriggers," generally composed of four wide-spaced spars which are interconnected so as to constitute a box-girder. The fuselage of a tractor is in most cases of identical construction except for the less wide spacing of the spars, which are covered in with cloth so as to produce a good stream-line effect.

Opinions vary considerably in regard to the relative merits of the fuselage and the outrigger systems.

Advocates of the former claim greater compactness and strength for the fuselage, which is due to the small spacing of the spars. Those defending the outrigger system contend that the fuselage presents too easy a target for the gunner, whereas the outriggers are hardly discernible in flight even at a small range. While this academic discussion is going on it may be of interest to note that there is a third system of fuselage construction, called the *monocoque* (one-piece-shell) system, which curiously enough has found so far little favor with military authorities. In the monocoque there are no spars at all; the fuselage is built up of several thin layers of light wood, which are glued and compressed over a spindle shaped form. The result is a perfectly stream-lined body, possessed of great strength and lightness, which on account of its great passive resistance to rifle fire, should prove particularly desirable for the construction of military aircraft.

This assumption is borne out by the fact that a dozen rifle bullets landing in a row on a *monocoque* fuselage—a common occurrence with machine gun fire—will simply perforate this "shell" without impairing in the least the fuselage's constitutional strength; whereas the same broadside delivered against a box-girder fuselage is very liable to cut a spar or a strut right in two and spell thereby disaster to the aircraft concerned.

Maple Wood, a Substitute for French Briar

THE constantly increasing difficulty of obtaining the necessary amount of so-called French briar from southern Europe for the manufacture of smoke pipes is caused not so much by the restrictions placed on the export of this wood as it is by the growing scarcity in the region of its growth. The value of briar wood shipped to the United States increased over 150 per cent in 1914, which may be attributed to the fact that the sources of supply are very limited. French briar is the root and not the trunk of a plant that is not only small but grows very slowly, and, in consequence, large tracts of land are necessary for obtaining the needed supplies. The endeavors to overcome the present scarcity of this European product, by using quick-growing woods with nearly similar properties, have at least been partly successful through the utilization of domestic woods which are not only cheaper but also more plentiful. The native woods first used for making pipes successfully on a large scale were the mountain laurel and the rhododendron. Both of these plants have very large roots considering the size of the stems and crowns.

There seems likely, however, to be a demand in the near future for other woods for making smoke pipes. Apple wood and to a lesser extent black or wild cherry wood are used, but they burn out more rapidly than the mountain laurel and rhododendron. Recent experiments have been conducted with wild cherry and hard maple, and it is claimed that the latter wood stands up successfully as a substitute for French briar. In this connection the *Hardwood Record* for August 10th states that the maple pipe will color like the best meerschaum, and, being a sweet, absorbent wood, absorbs all the juices as well as a clay pipe would do, but it is without the unpleasant taste of a clay pipe. As it is free from oils, it is never bitter, and is not as liable to burn or check as the briar. It may, however, burn if smoked in a gale. Another thing in favor of maple is that no putty has to be placed in it to stop holes, because there are no holes to stop. The wood, of course, must be dry before it is worked, or it will warp.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Discussion of High-Velocity Photography

To the Editor of the SCIENTIFIC AMERICAN:

The splendid reproduction, in your issue of August 26th, of the wonderful photograph showing a bullet traveling through the air at a speed of 2,700 feet per second is worthy of careful consideration. This probably is the first picture ever published of thunder—I say it depicts thunder, because it shows the actual commotion of the air and the sound waves sent off as it rushes in to fill a vacuum—just such a phenomenon as occasions thunder. We may then ask, how long will it be before we have a photograph where the lightning itself is utilized for the flash to imprint its own following peal of thunder upon the plate?

It has been shown that any object traveling through the air at a velocity greater than that of sound will set up a sound wave. Thus, the point of a bullet from our Army rifle, with a muzzle speed of 2,700 feet per second, throws off a sound wave at an angle of 60 deg. when atmospheric conditions are such that sound velocity is 1,085 feet per second. Since these bow waves jump off the very point of the bullet, it is readily understood why bullets of all sizes will crack the same, so long as the tapering nose remains under 60 deg. A very large projectile with the same sharp point, and head tapering anywhere under 60 deg., should not, under the same conditions of atmosphere and velocity, set up a greater head noise than a very small bullet.

The next sound wave, set up by the bullet itself, seems to be caused by the piling or skin friction of the air on the bullet's straight wall. This wave is plainly shown in all the photographs you have published, with one exception. But in that case, the photograph was taken just beyond the muzzle of the gun, where the noise of the barrel explosion itself seemed to eclipse all other sounds near the rear of the bullet; and, indeed, this wave could hardly have been generated at all so soon, as the bullet probably was not yet clear of the gases from the barrel. The effect in question is shown most clearly in Dr. Hyde's picture, which is of extraordinary effectiveness, owing no doubt to the refractive method used, and to the fact that the bullet had traveled sufficiently far from the barrel to give the air opportunity to get in its action.

Again, this is the first photograph I have seen which shows the pinch or quick closing of the air behind the bullet, thereby verifying the theoretic correctness of the streamline body for eliminating the vacuum following the projectile. This streamline angle, or flow of air, is shown in the picture to be about 20 deg. Then it is necessary to shape the tail of the streamline bullet to an angle of 20 deg. or more, in order to overcome the vacuum and give the bullet stability of flight and do away with all flight noises except the whiplash crack.

So this picture indicates completely how bullets should be shaped, giving the maximum angle for the head, the minimum for the tail, and showing that there should be no straight walls, but a long-drawn-out gracefully curving streamline contour, pointed at both ends.

ELI E. GREGORY.

A Correction

To the Editor of the SCIENTIFIC AMERICAN:

Please refer to the article in your issue of September 2, 1916, "Blazing a Trail for the Industries," by Mr. Harry Knowles. We respectfully call your attention to a misleading statement in the first paragraph on page 224, relating to the smoke nuisance in Pittsburgh.

The misleading part of the statement in the said paragraph is that relating to the electric precipitator. While it is true that there has been at least a 25 per cent reduction in the amount of smoke and an annual saving of more than \$2,000,000 to the people of Pittsburgh, this was not brought about in any instance by electric precipitation. In fact, there is not, nor has there been in successful operation, an electric precipitator for the purpose of doing away with the smoke from stacks. There is, however, one such installation recovering by-products from a metallurgical furnace and another one now being tried out and perfected in connection with a railroad roundhouse stack connected with forty-two smoke jacks.

It is to be noted in this connection that the Mellon Institute did devise one type of electric precipitator shown in an experimental way at the Institute. It is also a fact that the smoke can be prevented from being emitted from stacks by the use of the electric precipitator.

Respectfully yours,

PITTSBURGH BUREAU OF SMOKE REGULATION,

J. W. HENDERSON,
Bureau Chief.

Recent Cruise of Patrol Squadron No. I

Work of Part of the Mosquito Fleet

By Orson D. Munn



PATROL SQUADRON NO. 1, or, as it was originally designated, The Patrol Squadron, has recently completed its third official cruise under the auspices of the Navy Department, and has thus finished its practice and training for the present season.

Patrol Squadron No. 1, after the completion of a week of work in June, in waters adjacent to Block Island and Newport, was formally enrolled in the Second Naval District as part of the reserve forces of the United States Navy. The Second District is one of the most important of the naval districts of the country, and embraces the coast line and islands from Chatham on Cape Cod to New London, Connecticut, and Sag Harbor, Long Island. It is of particular importance as it includes the "back door" to New York City, that is, the eastern entrance to Long Island Sound and the shoreline involved.

On the afternoon of August 28th last, Patrol Squadron No. 1, consisting of patrol boats Nos. 1, 2, 4, 5, 7, and the mother ship "Daraga" left Sag Harbor under command of Lieut. W. D. Puleston, U. S. N., aide to Admiral Knight, who is in command of the Second Naval District. Boat No. 3 was unfortunately not able to take part in the cruise owing to the fact that just prior to the start she was disabled by an accident. The commander of Patrol Squadron No. 1 is Mr. Stuart Davis of Southampton, Long Island. The skippers of the patrol boats are: A. Loring Swasey, No. 1; Orson D. Munn, No. 2; Frederick Humphries, No. 3; Charles A. Painter, Jr., No. 4; Roland Nickerson, No. 5, and J. Philip Hart, No. 7.

These boats are of a standardized type and are 40 feet in length. Boats Nos. 6 and 8, which have recently been added to the squadron, are respectively owned and captained by Herman Oelrichs and Harold A. Vanderbilt. No. 6 is 62 feet long and is driven by two 400-horse-power, 12-cylinder engines. When tuned up she is expected to make 33 miles an hour or better. No. 8 is about 70 feet long and is also heavily engined for her size, and will probably make over 28 miles an hour. The engine power of the forty-footers is from 150 to 200, and they will make between 25 and 27 miles per hour. All these boats are designed for heavy weather, and have shown themselves to be remarkably good sea boats.

