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

TRYING TO PUT A QUART INTO A PINT CUP.

The contention between the House and the Senate on the question of the size of the new battleships has been compromised in a manner which reflects great credit on the generosity of Congress and proves that it is fully alive to the necessity for a large increase in our naval power. The House wished to provide for three battleships of 16,000 tons displacement; the Senate was in favor of four battleships of 12,000 tons displacement. The compromise arrived at provides for three 16,000-ton ships and two 13,000-ton ships. The larger vessels will be of the same class as the "Connecticut" and "Louisiana," and the 13,000-ton ships will class very well with the "Maine" type, thus giving the navy two fleets of five vessels of each type.

In the recent controversy we see the recrudescence of an old fallacy, which has always caused, and always will, more or less trouble in the matter of battleship design; and of battleship design in general it may be truly said that there are no problems in the whole field of technical knowledge in which the layman can more quickly fall into error, than in those affecting the relative efficiency of warships. The trouble with the advocate of the small ship is that he seems to have an idea that it is possible to put a quart of liquid in a pint cup—that a given total tonnage may be divided into a number of numerous small units, each of which would represent individually as much fighting efficiency as would be secured if that same total tonnage were divided into a fewer number of units of much greater displacement.

Now, as a matter of fact, nothing could be farther from the truth. It is as well understood in the navy, as it is in the merchant marine, that the larger the ship the greater the efficiency per ton of ship. Why is it that merchant vessels are climbing up in size so rapidly that to-day they have reached the enormous displacement of 37,000 tons, as represented by the "Cedric" and "Celtic"? It is for the very good reason that each ton in the big vessel has a greater earning capacity than each ton in a smaller vessel; and the situation is strictly the same in the case of ships of war. Each ton of the 16,000 tons of the "Connecticut" represents vastly more fighting power than each ton of a 12,000-ton "Alabama;" and just here, by way of parenthesis, we may add that the theory of building many small ships with a view to covering our coast line is false, for the reason that in future wars battleships will never be scattered in isolated positions for the purpose of doing police duty. They will be gathered into fleets, and the fortunes of war will depend entirely upon the fortunes of these fleets. This is clearly shown in the series of war games which we are publishing week by week in the SCIENTIFIC AMERICAN SUPPLEMENT.

All the navies of the world are steadily increasing the size of their battleships at each appropriation. Great Britain, indeed, whose very existence depends upon keeping her navy in a state of the highest efficiency, is this year providing for the construction of three great vessels of 18,000 tons displacement, or 2,000 tons more than that of the large vessels we have just authorized. This in itself is a most potent argument, when we consider the vast interests at stake, against a return on our part to small battleships of the second-class size. Having said this much, perhaps the best way to consider the subject is to present the arguments in favor of the big ship categorically and as briefly as possible.

1. In the large ship there is a gain in effective battery power. The weight of one round from the 12,000-ton "Alabama" is 5,312 pounds, and from the 16,000-ton "Connecticut" 7,856 pounds. Hence, for an increase of one-third in size, there is a gain of about one-half in effective battery power, or \$30,000,000 will give us four "Connecticuts" of a battery power of 6, or five "Alabamas" of a relative battery power of 5.

2. The armor protection of the "Maine" is 2,770 tons, of the "Connecticut," 4,000 tons; an increase of protection of 44 per cent, for an increase in size of 33 per cent. This great gain in power of attack and defense is

due to the fact that the big ship requires a smaller proportion of her weight to be given to hull and machinery than does the smaller one for the same power and speed; for, whereas in a 12,000-ton ship 4 tons of any 10 tons of weight must be devoted to the structure, leaving 6 tons for speed, battery, and armor, in 16,000-ton ships similar to the 12,000-ton, only 3¼ instead of 4 tons out of every 10 must be devoted to the structure, so that the weight available for the fighting elements of the vessel is not actually, but relatively, greater for the big ship.

