side of the upright leg of the "T." So nicely are the leaders balanced that with very little power they can be moved from either the horizontal or the vertical position.

For extension work the deck of the pile-driver can be moved forward until the center of the leaders is 18 feet beyond the center of the front car wheels. The deck is swung by pinions which engage circular racks attached to the intermediate deck. At each end of the intermediate deck is a segmental rack, and at the center is a complete circular rack, by which the deck can be swung clearly around. The ends, while over the intermediate deck, are partly supported and enabled to move freely by rollers; but after having swung clear, the deck is balanced by the equal distribution of the load. Fig. 2 shows the pile-driver swung at right angles across the car, in which position the center of the leaders in this position is 22 feet 6 inches from the center of the railway track. The weights on the deck are so adjusted that the center of gravity is never outside of the 9-foot circle on which the deck rests. In this position a pile can be picked up and driven with perfect safety.

Some nine years ago Mr. Smith found that he could dispense with the special drivers used for emergency repairs in driving the piles for the temporary support of through truss bridges by attaching an additional swinging set of leaders to the head block of his regular driver. Thus he was enabled to drive a pile close to the lower chord of a through truss bridge without swinging the deck of the driver out far enough to interfere. The swinging leaders proved so serviceable that he has incorporated them in the driver under discussion. Swinging leaders, besides dispensing with special drivers, are of great value in giving the outside piles of bents a good batter and the bents wide bases.

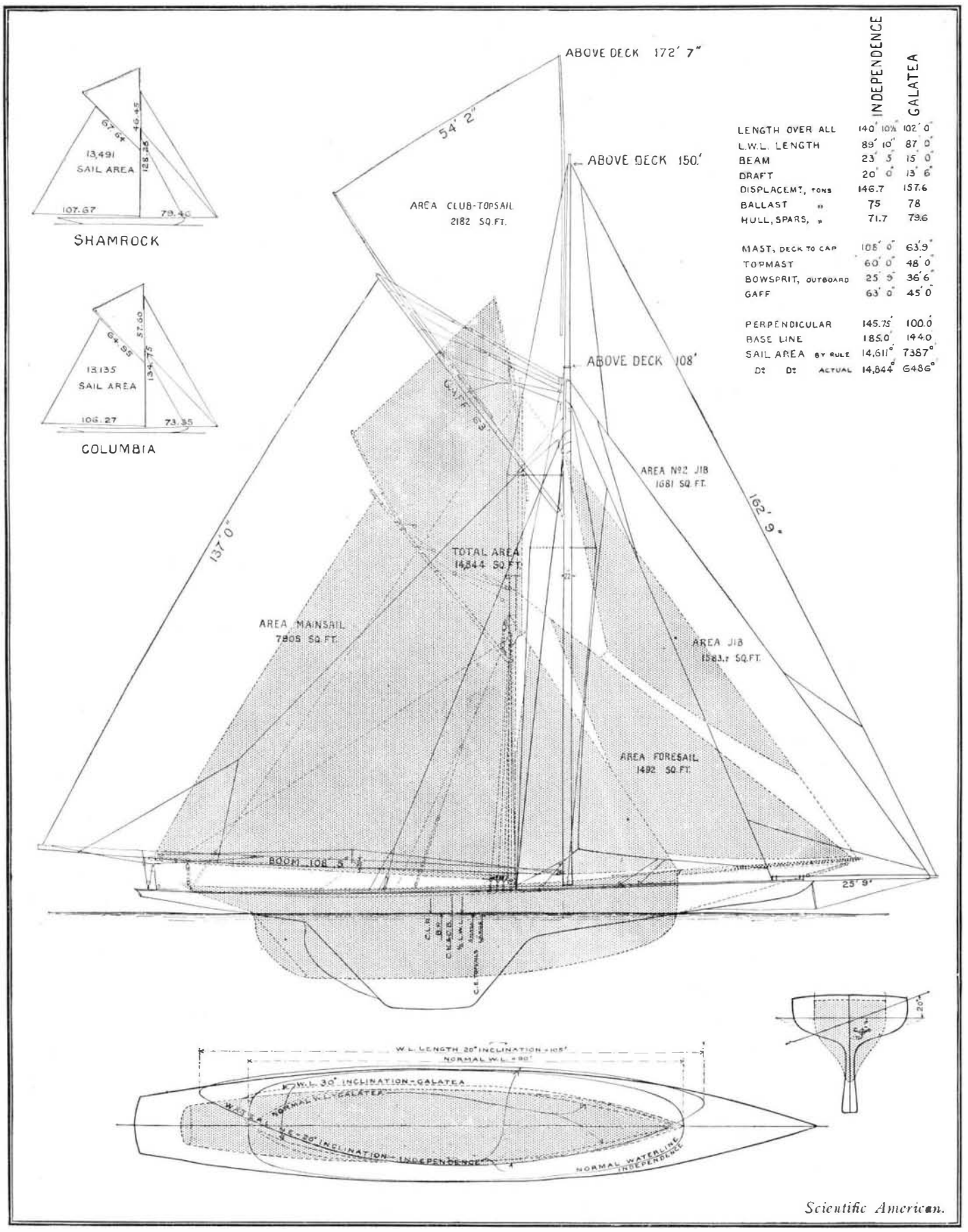
The Smith pile-driver is compact, easily coupled by the usual means with a train and is self-contained in every respect. The leaders can be raised and lowered by men on the car. The driver will drive piles in all places and under all the conditions encountered in railway service.