On leaving Sag Harbor the squadron went to Fisher's Island, and, after a brief halt for the evening meal, performed night maneuvers until about ten o'clock, at which time the boats were moored for the night. In the morning the flotilla went to the Government dock at Fort Wright and the officers of the squadron were shown through the various forts and mortar batteries, through the courtesy of the commanding officer in charge.

On the afternoon of the 29th the squadron left Fisher's Island and proceeded to Point Judith, mooring

for the night inside of the breakwater. On the morning of the 30th the fleet left for Edgartown, near the eastern end of the Second District, passing through Wood's Hole en route. The following day the cruise was continued from Edgartown to Chatham, and from Chatham to Wood's Hole, where they tied up to the Government dock for the night. Between Chatham and Wood's Hole a rough and choppy sea was encountered, which constituted a splendid test of the boats' seaworthiness and their staying qualities under unfavorable weather conditions.

On Saturday, the 2nd of September, the fleet left Wood's Hole and arrived at New Bedford at 11 in the morning. During the afternoon of that day the flotilla was exercised at some length in Buzzards Bay, executing tactical maneuvers and carrying out various submarine search problems which had been previously planned. The following morning the squadron advanced to Newport, where it was moored in one of the slips at the torpedo station. On Monday, the 4th of September,

and the power yawl "Dawn." At this time, too, the squadron was joined by No. 8, which had arrived from Boston. No. 6, unfortunately, was not able to take part in these maneuvers as she was not completed in time. The succeeding two or three days were spent in operations and maneuvers, with Block Island as a base, in conjunction with the battleship "Virginia," the torpedo-boat destroyers "Worden" and "Winslow," and the submarines D¹ and D², and E¹, together with the submarine mother ship, the "Fulton."

The work of the squadron at Block Island was more or less affected by the fact that the weather was somewhat unfavorable, in that frequent fogs were encountered. However, the following maneuvers and problems were successfully carried out:

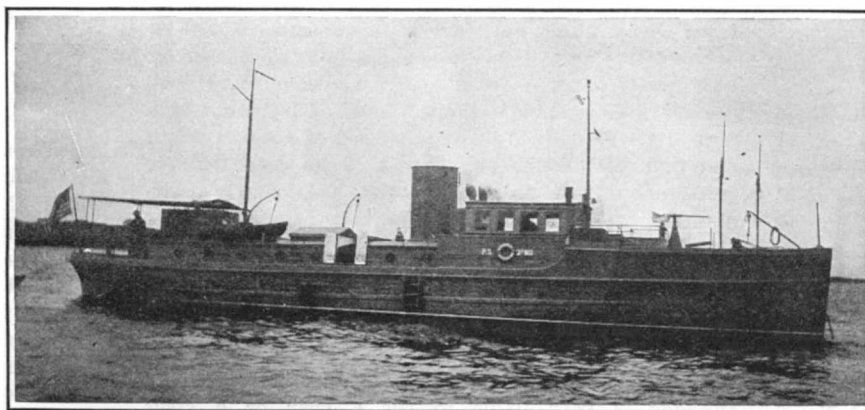
The first problem consisted of an effort to locate a submarine after she had submerged, the point of submergence being known to the patrol squadron. This problem consisted in the boats traveling on predetermined compass courses radially, and in effect spirally,

in order to cover as much area of water as possible so that the submarine could be detected as soon as she projected her periscope above the surface. In this maneuver, which took place between Block Island and the Connecticut shore, patrol boat No. 5 detected the submarine after 22 minutes of search. A similar problem was later worked out by the second division, and the second submarine involved was detected by the "Romany."

The next problem consisted in the forming of a screen about the battleship "Virginia" to protect her from submarine attack while traveling on a predetermined course in Long Island Sound. The two submarines, which had been sent out before the "Virginia" and her screen had started, attempted to get within torpedo range, but both were captured, technically,

or forced to submerge and retreat before they were able to pierce the protecting screen.

The third exercise consisted in the use of the patrol boats in protecting the battleship against night attack on the part of torpedo-boat destroyers. The first division of the patrol squadron formed a line between Block Island and Montauk Point; and the second division, one between Point Judith and Block Island. All the boats, as well as the destroyers, of course ran without lights. Night signals were given through the agency of the Very pistol, by means of which red and green rockets can be fired into the air, the rockets being visible at a considerable distance. The destroyer "Worden" attempted to pierce the line between Block Island and Montauk Point, but was immediately sighted by patrol boat No. 2. The signal of detection, consisting of the firing of a red rocket, was at once given, and this was repeated at brief intervals, not only by this patrol boat but by the others which on receiving the signal then sighted the destroyer. In this way the "Virginia" was warned and was able to pick up the destroyer with

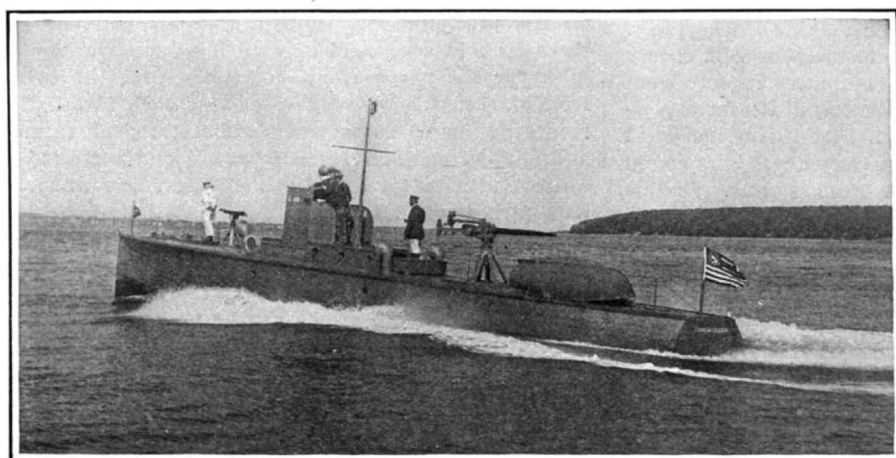


The yacht "Daraga," the mother-ship of Patrol Squadron No. 1

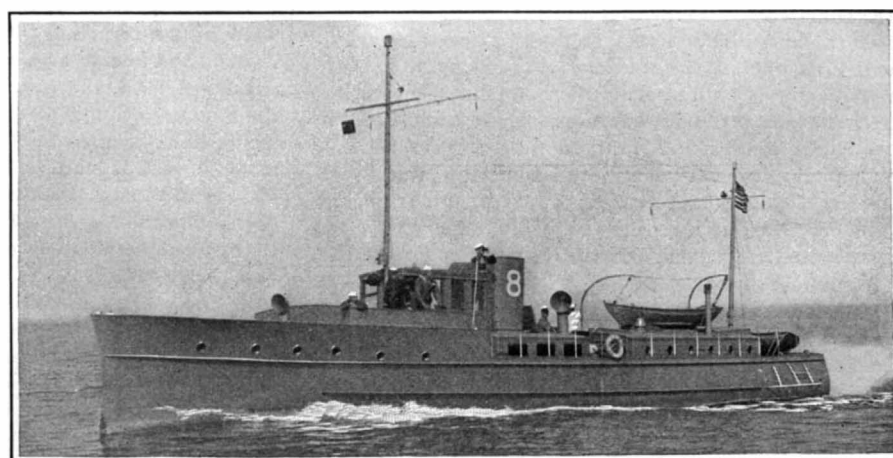
the boats went to Melville, where gasoline was obtained from the Government oil station.

From the foregoing itinerary it will be seen that the objects of the first week's cruise were to cover as much as possible of the Second Naval District and to familiarize the personnel of the fleet with the waters and coastlines in and about which the squadron would operate when in actual service.

On Tuesday, September 5th, the squadron proceeded to Block Island to carry out the second part of the program, which consisted in virtual service problems with submarines, torpedo-boat destroyers, and other war vessels. At this time the squadron had been joined by the second division, consisting of fast motor boats which had been mobilized by the Citizens Committee of the Second and Third Districts, and which constituted a squadron similar to the civilian mosquito fleets put in service for the week's work at Boston, New York and Philadelphia. The second division consisted of the flag ship "Chingachgook," the "Maunola," the "Romany," the "Flyaway III," the "Mystery," the "Edamena,"



The "Chingachgook," flagship of the second division



No. 8, a recent addition to the squadron



Tactical maneuvers in Buzzards Bay

her searchlights before the attacker could come within effective range. Another destroyer, attempting to pass through by way of Point Judith, was also caught by one of the boats of the second division. In this instance the battleship, too, duly received the signals and the destroyer was, technically, sunk before she could make an effective attack.

