

to be built of steel. She was about 5 feet longer on the water-line than "Puritan," and carried a much larger sail plan, the boom being 84 feet as against 76½ feet of "Puritan," and the hoist to the topmast sheave being 111 feet as against 104 feet in the earlier boat. "Volunteer" also was a perfectly sound and wholesome vessel. Although her rig was a large one, she was well able to carry it; and like her predecessor she was changed after the cup races to a schooner, and is to-day in service as a successful cruiser. After a lapse of six years the New York Yacht Club was called upon once more to defend the cup, and on this occasion they went to Herreshoff, from whom they obtained two yachts, one of which, the "Colonia," was a keel boat, drawing 14 feet of water, built of steel, and carrying about 11,000 square feet of sail. She was a failure, for the reason that, like the "Navaho," another Herreshoff 90-footer of the same year, she was a poor boat on the wind.

The other yacht built for cup defense by Herreshoff was the "Vigilant," and in her we see the engineer attacking the problem of yacht design from his own particular point of view. Tobin bronze is used for the plating, hollow spars are experimented with, high-grade steel wire rope, blocks and other gear of extreme lightness, make their appearance in the spar and sail plans. As a consequence, although the "Vigilant" was only a few inches longer on the water-line than the "Volunteer," she carried over 2,000 square feet more sail. The boom was lengthened out to nigh upon 100 feet, while the hoist went up to 132 feet; and the sail spread to 11,312 square feet. "Vigilant" was to be the last of the centerboard yachts; for although she beat "Valkyrie II." in the series of races, she was beaten badly to windward by that boat in a stiff breeze; and subsequently, during a season in English waters, was beaten eleven times out of eighteen by the deep-keel cutter "Britannia," a sister boat to "Valkyrie II." That season's experience sealed the fate of the centerboard, and when the next challenge came, the Herreshoffs, intrusted with the contract of building a yacht to beat her, turned out to meet her the deep-keel cutter-sloop "Defender." "Vigilant" was the last of the cup defenders that was good for anything but cup defense. She has been changed into a yawl, and has proved to be an excellent cruiser under her reduced rig. In "Defender" we see the engineer still at work, reducing scantling and lightening up on construction even to the smallest detail. "Defender" was built of manganese bronze in the underbody, and aluminium in the topsides and framing. She carried a hollow steel mast, boom, and gaff. As a consequence, although she was a smaller boat than "Vigilant," having some 3 feet less beam, so great was the lightening of her weights, and the increase in stability due to lower ballast, that she carried over 1,000 feet more sail than the larger yacht, spreading 12,640 square feet. The main boom reached far over the taffrail, being 106 feet in length over all. The hoist was 7½ feet greater, and the forward measurement from mast to end of bowsprit had increased to over 73 feet.

THE DEVELOPMENT OF THE 90-FOOT RACING YACHT.

	Waterline Length.		Base of Fore Triangle.	Hoist from Boom to Topmast Sheave.		Boom.	Gaff.	Spinnaker Boom.	Total Sail Area.		
	ft.	in.		ft.	in.					ft.	in.
Puritan.....	81	11½	63	0	104	0	76	6	47	0	7,370
Mayflower.....	85	7	67	0	111	0	80	0	50	0	8,324
Volunteer.....	85	10	67	0	111	0	84	0	51	0	9,107
Vigilant.....	84	2	69	0	123	0	98	0	57	0	11,312
Defender.....	88	5½	73	3	129	5	105	0	64	10	12,640
Columbia.....	89	7½	73	3	138	5	107	0	64	10	13,211
Constitution.....	89	9	78	0	142	0	110	0	73	0	14,400
Reliance.....	90	0	84	0	155	0	115	0	72	0	16,247

