A 7,300-Kva. Automatic Hydro Station—II

Hydro-Electric Features of the Development—Design Details of Dam, Gates, Penstocks and Intakes—Cost of Station and Hydro-Electric Works in Graphic Form

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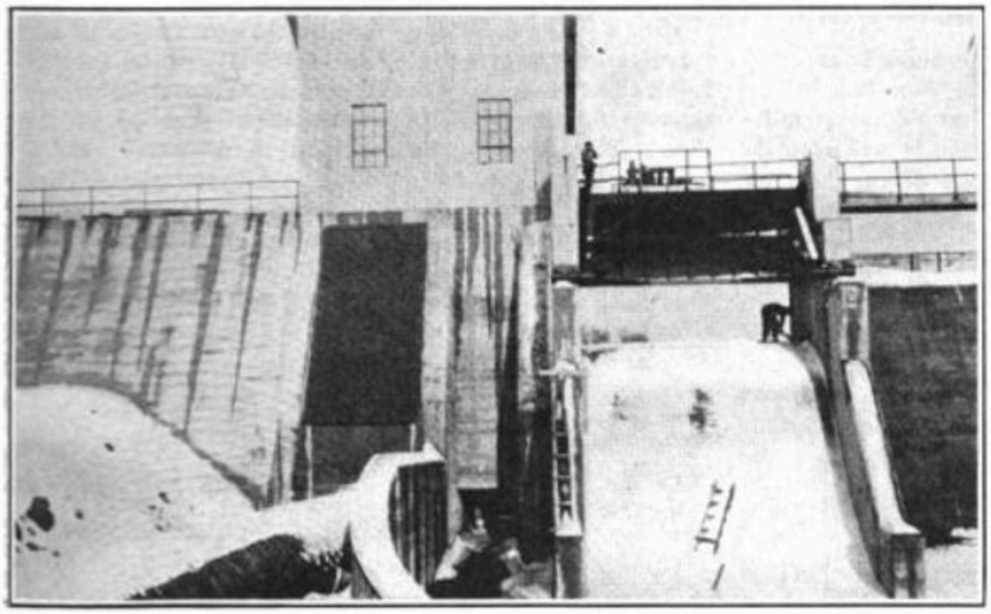
IN THE ELECTRICAL WORLD for June 28 the electrical features of the largest automatic hydro-electric station were described. Many interesting features were associated with the more strictly hydraulic part of the installation and the engineering analysis required to secure an economic and practicable installation.

Sprite Creek has its beginning at the outlet of Canada Lake and extends a distance of about 9 miles west to its confluence with East Canada Creek. In this distance the total drop of the stream is 625 ft. and this development conserves 410 ft. of fall at the upper end of the stream. The total present available storage capacity of Canada Lake and the three tributary lakes is 550,000,000 cu.ft., affording 7,800,000 kw.-hr. of storage in the new development and the energy for the Utica Gas & Electric plant at Dolgeville, the Inghams plant and the proposed Beardslee Falls development.

The principal features of the development consist of a new concrete reservoir dam 1,600 ft. below the old reservoir dam at Stewart Landing. The old structure was a timber-crib rock-filled dam which has been removed in order to afford an open waterway to the new structure. There is a pipe line, the first part of which is a wooden-stave structure and the lower end a steel-penstock line, and a surge tank is placed at the end of the wooden-stave line and the beginning of the steel line. The power house contains a single generating unit having a capacity of 6,000 hp. and a speed of 600 r.p.m. The natural creek bed was excavated for a distance of 700 ft. below the plant in order to afford a better tailrace discharge and obtain additional head. A wooden-pole transmission line 7.3 miles in length extends from the Sprite Creek power house to the Inghams station. It is a single-circuit line of No. 2 copper wire and is operated at 66,000 volts.