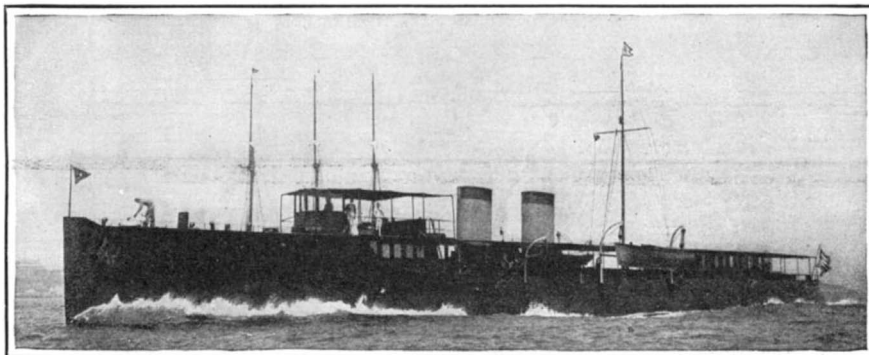
The next exercise called for the protection of the "Virginia" while at anchor against night attack by the destroyers. The patrol boats were stationed about 2 miles apart in two large semi-circles in the Sound around the anchorage of the battleship. Two of the destroyers attempted to break through the screen, but were located immediately by the patrol boats and their successive positions indicated by signals from the Very pistol. This maneuver was particularly successful in view of the fact that the weather conditions were rather unfavorable to the patrol boats, as a very severe thunderstorm took place during the attack by the destroyers.

On Saturday, September 9th, the squadron again traveled eastward in the company of the destroyers "Winslow" and "Benham." Search problems with two submarines were carried out on the journey, by both the first and second division. Weather conditions were extremely favorable and both submarines were easily detected by the boats of the first division which formed the first line in the advance from Block Island. On the afternoon of the 9th the squadron entered New Bedford Harbor and tied up at the Government wharf. On the following day, target practice

with the Colt rapid fire gun and the three-pounder on the "Chingachgook," took place in Buzzards Bay. On Monday, after tactical maneuvers and exercises, the squadron together with the destroyers returned to Newport. On Tuesday, the 12th of September, both divisions, which was joined by No. 6, were reviewed by Admiral Knight, after which, the squadron disbanded.

It may be safely said that in the main, the result of the maneuvers and exercises conducted by the squadron were eminently satisfactory. While the performances of the boats were excellent, many of the officers of the squadron, and of the naval officers, who had an opportunity to familiarize themselves with the work which has been done, are reaching the conclusion that for patrol and scouting duty in heavy weather, and particularly during the winter months, boats of a different type would probably have to be used, or at least included in the present squadron. It would appear that more adequate protection against cold and inclemency of weather must be given the navigating officers and crews of the boats. While they are very fast and seldom take green water over the bow, spray is constantly coming inboard, if any sea at all is running. It would seem imperative in constructing new boats, that a conning tower or an effective shield should be provided, to protect the officer in charge and the man at the wheel. While speed, and more speed is of course a requisite, there is a tendency on the part of certain members of the Patrol Squadron who have had considerable experience during the past summer, to consider the steam engine as a better means of propulsion for work of this kind, than the gas engine, owing to its far higher degree of reliability, and furthermore, owing to the fact that the boats can be heated and rendered far more habitable, if provided with a steam power plant. The use of fuel oil for this purpose presents an obvious advantage.

Too much credit cannot be given the officers of the Navy who have been in charge of this work and have devoted so much of their time and effort to making the cruises successful. The aid and coöperation of Admiral Knight have been most valuable. Much credit and



Steam turbine yacht that makes thirty-seven miles an hour

thanks are due to Lieut. W. D. Puleston, who was in immediate charge of the last two cruises, and to Lieut. Com. V. A. Kimberley, who participated in the cruise in June. Lieut. Puleston has been indefatigable in planning the operations of the squadron, in instructing the officers and members in their work, and in closely supervising all that has been done. All the members of the squadron thoroughly appreciate, from professional as well as personal reasons, their debt to Lieut. Puleston.



Correct deportment for a commander of a captured submarine

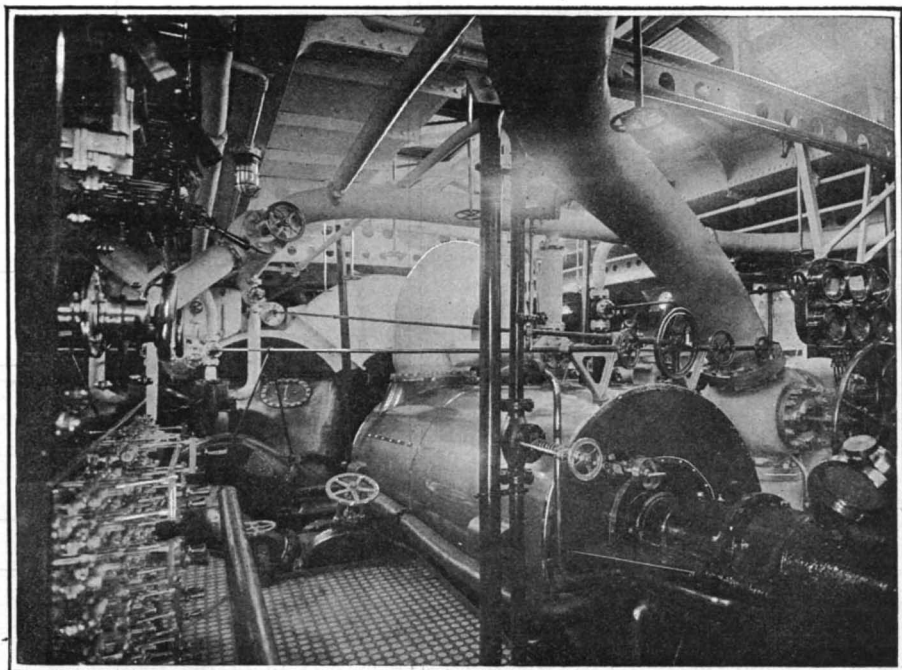
The Last Word in Steam Yachts

THE tendency of the age is a craving for speed, and this is not confined to the practical and business affairs of men, but extends to their pleasures as well. The automobile has displaced the horse, and the power yacht is doing the same with the sail craft. In some few cases, however, there is a very good reason for desiring high speed, for a fast conveyance enables a busy man of business to establish his residence at some quiet and healthful place, far from the noise, dust and heat of the city, and to make the daily journeys to and from his office in a reasonable time, and with comfort and enjoyment.

An instance of this kind is that of a New York business man whose summer residence is on Long Island Sound, about 30 miles from the city. For a number of years Mr. Peter W. Rouss has been experimenting with high speed "ferry boats" for use in his daily trips to the city, and for brief outings along the coast, and his craft, of which he has built several, have always been of the torpedo boat destroyer type, long and narrow, and provided with tremendous power, but incorporating every device that could contribute to seaworthiness and comfort.

The latest "Winchester," for that is the name borne by all of the fast boats built by this owner, which made its appearance this summer, is 225 feet long with a beam of

(Concluded on page 309)



The 7,500 horse-power motors



Luxuriously furnished main saloon

The Heavens in October

Nebulae of Dimensions that Stagger the Imagination

By Prof. Henry Norris Russell, Ph. D.

AMONG the rapid advances which are now being made in astronomy, none is more remarkable than those in our knowledge of the nebulae—especially the spiral nebulae, whose real nature was so long a matter of uncertainty.

Between twenty and thirty years ago, the application of photography to the study of the nebulae showed that the spiral form, not often shown by direct telescopic observations, was really very common—the outer extensions being often too faint to see with the unaided eye. These spirals were evidently flat affairs, each nebula lying nearly in one plane, which was in some cases turned also edgewise toward the observer, and in others seen nearly at right angles showing the spiral curves in their fine form.

For a good many years our knowledge stopped at this point. Five or six years ago, however, Fath, at Mount Wilson, photographed the spectra of a number of these bodies, and found it such as would be given by a cluster of stars too remote to be seen separately, even with larger telescopes.

Later Stephen, at Flagstaff, determined the radial velocities of several spirals, and found them amazingly large, averaging about 400 kilometers per second—fully 20 times as great as for the stars—with some values exceeding 1,000 kilometers per second. These extraordinary results have been fully confirmed by other observers. Curtis, at the Leeds Observatory, by comparing pairs of photographs of the same objects taken at 15 or 20 years' interval, found that these nebulae have small but perceptible proper motions in the heavens, averaging two or three seconds of arc per century. On the assumption that the real velocities of these motions at right angles to our line of sight are the magnitude indicated by the spectroscopic observations, it follows that the distances of the spiral nebulae must average 10,000 light years or more, that is fully 600,000,000 times the Earth's distance from the sun. As these nebulae cover considerable areas of the sky (views offer a considerable fraction of a degree in diameter) their real dimensions must be exceedingly great, so vast that it would take light many years—perhaps 20, 50 or even more—to travel from the center to the edge.

The question whether the various portions of these enormous bodies are in motion relative to one another is of great interest. The first evidence bearing on it came from the Lowell Observatory, where Stephen's photograph's showed that a remarkable nebula in Virgo, apparently a spiral seen edgewise, was in rotation, at a very high linear speed, of 100 kilometers per second or more.

Wolf, at Heidelberg, made the same discovery in the case of certain other nebulae.

