tions, but not the smaller ones, and that the problem was not yet solved. It is only recently that M. Hamy, of the Paris Observatory, established theoretically the conditions which the bath should fill, and he has obtained with his new bath an image which is practically motionless. This apparatus was shown at the Paris Exposition, and is at present undergoing some modifications in detail. M. Hamy wished to find by calculation whether it was possible to realize a method of suspension which would give a perfect surface to the mercury. The two main problems may be briefly mentioned. The study of small movements of a solid swinging in a liquid when the vessel is submitted to vertical vibrations shows that after a time the solid takes a vibratory movement, synchronous with that of the vessel, but of different amplitude; the latter is much smaller than that of the vessel, if, with a sufficient immersion, the resistance to movement due to viscosity is not too great. Then, remarking that the action of a liquid upon the solid in movement is comparable with the elastic action of a spring, M. Hamy was led to solve the second problem, this time not making the restriction that the vibrations should be vertical. A rigid support, having a vibratory movement, acts upon a heavy solid, *M*, which is suspended from it by coiled springs of negligible mass and attached at the points of a regular polygon. The question is to determine the absolute movement of the mass, *M*, knowing that the speed of a point, *Q*, of the solid with relation to the support is opposed by resistances proportional to this speed. The consideration of the problem shows that the effect of the trepidations of the soil upon the surface of the mercury may be nearly annuled by the proper suspension of the vessel. In the present apparatus the vessel is suspended from a framework by four long double springs. The vessel is very heavy, and arranged so that the center of gravity is near the surface of the liquid. The springs are arranged in pairs, two springs of different thicknesses being placed side by side so as to oppose their vibrations. Below the vessel is a vane which plunges into a viscous mixture of tar and oil. Above the vane is a weight for regulating the center of gravity and bringing it near the surface of the liquid. The experiments made with the new system at the Paris Observatory have completely confirmed the previsions of theory. During two consecutive days the images given by the new bath have been observable at all hours of the day and in satisfactory conditions of sharpness.