When the "Defender" commenced her trials, it began to be evident that in the development of the 90-foot racing yacht the limit, not merely of convenience, but of actual safety, had been passed. The draft of 19 feet was in itself prohibitive of the use of the boat as a cruiser, since it shut her out from many of the harbors and desirable anchorages, while the experience of the boat in fresh to moderate breezes was marked by breakdowns which, on one occasion, came very near to being disastrous. In some races, when the wind breezed up, rivets were sheared off, and the climax came when in a bit of a squall the pull of the weather shrouds was so great that the mast came very near punching a hole for itself through the bottom of the boat. Herreshoff evidently had overlooked the fact that, in cutting into the keel until its forward edge was aft of the mast-step, he had left nothing but the light floor-plates and the frail plating to take the enormous downward thrust of the mast. Emergency repairs were at once made by carrying a pair of ½-inch by 8-inch steel straps from the foot of the mast up to a junction with the chain-plates at the deck. Trouble was also experienced in keeping the bowsprit from coming inboard; several of the frames of the boat broke at the turn of the garboards; and from first to last the extreme lightness of the craft was a source of unceasing anxiety to her owners.

Four years later the Bristol yard turned out "Columbia," a yacht that embodied some of those features of hull and sail plan which experience in the smaller classes had shown to be conducive to high speed. She had a foot more depth, or 20 feet; her overhangs, forward and aft, were carried out until on a water-line length of 89 feet 7½ inches she had an overall length of about 50 per cent more, or 132 feet. Although a 90-footer when at anchor, she was a 115-footer when heeled to her sailing lines, the great increase in the overhangs being due to the effort to build the biggest possible boat on the arbitrary so-called 90-foot length. The enlargement of the sail plan was chiefly in the direction of greater hoist, the distance from main boom to topmast sheave being 138½ feet. The disastrous experience with "Defender" showed the absolute necessity of using more reliable materials in the hull, which was constructed of Tobin bronze plating on steel frames. The hull structure proved satisfactory, but the lightening up of the spars and standing rigging had been carried too far, as shown by the fact that in her trial races she carried away her mast.

Two years later, to meet "Shamrock II.," Herreshoff brought out the "Constitution," which differed in form from "Columbia" merely by an increase of one foot in the beam. The sail plan was greater than that of "Columbia" by about 1,200 square feet. The hoist had now increased to 142 feet, the boom to 110 feet, and the base of the forward triangle to 78 feet. "Constitution's" appearance is comparable only to that of "Defender" in the constant succession of breakdowns that have occurred; but with this distinction, however, that whereas "Defender's" trouble was in the hull, "Constitution's" has been up aloft. At different times she has carried away her mainmast, her topmast, and her gaff. Of the hull, however, it must be admitted that the system of belt-and-longitudinal framing adopted by Herreshoff has been eminently successful. Although it is probable that no large amount of weight is saved over the old system of framing, it is certain that weight for weight it is considerably stronger. "Constitution" proved so much of a disappointment, that it was realized this year that to defend the cup successfully some radical departure must be taken, and Herreshoff struck out most boldly in the direction of the "scow" type, which had proved so fast in the smaller classes of yachts. On a water-line of 90 feet, the new boat has a beam of over 26 feet, a draft of 20 feet, and an overall length of close upon 150 feet. Although she is a 90-footer at anchor, she is fully a 120-footer when heeled to a breeze; and to this fact is to be ascribed the astonishing sail-carrying power which she has shown, the area under the New York Yacht Club measurement being 16,247 square feet; and if changes are made, they will be rather in the direction of an increase than a reduction of sail plan. The growth of sail power in the last fifteen years may be summed up in the statement that on an increased water-line length of only 10 feet the "Reliance" of 1903 spreads over twice as much sail as did "Puritan" in 1885. In her we see unquestionably the highest possible development under the existing rule, and although the boat is an overgrown monstrosity as a sailing craft, she is certainly a great tribute to her builder, both as a naval architect and as a wonderfully resourceful and ingenious mechanic. She is the biggest, lightest constructed, most powerful, and probably the fastest yacht of her water-line length that ever was or ever will be constructed; and she possesses that dual quality, never before found in one and the same yacht, of being relatively just as fast in light as she is in strong winds.