The most recent contributions come again from the Pacific Coast observatories, where most of the work on this subject has been done. Van Maanen, at Mount Wilson, has recently compared pairs of plates of the spiral nebula known as Messier 101 (from its number in Messier's catalogue), which were taken at Mount Wilson in 1910 and 1916, and at the Leeds Observatory in 1899, 1908 and 1914. This nebula is one of the spirals which is evidently seen nearly in plane, one line of sight being at right angles to its own plane, and is noteworthy for the large number of definite and almost star-like knots and condensations which are found all along its spiral arms.

Dr. Van Maanen's measures show that the nebulous material (compared with 32 faint stars in the surrounding sky as points of reference) is in motion, the main motion being one of rotation about the center in a vast whirl, with a small tendency outward along the spiral lines. The average rate of motion 2" to 3" per century, is fairly large, from the standpoint of the astronomer, though it corresponds only to one rotation about the center in some 85,000 years. (For a point about half way out to the edge.)

The real rate of motion must be very rapid. If the distance of the nebula is 1,000 light years (probably far too low an estimate), the average velocity of the moving matter would be 35 kilometers per second. If the distance is 10,000 light years, which now-a-days seems more reasonable, the velocity would be about 350 kilometers, or more than 200 miles, per second.

Is it credible that such enormous internal velocities,

within the confines of a single nebula, should exist? The spectrographic results already mentioned suggest an affirmative answer, and a still more definite support is given by works of Pease at Mount Wilson—just reported to the American Astronomical Society—who, from a spectrograph of the nebula in Virgo, with 80 hours' exposure, finds that the velocity of the center is almost 1,200 kilometers a second (receding from us), while the opposite edges are moving, relative to the center, at 330 kilometers per second in opposite directions—the whole mass being a rotation.

The conception of the spiral nebulae, which is opened to us by these discoveries, is almost overwhelming in its magnitude. These stupendous objects are so huge that if the center of one was placed near the sun, its outskirts would extend far beyond the nearer stars, all around the heavens. The whole amount of light which one of these nebulae sends out must be thousands—probably hundreds of thousands—of times as great as that emitted by the sun. It seems probable, that the quantity of matter contained in such a nebula—the total mass—is correspondingly great; indeed,

to be in rotation, like the nebulae described above.

The next star in our original line, Gamma Andromedae, is a fine double for a small telescope; then, after a little greater interval, we come upon Alpha Persei—a star whose spectrum is not very different from that of the sun though indicating probably a little higher temperature, but whose light probably exceeds that of the sun a thousand-fold or more.

Below Perseus, in the northeast, is Auriga, and Gemini is rising. In the east Taurus is well up and Orion rising below. Eridanus and Cetus occupy the dull southeastern sky. Aquarius and Capricornus, in the southwest, are almost equally dull, and the only conspicuous stars in all this region are Beta Ceti and Fomalhaut, in the Southern Fish.

Jupiter, which is in Aries, high in the east, far outshines any of the fixed stars.

Cygnus, Lyra and Aquila are sinking in the west and northwest. Cassiopeia and Cepheus are high above the Pole. Ursa Minor and Draco are below them, and the Great Bear is low on the northern horizon, as if attempting to hide from our vision.

The Planets

Mercury is invisible early in the month, being almost between us and the sun. On the 5th he passes through inferior conjunction and becomes a morning star, moving rapidly out to elongation, on the 20th, when he is 18 degrees west of the sun, and 8 degrees north of him. This affords a favorable opportunity for early risers to see the planet, which appears on the horizon at about 4:50 A.M. He is near perihelion, and appears brighter than Arcturus, and, as he is in Virgo, remote from any bright star, he cannot be mistaken.

Venus is a morning star in Leo, rising about 2:15 A.M. on the 1st, and a little before 3 A.M. on the 31st. She is still seven times brighter than Sirius, and easily visible by daylight without telescopic aid.

Mars is still an evening star, but is getting pretty near the sun, and is hard to see. At the beginning of the month he is close to Alpha Librae, while at its close he is about 5 degrees north of Antares. Being so far south, he sets before 7 P.M. and is almost lost in the twilight.

Jupiter comes to opposition on the 26th, and is visible all night long. He is a splendid telescopic object and a long series of interesting eclipses and transits of his satellites are visible. The first and second satellites may be seen simultaneously in transit across the planet's disk, together with their shadows, on the 2d

(about 2 A.M.), the 9th (3 A.M.), the 20th (8 P.M.), and the 27th (9 P.M.); while on the 4th, from 7:56 to 8:57 P.M., and again on the 11th, from 11:07 to 11:47 P.M. The second and third satellites are behind the planet, or in its shadow, and the first in front of it, leaving only the fourth visible. All things considered, it would be difficult to imagine a more brilliant display by the giant of the solar system and his attendants.

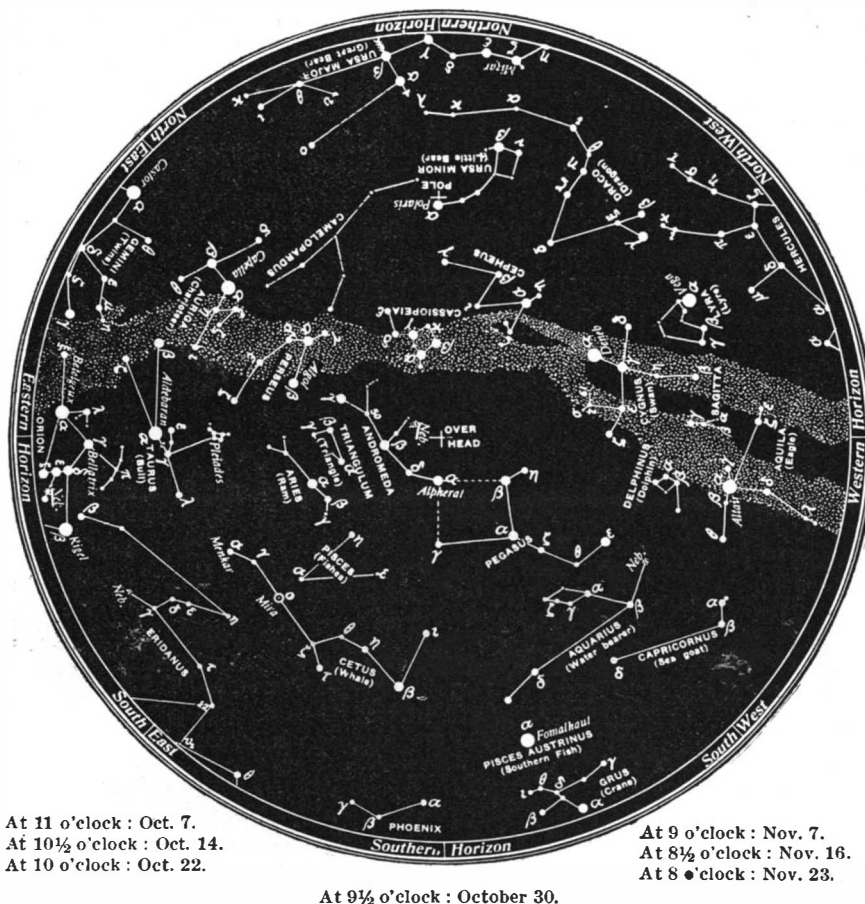
Saturn is in quadrature with the sun on the 23d. At this time he is in Cancer and rises at about 11 P.M. He appears about as bright as Procyon—being farther from us than at the last opposition, and with his rings less widely displayed. Uranus is in Capricornus, observable in the early evening, and Neptune in Cancer, about 5 degrees east of Saturn, so that he is also in quadrature with the sun, on the 28th, and is observable in the morning hours.

The Moon is in her first quarter at 6 A.M. on the 4th, full at 2 A.M. on the 11th, in her last quarter at 8 P.M. on the 18th, and new at 5 P.M. on the 26th. She is nearest the earth on the 6th, farthest away on the 19th, and nearest again on the 31st.

As she circles about the heavens she passes near Uranus on the 6th, Jupiter on the 12th, Saturn on the 19th, Neptune on the same day, Venus on the 23d, Mercury on the 25th, and Mars on the 28th.

The conjunctions with Saturn and Neptune are close, and occultations are visible from some parts of the earth's surface. For observers in the United States the conjunction is pretty close, but there is no occultation.

Southport, Connecticut, September 18th, 1916.



NIGHT SKY: OCTOBER AND NOVEMBER

Van Maanen calculates, in the case of Messier 101, that it may be great enough to make millions of bodies like the sun. And the number of these spiral nebulae runs up into the thousands!

No astronomical discovery since the first measurement of the distances of the fixed stars has so greatly widened, at a single bound, the limits of distance within which our investigations may operate; and in the collection of further observational evidence, and the attempts to interpret the causes of these extraordinarily rapid motions, there will be material for many years of profitable work.

The Heavens

At the selected hour of observation—which varies from a little after 11 P.M. at the beginning of the month to 9:30 at its close—the heavens present the appearance shown by our map.

