while Fig. 4 might be mistaken for a lace handkerchief, although the outlines are more irregular than most of the others. Figs. 1, 6, and 10, however, form designs which the expert in embroidery might select for patterns. In Fig. 6 the groundwork of the corners is so delicate that it bears a remarkable resemblance to fine linen. Probably snow flakes take the form of coral more than that of any other substance. Fig. 3 is an exquisite facsimile of coral branches, although it is not considered by experts in meteorology as among the most perfectly-formed crystals. Fig. 2 is also very similar to the formation referred to. Fig. 8 might be utilized by the cabinet maker who wishes a unique ornament for inlaying the surface of a table or other article of furniture. Some of the designs pressed upon oilcloth bear a similarity to it.

The study of snow crystals and the preservation of their likenesses by means of the photographic negative dates back but comparatively few years, but as already stated, much valuable data has been secured as to their origin. Probably the finest collection of views which has been made is that produced by Mr. W. A. Bentley, of Vermont, who has devoted much of his time during the last twenty-five years to this subject. Fortunately, he is located at a point which is exposed in winter to not only northern and western, but eastern and southern storms, some of them merely local in character, others covering a large area of the country. From his conclusions and the deductions of other students of snow formation, the belief prevails that the most perfectly-formed crystals come from general storms. Strange to say, many of the finest specimens have been secured during so-called blizzards, when the mercury registered an extremely low temperature. The comparatively few triangular shapes which have been obtained by the observers were secured during violent storms of this character. Fig. 10 is an excellent illustration of the triangular crystal, but, as will be noted, it comprises six points in its outlines, being quite similar to the modern toy kite, although its nucleus is triangular. Northern and western storms also produce more perfectly-formed crystals than those from the East and South, possibly because the temperature as a rule is much colder and the air drier, while the eastern or southern storms are apt to be accompanied by dampness in the atmosphere.

The distance of the snow-producing clouds over the earth is also of much importance in the formation of the crystals. Those coming from strata of high clouds are apparently less changed in their passage to the earth than the ones which come from lower strata, although exposure to different atmospheres and different forms of cloud from strata where they have originated frequently alters the shape materially, and sometimes completely changes the original figure. When the delicacy of a snow flake itself is considered, it seems remarkable that the crystals should retain any semblance of their original shape, especially when whirled through the air by the force of such a wind current as produces a blizzard, for the snow flake itself may represent a combination of several crystals. As it is, the collection of crystals which are not broken or partially destroyed from some other cause, is extremely difficult. During an entire winter, not over a dozen storms may be of such a character that the crystals can be secured for illustration and observation. Therefore it is probable that many thousands of designs equally as curious and beautiful have not been illustrated as yet by the collectors, in spite of the extent of the work which has already been accomplished in this line of investigation.

In securing specimens for study and illustration, it is of course necessary to work at a temperature below the freezing point, and usually a room is selected in which one window is open. The room should be on the side of the building exposed to the most frequent storms, so that the snow will fall into the open window, since the particles must be handled as quickly as possible, and then with the utmost delicacy to prevent injury. One method for placing them under the reproducing apparatus is to catch the crystal on a slip of dark paper, which forms the background. After being placed in position, it is pressed flat against the surface by means of a feather. The objective of the microscope ranges from ½ to 2-3 of an inch, while the diaphragm is 1-16 of an inch. The length of exposure in making the photo-micrograph varies, of course, according to the quality of the light, but at least 40 seconds is required, while it may be necessary to make an exposure of 300 seconds. During all the operations, however, the photographer must exercise the greatest care to prevent any current of warmer air from injuring the crystal. The slides should be handled only with gloves, and even a slight breath may be sufficient to so dissolve the formation that its delicate lines are blurred or entirely lost. Unless the temperature of the room is also at a certain degree, it is useless to attempt the reproduction of the specimens, while an air current of any kind passing in the direction of the apparatus is liable to blow away the crystal. The difficulty which attends this study is one of the reasons why such an apparently small number of different shapes of snow formation have been secured. The collection of Mr. Bentley is probably the largest in the country or in the world, yet it does not aggregate over a thousand in all. All of the other collections are much smaller.