Adopts Baggage Check System.

The Great Eastern Railway, of England, will introduce the baggage check system on its lines on June 1. A small fee will be charged, but the adoption of the system by the passengers is optional with them. The Caledonian Railway is having thirty large steel cars built at Leeds and twenty in America with the object of comparing results.

FIFTEEN YEARS' DEVELOPMENT OF THE 90-FOOT RACING YACHT.

In pursuance of their commendable policy of satisfying the very natural and perfectly proper public curiosity as to what manner of yachts are being put afloat for the defense of the "America" cup this year, Messrs. Lawson and Crowninshield, the owner and the designer of "Independence," have furnished the SCIENTIFIC AMERICAN with the sail plan of "Independence" which is herewith reproduced from the original blue-prints. At the same time, by the courtesy of J. Beavor Webb, the designer of the famous old "Genesta" and "Galatea," we are enabled to present the sail, sheer and deck plans and midship section of the latter yacht, these plans being also reproduced from the original working drawings.



FIFTEEN YEARS DEVELOPMENT OF THE 90 FOOT RACING YACHT.

As shown by a comparison of "Galatea" (cutter, 1886) and "Independence" (cutter-sloop, 1901).

(Reproduced by the courtesy of the designers, J Beavor Webb and B. B. Crowninshield, from the original working drawings.)

It will be fifteen years ago this summer since the 90-foot cutter "Galatea" (her actual water-line length was 87 feet, but she classes with the 90-foot "Independence") came across the Atlantic to make the second attempt on the part of the typical English cutter to secure the "America" cup. She and her sister the "Genesta" may be said to have opened the latest period of the cup contests, a period which has been far the most brilliant in the history of this memorable and long-drawn-out struggle. Although her genial owner, Lieutenant Henn, one of the most thorough English yachtsmen that ever crossed the water, sailed "Galatea," not merely in the cup races, but throughout the yachting season of the following year, she did little to add to the prestige of her predecessor, "Genesta," whose performance stands to day as the most creditable among the many English yachts that have competed for the cup. We have chosen the "Galatea," however, for this comparison, because on the basis of water-line length, by which the modern racing yacht is classed, she lends herself admirably to comparison with the 90-foot "Independence" of 1901. In our drawing, the cutter of 1886 is thrown in shadow upon the cutter-sloop of 1901, and the two drawings being exactly to the same scale, they tell the story of the development which has been taking place during the past decade and a half better than would a whole volume of verbal description.

Speaking in a general way, it may be said that among the many conditions surrounding the cup contests, there is only one, at least as regards the dimensions of the yachts, that is strictly negative, and this is the rule that neither yacht must exceed 90 feet in length on the water-line. They may be as deep, as broad, as long on deck, as their respective designers may care to make them, but in length, wnile they may be many feet less than they must not be a fraction of an inch over, 90 feet. Subject to this restriction, then, the problem is to design a yacht which shall carry a maximum amount of sail upon a hull that shall have the smallest possible displacement and wetted surface, and shall present the easiest form to drive through the water. At the time of the "Galatea" - "Mayflower" races, the American and English yachts were widely different in form, the English cutter being of narrow beam and considerable depth of body, the American sloop being of shallow draught and great beam, and depending upon the movable centerboard to give her the proper lateral plane when sailing by the wind. The initial stability of the sloop was large, the center of buoyancy moving out rapidly to leeward as the vessel heeled, and thus automatically, as it were, maintaining the margin of stability. In the narrow cutter, the initial stability was small, the center of buoyancy moving to leeward but little as she listed, although the righting moment increased rapidly with every increase in the angle of heel. On equal displacements, the greater initial stability of the sloop enabled her to carry a considerably larger sail plan, and hence in light winds she was invariably faster than the cutter. At higher speeds, however, the finer form of the cutter showed to advantage against the bluffer lines of the sloop; there was less wave-making resistance and, hence, in the second race