Very high up in the south—so high as to seem almost overhead—we find the Great Square of Pegasus—a very conspicuous figure, which may well serve as our starting point. From its upper left hand corner a line of bright stars run toward the northeast, at intervals nearly equal to one of the sides of the square. The first of these stars, Beta Andromedae, serves as a pointer to the Great Nebula of Andromeda, which lies about five degrees to the northward, as our map shows. This nebula, though conspicuous to the naked eye on a dark night, does not show its spiral character except to the photographic plate—the outer extensions being too faint to be detected visually, even with telescopic aid. It has recently been found

Walking, Hopping, Creeping and Crawling Mechanical Beasts

Various Traction Mechanisms that Might Be Employed for Armored Battlecars

STRANGE tales are coming to us from the battlefields of northern France. We would almost believe that our old friend Baron Münchhausen had come to life had not the extraordinary developments of the present war prepared us to accept the wildest yarns as possible. War correspondents have been telling us of a huge British machine that hurdles trenches and shell-holes, that prefers to smash through a tree rather than pass around it, that delights to crush into the brick walls of a house and wallow about inside, tramping upon the enemy. Of course, these stories have been colored by the highly-stimulated imagination of the writers, but, after making due allowances, the fabulous antics of these new juggernauts come within the limits of possibility.

It is probable that the machine is an armored tractor which travels over the ground with the "caterpillar" type of propulsion, which has been highly developed in this country within the past few years. Indeed, we are informed by an American officer that he saw under construction in England huge tractors of the caterpillar type, greatly exceeding in width and length any previous model. The caterpillar belt is of unusual length so as to provide sufficient adhesive traction to utilize the several hundred horse-power of the gasoline engines by which they are driven. The tractors used in this country are able to cross a ditch five or six feet wide, and it is conceivable that by extending the tractor belt enormously, machines could be built which would pass over shell-holes of considerable size and any of the trenches constructed by the enemy.

Caterpillar tractors have been employed in this country for uprooting trees and stumps, and hence it should not be a difficult matter for a much larger model of such a machine to bowl over a tree of moderate dimensions. The momentum of the huge mass would enable the tractor to ride over barbed-wire fences, and even to crush in brick walls.

While it is probable that the "tanks," as these new machines are called, use the caterpillar type of traction, it is barely possible that some other form of walking mechanism may be utilized. We have made a search of the Patent Office's files to see what has been done in this field of invention. A surprisingly large number of patents on this subject have been issued, from which we have selected the six shown in the accompanying engraving as typical and of particular interest. The caterpillar form of traction is shown in Fig. 2. It is so familiar to our readers that it scarcely needs any explanation. The machine travels on a tractor chain or belt, driven by a rear sprocket wheel, which passes over a smaller idler at the forward end. Intermediate between these wheels are rollers, which bear against the inner surface of a chain. This is in effect an endless road built for the machine to travel upon. It adapts itself to un-

even ground and enables the machine to crawl out of hollows and up steep banks.

The mechanism shown in Fig. 1 is decidedly different in principle. It has been employed in excavators adapted for use in marshy ground, so as to give a very broad footing. Only part of the walking mechanism is shown in the illustration. The part that is left out so as to avoid complicating the drawing is a broad turntable on which the excavator normally "sits" while performing its work. When the machine is being moved into a new position a camshaft is operated to which are hung a pair of broad shoes or beams, as indicated in the drawing. As the camshaft revolves, these shoes are moved forward and planted upon the ground in advance of the turntable. Further rotation of the camshaft then brings the toothed peripheries of the cams into contact with the upper surface of the shoes, thus bodily lifting the entire machine, dragging it forward on the shoes as a fulcrum and setting the turntable down a step in advance of its previous position. Thus the machine proceeds forward with a sort of hopping motion, sitting down on the turntable between hops. Curious as this motion may seem to be, it has proved very practical for the special conditions under which these excavators have to work.

The mechanism shown in Fig. 3 consists of a walking apparatus which imitates the motion of a man on skis, or snowshoes. As shown in the cross-sectional view, there are two long shoes or runners, which are alternately lifted by the action of springs and slid forward, while mutilated gear-wheels travel upon the racks which form the upper faces of these shoes. Lack of space prevents us from describing this in detail, but a brief study of the drawing should make the principle of the mechanism quite clear.

A very novel walking mechanism is shown in Fig. 4. The wheels of this vehicle run on a vertical shaft, and on the lower face of each wheel is a cam surface which engages the upper ends of a series of feet. As the wheels revolve, the feet also revolve on the same axis, but are brought into contact with the ground successively, one at a time, so that there is a steady forward movement.

The fifth mechanism shown in our engraving is quite

ingenious. It furnishes a series of toothed tracks for the driving-wheels to travel upon. Each unit consists of three toothed driving-wheels, each wheel engaging an endless rack. The racks are set one in advance of the other. When a wheel reaches the end of its track, further rotation of the wheel results in swinging the entire rack over, as indicated by the dotted lines in the drawing, to a new position in advance of the other two racks. The machine can thus proceed, always traveling on a good toothed-track and laying the track ahead of itself.

The sixth walking mechanism is somewhat similar to the one shown in Fig. 2, except that in this case the machine travels on feet which are carried by an endless chain, and which support rollers that bear against rails on the machine. The feet are planted upon the ground and the chain drags the machine forward while the feet stand still. At the rear end of the belt mechanism the feet are picked up off the ground and carried forward, only to be planted upon the ground at the forward end of the machine.

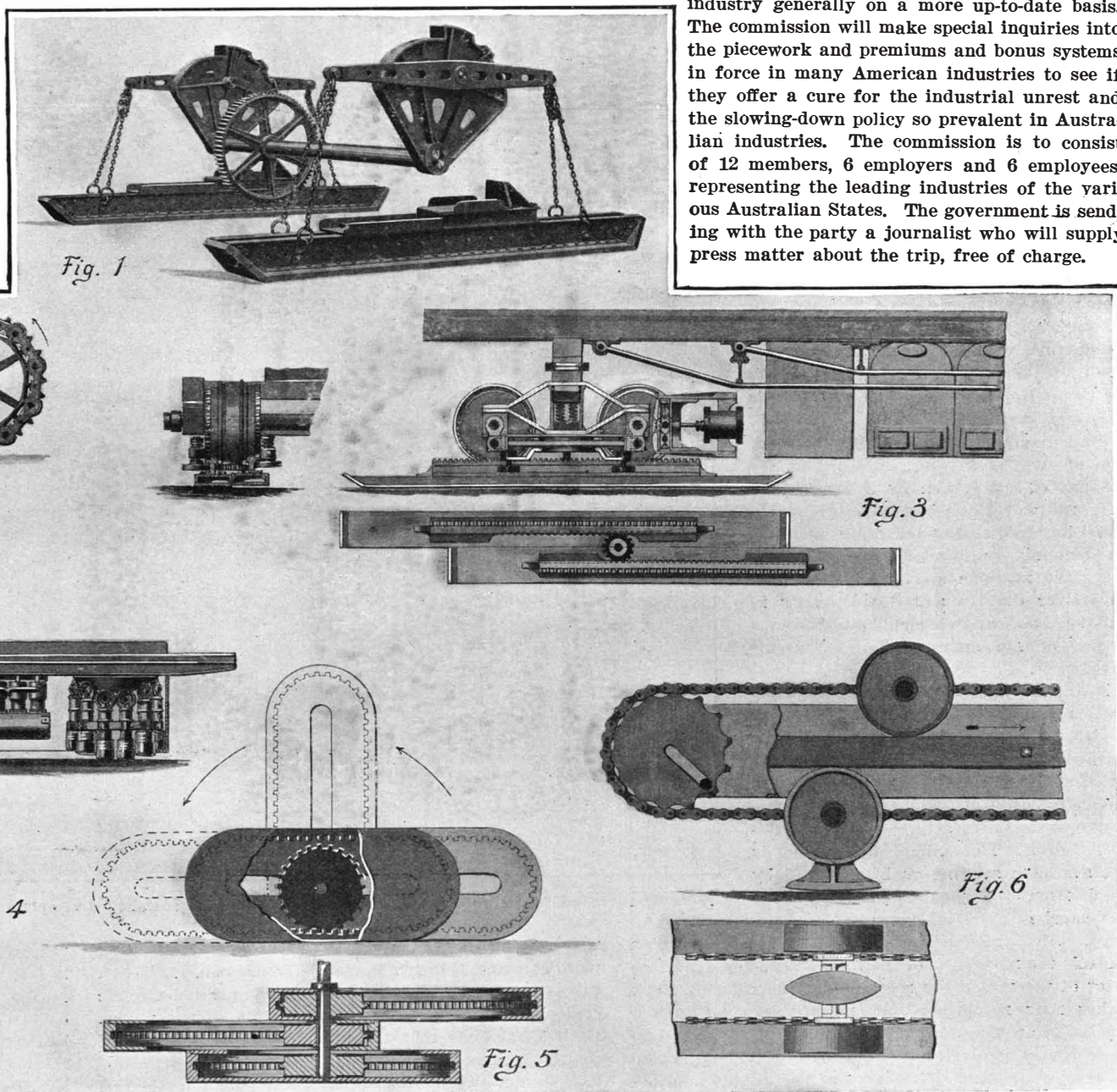
Valuable Clay Discovered

THE United States Bureau of Standards is proving an efficient help to business men and manufacturers throughout the country. Examples of this are coming to light every day. Just recently a Florida man conceived the idea that a clay cup for getting turpentine from the trees might prove better than those used at present, especially since the present ones, made from another material, are causing much trouble.