3. In a comparison of the 10,288-ton "Oregon" and the 16,000-ton "Connecticut," we find that the contract speed has risen from 15 knots to 18 knots, and in heavy weather the difference will be yet greater, since the big vessel will maintain her speed, and cast loose her guns for action, in weather that would cause the "Oregon," with her low freeboard, to heave to.

4. Then, again, contrary to popular belief, the big "Connecticut" will be a much more handy ship than the "Indiana." Improved steering gear, and improvements in modeling, will render the "Connecticut" a more mobile vessel, with probably a smaller turning circle, than the "Indiana"—she would require no more, if as much, room in which to maneuver than the smaller vessels.

5. The "Connecticut" carries 2,200 tons of coal; the "Oregon" 1,600, and the radius of action of the larger ship is somewhat greater. To load up the small "Indiana" from her normal coal supply of 400 tons to her maximum supply will increase her draft by 28 inches, whereas the big "Connecticut" in taking on the extra 1,300 tons above her normal supply of 900 tons of coal will only be sent down 20 inches deeper; but most serious of all, at full-load displacement, the "Indiana" will sink her waterline belt armor entirely under water, while the belt of the "Connecticut" would remain where it always should be, partly above and partly below the waterline.

6. As regards fighting powers, the "Connecticut" carries 70 per cent more weight of guns and 90 per cent more weight of ammunition than the "Oregon;" and when we take account of the energy and rapidity of fire of the guns, we find that if all the guns on the battleships were engaged at full capacity for a period of five minutes, the total energy of the "Connecticut" would be 3½ times the greater.

7. In a comparison of defensive qualities, we find that the "Connecticut" carries 4,000 tons of armor against 2,900 tons carried on the "Oregon;" moreover, this greater weight of armor covers a relatively larger area. The belt extends, in the big ships, entirely from stem to stern, whereas in the "Oregon" it only extends over the middle two-thirds of the ship, while there is a total armored area on the sides of the "Connecticut" of 7,827 square feet as against 2,229 square feet in the "Oregon." Again, owing to the great size of the "Connecticut," the secondary battery of twenty guns can be widely scattered and protected by armor; whereas the effect of the smaller size of the "Oregon" on her secondary battery of twenty 6-pounders is that they are packed cheek-by-jowl and without protection, within the limited area of the superstructure amidships. A single high explosive shell properly placed would probably wipe out the whole lot!

8. On the vital question of habitability and comfort for the officers and crew, everything favors the big ship. The men can be housed well above the water line in larger quarters, and the effect of this on the morale of the ship's company is beyond estimate.

9. Lastly (and to our thinking, in the test of savage war, it may well prove to be more important than anything else) is the fact that the big vessel is much more difficult to sink than the small one. Should the 10,000-ton "Oregon" and the 16,000-ton "Connecticut" be torpedoed in the same spot, at the same time, with the same type and size of torpedo, it would take, broadly speaking, only six-tenths as long for the "Oregon" to sink as it would for the "Connecticut." A wound, mortal to the "Oregon," might not be so to the "Connecticut," for it is likely that the extra subdivision obtained in the large vessel would serve to keep the "Connecticut" afloat, though the other went down. So also the relative destruction of a 12-inch high explosive shell would be less on the bigger vessel, for the reason that a larger proportion of the bulk of the ship would be outside the immediate danger zone. Indeed, the same inverse ratio of 10 to 16 would apply. Then, furthermore, the gun crews being more widely separated, there would be less disablement by the bursting of a single shell. And would not the "Connecticut" have the prestige and moral effect which always goes with great size, if that size is known to be backed up with high efficiency? The "Connecticut" could pass alone without fear of attack over stretches of hostile water, through which an "Oregon" would not dare to venture.

The test is between size and numbers. We have proved that size is best; and since our country is now the wealthiest in the world, and the most generous in its expenditures, why should we not solve the problem

at once and reconcile opposing theories, by adopting both, and building at once the biggest ships and, with the exception of Great Britain, the greatest number of them in the world?