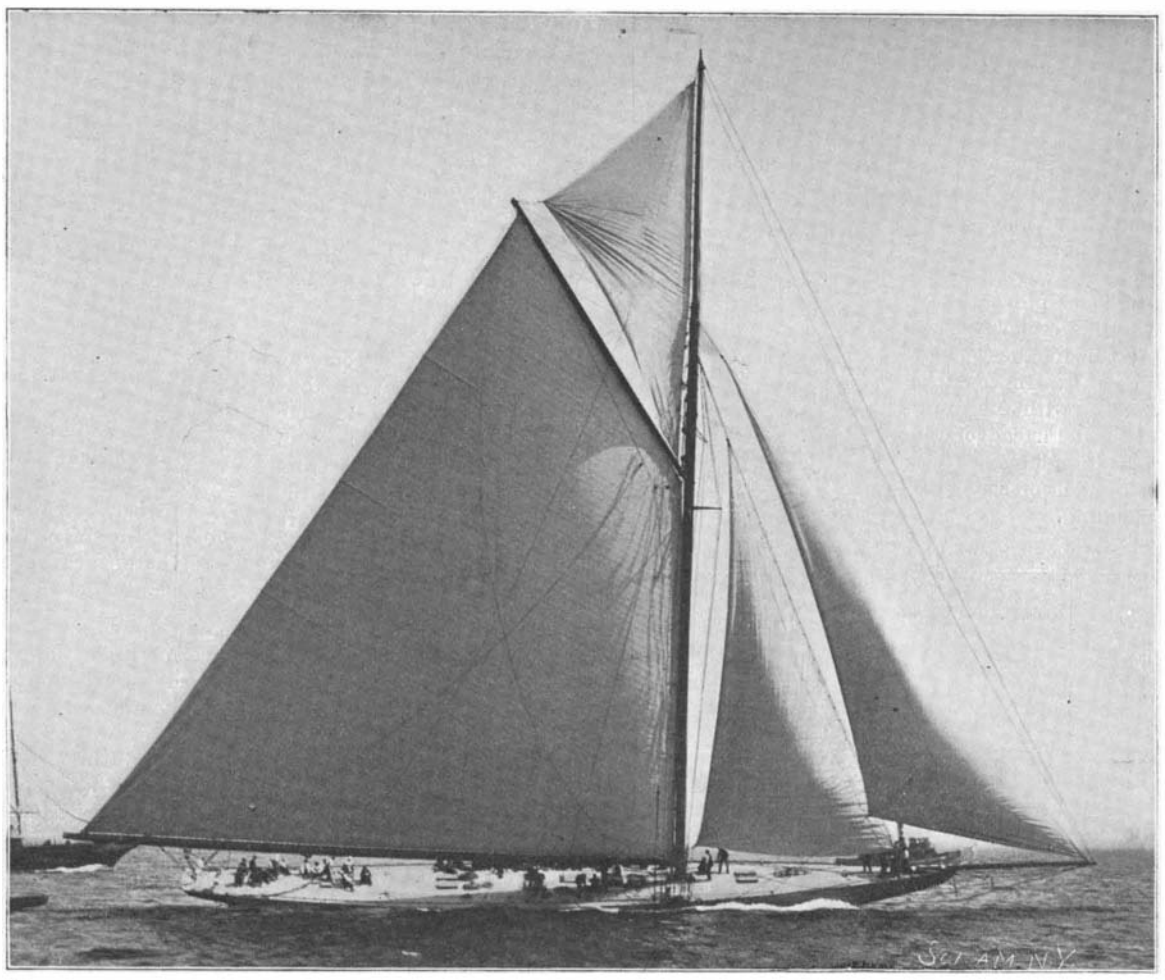


Photo. by N. L. Stebbins, Boston.

"INDEPENDENCE."

Length over all, 140 feet 10½ inches. **Beam,** 23 feet 11⅛ inches. **Draft,** 20 feet. **Ballast,** 75 tons.
Sail Area, 14,300 square feet.

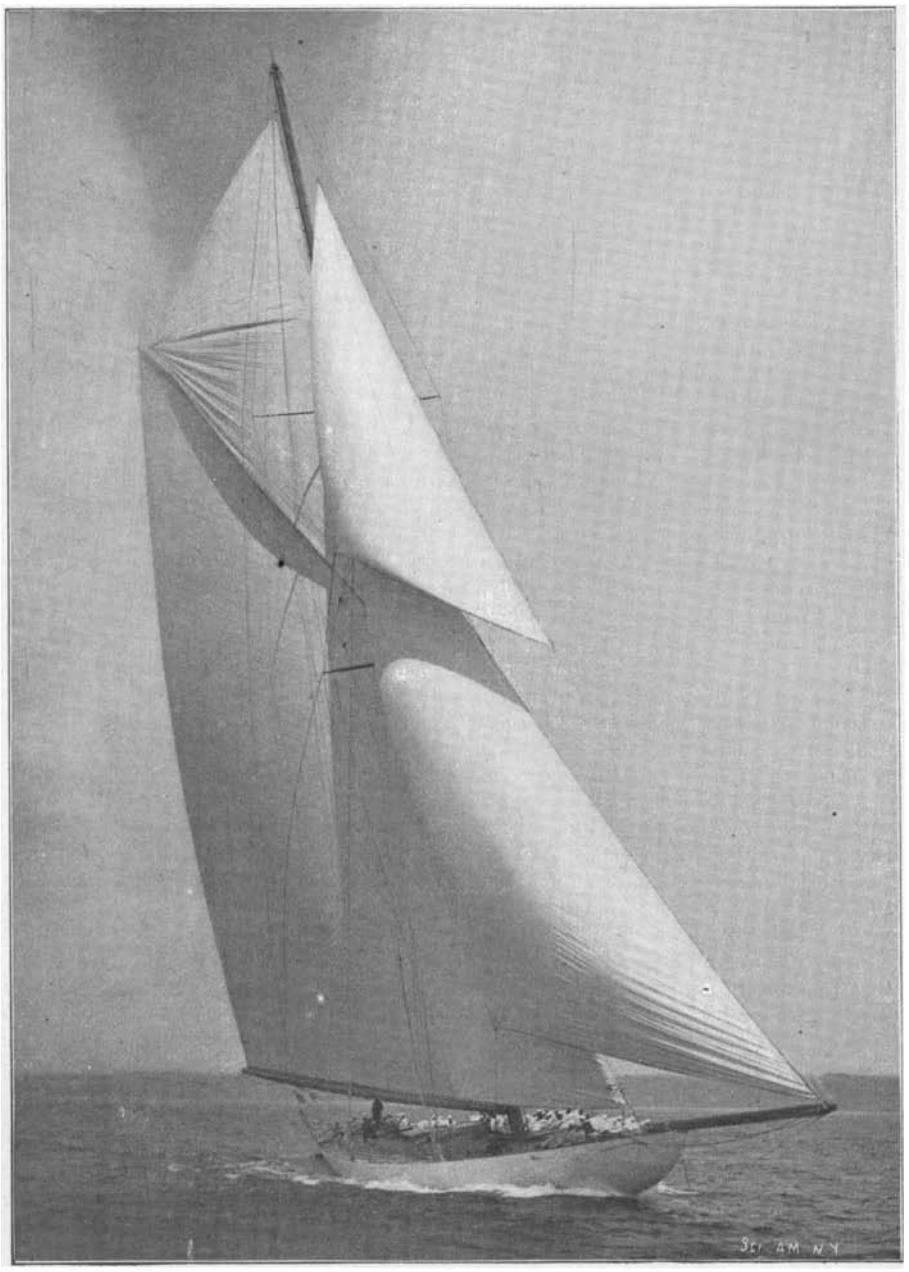
THE THREE CUP-YACHTS OF 1901.