He sent a sample of the clay on his property to the Bureau to see if turpentine cups could be made from it. Not only were some very fine cups made and sent to him, but experts at the Bureau of Standards discovered that the clay was of an excellent quality for the making of vitrified paving brick. As a result of this the Florida man is going to sell his land at a good figure to a brick concern located in his State.

American Methods for Australian Industries

THE Federal Government of Australia is sending a commission to study industrial conditions and methods of production in the United States, and to bring back ideas for putting Australian manufactures and industry generally on a more up-to-date basis. The commission will make special inquiries into the piecework and premiums and bonus systems in force in many American industries to see if they offer a cure for the industrial unrest and the slowing-down policy so prevalent in Australian industries. The commission is to consist of 12 members, 6 employers and 6 employees, representing the leading industries of the various Australian States. The government is sending with the party a journalist who will supply press matter about the trip, free of charge.



A variety of curious mechanisms designed to overcome the disadvantages of wheel traction

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

Screening Water for Power Plant Service

By W. F. Schaphorst

EVERYONE is familiar with the necessity of filtering drinking water if it is at all impure, but only engineers know that the stomach of a power plant will get out of order unless it is fed clean water. To please these fastidious stomachs, the boilers, the water must be filtered or treated in some other way to remove foreign matter.

Water is used in even larger amounts for cooling the steam—condensing it, in other words—and even here it must be filtered in some manner in order that nothing in it may clog the condenser tubes. Wire screens are therefore often placed at the entrance to the intake tunnel so that all water destined for the condensers must pass through them.

When this method of cleaning was first tried, stationary screens were used. These, however, rapidly clogged. The next step in development was the revolving screen. These have been improved to a high point. The view shows an installation of these water screens in one of the generating stations of the Commonwealth Edison Company of Chicago.

The Gold Street generating station of the Brooklyn Edison Company has its intake tunnel almost at the entrance of a big trunk sewer. As may readily be imagined, if the water here were not screened a large amount of sewage, even of solids, would find its way into the condenser tubes. A screen was installed in this intake and many and various objects have been brought to the surface by it. On one occasion in particular the body of a child was lifted by this slow-moving screen. It is such occurrences as this which make plain the absolute necessity of screening the water before introducing it into the delicate internal mechanisms of expensive machinery.

A Machine That Records the Volume of Coal Used by Locomotive Firemen

ONE of the largest items in the operation of a steam road is the fuel; and yet it is the exception rather than the rule for a railroad to maintain a system of some sort that will indicate at all times how much coal each fireman is using. The consequence is that the firemen are apt to waste fuel, with the result that the railroad loses a sum running into five figures by the end of each year, and which could easily be saved.

With the object of preventing the wastage of fuel by keeping a record of the amount of coal taken by every fireman of a railroad, there has been invented a novel loader that may be readily installed in existing coaling stations. Briefly, what the machine accomplishes is, first, to deliver coal to a railroad tender in one-ton lots, and secondly, to keep a record of the number of tons passing through it.

In the insert of the accompanying illustration appears a side view of the new loader, while the general view depicts the method of installing the apparatus in an existing coaling station, as well as the method of using it. The loader is preferably operated with a three quarter horsepower electric motor, but when current is not available a crane chain, operated by hand from the platform, controls the movement of gates and issues coal as desired. An ingenious rotary motion in one direction controls the movement of the inlet and heavy discharge gates of the measuring receptacle. The rotating shaft makes four revolutions per minute, and with each revolution an exact measured quantity of coal equal to 40 cubic feet or one ton is delivered to the tender. The capacity of the loader is four tons per minute, and accordingly the rate of charging a tender is very high.

The sagging of a coal pocket, shrinkage of timber, settling of foundations, or other such defects do not detract from the accuracy of the loader, claim the inventors, although such conditions might affect the accuracy of a scale weight hopper.

In operation, the tender is brought into position under the sway hooded apron in the usual manner. The apron,

flow into the tender. By the hand chain the apron is then lifted out of the clearance in the usual manner. The operation of the gates of the load is such that it is impossible for the bin gate and delivery gate to be opened at one time. When one gate is opened, the other is closed, so that the flooding of tenders with coal, causing serious delays of trains, is absolutely prevented.

There is a small, compact, revolution counter placed on the post of the coal bin, the figures of which are easily readable from the engine. When the train arrives to take coal, this counter will read, for instance, 400. The fireman will take from the bin, for example, 7 tons. Each time a ton is taken the counter automatically registers. The fireman at first writes on his ticket "400"; and upon leaving he writes the figures "407." This ticket is turned in to the auditor, showing that engine No. 120 took the difference in the figures, or seven tons. When the next locomotive arrives, the fireman necessarily writes on his ticket the number left by the preceding fireman, "407." Suppose he takes five tons. When he leaves the counter shows figures "412," which he writes on his ticket, indicating to the auditor that the locomotive has taken on the difference between the two figures, or five tons. Since each fireman has to show on his ticket at the start the same number left by the preceding engine, it is impossible for a locomotive crew to steal coal without altering the figures. In such an event the figures would not be consecutive, resulting in the immediate discovery of the theft.

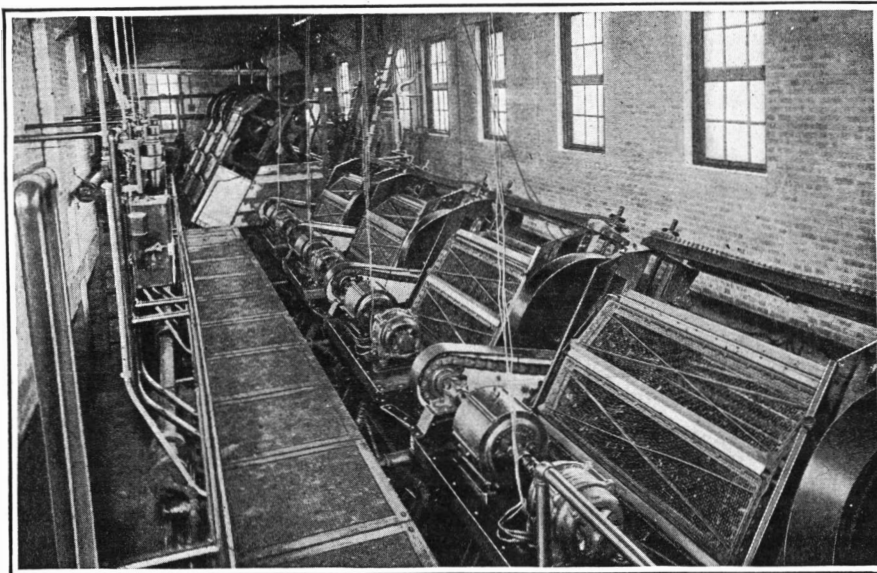
The main point in favor of the present loader is that it can be installed in existing coaling plants without alteration of the structures.

Proposed Introduction of Silkworm Industry in Germany

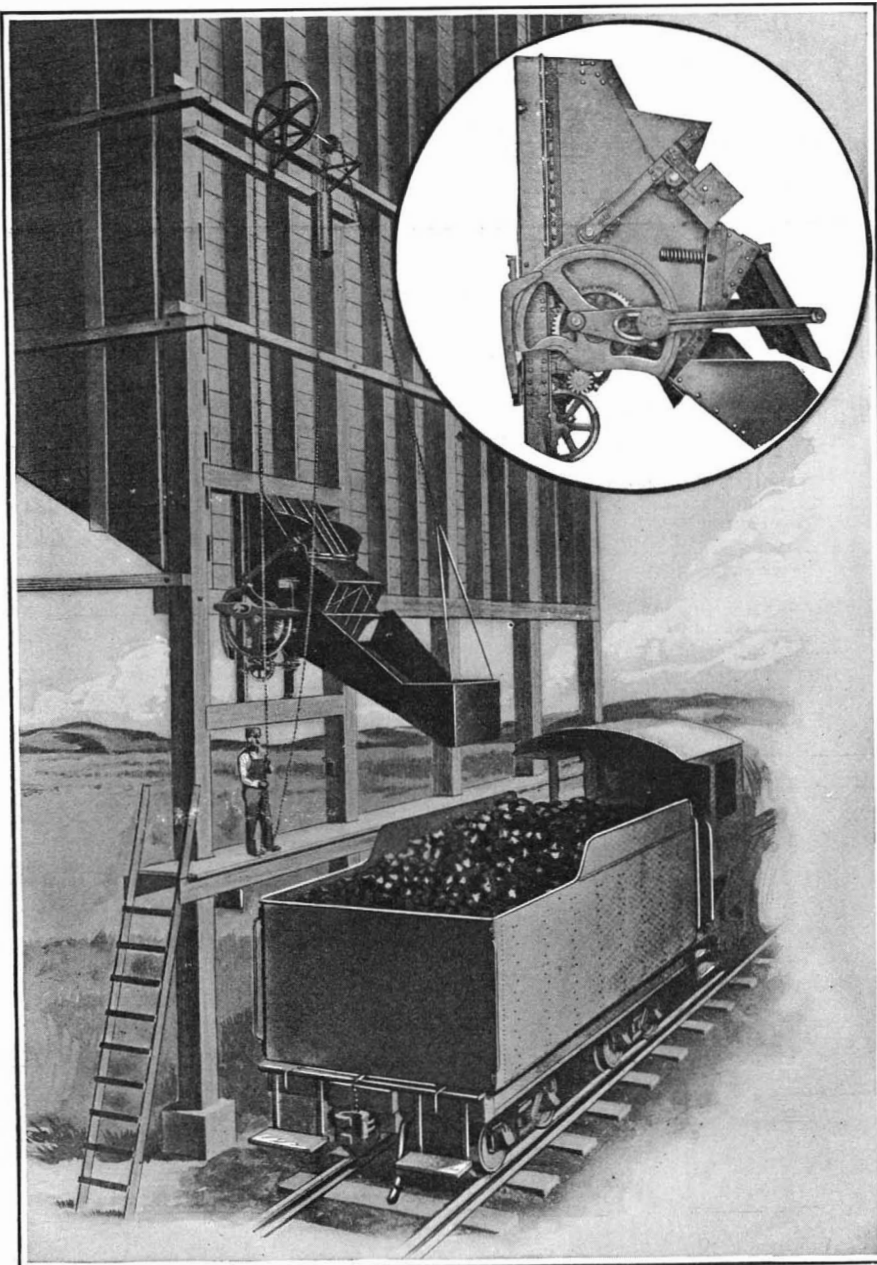
MUCH discussion is going on with regard to the growing of raw silk in Germany, thus making the silk industry in that country independent of outside supplies. However, attention is called to the fact that at various times attempts have been made to introduce silk-worm culture, but none has been successful. The physical obstacles appear less serious than the technical.