ENACTMENT OF THE AMENDMENT OF UNITED STATES PATENT STATUTES.

The patent bill H. R. 17,085 was passed by the United States Senate before the expiration of the session of the Fifty-seventh Congress, and, as the bill has also received the President's approval, the amendments referred to in our last issue are now incorporated in the United States patent law.

The patent bill was prepared by the Commissioner of Patents at the request of the State Department, and it was introduced in the two houses of Congress early in the second session of the Fifty-seventh Congress; but, because of the failure of the patent committee to see the importance of the amendment, the bill was not reported until a short time ago. The amendment of our patent law in accordance with the provisions of the International Convention has cleared the field for American inventors in the foreign countries which are signatories to the International Convention, for they may now claim all the privileges of the Convention, without the fear that the courts may hold that they are not entitled to them, because of the failure of the United States to reciprocate. The United States is now extending to foreigners all the rights to which they are entitled under the treaty. The benefits of the amendments to the patent laws here and abroad, which have been made in accordance with the amended rules of the International Convention, will be claimed by many inventors who, under the old treaty and laws, were unable to file their foreign patent applications within the short time prescribed by the old regulations.

OUR AGRICULTURAL COLLEGES.

As the result of National and State co-operation, which enables the ordinary farmer to profit from the experiments of widely separated individuals interested in scientific farming, the United States stands foremost in the matter of agricultural development. Our Department of Agriculture renders the greatest service imaginable to the country; but its facilities are greatly improved by the co-operation of the different State agricultural institutions, while the farmers of each section can rely upon their special State colleges to supplement the general work of the National institution. These State agricultural colleges are quietly doing a great good in the cause of scientific agriculture and horticulture.

The Massachusetts Agricultural College is one of the foremost representatives of the typical institution devoted to practical agricultural education, and its work and studies are devoted chiefly to the training of students in modern scientific farming. The work is conducted both in the classroom and on an experimental farm. The institution is located on a farm of 400 acres at Amherst, Mass., and its buildings and land are valued at \$315,000. Its annual income from the State and United States amounts to \$45,000, and it is provided with a permanent endowment fund of over \$350,000. There are buildings for nearly every imaginable specialty pertaining to agriculture—a chemical laboratory, botanical laboratory, plant house, creamery and dairy laboratory, veterinary buildings, barns, museum, library, and entomological laboratory and insectary.

Instruction is given by a corps of eighteen professors and assistants in chemistry, botany, agriculture, horticulture, zoology, veterinary science, mathematics, civil engineering, and similar studies. Practical work on the farm is a part of the course, and the students cultivate the whole farm and experimental orchard and nursery. There are 100 acres devoted to orchards, vineyards, and the cultivation of small fruits. One hundred and fifty acres are under cultivation with field crops, and nearly as many more acres are devoted to grass and hay for the 100 head of cattle which are kept on the farm. Considerably over a thousand men have passed through the Massachusetts Agricultural College. It is interesting to note the locations and occupations of these men. A recent census of them showed that nearly 400 are to-day engaged in agricultural pursuits, more than a score are instructors in other similar institutions, many are dead, and others have drifted into a variety of callings. The effect of the college on the agriculture of the country must prove of immeasurable value if a similar proportion of its graduates adopt farming for their life's work, performing their labors in a scientific manner such as they were taught to do at the institution.