It takes but a glance at the three photographic views of the cup yachts of the present season, and the accompanying table of their measurements, to be convinced that in the effort to produce, on a given water-line length, the fastest possible sail-driven racing yacht, our present-day designers have arrived at a common type from which they vary only in minor particulars. Admitting the existence of a type-yacht, it must be confessed that the palm for originality, as far as the modeling of the hull is concerned, belongs to Crowninshield, the young designer at Boston, who, in the modeling of his first 90-foot cutter, has not hesitated to branch out on new and hitherto untried lines. Judged on the basis of construction, however, the most original boat of the three is the "Constitution," which differs so

Photo. by Symonds & Co., Portsmouth, England.

"SHAMROCK II."

Length over all, 135 feet. **Beam,** 25 feet. **Draft,** 19 feet. **Ballast,** 95 tons.
Sail Area, 14,200 square feet.



Copyright, 1901, by Frank H. Child, Newport, R. I.

"CONSTITUTION."

Length over all, 132 feet 6 inches. **Beam,** 25 feet 2¼ inches. **Draft,** 19 feet 10 inches.
Ballast, 93 tons. **Sail Area,** 14,400 square feet.

widely in this respect from her competitors and, indeed, from all other 90-foot racing yachts that have preceded her, that she stands in a class entirely by herself. Of the Watson yacht it must be confessed that she presents less novelty than the other two boats. She reminds the writer strongly of the yawl "Sybarita," also built from Mr. Watson's designs, which has hitherto proved the fastest 90-foot yacht in British waters. The "Shamrock" differs from that boat chiefly in her bow sections, the overhang being much longer and the beam being carried much further into the bow, with a substitution of flat and full sections for the sharper V-sections which are found in the bow of the "Sybarita" and other Watson craft. In construction she is not unlike "Shamrock I.," with the difference that her sheer strake is of steel instead of aluminium. The body of the yacht is plated with a special make of bronze, and the deck is of steel, covered with a thin layer of pine planking.

DIMENSIONS OF 90-FOOT CUP-YACHTS.