between "Genesta" and "Puritan," which was sailed in a piping breeze, the cutter was practically a match for her shallower-bodied competitor.

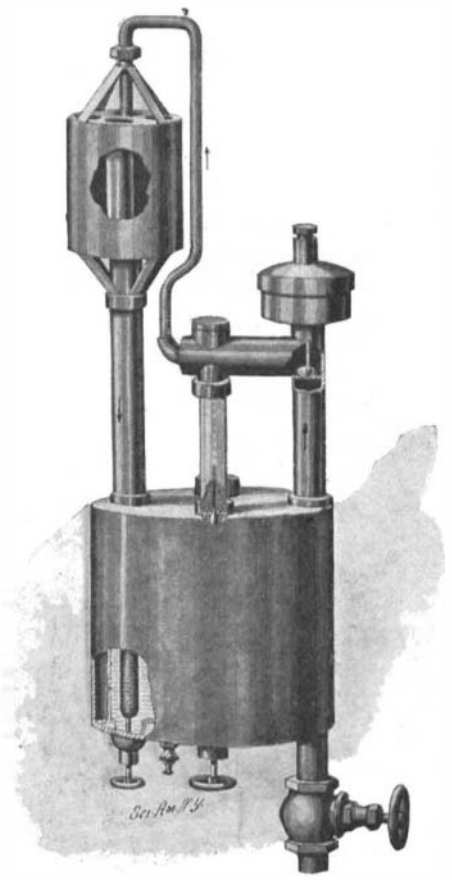
The narrow beam of the cutter was due to an English rule of measurement which put a heavy tax upon beam, but none upon draught. As soon as this was removed, and a rule of measurement based on water-line length and sail area substituted, the English designers reverted to the more generous breadth of the original cutter type, the "Thistle" having a beam of 20 feet 3 inches to a length of 86 feet 6 inches, as against the "Galatea's" beam of 15 feet on a length of 87 feet. The "Valkyrie II." of 1893, which, with her sister the "Britannia," may justly be termed the type from which the modern racing craft has sprung, showed on a water-line length of 85 feet, a beam of 22 feet 6 inches, and a depth of 17 feet 6 inches. Simultaneously with this lowering of the lead and widening of the beam, the forefoot was cut away, the sternpost and rudder brought well forward of the after end of the water-line, with the result that the wetted surface and, therefore, the frictional resistance of the yacht was considerably reduced.

On the American side, development had been in the direction of deeper draught and a lowering of the center of gravity, until in "Vigilant," the competitor of "Valkyrie," we see a boat with the enormous beam of 26 feet and the deep draught, for a sloop, of 13 feet 6 inches. With such a draught it was evident that the days of the centerboard were over, and in the next yacht, "Defender," Herreshoff produced a keel boat of similar contour to "Valkyrie," but with even 2 feet greater draught than that yacht. It was at the time of the "Valkyrie"-"Vigilant" races that the forward and after overhangs of the racing yacht began to be carried out far beyond the load water-line, and so great has been the development in this direction that in the "Independence" we have a forward overhang of 27 feet 5½ inches and an after overhang of 23 feet 5 inches. These exaggerated overhangs have the advantage of compensating for the increase in beam, (compare the deck plans of "Galatea" and "Independence") by permitting the fore-and-aft lines to be practically as fair and easy as those of the old cutter type.