The State agricultural and mechanical colleges which have sprung up in most of the leading agricultural States of the East and West, and many parts of the South, in recent years, have in view the training of young men for scientific and practical agriculture, and also for mechanical and manufacturing arts and sciences. They are endowed by the State in which

they are located, and also by private individuals. They are for the most part under the control of the State board of agriculture, the Governor, and other State officers; but the president of the institution and the faculty practically have all the liberty they demand in carrying out the work according to well-defined policies. Some of these State agricultural colleges are remarkably well equipped and endowed for the work they have in hand. Thus the Iowa State College has fifteen buildings, which have been erected by the State at a total cost of half a million dollars. There are nearly a thousand acres of land attached to the institution. A corps of 55 professors and nearly 600 students is engaged in study and work. All kinds of crops raised in the State of Iowa are planted and cultivated on the farm, and cattle, horses, and poultry are kept by the students. Experiments are constantly being carried on by the professors and students in agriculture, horticulture, chemistry, and general farming; and the results of these experiments are published in bulletins and papers for the benefit of the world.

The Pennsylvania State College, or "The Agricultural College of Pennsylvania," is even broader in its educational aims than the Iowa State College of Agriculture. Almost all studies from agriculture, chemistry, physics, engineering, mining, and mathematics up to philosophy, general literature, and languages are taught there. In recent years this college has steadily broadened toward a high-grade technical, scientific, and classical institution. Nevertheless, agriculture, in all its wide fields of application, is one of the chief studies emphasized at the college. A correspondence course has in late years been organized for the purpose of instructing students on farms who cannot attend the college, but who wish to avail themselves of the researches and facts obtained at it. Forestry is one of the most useful branches of work carried on at this college; and it not only trains young men to appreciate the value of cultivating orchards and woods, but also turns out practical foresters, capable of taking charge of large forests and converting them into profitable possessions, without destroying and denuding them of trees.

The Michigan State Agricultural College is another similar institution which, for more than forty years, has endeavored to help the farmers in their struggle to wrest from the soil a fair compensation for their labors. The original idea of this college was to perfect in their studies all graduates of the common school who wished to possess a complete practical and theoretic knowledge of the arts and sciences which bore directly upon agricultural and kindred pursuits. Economic zoology, meteorology, physics, veterinary science, entomology, bacteriology, chemistry, geology, and agriculture and horticulture are a few of the studies pursued. Post-graduates can pursue advanced studies in the sciences, and in the library of 20,000 volumes they can find nearly all the literature of value pertaining to their particular studies. There are some 676 acres of land attached to the college, 230 acres of which are devoted to field crops, 45 to woodland, 114 to orchards and garden, 47 to experimental fields, and 240 to forest. There is a fine arboretum, a fine botanic garden, a grass garden, and a weed garden, where a hundred or more noxious weeds are grown to show their destructive possibilities to the students. There are some 450 students at the college, and more than half of them take the full agricultural course.

The South has a good institution of this class in the Mississippi Agricultural and Mechanical College, with a faculty of some two dozen members, and a student membership of nearly 400. The college is under the management of a board of trustees, with the Governor of the State an *ex-officio* member. The students who attend this college are paid eight cents per hour for their work in the fields or orchards, which enables them to pay for a part of their living while studying.

The Kansas State College, with its 300 acres of land, buildings valued at \$350,000, and a faculty of 45 professors and assistants, has become an important factor in the middle West in developing the agricultural possibilities. Agriculture, engineering, and general and household economics are taught to the students. There is a dairy, blacksmith shop, foundry, machine shop, printing office, and woodwork and painting shop connected with the college, where practical work can be followed by the students.

With agriculture as our leading industry, many of the large universities have in recent years established an agricultural course and experimental farms as a part of the regular college course. When this subject is mentioned, one turns instinctively toward Cornell University, with its admirable agricultural and forestry departments; toward the Ohio State University, with its buildings and equipments aggregating nearly \$3,000,000 and with an income of \$350,000; or toward the University of Wisconsin or of California. These typical universities, which have given agriculture and horticulture a prominent place in their curriculums, have sent forth annually hundreds of students to teach

practical farming to new communities, which may still labor under the disadvantage of old methods and ideas of agricultural production. The Ohio State University at Columbus, Ohio, has over a thousand students, and a corps of 78 professors and assistants; but it aims to give a scientific and classical education to both young men and women. It is divided into six colleges, with one devoted to agriculture and domestic science, and another to veterinary science. Students pursuing other studies can take courses in these departments, and there are also opportunities for graduate studies in the science of agriculture. There is a well-stocked farm of 200 acres connected with the university, a fine dairy department, a large laboratory for student work in soils and crops, and a fine veterinary laboratory and operating building.