	Length over all.	Beam.	Draft.	Ballast.	Sail Area.
	Ft. In.	Ft. In.	Ft. In.	Tons.	Sq. Ft.
Shamrock II.....	135 0	25 0	19 0	95	14,200
Constitution.....	132 6	25 2½	19 10	93	14,400
Independence... ...	140 10½	23 11½	20 0	75	14,300

As to the performance of the three competing yachts under sail, it may be described as truly sensational. Both "Shamrock" and "Constitution" have been dismasted, and "Independence," as the result of a jamming of her steering gear, came very near being so. As far as can be judged from these sailing trials, "Shamrock II.," after her defeat by "Shamrock I.," appears to have very little prospect of winning the cup. The only element of uncertainty, as far as she is concerned, hinges on the possibility that "Shamrock I." is sailing faster than she was when over here in 1899; but inasmuch as orders were given that, to render her a medium of comparison, the older vessel should not be changed, we see no reason to suppose that she is a faster boat now than then. As to the speed of "Constitution" and "Independence" there has been no scale by which to judge of it, other than the perfervid imagination of the spectators who have followed these vessels in their canvas-stretching trials. Nevertheless, we should be greatly surprised if both of these boats are not faster than "Columbia," and this for two reasons. In the first place, "Constitution" is several tons lighter in construction than "Columbia," and by transferring the weight so saved from the hull to the keel, and adding 12 inches to her beam, it has been possible to increase her sail-plan at least 10 per cent over that of "Columbia," without giving her more displacement than that boat. "Independence," on the other hand, has achieved the same result by the peculiarity of her model. Although her hull is probably no lighter than that of "Columbia," she gains power through the flattening of the floor and hardening of the bilges, and the carrying of the floor out into overhangs of exceptional length. As originally designed she was to carry a sail-spread of 14,611 square feet, with a total amount of ballast of 75 tons. Mr. Crowninshield, the designer, gave her an excessive sail-spread and a moderate amount of ballast, with the idea of decreasing the first and increasing the second, should the sailing trials prove it to be necessary, until the proper balance between the two had been established. The unprecedented character of her model—unprecedented, that is, for a 90-footer—rendered this tentative method of proportioning the spars almost a necessity; and, very wisely, care was taken to have the sail-spread over rather than under the capacity of the boat. It is easier to cut down a sail-plan than to increase it, and the Boston boat is now having 5 feet cut from her mast and as much from the topmast, with the result that 300 square feet of canvas, and a corresponding weight in spars and gear, will be removed from an altitude of from 100 to 173 feet above the deck. The reduction of weight aloft will fully compensate for the reduced sail-power. Another change is the substitution of a rudder of the normal type for the experimental balanced rudder with which the preliminary trials have been carried out. Altogether, the coming races promise to be, to say the least, exciting. The enormous sail-plans, the fact that the designers have kept down the factor of safety to the vanishing point, and the possibility of piping breezes during the month of September, when the races will be held, introduce elements of uncertainty which may yet land the cup in the lockers of the boat which carries the stoutest spars and gear.

Copyright Business in 1900.

From January 1 to December 31, 1900, the United States copyright fees amounted to $66,630.50, distributed as follows: Filing 8,478 titles foreign productions, $8,478; filing 89,489 titles United States productions, $44,744.50; 23,832 copyright certificates, $11,916; for copies of record, $662; for recording assignments, $801; search fees, etc., $29.

Automobile News.

Electric cab service in Paris has proved very unprofitable, and it is said that the loss represents $900,000. The failure of the enterprise is considered to be the high cost of maintaining the accumulators and the consequent high charge for the service.

The Northwich Union Fire Brigade had a startling experience recently, and the attendant circumstances were of a serious nature, says The Mechanical Engineer. Lately the steam fire engine, hitherto drawn by horses, has been converted so that steam propulsion is now used. The trials have not been wholly satisfactory owing to the continuous emission of sparks from the funnel. One evening the brigade received a call to a fire about three miles from the city. The brigade turned out with their steam-motor fire engine, and before they reached the city boundary the sparks from the engine had ignited a load of straw standing in the roadway, and the hedges in two places. The city fire brigade were called out to extinguish the blazing straw, but the whole was consumed and the wagon damaged. Other hedge fires, as well as two large straw ricks, were ignited by the engine before it reached its destination, while on arriving there a pipe in the engine burst and rendered it useless for all practical purposes.