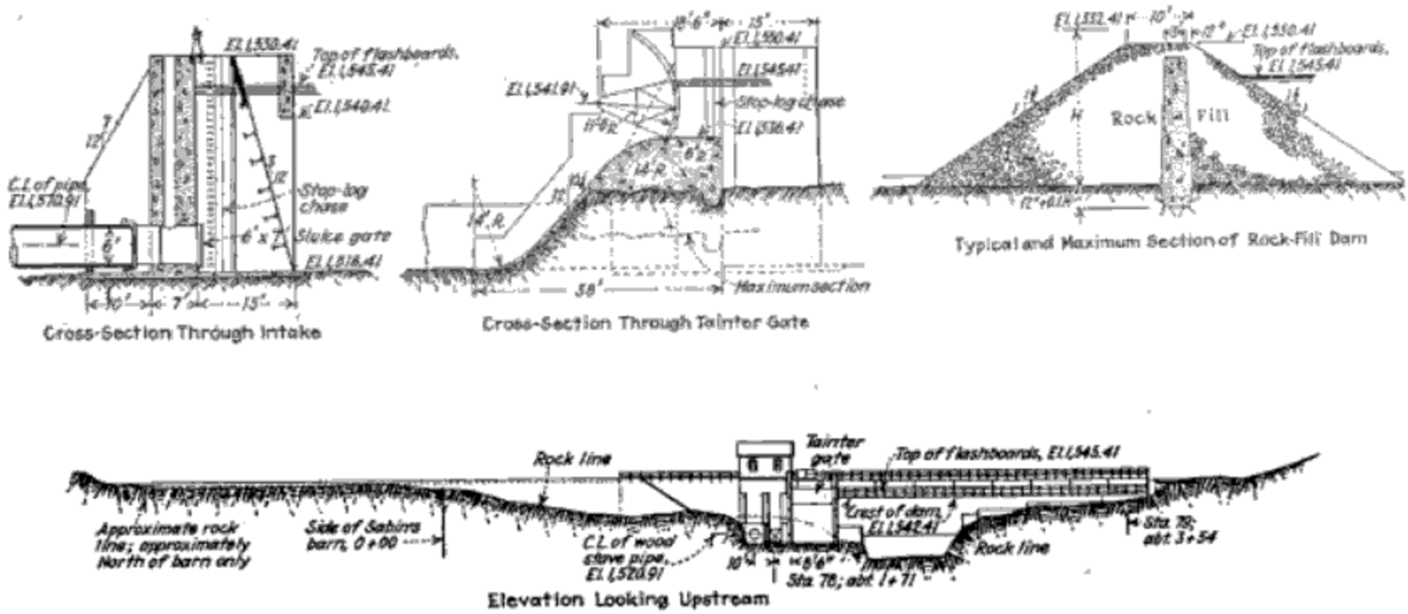
THE SPRITE CREEK DAM

This dam is 580 ft. long and 36 ft. high and contains an intake for a 7-ft. wooden-stave pipe line, a 6-ft. x 7-ft. sluice gate and a 9-ft. x 20-ft. Taintor gate. It has spillway 159 ft. long.

STEEL-PIPE LINE AND THE SURGE TANK, WHICH IS MOUNTED ON A TOWER

The length of the concrete dam is 580 ft., of which 270 ft. consists of a concrete core wall supported by a rock fill on the up and down stream sides. There is an overflow spillway section of 159 ft. on which provision has been made for 3 ft. of flashboards, and a solid rock foundation was available for the entire length of the dam.

In order to be assured of the maximum benefits of reservoir storage in Canada Lake, the discharge capacity of the reservoir dam had to be made such that any sudden increase in water supply from summer rains will not result in damage to private property around the lake and still will permit full utilization of storage capacity. The operation of the flashboards will control the variation during the spring flood conditions. In addition to this feature a 9-ft. x 20-ft. Taintor gate is installed which will take care of all normal fluctuations in water level during the summer season. It is supplemented by a sluice gate 6 ft. x 7 ft. whose center is placed at 24.5 ft. below the reservoir elevation. The intake for the wooden-stave pipe line is at the same elevation. A vent pipe of ample size has been placed immediately back of the head gate for the pipe line, and the sluicegate is so placed as to assist in clearing