Motors for Long Island Railroad.

The Westinghouse Electric and Manufacturing Company has begun work on multiple-control electric motors for 122 cars to be used on the Long Island Railroad, which the Pennsylvania Railroad will operate by electricity.

The 122 cars are to be equipped with four motors of 125 horse-power each. These will haul ordinary trains. As soon as the first order is installed a second contract will be let.

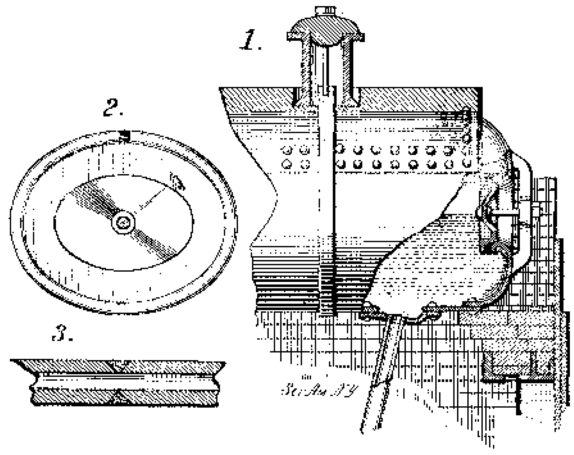
The motor cars will be used to haul trains through the Long Island tunnel, and eventually express trains are to be run from Jersey City to Montauk Point. The short-run trains are to be equipped with motors first.

The Pennsylvania Company will equip the whole length of the Long Island Railroad with copper wires immediately, and the new system will be ready for installation in the spring.

PACKING FOR STEAM-BOILER MANHOLES.

A simple method of packing manholes of steam boilers is submitted to us by Mr. E. P. Larkin, of Hudson, Mass., as shown by the accompanying illustration.

He states that it is not generally known among users of steam boilers that the best and cheapest packing for manhole or handhole is a piece of common lead pipe. For a manhole take ⅜ or ½ inch, bend it around the plate, and cut the ends square and solder together, so as to leave no bunch. With a nail or other tool make two or three small holes on outside, to let out the air when the pipe compresses, and a packing is provided that can be used over and over again. A packing of this kind has been used for fifteen years, and it is found that one lasts from three to five years at an outlay of about 35 or 40 cents. When used up they are worth half price for old lead.



SIMPLE MANHOLE PACKING.

A handhole packing used in this way requires a ¼-inch pipe.

AN ANNUAL ITALIAN AUTOMOBILE CUP RACE.

Automobile matters in Italy are to be greatly stimulated by the efforts of Sig. Vincenzo Florio, who has recently offered a very handsome cup, to be competed for in the annual races at Brescia. Sig. Florio is one of the leading spirits in automobile affairs, and he proposes to make the Brescia week one of the great events of the year. To attain this result he engaged in an active campaign, and there is no doubt that next year the Brescia circuit will rival the Gordon Bennett Cup in interest. The leading event on the programme will now be the Florio Cup. The circuit already had two prizes, the Italian Cup and the one offered by Princess Letitia. In the new programme these latter will not be merged with the Florio Cup, but will be competed for at the same time upon different distances in the circuit. The principal cup race will be run over a distance of about 600 miles, or about five times around the circuit. The other cups will be raced for over the intermediate distances. As will be noticed in the following regulations, the Florio Cup will be competed for annually during a period of seven years, from 1905 to 1912. After it has been won the seventh time it will become the property of the constructor whose car has won it the greatest number of times. In case of an equality of points, an extra race will be run. Each year the cup will remain with the corresponding automobile club. This regulation differs considerably from the ordinary, as will be noticed, and besides, a smaller cup, a reduction of the large one, will be given as actual property each year to the person entering the car. But in the final classification, the constructor alone is to be taken into account. Besides the annual cup, prizes of $600, $250, and $160 will be awarded to the first three cars. These rules have been established on a new basis, and it is judged that a distance of 300 miles is no longer sufficient to estimate the performances of cars which can now make 60 miles an hour on the average. The different cities along the course, Brescia, Cremona, and Mantua, are also to award prizes for the race.