When the out-of-town use of electric automobiles is discussed the question is often raised in a dubious way as to the existence of proper facilities for charging and storage of vehicles. The Electrical World gives an interesting list of the charging plants between New York city and Greenwich, Conn., a distance of possibly thirty miles. It will be seen that there are ten plants, averaging one to every three miles: No. 1. West Chester Village, near Morris Park; No. 2. Union Port, electric power house—both convenient to Westchester Country Club and Century Golf Club. No. 3. Pelham Manor, near station of N. Y., N. H. & H. RR., Harlem River branch; convenient to N. Y. Athletic Club, Pelham Country and Golf clubs; at the laboratory of Mr. E. T. Gilliland. No. 4. New Rochelle, Rose and Huguenot Streets, one block from N. Y., N. H. & H. RR. station, at livery establishment of Mr. Charles H. Coe; vehicles cared for and batteries recharged. No. 5. New Rochelle, electric power house, Webster Avenue. No. 6. Larchmont, Boston Post Road and Chatsworth Avenue, opposite golf links, and convenient to Larchmont Yacht Club; J. Maddox & Sons. This will be a model station for the care of vehicles and recharging of batteries; also the Central office of the company. No. 7. Rye, "Rye School for Riding and Driving," at N. Y., N. H. & H. RR. station, and the entrance to Apawamis Golf Club; care of vehicles and recharging of batteries. No. 8. Portchester, Portchester Electric power house, after June 1. No. 9. Portchester, directly opposite N. Y., N. H. & H. RR. station, at livery establishment of Charles H. Benedict; care of vehicles and recharging of batteries. No. 10. Greenwich, after June 1, 1901, near entrance to Fairfield Country Golf Club and at station of N. Y., N. H. & H. RR., or other locations convenient for residents of Belle Haven.

The annual race known as the "Course du Catalogue" presents a rather unique feature, as the machines, instead of being classed as usual in regard to weight or capacity, are classed according to the catalogue price, making five series, with a sixth for electric vehicles. The race was run this year on the 28th of April from Melun to Nangis, Valence and back; this route forms a quadrilateral of 46 miles, and the distance was covered once by the light machines of the first class and the electric vehicles, and twice by the others, or 92 miles. The race was one of the most successful of the season, and attracted a great crowd of prominent chauffeurs. In the first class, machines valued up to $800, the best record was made by Demester on a Gladiator machine, who covered the 46 miles in 1h. 19m. 22 2-5 sec., or an average of 35.1 miles an hour. The second series (machines valued at $800 to $1,600) was won by Edmond (Darracq machine), making 92 miles in 2h. 32m. 55 sec., or 36.5 miles an hour. Third series, $1,600 to $2,400, Cuenod (Geo. Richard machine), 92 miles in 3h. 47m. 53 sec., or 25.1 miles an hour. Fourth series, $2,400 to $3,200, none. Fifth, value above $3,200, De Champrobert (Bolide machine), 92 miles in 2h. 27m. 27 1-5 sec., or 38.4 miles an hour. Electric series, Garcin (Bouquet, Garcin & Schiore), 46 miles in 3h. 16m. 20 2-5 sec., or 14.4 miles an hour. The record made by De Champrobert is the best which has been made for two tours over this route; M. De Rothschild made the best record for one tour, but this was run outside of the official race. This was the result of a wager laid between MM. De Rothschild and René de Knyff at the time of last year's race; the former gentleman had bet that he could make an average of 36 miles an hour with his 28 horse power Daimler machine, but did not succeed. This year he raised this figure to 42 miles an hour, and won the bet with a very small margin, using a Mercedes (German) machine, which carried three persons.

Engineering Notes.

According to the report issued by the Minister of Railways in Austria for 1899, there were 18,738 kilometers in existence; 2,015 accidents occurred, of which 318 were due to collisions, and trains left the rails in 308 cases. The number of passengers injured through accidents and neglect on their own part was 215, with 15 fatal injuries. The proportion of personal injuries was 1.51 per million passengers, and 0.04 per million passenger-kilometers.