It has been shown that the silkworms and the mulberry tree both thrive in Germany, and it is now proposed to feed the worms on the leaves of the "Schwarz-wurzel" (comfrey, *Symphytum officinale*), which grows readily in the Empire. It is said that four or five crops of cocoons could be secured during one year instead of one, as with mulberry leaves. A company has been organized, experiments are being continually made, and good results are reported; the worms seem to thrive on the leaves and the silk to be of excellent quality.

The technical difficulties are not so easily overcome. Advocates of the movement think that the culture of the silkworm might give employment to many of the invalids and cripples made by the war. The spinning of the silk of the cocoons, however, requires much experience and skill. In 1913, Germany used 4,300,000 kilos (9,479,875 American pounds) of raw silk, valued at 160,000,000 marks (\$38,080,000). To produce the necessary cocoon for this quantity would require the labor of 400,000 people, and the spinning of the cocoons would call for 20,000 to 25,000 more. It seems quite impossible that within a reasonable length of time a sufficient number of people could be trained for this work, and it would probably be inexpedient, with the shortage of labor sure to result from the war, to divert so many workers from established fields. Besides, it is feared the product would cost more than the imported raw silk.



Revolving intake screen for water power plant



A newly-invented loader for coaling stations, and how it is installed and operated

which is operated from a platform between the coaling plant columns, is drawn down by the fireman. Attached to the post of the structure is a hand-operated electric controller which controls the operation of the motor. Each 15 seconds that the motor operates, one ton of coal is delivered to the tender. When the fireman has taken all the coal desired, he again pushes the lever, immediately stopping the motor, and the coal ceases to

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the national joy smoke

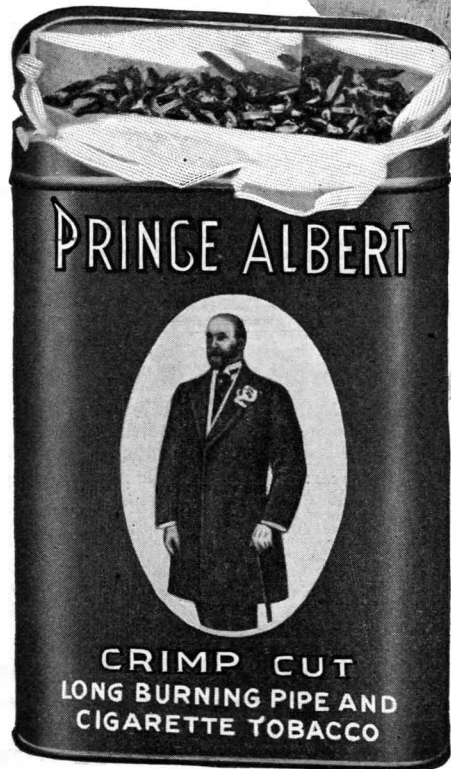
certainly cuts loose tobacco cheeriness! It shinnies up to your smokespirit because it is *right* in every big and little way a smoker ever can demand! And *you'll prove that* first-water information first-crack-out-of-the-box!

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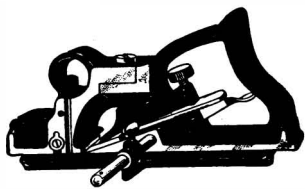
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The Aeroplane in Arctic Exploration

(Concluded from page 295)

allowed to drift. For two years she held a northwest course, and was then crushed in the ice and sunk near Bennett Island. The drift of the "Fram," in command of Nansen, began approximately 15 deg. west of Bennett Island and ended in the vicinity of Spitsbergen. If the courses of these two vessels are laid down upon a chart, an abrupt angle is at once noticeable. This would indicate the proximity of a corner of a large land mass to the northeast, around which the "Jeanette" possibly would have drifted had she not been crushed. Stefansson's discoveries of 1915 have confirmed this to a certain degree, although he was able to cover only a limited area with dog teams, and that area lay far to the eastward.

Further, migration of birds directly northward from the Arctic coast of Alaska has been reported by whaling captains; and there is no good ground for rejecting these statements, and others that the birds return from the north a few months later with their young. This would hardly be susceptible of any explanation other than that afforded by the existence of a considerable land mass in the direction taken. Again, it is asserted by the whalers that the bowhead whales, entering the Arctic from the Pacific through Bering Strait each Spring, proceed past Wrangel Island and disappear into the north, to be next seen in the vicinity of Banks Land, going southeast along the coast. Twelve hundred miles is a long deep-water cruise, even for a bowhead whale; and the alternative naturally occurs, that the whales may follow the shore line of an unknown continent, feeding in the shallows en route.

Assuming, then, from the various indications, that an extensive land mass does exist between Alaska and the Pole, is it worth finding? The question can be answered in the affirmative, even by the utilitarian. The Arctic regions of Canada, and even Spitsbergen, were worth finding, though the latter lies in approximately the same latitude as Dr. Harris's hypothetical continent—about 77° north. Valuable coal deposits have been found there within the past few years, although it had been freely characterized as a "region fit only for polar bears." Just what would be found on any land that might be discovered between Alaska and the Pole cannot of course be forecasted. But some material advantage would surely accrue; and to know whether or not land *does* exist in this area would be of considerable benefit to science.

For the work of exploring this vast unknown area the aeroplane would seem to offer the best, if not the only, means. Little difficulty would be experienced in summer flights over the Arctic Ocean. As in land flights, it would be necessary for the pilot to know the engine speed of his machine, its actual speed relative to the earth, his altitude, and his geographical position at stated intervals. The speed and course could be found by astronomical means familiar to the marine navigator, who can with watch and sextant determine his position to within two minutes of arc—i. e., to within 2 miles. With the recently invented Sperry drift indicator, it is not to be anticipated that wind velocity would complicate the issue to any great extent in flights of less than 400 miles. In this connection it should be borne in mind that the prevailing northeasterly winds, having blown over the sea for hundreds of miles, would be constant, and no more dangerous to the aviator than dead calm; whereas strong air currents over land, broken up by hills, rivers, buildings and trees, are most erratic and troublesome.

In view of the hazardous nature of exploration in the Arctic, even in the summer, it would be well to have each aeroplane equipped with a gyroscopic stabilizer, which automatically controls the machine and keeps it on an even keel in the highest winds. Also, because of the proximity to the magnetic pole and

the consequent difficulty in using the ordinary compass, some better guide to directions would be of value. Were it not for their almost prohibitive weight, two gyroscopic compasses might well be employed, one set parallel to the earth's axis, indicating true north, the other perpendicular thereto, indicating the longitude.

A wide range of speed would be necessary for accurate observations coupled with ability to cover the ground; and the hull would have to be covered with walrus hide, as the Eskimos cover their kayaks and umiaks, to prevent puncture by floating bits of ice. Only in exceptional seasons would it be possible to alight upon the water without contact with these. The equipment should also include sled runners, although there might never be occasion to use them, as the proportion of floating ice to water is about one to nine in the summer time. Still, a situation might arise where the runners would save the aeroplane from destruction.

