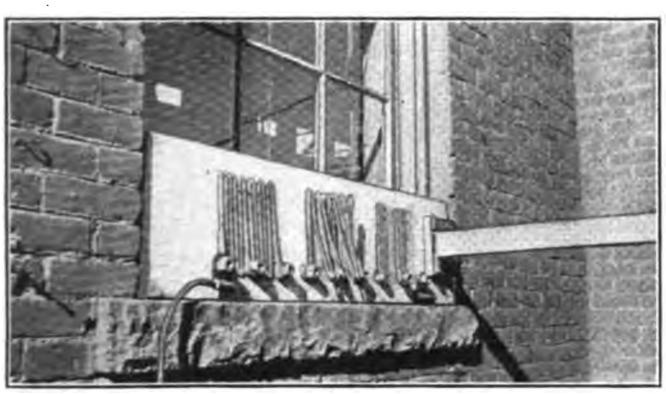
controller fingers supported on brass blocks which in turn are mounted on a block of wood. The brass blocks form the terminals of a loop from the resistor circuit of the control system. Brass stops are mounted as shown to permit adjustment of the spring tension by means of the set screws. The contact fingers are bridged by means of a brass, wedge-shaped contact block mounted on the end of a wooden rod which is retracted whenever the step is down.

The contactor is inclosed in a wooden box, 8 in. long and 7 in. wide, lined with asbestos board. This is surrounded by another box 20 in. long, 9½ in. wide, 5½ in. deep, with cover, in one end of which is the guide for the step rod.

Reclaiming Warped Resistance Grids

By W. H. McAloney
Superintendent of Rolling Stock Denver (Col.) Tramway

Many resistance grids which are broken or badly warped can be reclaimed to make savings which represent quite a considerable proportion of the cost of new grids. On our system the broken grids are reclaimed by welding, which is a rather simple process. We have also devised a scheme for reclaiming warped grids by heating them with current and holding them in proper position while they cool.



SCHEME FOR HOLDING GRIDS IN SHAPE WHILE COOLING

The rig fixed up for doing this work is shown in the accompanying illustration. A piece of ½-in. transite board, 13 in. wide and 48 in. long, reinforced on the back with a ¼-in. iron plate, is equipped with ¾-in. bolts properly spaced so that three grids can be bolted on the board at one time. The proper spacing between adjacent segments of the grids is maintained by inserting No. 8-32 machine screws as spacers. These project through the transite and into a ½-in. fiber strip on the back, which is used in order to make the threads hold.

An arm made of ½-in. x 3-in. transite, 36 in. long, is hinged at one end of the board and clamped down at the other, thereby holding the grids firmly against the board. Electrical connection is made by means of copper connecting strips on the back of the board. A current of about 250 amp. is maintained for approximately thirty seconds through the three grids in series. This brings the grids to a red heat, and as they are held firmly in position while they cool off they remain permanently in a plane.

In the illustration, the middle grid is warped, typical of the condition before reclaiming, while the one at the left shows the result of this reclaiming process. The cost of doing this work, including energy and labor, amounts to only 3 or 4 cents, as against a present net cost of 14 cents to 28 cents for a new grid, depending on the size.

Developments in Electrical Apparatus During 1917

Development Work Has Suffered Owing to Congestion of Orders for Standard Apparatus

The Westinghouse Electric & Manufacturing Company has prepared a comprehensive review of the manufacturing and engineering situation in this field during the last year. From this review the following paragraphs have been abstracted.

Power Generation and Distribution

The demand for underfeed stokers has been greater than was anticipated, most of the stokers for new plants being for use with relatively large boiler units. The 1200-hp. to 1400-hp. sizes are popular. In a plant at Windsor, W. Va., which will be described in a later issue of the Electric Railway Journal, stokers of this type have been installed to evaporate 100,000 lb. of water each per hour from 100 deg. feed-water temperature to steam at 250 lb. gage pressure, superheated to 250 deg. For two hours these stokers can cause an evaporation of 120,000 lb. per hour. The company finds a demand for the Roney stokers which is still ahead of available production. Most of these, however, are for small industrial plants.

In generating equipment the most notable feature has been the increasing use of hydroelectric power, stimulated by the high cost of coal. During the year the Montana Power Company has installed four 12,000-kva. vertical units at Holter, Mont., very largely to supply power for the Chicago, Milwaukee & St. Paul electrification. The high cost of materials, labor, etc., has also stimulated the use of synchronous condensers for power factor correction and voltage regulation. This it has done because the installation of such apparatus saves an increase in transmission line copper, or allows additional load to be taken on a given line.

The outstanding feature of the switchboard business has been the continued purchase of switch gear of great initial and ultimate capacity. A number of 150,000-volt outdoor oil circuit breakers of rupturing capacity far in advance of anything heretofore within the limits of high-voltage breakers have been completed. These breakers have round instead of elliptical tanks, domed instead of almost flat tops, and are of rolled steel construction.

Among other developments worthy of mention are the frame-mounted, indoor and outdoor high-powered steel tub 73,000-volt breaker, the combination 37,500-volt and 132,000-volt outdoor single-pole disconnecting switches and choke coils all on a common base, and the 66,000-volt post-type bus supports and disconnecting switches. There has also been developed a very compact drum type of circuit breaker controller. A number of outdoor switch houses have been installed to control circuits up to 6600 and 11,000 volts, a considerable increase in voltage over previous practice. The Westinghouse Company has also developed a control equipment for automatic rotary converter substations.