The Current Supplement.

The current SUPPLEMENT, No. 1438, has for its front page article a very good description of the new Corinthian canal, which promises to be of much commercial importance to Greece. Admirable illustrations give one a good idea of the engineering difficulties which must have been encountered during the course of construction. Dr. Fleming's fourth paper on Hertzian wave telegraphy is presented. Prof. Wattiez gives a résumé of our present knowledge of radium. The Paris correspondent of the SCIENTIFIC AMERICAN presents the last installment of his series on some details of the Paris-Madrid automobile race. In the present installment, the Passy-Thellier and Clement voitures are described. The Antarctic experiences of the "Discovery" are given. The Atomic Theory and the Development of Modern Chemistry is the subject of an article which is of timely interest, since this is the centenary of John Dalton's famous discovery. Of archaeological interest are articles bearing the titles "Discovery of a Roman Palace at Carthage" and "Investigations at Assos." Randolph I. Geare gives a most interesting account of bronze casting in Egypt, Europe, and Japan.

It has been announced that Dr. Charles Wardell Stiles, the well-known zoologist who has been associated with the Marine Hospital Service for several years, has discovered a parasite which is a natural enemy of the mosquito.

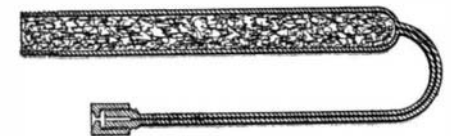


LAMP FOR BURNING VAPORIZED GASOLINE.

A patent was recently granted to Mr. E. P. Brown, of Cottonwood Falls, Kan., covering a lamp burning a mixture of air and vaporized gasoline, the oil being vaporized by the heat of the lamp itself. We illustrate herewith one form of this lamp, though obviously the same invention could be applied to many different constructions. The oil is stored in a tank of neat design, placed near the ceiling. Leading down from this is a feeder tube which terminates in a valve just above the top of the lamp chimney. From this point the vaporizer projects at right angles over the chimney and doubles on itself, ending in a nipple at the mouth of the mixing tube. The mixing tube is bent around the lamp and opens into the burner at the bottom. The novel feature of the lamp is the peculiar form of vaporizer, which consists of two sections, as shown in our detail view. One of these sections, which has a circular cross section, contains wire gauze packing, this serving to break up or atomize the oil. The oil then passes into the flattened section, and here it is vaporized by the heat of the lamp or in starting by the heat of the lighted lamp. It is obvious that owing to its shape this flattened section affords an excellent heating surface on which the oil can be quickly and thoroughly vaporized. The vapor thus generated passes out of the vaporizer into the mixing tube, sucking in with it a quantity of air which thoroughly mixes with the vapor



IMPROVED GASOLINE VAPOR LAMP.



THE VAPORIZER SHOWN IN SECTION.

while passing on to the burner where the mixture is burned. The lamp can be started with a single match and requires no alcohol torch. We are informed that these burners have been in use for over a year and have proven singularly free from clogging.

SNOW GUARD FOR LUMBERMEN'S OVERSHOES.

A recent invention which should prove of particular value to lumbermen and others who are obliged to travel through deep snow and slush, provides a foot covering which prevents the intrusion of snow, keeping the feet dry and comfortable. The improvement relates particularly to the boots of felt and the heavy rubber overshoes which are ordinarily worn by lumbermen. It is found that if the vents in the rubber overshoes are closed completely for the exclusion of snow and slush, the ankle joints are so bound that free action of the feet is impeded, and if the shoe vents are not fully closed, so as to incase the ankles, the intrusion of snow and the like will soon wet the feet of the wearer, much to his discomfort. Furthermore, as more or less friction between the heel portions of the