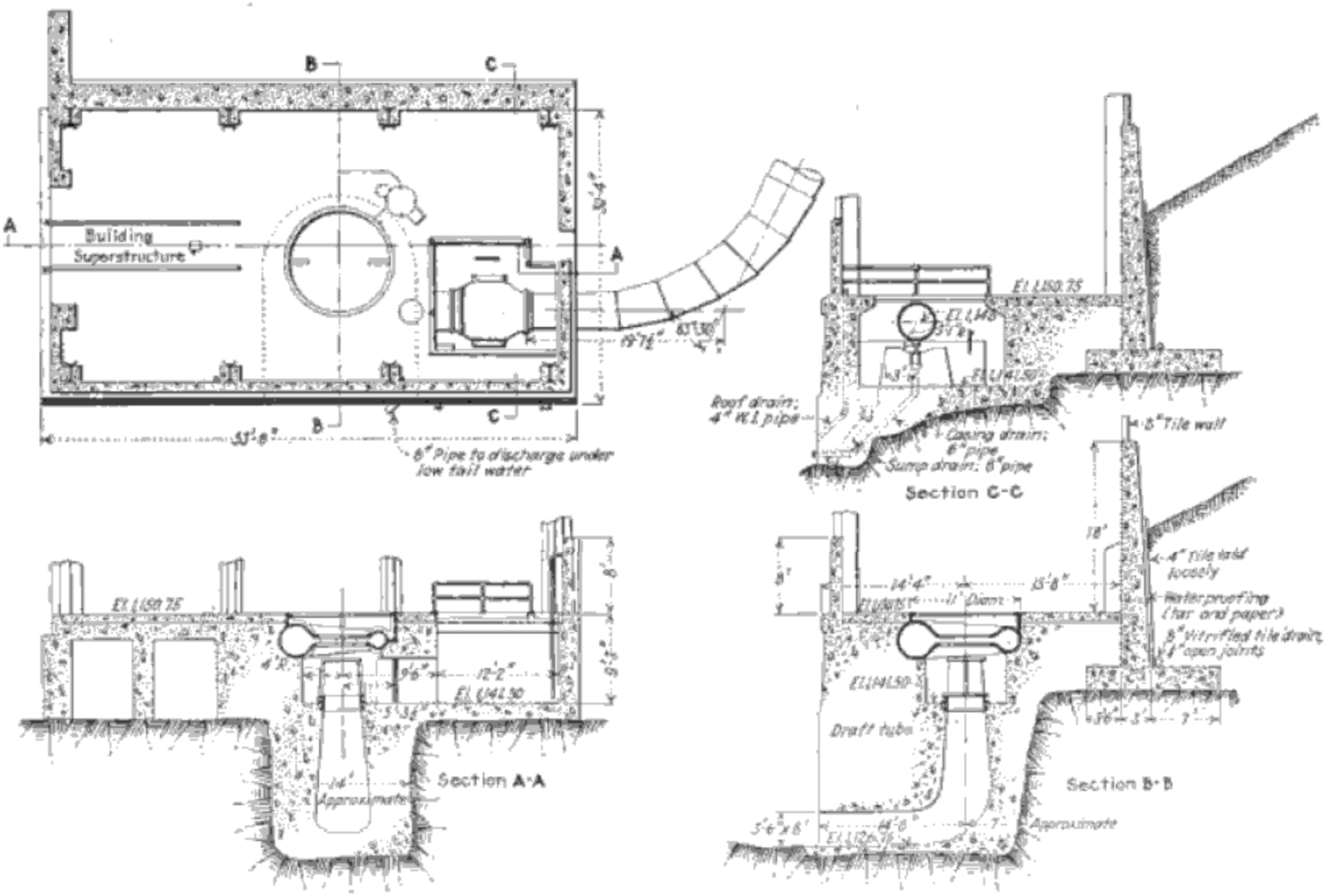
LAYOUT AND SECTIONS OF DAM, SHOWING CONSTRUCTION DETAILS OF THE WORKS

out sediment in front of the intake. The illustrations show the general design of the dam and of the rock-bar protection to the intake.

The dam has been designed so as to make it possible to raise the lake level at some future time should the value of additional reservoir capacity at that time indicate the economy of such a procedure. It will also be possible to gain additional storage by a lower draft on the reservoir after certain improvements have been made in the outlet channel of the lake.

Construction work was started on the dam April, 1923, and was completed in December, 1923. It contains about 4,000 cu.yd. of concrete and has a maximum height of 36 ft.

The wooden-stave pipe line is 15,980 ft. long and consists of 4,864 ft. of 72-in., 8,499 ft. of 66-in. and 2,617 ft. of 60-in. pipe. The material consists of 2½-in. Oregon fir staves, forty to the circumference of the pipe. The steel bands are ⅝-in. in diameter at the upper end and ¾ in. at the lower end of the pipe. They have a rolled thread and are spaced 8 in. for the 72-in. pipe, with varying spacings down to 1.6 in. on the lower end of the 66-in. pipe and 2.1 in. on the lower end of the 60-in. pipe. The staves were not creosoted. The



PLAN OF AUTOMATIC HYDRO-ELECTRIC POWER HOUSE, SHOWING DETAILS OF EQUIPMENT INSTALLATION pipe is supported on creosoted cradles spaced on 10-ft. centers which rest upon 6-in. x 8-in. creosoted mudsills. Considerable rock excavation was required for the pipe line at the upper end, and for one-half of the length excavation consisted of large boulders and some sidehill excavation. The remainder of the pipe-line excavation was of normal character and not especially difficult. Three steam shovels were used for these operations, and the excavation was made somewhat larger than was absolutely necessary in order to provide continuing downward gradient from the dam to the power house. This is one of the important features of the development not usually incorporated in a pipe line of this length. It should improve the operating characteristics and decrease the chances of accident from collapse of the wooden-pipe line. There are two road crossings for which bridges were required, and at these points the grade of the pipe was placed below the natural ground surface. Work was started April, 1923, and completed in December.