In the University of Wisconsin, with its membership rapidly approaching 2,000, and a corps of over 130 professors and assistants, there is a college of agriculture, which gives excellent courses in dairying, veterinary science, experimental farm work, entomology, scientific plant investigation, and general horticulture and agriculture. There are cheese factories, creameries, and dairies on the farm, with large green-houses for raising plants, extensive barns for cattle, and bacteriological laboratories. The college co-operates with the sixty-odd State institutes of the farmers, both in supplying literature and lecturers; and thus becomes a real and essential part of the State's chief industry.

Like the two former, the agricultural college of Cornell University, in New York, has become one of the greatest factors in stimulating and broadening the farming interests of the State and, indirectly, of the whole country, while it has contributed largely to the establishment of agriculture on a firmer and higher scientific basis than ever before in its history.

ACTION OF GELATINE UPON GLASS.

In a paper read before the Académie des Sciences M. Cailletet describes the action of gelatine upon glass and other surfaces. When a glass object is covered with a thick layer of strong glue, the latter adheres strongly when wet, but upon drying it may be detached and carries with it glass scales of different thicknesses which have been lifted from the surface. The glass which is thus treated presents a surface whose designs resemble those of frost on a window-pane, and have a decorative effect.

M. Cailletet made experiments with gelatine upon different substances, and found that tempered glass was easily attacked, as well as Iceland spar, polished marble, flint-spar and other bodies. A sample of quartz cut parallel to the axis of the crystal was covered with two layers of fish-glue; after drying it was found that the surface was attacked and showed a series of striæ which were parallel, rectilinear and ran close together, while in the case of glass the striæ were curved. When certain salts were dissolved in the gelatine, namely, those which were easily crystallized and had no action, there was produced on the glass a series of engraved designs which had a crystalline appearance. Thus a solution of strong glue containing 6 per cent of alum gave very fine designs somewhat resembling moss in appearance; other salts such as hyposulphite of soda, nitrate and chlorate of potash, will produce analogous forms.

M. Cailletet told of the strong mechanical action exerted by a layer of gelatine when drying. If a sheet of cardboard, lead or even wire-gauze is covered with a gelatine solution the surfaces are seen to curve into the form of a cylinder as the gelatine contracts. Upon thin glass the effect is striking; when a layer of strong glue is spread upon a cylindrical vessel of thin glass the effort which it exerts when drying is sufficient to break the vessel with explosion. When a plate of thick glass covered with gelatine is examined by polarized light a powerful mechanical strain is observed in the glass, and the value of this effect could no doubt be measured.

NEW ELECTROMAGNET FOR MAGNETO-OPTIC WORK.

Prof. A. Gray delivered an interesting paper before the Glasgow Section of the Institution of Electrical Engineers on March 11, on magneto-optics. He explained at the outset that the old Ruhmkorff electromagnet, though better than the permanent magnet, was incapable of giving a very intense field, a circumstance which was chiefly due to general ignorance of the theory of the magnetic circuit. Given this, however, the improved knowledge enabled more powerful magnets to be constructed, and several of these were described and illustrated on the screen. Among them was one constructed at the author's instigation for work on the properties of substances in magnetic fields at his laboratory in the University College of North Wales, Bangor. A magnet described by Mr. S. L. James in Nature (June 13, 1901) was also detailed and illustrated. On going to Glasgow, Prof. Gray decided to have a much larger magnet built for a series of researches on magneto-optic effects, somewhat similar in form to his Bangor magnet and that of Mr. James. A different arrangement for carrying the pole-pieces