A NOVEL WATER WHEEL.

(Continued from page 20.)

Third, the wheel during its revolution loses too early the weight of the water accumulated. Prof. Frank Kirchbach, of Munich, Germany, has tried to obviate these three objectionable features in his "hydrovolve," thus increasing the efficiency of water wheels and opening new fields for the utilization of hydraulic power.

The hydrovolve, as shown in the drawing, has two sets of buckets, spaced apart by a narrow channel and so arranged that the overflow of the inner set of buckets will pour down the channel, filling the outer set of buckets. This arrangement results in half of the rim being loaded so as to impart to the wheel a high starting torque. After the wheel has once commenced its revolution, the amount of impact water can be so increased as to fill the buckets nearly up to the outer edge, when the surplus water instead of being lost always flows inward. The capacity is thus far greater than with overshot wheels, where the buckets should best be filled only to one-third of their capacity lest the water be lost too early.

The operation of the hydrovolve is as follows: First, the live force of the water is projected against the curved inner surfaces of the buckets, the water being deviated downward, and the detrimental back impetus being avoided as in the Pelton wheel. The impact obviously decreases as the peripheral speed augments. The second action is due to the action of gravity, which produces an accelerated motion of the buckets, and to the passage of the water through the overflow channels. There is further a considerable reaction caused by the water leaving the inner bucket over the outer buckets. As the water on leaving the wheel must have given off the whole of its speed, issuing in a direction diametrically opposite to the inflow, all its capacity of work has been absorbed by the wheel. It should be mentioned in this connection that with ordinary water wheels and turbines the foaming water that issues gives evidence of the amount of energy still contained in the outflowing water, while with the hydrovolve, the lower water level in front of the wheel remains practically quiet.

Small hydrovolves (50 centimeters in diameter and 30 centimeters in width) may be connected to the water mains so as to serve for driving sewing machines, ventilating fans, and the like. In the design of the hydrovolve the well-known hydraulic formulæ have to be used. It is claimed that upward of 90 per cent efficiency is derived from the theoretical force as calculated from the diameter of the wheel (H) and the amount of water per second (q), being equal to qH, while a further improvement of the efficiency is derived from the impulse due to the speed of the water which is allowed to act fully.

A novel application of this hydrovolve has been made by its inventor in the design of a locomotive propelled by the impact of flowing water. The hydrolocomotive consists mainly of three parts arranged on a truck; first the syphon, which has connection with a water channel that runs alongside the track; second, one or two hydrovolves; and third, the intermediate gearing, insuring a suitable utilization of the available motive force. A small experimental model which has been used by Prof. Kirchbach on a circular track for making practical measurements is illustrated herewith. This small engine has a weight of 30 kilogrammes (66 pounds), the ratio of the chains and sprocket wheels being so designed that the driving wheels have to perform six revolutions while the water wheel makes one revolution. The work in starting is thus 30 kilogrammes × 6 = 180 kilogrammes (396 pounds), which is done also on a gradient of 1 per cent; the engine may also carry a load of 15 kilogrammes. The output of the syphon is in the present case 2 kilogrammes (4½ pounds) of water per second, the total head from the upper level in the channel to the lowest point of the hydrovolve being 0.65 meter (26 inches). The maximum speed this small engine would be susceptible of on a strictly horizontal and straight track, would be 24 kilometers per hour, but friction and other resistances would have to be ascertained by experiment.

One type of syphon used by Prof. Kirchbach comprises two falling tubes, which feed two hydrovolves on the locomotive, insuring a steadier action.

The syphons each contain two openings for forward and backward running respectively, which are provided with accurately fitting gates. The latter may be opened or closed to any desired extent for starting and stopping and for varying the speed of the device.