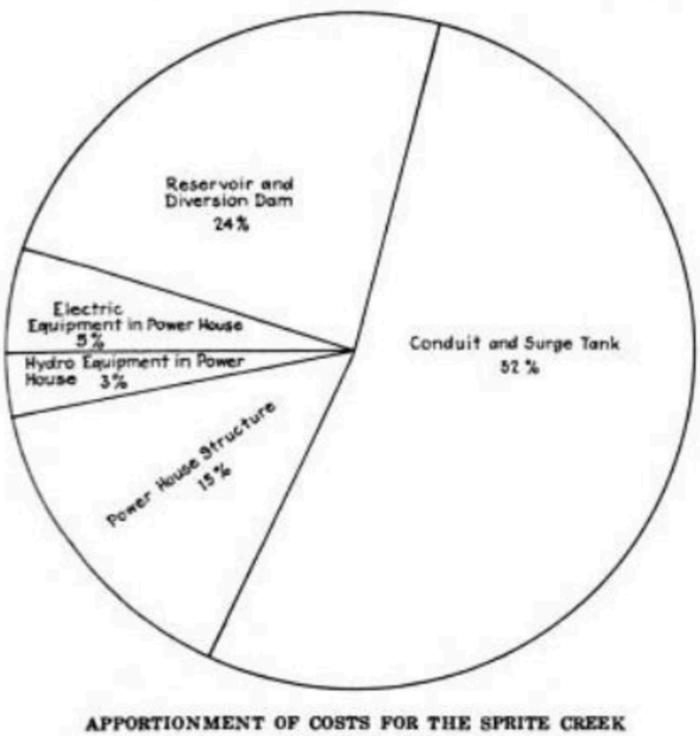
The wooden-stave pipe line will not be buried at any point of its length, and therefore will be better preserved and open to inspection. Experience has shown that there is no danger of water freezing in a wooden-pipe line, although this is not true of a steel-pipe line. A 100-ft. strip is to be cleared on each side of the pipe to prevent falling trees from damaging the line, and special precautions are to be taken to cut the brush close to the ground in order to prevent damage from ground fires.

The gradient of the pipe is fairly uniform from the dam to the surge tank except for the first 3,400 ft., which is at a gradient only sufficient to furnish the required velocity. At the end of this distance an air-relief valve is installed to prevent accidental collapse.

Steel Pipe Line

The steel-penstock line is 2,300 ft. in length. It has a diameter of 60 in. for 2,250 ft. and a thickness of material varying from $\frac{3}{8}$ in. to $\frac{11}{16}$ in. The lower bend of the pipe line converges to 42 in. in diameter, which is the diameter at the entrance to the turbine. A

90-FT. X 12-FT., 6-IN. DIAMETER SURGE TANK
Mounted on a 130-ft. steel tower, the total height is 220 ft.



APPORTIONMENT OF COSTS FOR THE SPRITE CREEK DEVELOPMENT

Wellman-Seaver-Morgan valve is placed at the entrance to the turbine and is mechanically operated. Advantage has been taken of the difference in diameters at the lower end of the penstock to maintain a continuous record of the amount of water used. The hydraulic characteristics of this convergence will be calibrated, and an integrated record of the calibrated discharge will be obtained automatically. One expansion joint is provided at the middle point of the steel pipe and the pipe is securely anchored at a point where it joins the wooden-stave pipe line and at three bends in the alignment. The steel line is to be buried throughout its entire length in order to prevent the water from freezing.

The cost of the wooden-stave pipe line per foot at the point of junction with the steel was about the same as the cost of the steel. It would have been possible to have extended the wooden-stave pipe line further, except that this point was the logical location for the surge tank and therefore the beginning of the steel construction.