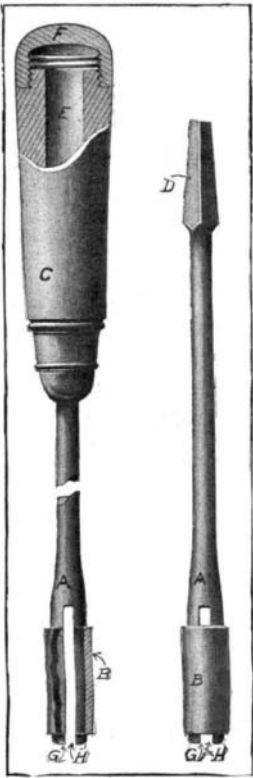


SNOW GUARD FOR LUMBERMEN'S SHOES.

overshoes and like portions of the felt boots is constantly occurring when these foot coverings are worn, the heels of the felt boots quickly wear out and the boots become useless. The present invention, therefore, provides a waterproof leather heel protector shown more clearly in Fig. 2, which is adapted to be slipped over the felt boot, fitting snugly over the heel and extending well up over the ankle. This prevents the wearing of the boot by friction at the heel or at the top of the rubber shoe. A flap or skirt-piece is secured to the upper end of the heel protector, and is adapted to cover the top of the rubber shoe, preventing snow, slush or rain from entering the shoe. Messrs. S. W. Wehn and C. W. Oler, of Everett, Pa., are the inventors of this improved foot covering.

**MAGNETIC TOOL HOLDER.**

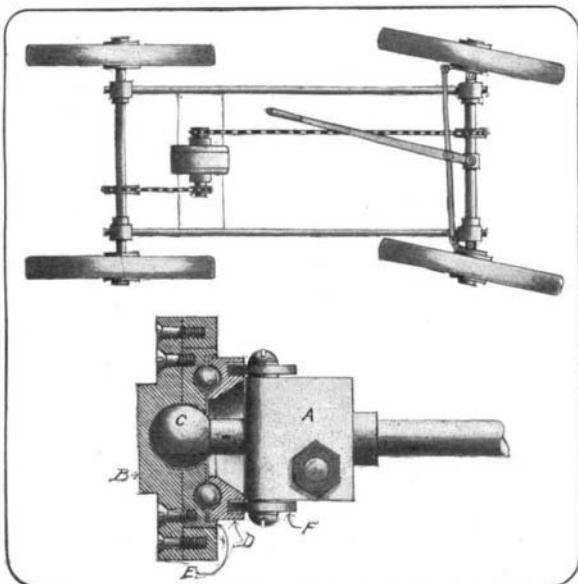
Considerable trouble is often experienced with the screw chucks of an ordinary tool holder, because the tool blade is either too loosely held or else so tightly gripped that it cannot be readily removed. These difficulties are overcome by a new type of tool holder recently invented by Mr. Charles Bellows, of 137 High Street, Boston, Mass. The tool holder as shown in our illustration comprises the shank A, with the usual handle, C, and the chamber E, for the various sizes of tools, also cap F, covering the chamber. The lower end of the shank A is slotted, forming fingers G and H. The fingers are of steel and are hardened so as to form a permanent horseshoe magnet. The shank of the tool blade is inserted between the fingers, fitting snugly therein, and is held in position by magnetic attraction. To prevent the fingers from spreading apart when the tool is in use they are encircled by a sleeve of non-magnetic material, such as Benedict metal, which is snapped into the seat formed on the fingers. While the tool is being used, for instance, in driving or removing a screw, the blade will naturally remain in the holder. The magnetism is merely strong enough to retain the blades when they are not in use. Obviously, this form of chuck permits a great saving of time in changing the blades. Where the holder is to be used with a brace or the like, in place of the handle, the shank is provided with a squared end to fit the bit stock.