It will be seen in the comparison of the midship sections that the modern yacht embodies two points of excellence of the cutter and sloop, for it has the low center of gravity of the one and the high center of buoyancy of the other. The bottom of the lead of the "Independence" is 6 feet 6 inches lower than that of "Galatea" and her beam is 8 feet 5 inches greater. Thanks to her great length, her lines are at least as easy, and by carrying the flat floor of the hull well out into the overhangs, Mr. Crowninshield has secured the unmistakable advantage that when the yacht is heeled, even in a moderate sailing breeze, she lengthens her water-line from 90 to 105 feet. The cutter, on the other hand, lengthens but little; as will be seen by comparing the listed water-line of both yachts. The comparison is not made on the same degree of inclination, for the reason that the relative tenderness of the cutter would cause her to heel about 30 degrees in a breeze which would only incline the cutter-sloop by 20 degrees. With her straight stem the cutter, of course, gains nothing when heeled forward and her gain aft, at the given inclination, is not more than a couple of feet.

In considering the form of "Independence," as shown from the midship section, we must bear in mind not only that she possesses all the initial stability of the sloop type due, as we have seen, to great beam and shallow body, but that the height of the center of buoyancy, when the yacht is heeled, is increased by the great lengthening of the water-line and consequent submersion of the full ends of the yacht, as shown in the plan of the listed load water-line. Under 20 degrees of heel, the center of buoyancy of the submerged portion of the hull moves out to leeward until it is 2.75 feet from the vertical axis of the boat and only 2.83 feet below the normal water-line. Compared even with "Columbia" she shows in this respect a remarkable gain; and it is probable, moreover, that the center of gravity of the boat is lower than that of the last cup defender. That this is the case is suggested by the fact that "Independence" will spread 1,476 square feet, or 11 per cent, more sail that "Columbia," although the displacement of the latter vessel is greater.

The increased power of the cutter-sloop over the cutter is not, however, to be all attributed to form and disposition of weights; for a corresponding gain has been made both in the materials and methods of construction. Looking at the hulls of the two boats, as shown in outline and in shadow, it is seen that although her displacement is less, in bulk or cubical capacity "Independence" is enormously larger than "Galatea." She is 39 feet longer on the deck, 8½ feet greater in beam, her deck area alone being 2¼ times as great as that of "Galatea." Although nominally in the same class by virtue of her water-line length, "Independence," measured by her actual superficial area, is a vastly bigger boat. The same disparity is present in the spars and sails. Nevertheless, as will be seen from our comparative table of dimensions, the total weight of the hull, spars, rigging, sails, etc., of the bigger boat is less than that of the cutter by 8.9 tons, or 11 per cent—a structural paradox which tells more eloquently than words the story of the advance which has been made during the past fifteen years, not merely in the quality of the materials themselves, but in their scientific adaptation to the problem in hand. Doubtless "Galatea" as designed by Webb embodied the latest ideas in the way of lightness of construction known at that date to the naval architect. Her hull was of steel, but the deck was wood-planked, and the spars were solid throughout. Although she was lightly constructed, as things went in those days, nothing was sacrificed to the determination to make her a perfectly stanch and seaworthy vessel; and doubtless to-day she could snug down and thrash her way, without starting a rivet or loosening a spar, through a gale that would send "Independence" or in fact any of this year's 90-footers to the bottom. Still, the "America" cup contests are not supposed to be, or, at any rate, have had the luck never as yet to be sailed in a gale of wind. Therefore "Independence" is a perfectly proper and legitimate craft for the work she is called upon to do. Allowing then that stanchness has been somewhat sacrificed to lightness, as compared with the cutter, we may still attribute the remarkable lightness of "Independence," both in hull, spars and sails, to the far greater strength per unit of weight of her materials of construction, and



THE SLATER LUBRICATOR.

to the great care which has been exercised to dispose this material to the best structural advantage. To particularize, we may mention the substitution of nickel-steel framing and Tobin bronze plating for the mild steel frames and plating of the "Galatea;" the substitution of steel and aluminium plating for the heavy wood deck; and the use of plough steel, having a strength that runs pretty close to 100 tons to the square inch, for the standing rigging; and the substitution of hollow steel and hollow wooden spars for the solid pine sticks which were used on the earlier boat.