For the protection of apparatus on railway cars further developments have been made in the use of condensers by surrounding them with molded insulating cases impervious to moisture. The capacity has been increased to 1 microfarad in all forms of arresters (for pole mounting as well as car mounting) giving a static discharge capacity said to be sufficient to take care of the worst conditions found in practice.

During the year the company has added to its line of motors a new type, No. 577, having a rating of 200 hp. at 600 volts. This motor is especially suited for heavy subway service and is a striking contrast to the "Wee" motor. The H.S. and H.S.D. types of control have been combined into a one-piece outfit for economy of space and simplicity of wiring and mounting.

Regeneration has been extended to ordinary interurban applications, especially in locomotive service, and it is expected that this development will rapidly expand.

STEAM RAILROAD ELECTRIFICATION

The past year has seen considerable detail development and improvement in apparatus pertaining to electrification of steam railroads. The company has developed a very powerful split-phase locomotive which weighs 250 tons complete, has a horsepower capacity of 4800 and a maximum tractive effort of 130,000 lb., all concentrated in one single cab unit. The locomotive contains a synchronous phase converter by means of which 100 per cent power factor can be obtained. This eliminates some of the line losses encountered with the induction type of phase converters.

The high-voltage direct-current system has also received attention and a high-powered passenger locomotive was designed. This will be rated at 4000 hp. and the starting tractive effort will be 112,000 lb. The total weight will be 266 tons. This engine will also be a single cab unit.

Cooling Water for Power Plant Purposes*

New Type of Adjustable Spray Head—Nozzles Should Be Kept as Low as Possible—Efficiency Increases with Increase in Pressure and Decrease in Capacity

EXPERIMENTS to ascertain the conditions governing the cooling of water by means of spray ponds, involving the efficiency of the cooling process under varying conditions of pressure at the spray nozzles, temperature of water to be cooled, power applied to the pump, and height of sprays above the pond, have been conducted by the department of engineering of The Johns Hopkins University. The pond used was 35 ft. in diameter and 4 ft. deep and the water was ordinarily sprayed through one spray head, or nozzle. A motor-driven centrifugal pump with 4-in. suction and discharge was used to send the water through the condenser tube to the spray head. The pressure of the spray head was in all cases measured by means of a mercury column connected to the entrance of the spraying device. Wind velocity was measured on a standard anemometer and the humidity by means of a wet-and-dry-bulb sling psychrometer. The amount of water circulated was measured over a 10-in. weir, fitted with a micrometer hook gage. About 600 tests were made.

The adjustable spray head used in most of the tests consisted of a cast-iron supporting base containing the water-entry opening, and carrying a 3¼-in. outside diameter bronze tube in which was cut a spiral opening of coarse pitch. This opening was cut with a tool placed at an angle of about 60 deg., with the axis of the tube so that the water was thrown up at this angle. The spiral tube was held between the base and a cap which fitted the top by means of a central bronze stem. This passed down to a close clearance bushing in the base. The stem was movable and operated through a bell-crank and an extended vertical arm, giving accurate control of the position of the stem. The result of the motion was to either increase or decrease the fineness of the film of water as it left the spray head. When the head was in operation, the water was discharged in a continuous sheet in a direction which inclined upward, due to the angle of the spiral opening. As the water film spread, it became thinner on account of its increase in diameter until a point was reached where the surface tension was overcome, and the sheet of water broke into a uniformly fine spray, a mist or a large number of small drops, depending upon the size of opening to which the spray had been adjusted. This principle of spraying a liquid as a result of the spreading of a film of water until it breaks into mists, or spray, or fine drops, is particularly applicable to low-pressure work. The pressures used in the experiments described are relatively low, being in general from 5 in. to 8 in. of mercury.

It was desired to ascertain, among other things, the effect of placing a wire fly-screen cylinder about the spray head, and many of the tests were so made. Under some conditions this screen seemed to improve the efficiency, but in general it was not found to be necessary.

The efficiency of a cooling pond or tower may be expressed as a ratio between the cooling actually produced and that which would have resulted from cooling the water down to the dew-point or wet-bulb temperature. A perfect spray cooling device would be one capable of subdividing the water so that evaporation would take place at the dew-point and to an extent such as to lower the pressure of the remaining liquid spray to that temperature.

Experiments were made at three initial temperatures, namely, 98, 105 and 125 deg. Fahr., adjusting the spray head to suit the weather conditions. The results show that the efficiency increases with an increase in pressure, and with a decrease in capacity, and that the increase in efficiency is slightly less for temperatures of 105 and 125 deg. than for a temperature of 98 deg.

Tests made to obtain the efficiencies with water falling upon the bare cement bottom of the pond as compared with those resulting when the pond contained its normal amount of water were rather surprising in their results, showing efficiencies of from 15 to 20 per cent less for the former. If a bare pond would serve as well as one containing water, the construction of the pond could be cheapened since less weight would come upon the foundation and less material would be required for the pond as a whole.

The average evaporation may probably be taken at about 2¼ per cent. This will, of course, vary with

*Abstract of paper delivered before annual meeting of American Society of Mechanical Engineers, by Carl C. Thomas.