**A MAGNETIC TOOL HOLDER.**

**AUTOMOBILE FRAME AND DRIVING AXLE GEAR.**

The desirability of connecting the driving power of an automobile with the front instead of the rear wheels, is offset by the difficulty of making connections such that the steering will not be interfered with, and this difficulty has proved an interesting problem for inventors. We show herewith a very good solution of the problem, for which a patent was recently granted to Mr. George R. Boulding, of Wells, Nev. The patent covers also an improved automobile frame which is flexible, enabling the vehicle to ride easily over an uneven road, with all four wheels continuously in con-



**AUTOMOBILE FRAME AND DRIVING AXLE GEAR.**

tact with the ground. The front and rear axles form part of the frame, being connected with the side frame rods by boxes, A, as shown in our detail view. The axles are mounted to turn freely in the boxes, so that the boxes can swing to take up any unevenness in the road. The hubs of the rear wheels may be of any desired pattern, but a special construction has been provided for the front wheels, which permits them to be slewed independently of the frame in steering, and which also permits one wheel to run faster than the other, in rounding corners, thus preventing sliding of the wheels. The front axle is provided with spherical ends, C, which enter spherical cavities formed in the hubs. Each hub is made up of two sections, a disk, B, and a ring lying along its periphery. Within this ring lies the plate, E, which has a ball-bearing on the member, D. The member D is provided with grooves, near the top and bottom in which the disks, F, enter, the latter being mounted on the boxes, A. The bottoms of these grooves are convex, so that the disks bearing against them will hold the member, D, firmly against the plate, E, when the former, which is connected with the steering rod, is swung about in rounding curves. Swinging the member, D, therefore, causes the hub to be turned, also, on the spherical portion, C, as a pivot. It will be observed that the center opening of the member, D, is tapered so as to prevent it from binding on the axle no matter at what angle it is turned. Connection between the hub and the axle is made by means of a pair of spring-pressed pins in the hub, which engage notches in the spherical portion, C. In our illustration, the section is so taken that neither of the pins can be seen, but one of the notches is shown. The ends of the pins are beveled so as to engage the notches only when the axle turns forward. In rounding curves, the outer wheel will have to run faster than the inner wheel and the axle by which it is turned. When this occurs, the axle will be moving backward relative to the outer wheel, and this is permitted by reason of the beveled ends of the pins, which slide freely over the notches when they travel in that direction.

**ODDITIES IN INVENTIONS.**

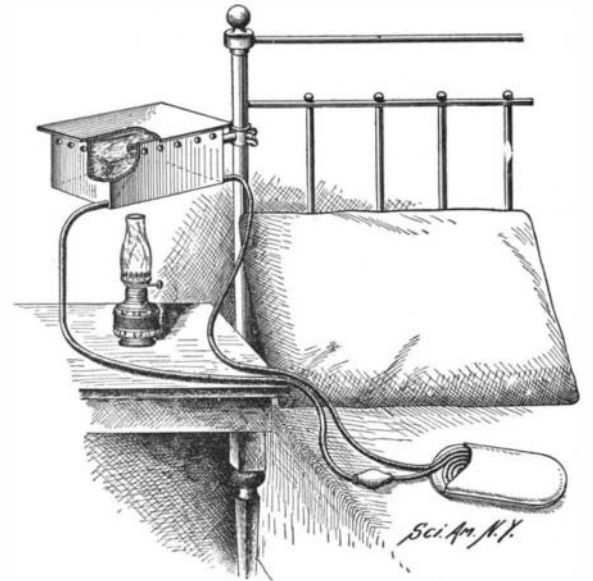
**FOOT-CYCLE.**—A German inventor has designed a foot-cycle of improved construction, in which the springs for raising the foot usually found in such devices are avoided. The support is thus steady and solid, even when the person is at rest. The driving wheel is located under the center of pressure of the wearer's foot, and this enables the person to move in smaller circles than with the usual construction. The details of this cycle may be readily understood from the illustration. Two spring pawls are secured to an extension from the footplate, and are adapted when pressed downward to engage projections formed on an endless chain, but to slide by the same when drawn upward. The chain is thus driven forward positively at every downward stroke of the foot, and its motion is communicated through intermediate gearing to the driving wheel. A brake is situated on the forward end of the device, which may be operated by downward pressure at the toe to frictionally engage the driving wheel.