A scientific expedition, using a ship as a base for five aeroplanes, could, in the course of a favorable summer, explore the entire area between the Asia-America boundary, near Wrangel Island, and the Alaska-Canada line at 141 deg. west longitude. With one machine the continental shelf, from the longitude of Point Barrow to Banks Land, could be located, sounded and charted. An aeroplane could obtain a series of soundings in an ice-infested sea by rising above the ice in moving from place to place, where a ship would be in constant danger.

One of the most valuable of the things definitely known about the geography of the western Arctic is that there is a current through the Polar sea from America to Europe. The existence of this current has been established by a long, laborious, and fragmentary process of launching and recovering drift-casks. The placing of such casks at points well off-shore, where the drift will catch them readily, could best be accomplished by aeroplanes, which could drop them with absolute certainty at any desired point; and if this were done on an extended scale it could only result in the discovery of much valuable oceanographic data. Then, too, the entire region in question is a virgin field for the motion picture camera. Altogether it appears that the possibilities for doing useful scientific work by aeroplane in the hitherto neglected western Arctic are almost unbounded, and it is to be expected that Stefansson, who has blocked out work for another dozen years, will avail himself of this resource.

Lipo-Vaccines

THE bacterial vaccines employed for prophylactic or therapeutic purposes are commonly prepared by placing in suspension in aqueous solutions of suitable salts bodies of microbes modified by appropriate treatment. A new method of preparation is advocated by two French savants, Mm. Moignic and Pinoy. They obtain the desired bacterial emulsion by a mixture of lanoline and vasoline, instead of the usual aqueous solution of a salt. They have established the fact that living microbes, placed in such a medium, to which one per cent of camphor has been added, lose their powers of reproduction at the end of a variable period, and can then be injected into healthy animals without fear of infection. The vaccines thus obtained they term lipo-vaccines.

In a report to the Biological Society made last March they stated that they had proved by careful experiment:

1. That autolysis is, if not entirely avoided, at least negligible.
2. That re-absorption takes place more slowly.
3. That consequently reactions in sensitive individuals tend to be reduced to the minimum.

Since in vaccinotherapy the auto-vaccines are those which give most success, especially since they are used as soon as prepared and hence contain few microbes entolysed by water, the authors believe this method presents definite advantages over that now generally employed.

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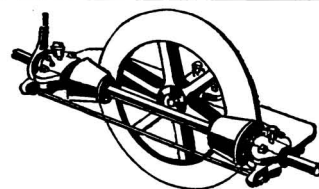
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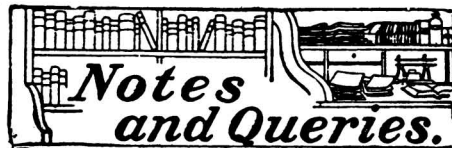
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Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(14158) H. G. asks: Just a question to settle an argument from an old subscriber. "A" at New York is sending a wireless message to "B" at London. Can "C" in the middle of the Atlantic confuse "B" by clicking off dots and dashes also? Can a "set" be tuned up or so arranged that it can only receive one message at a time while numerous other operators are sending? A wireless telegraph message can be confused by one who has the same wave length as the transmitting station by sending out meaningless signals of the same wave length. A receiving set must be tuned to the same wave length as its transmitting set. It will then not take up signals of a different wave length. Under the U. S. laws amateurs are not allowed to have transmitting apparatus of the wave lengths which are used in commercial and government service.

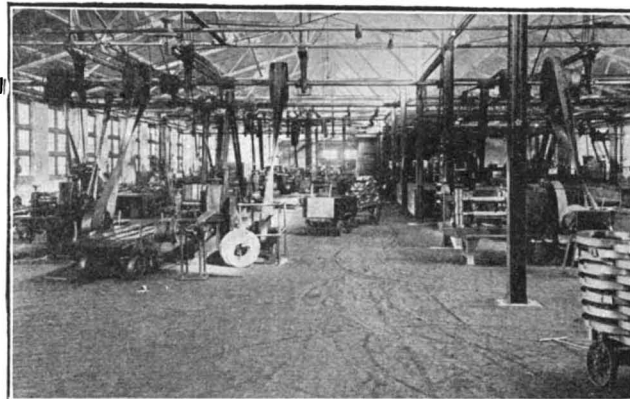
(14159) R. A. W. asks: I have had an argument with a friend in regard to Niagara Falls, and it is claimed that for a short period the Falls ceased to flow, due possibly to the backing up of ice, or some other means, of the waters of the lake. No authority can be found in regard to this, and I shall be glad to have you advise me if such a happening did occur, when, and how long? A. We are not able to either confirm or deny the statement that water once ceased to flow over Niagara Falls. It, however, seems beyond belief when one stands by the side of the Canadian Falls, but quite credible when one stands by the American Falls. Indeed, when a strong wind blows for some time up the river the American stream becomes very low indeed, and men cross on the rock to Goat Island. This is said to have been done many times, though we have never seen it done.

(14160) G. E. P. asks: In your July 1st issue, I notice that the "Does the Sun Ever Set on U. S. Territory?" question has bobbed up again, and this time the time of darkness or twilight is cut down to 1 minute 12.2 seconds. Would this cut out the remaining balance? The nations of the earth have what is known as the 3 mile limit. That is, a nation's sovereignty extends 3 miles into the high seas adjacent to its coast line. Three miles east of the eastern point of Porto Rico and 3 miles west of the Philippines, to the limit of its territorial waters, 6 miles in all, may cut out the seconds at least. A. Adding six nautical miles to the breadth of the United States will not make longitude enough to cut out the 1 minute 12.2 seconds which we lack of extending through 12 hours of longitude. Porto Rico and the Philippines are in nearly the same latitude, and a degree of longitude in both is about 56 nautical miles. Six miles are then about a ninth of a degree, and a ninth of a degree is about 27 seconds, which taken from 1 minute 12 seconds leaves 45 seconds, or three quarters of a minute lacking, with no known source from which it can be obtained.

The Last Word in Steam Yachts (Concluded from page 303)

21 feet, and, like its predecessors, closely resembles a navy destroyer, except that it carries deck cabins for the accommodation of its owner. The sheer is straight, which gives it a decidedly rakish look, and the topsides are raised forward and carried aft for a considerable distance from the stem thus providing spacious accommodations below. A pronounced flare is given to the bow sections, while the stern is of the rounded, naval cruiser type.

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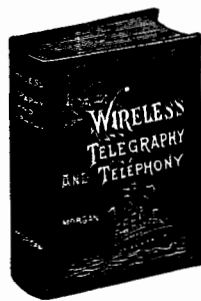
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Further Light on the Quebec Bridge Disaster

(Concluded from page 299)

many engineers who examined the bridge on the spot, that a point of great moment, in view of the failure of the southwest rocker, is the behavior of the other three rockers under the ends of the span. That they remained intact throughout is proved by the absence of severe punishment to the girder cover plates, hitch angles and shoes. They held the corners of the truss high above the lifting girders, so that it slid off without touching the girders or, at most, barely grazing them. Yet, these three rockers were subjected to a much more severe duty than the one which failed. For instance, after the southwest rocker failed, the southeast rocker at the same end of the span had to carry a great additional load, represented by the enormous weight of the now unsupported half of the westerly truss (a load which was sufficient to wreck the portal and lateral system of the bridge), to say nothing of the great impact produced by the drop of the southwest corner. At the same time, this southeast rocker was subjected to extreme canting and tipping actions, which were continued to the point of concentrating the whole load on one corner and forcing the rocker out of its seat. The north rockers bore nearly as severe tipping effects, yet they, too, held up intact.

It is a fair inference, therefore, that the southwest rocker did not fail because of any inherent fault (lack of strength, etc.) in the design. There was probably some inherent and undiscovered defect in this particular rocker which made it weaker than the other three.

Validation of Patents and Trade-marks in Mexico

THE Department of State announces that Mr. Charles B. Parker, representing American interests at Mexico City, has received a note from the Mexican Foreign Office, stating that sufficient time will be granted for the revalidation of patents and trade-marks issued by authorities in Mexico which are not recognized by the existing government.

The patents and trade-marks in question are those issued outside of the city of Vera Cruz during the Huerta regime, between November 4th, 1913, and August 25th, 1915. These were declared void by an order of September 24th, 1915, issued by the Carranza government.

The decision, accompanying the Mexican note, reads:

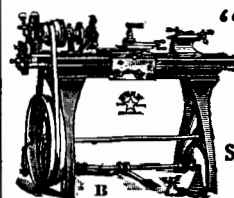
"As a matter of equity and in order that the interested parties may not lose their rights of priority, acquired property rights shall be recognized and the documents originally presented shall be considered as having been duly received, as shall also the fees paid, provided the interested parties fulfill the following requirements:

"First.—Present a stamped petition to the Office of Patents and Trade-marks, accompanied when possible by the title declared void, and asking that the procedure be revalidated in whole or in part, as the case may be, with the understanding that such revalidation of titles or ratification of documents shall not give rise to further fees.

"Second.—Restore the stamps affixed to the original applications."

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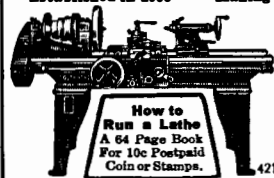
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