apart was adopted, and the cores of the upper coils were made sufficiently long to allow them to be slipped to the right and left through a distance great enough to give the length of gap required, and at the same time to accommodate the coils. The magnet was constructed by Messrs. Mavor and Coulson, and it was found that with a current of 25 amperes a field of upward of 50,000 C. G. S. units was produced and confirmed by determinations of different observers. The field was determined by putting a ring of wire round it between the faces of the poles, and then suddenly withdrawing it; the deflections produced on a standardized ballistic galvanometer having been observed, it between the faces of the poles, and then suddenly was found to be of ample power for the magneto-optic experiments. Since in the earlier experiments on the magnet it had been found impossible to obtain with pole-pieces with narrow tips so high a field intensity as at first, this raised the interesting question as to whether the poles had lost considerably their capacity for conducting lines of force; but the point was shortly to be put to the test. The author understood that dynamo builders believed that as a machine aged a greater speed was required to give the same E. M. F., and this was possibly due to deterioration of the iron, though he considered that the impaired insulation of the magnet coils was accountable for it. If any deterioration in the iron of a dynamo occurred it was more likely to occur, and that quickly, at the pole tips, and in view of the reluctance of that part of the circuit, a great deal depended for the success of such a magnet on the obtaining of the best possible iron for the conical pole-pieces.

SCIENCE NOTES.

The original map made by George Washington in 1775 of the lands on the Great Kanawha River, West Virginia, granted to him by the British government in 1763 for his services in the Braddock expedition, is now in the possession of the Library of Congress, says The National Geographic Magazine. The map is about two by five feet, and is entirely in the handwriting of Washington. The margin is filled with notes, also in Washington's handwriting, describing the boundary marks set by Washington and different features of the tract.

The coca plant, *Erythroxylon coca*, among others of medicinal value, is being experimentally cultivated in the Victoria botanical garden of the Cameroons. A firm of alkaloid makers in Germany, to whom some of the leaves were sent, found them to contain only 0.28 per cent of total alkaloid. This low yield may be attributable either to improper drying of the leaves or deterioration during the long voyage. It is suggested that it would be advisable to extract the crude alkaloid for export, unless the leaves can be carefully packed in air-tight boxes without unduly increasing their cost.

The British weather service is systematically collecting reports from the North Atlantic and Mediterranean of the temperatures observed by shipping masters. The data thus collected are to be worked up into charts showing the temperatures over marine areas between latitudes 30 deg. and 60 deg. What the practical results of this enterprise will be cannot be foretold. Much light will be thrown upon the Gulf Stream, for it will be possible to ascertain exactly where it extends. Naturally most of the information thus collected will relate to the Atlantic Ocean, for the North Pacific is not traversed so often by shipping.

In the decennial publication of the University of Chicago may be found a suggestion by Professor Michelson of a new method of determining the velocity of light. The Professor reviews previous results, contrasts astronomical, electrical and optical methods and processes. Instead of the revolving toothed wheel of Fizeau, he suggests the use of a stationary grating, and by a double reflection of light from stationary and revolving mirrors, proposes to measure the eclipses the light suffers from the gratings. Figures accompany the original article, which make the author's plan clear. He estimates that the velocity of light can be measured to a probable error of only 5 kilometers.

Dr. Ludwig Biro, the eminent Hungarian explorer and scientist, has returned to Europe with a large collection of zoological and ethnological specimens gathered in the Malay Peninsula and New Guinea, during a period of six years. So extensive and varied is his collection, that it will require several years to examine, catalogue, and classify them for the Hungarian National Museum, where they are to be exhibited. He has obtained among his zoological specimens a number of species which have been hitherto unknown to science. Dr. Biro was formerly an assistant master in a college in Hungary, but was so imbued with the desire to prosecute his studies abroad, that he sold his remarkably extensive entomological collection, numbering 60,000 specimens, to the Hungarian National Museum, to defray his Malay expenses.