It must be confessed that the sail plan of the "Independence" is very impressive. We were prepared for an increase over that of the last contestants, but not for such an increase as this. The ring or cap of the mainmast is 108 feet and the topmast is 150 feet above the deck, while the head of the topsail will be 172 feet 7 inches above the same level. What these dimensions are can best be realized when it is stated that were "Independence" to range alongside the center of the Brooklyn Bridge, the topmast would be level with the passenger foot-walk, while the peak of the club-topsail would tower 20 feet above the top chord of the trusses. Compared with "Shamrock" and "Columbia" it will be noticed that the gain in sail area has been in the direction of greater height. The base line from end of bowsprit to end of boom is only 3½ feet greater than that of "Columbia," and is, indeed, 4 feet less than that of "Shamrock." In height, however, there is a gain of 11 feet over "Columbia" and not less than 17½ feet over "Shamrock." The English yachting journals are crediting "Shamrock II." with a base line of 185 feet which is exactly that of "Independence," and a mast measurement of 148 feet. It is not stated whether this measurement is over all or whether it is from the deck. The "Shamrock's" boom is given as 112 feet or 3½ feet longer than that of "Independence," but as the measurement from the forward side of the mast to end of bowsprit of "Shamrock" is said to be 71 feet, as against 74.5 feet in "Independence," it is evident that the mast of "Shamrock" is to be placed several feet further forward and that she will probably show a larger area in her mainsail.

AN IMPROVEMENT IN LUBRICATORS.

Our illustration represents a simple lubricator, by means of which the lubricant is kept warm and flowing to insure a thorough lubrication of the parts. The inventor of the lubricator is Charles Slater, 76 Commercial Street, Portland, Me.

The device comprises a jacketed oil-cup, a space being provided for hot air to warm the oil. The air-space is heated by steam passed through a pipe connected either with the steam-chest or throttle. The steam-pipe passes through the air-space referred to, and at its upper end communicates with a horizontal mixing-chamber. The connection between the steam-pipe and the mixing chamber is controlled by a spring-pressed valve. The pressure of the steam passing through the pipe is sufficient to force the valve from its seat; and the spring seats the valve when the steam is cut off. A sight-glass connects the mixing-chamber and the oil-cup; and a needle-valve regulates the passage of oil from the cup to the mixing-chamber.

From the mixing-chamber a pipe leads upward and then downward into the top of a condensing-cylinder, through which cold-air flues pass to condense the steam. The water of condensation passes down through a pipe leading to the bottom of the oil-cup; and the opening at the lower end of this pipe is controlled by a screw-valve.

As the steam passes up through the steam-pipe, the valve at the upper end of the pipe is forced open by the pressure. The steam then passes through the mixing-chamber to the condenser, and is condensed. The condensation passes down into the bottom of the oil-cup and displaces a certain quantity of oil. The displaced oil passes up through the sight-tube and downward through the steam-pipe to the parts to be lubricated. Sediment or water may be removed from the oil-cup by a pet-cock.

Prehistoric Mines.

The prehistoric mines at Hartville, Wyoming, have been examined by Prof. George Dorsey, Curator of the Columbian Museum, Chicago, who finds that the Indians, in addition to working the mines, were also extensively engaged in manufacturing various instruments. Around the village the ground was strewn with fragments of flint and partly constructed arrows, lances, hammers, etc., showing that the people who worked these quarries carried on the manufacture of household and warlike instruments near at hand, the finishing being done by the women and children, in their lodges, while the men were at work quarrying. Dr. Dorsey will spend the summer in making further investigations.

The April Building Edition.

The Building Edition for April is filled with interesting matter, and the illustrations of houses are of a uniform excellence. "The Appellate Court-House, New York City," is the subject of an elaborately illustrated article. "The National Arts Club, New York City," is accompanied by interesting engravings showing the gallery and grillroom. The selection of houses at various prices is noteworthy. "Why Some Houses Are Good" is the editorial. The "Interview" this month is with Mr. William A. Boring. The departments are filled with interesting matter, including a critical review of Mr. Sturgis' new "Dictionary of Architecture and Building."

The Current Supplement.

The current Supplement, No. 1319, is of unusual interest. "The Restoration of the Castle of Milan" is accompanied by a number of interesting engravings. "The Termination of the Trials of Count von Zeppelin's Airship" gives a most graphic account of the interesting experiments. "Paris Automobile and Cycle Show" was written by our Paris correspondent. "The Anderson Ship Railway" describes a new plan. "Thomas Henry Huxley" is by Leslie Stephen. "The Distribution of Marine Invertebrate Animals" is a lecture by Prof. Henry A. Pilsbry, and was specially reported for the Scientific American Supplement.

Contents.

(Illustrated articles are marked with an asterisk.)