Consul Donaldson, of Managua, says that the Nicaraguan government has placed an order with its agent in New York for 2,400 tons of steel rails for the new central branch of the National Railroad, which is being constructed by a German engineer, Mr. Julio Wiest. Considering the fact that Nicaragua has always purchased rails in Germany and England, says Mr. Donaldson, and that the contractor for the present railroad is a German, the placing of this order in the United States is an item of considerable importance in the growth of our trade with Central American countries.

As a consequence of the increasing demand for superior grades of sugar in Japan, attention is being turned toward improving the very primitive methods of crushing now employed at Tainan, and turning out a cleaner and higher grade sugar, says The Engineer. As a first step in this direction four iron mills —crushers—were introduced during the year to replace old stone crushers, but as the same motive power—bullocks—is used as before, this improvement is limited only to the extraction of a larger percentage of juice, and the quality of the sugar produced remains much the same.

According to statistics issued by Lloyd's Register, during 1900, exclusive of warships, 692 vessels of 1,442,471 tons gross—viz., 664 steamers of 1,432,600 tons, and 28 sailing vessels of 9,871 tons—have been launched in the United Kingdom. The warships launched at both government and private yards amount to 29, of 68,364 tons displacement. The total output of the United Kingdom for the year has, therefore, been 721 vessels, of 1,510,835 tons. The tonnage launched in 1898 and 1899 was less by 75,000 tons and 26,000 tons respectively than that launched in 1900. As regards war vessels, the figures for 1900 are less than those for 1899 by 100,000 tons.

A committee of the Canadian Roadmasters' Association reported that the best method to prevent the creeping of rails on a soft or swampy road-bed is to put on 18 inches of cinders—to lay ties 10 to 12 feet long, and 7 to 8 inches thick, and not more than 8 inches from bearing to bearing; also to block four ties on each side of joint, under each rail, with angle bars of 4 inches by 4 inches scantling. In the discussion, an official of the Canadian Pacific Railway said that several years ago he had some experience with badly creeping rails, and had adopted the practice of putting in ties of 12 feet length, and 8 inches thick, with a bed of cinders, using a long angle bar. He found that it prevented the rails from creeping, but thinks that with heavy trains and engines it is almost impossible to prevent it altogether. Another railway man laid stress upon the importance of keeping the bolts tight in track over swampy land. He has had experience of track which will creep 8 to 9 inches both ways the same day in hot weather, but this is believed to be an extraordinary experience.

The Nilgiri Railway is notable as being the first Abt-rack railway constructed in India, and, at present, the longest of its class in the world. It is, moreover, the first for which all the plant and material was manufactured in England. An account of the permanent way and rolling stock was given at the meeting of the Institution of Civil Engineers, on February 12, by Mr. W. J. Weightman, says Nature. The railway was chiefly designed to serve the important towns of Ootacamund, the summer headquarters of the Madras government, Coonoor, Kotageri and Wellington, the latter being the military sanatorium for South India and Burma. It is 16¾ miles long, and from its starting point at Mettapollium on the Madras Railway, ascends nearly 5,000 feet to the plateau on the Nilgiri Hills. The first 4¾ miles are adhesion-line with gradients not exceeding 1 in 40; the remaining 12 miles are built on the Abt-rack system, and have a ruling gradient of 1 in 12½. The formation-width is everywhere 16 feet, and as the rainfall is frequently 6 inches in as many hours, the greatest possible care has had to be taken to see that it is effectually drained. The locomotives are of the type known as "combined" Abt engines, that is, they can run either on rack or on ordinary line. Before the line was opened for traffic a series of brake experiments was made with a fully loaded train of 100 tons gross weight. With an ascending train at speeds of 6, 8 and 10 miles per hour on a 1 in 12½ gradient, stops were made in 24, 36 and 60 feet respectively; with a descending train at various speeds ranging from 4 to 12 miles per hour, relative stops were made in 54 feet, increasing to 425 feet.