**FOOT-CYCLE.**

**HOT-WATER BAG.**—Hot-water bags as commonly made consist merely of a rubber casing in bag form, which is adapted to be filled with hot water. After a time the water loses its heat, and for further use the bag must be emptied of its contents and refilled with hot water. We show here a hot-water bag of improved design in which a constant circulation of hot water is maintained and the inconvenience of refilling the bag is entirely avoided. The device will be found very useful for the sick-room. The bag consists of a casing in which a rubber tubing is snugly coiled. This tubing leads to a reservoir, which may be clamped at a convenient height to one of the bedposts. The water in the reservoir may be properly heated by a lamp placed thereunder. The bottom of the reservoir is bent upward in the shape of a cone, from the apex of which a short tube opens at the top into the interior of the chamber. Heat from the lamp is thus utilized

to the best advantage, the products of combustion being drawn up into the reservoir and passing out through perforations in the side walls. The rubber tubing, at a convenient point, is provided with a pressure bulb, at each end of which is a valve. These valves are normally open, so as not to interfere with



**HOT-WATER BAG.**

the proper circulation of the water. By compressing the pressure bulb and subsequently relaxing the pressure, the flow of water may be positively regulated.

**MILK-DIPPER.**—With the ordinary type of milk-dipper considerable difficulty is often experienced on account of its awkward shape. The usual construction comprises a cup and a long handle, by means of which the milk may be dipped up from the can and poured into the bottles or measures. The cup, as a rule, cannot be filled to the brim, because a large quantity of milk is apt to be spilled in removing and emptying the dipper. We illustrate herewith a milk-dipper which is provided with a tightly-fitting lid. This may be opened by drawing together two levers on the handle. As soon as the dipper has been filled to its full extent, the levers are released and the lid drops down under spring pressure to closed position. The dipper may then be carried to the point desired without danger of spilling the contents. When the dipper is to be emptied the levers are again pressed, opening the cover, and the milk can be poured out as usual. Thus it will be seen that the dipper may also serve as a measure for the quantity taken from the can, since it may always be filled to the limit without danger of spilling.



**MILK DIPPER.**

**Making Fuel from Garbage.**

A recent patent granted to Mr. Eugene C. May, of 67 Wabash Avenue, Chicago, Ill., describes a new process of making fuel from garbage. The garbage after being first cleared of metal and glass pieces, or any other undesirable substances, is run through a crusher which breaks up the brittle portions and reduces the softer substances to pulp. About three per cent. of calcium chloride is added to disinfect the mass and it is then dried by evaporation. About 400 pounds of crude oil is now treated with 10 pounds of potassium protoxid, which causes the oil to coagulate and form a soapy substance. The oil is then thoroughly mixed with a ton of the dry garbage, and, with 3 per cent of coal tar as a binding agent, is molded into briquettes ready for use. It gives a clear, dry flame and is entirely free from offensive odors. The fuel was recently subjected to a test by Prof. W. T. McClement, of the Armour Institute of Technology, Chicago, and it yielded the following results:

	Per cent.
Moisture .....	8.10
Volatile combustible matter.....	80.387
Fixed carbon .....	6.06
Non-combustible matter .....	5.45

The calorimeter gave the following results, the fuel being burned in oxygen:  
One pound fuel yielded 21,387.8 British thermal units. This is equivalent to evaporating 221 pounds of water per pound of fuel. Ordinary soft coal should evaporate from 11 pounds to 14 pounds of water per pound of coal. Anthracite coal yields sometimes a little more.