Differential Surge Tank

The installation of a surge tank was thought preferable to a relief valve. The decrease in cost of the wooden-stave pipe line by virtue of the increased pressure rise that would have had to be provided with a relief valve was sufficient to pay for the surge tank. Foundations for the surge tank were not of a character or elevation that could have been desired and consisted of a very fine sand of unknown depth. A 90-ft. tank with a diameter of 12 ft. 6 in. and an inside riser of 3 ft. 6 in. was determined upon, and as the natural ground elevation was 190 ft. below the forebay elevation, it was necessary to support the tank on a tower 130 ft. high. The base of the tower was made of a concrete mat 3 ft. in thickness and with outside dimensions of 42 ft. x 42 ft. The bottom of this foundation is 15 ft. below the ground surface, and a compact backfill was placed on the mat.

The surge tank is in a very exposed position and in a country where the temperature is very low at times. It was therefore necessary to lag the tank and to install a heating system for use during very cold weather. The lagging consists of a double thickness of 1-in. wooden sheeting separated by "Neptune" hair felt. The heating system consists of two closed steam lines with a condensate return. Electrical thermometers are to be installed by means of which the actual temperature of the water will be known.

Power House and Generating Equipment

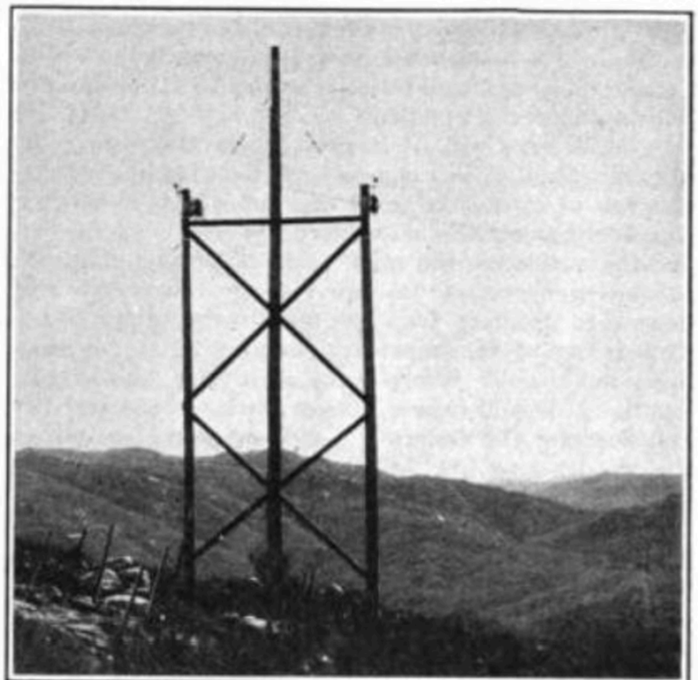
The power house is a structure with inside dimensions of 26 ft. x 48 ft., with a clear inside height of 37 ft. The substructure is reinforced concrete on a solid rock foundation. The superstructure is a steel framework and flat-steel roof trusses. The wall structure consists of a single thickness of hollow tile having dimensions of 5 in. x 8 in. x 12 in. The outside and inside faces of the brick are combed with a vertical fluting. This type of tile is a little more expensive to place than ordinary brick, yet the placing of the single thickness of tile provides a finished inside and exterior surface. There are three lines of cored-out spaces in each tile which give it a heat-insulation characteristic strongly recommending its use for hydroelectric power houses. The roof consists of hollow gypsum tile on which a Barrett roofing is placed. The outdoor substation structure is galvanized steel and joins the west end of the power house.

Power House Equipment

The generating equipment consists of one Worthington turbine rated at 6,000 hp. at 370 ft. net operating head operating at 600 r.p.m. The governor is also made by the Worthington company and is equipped with the automatic devices above mentioned. A General Electric generator having a capacity of 7,300 kva. and an operating voltage of 6,000 is placed on a cast-iron distance piece which in turn rests upon the cast-iron scroll case of the turbine. The turbine, distance piece and generator therefore make one self-contained and metal-connected unit.

The power house is equipped with a 30-ton electrical crane. A heating system is installed for use during periods when the unit is not running. The heat-insulation characteristics of the wall and roof structure are such that, together with the small inside dimensions, the heat from the operating unit will easily keep the station at a comfortable temperature. Three 2,500-kva. transformers are installed in the outdoor structure for raising the voltage to 66,000, and a track arrangement has been provided for taking the transformers into the station in case they have to be dismantled.

The plant was placed in operation on February 18, 1924. The annual output of an average year will be 15,000,000 kw.-hr. The design and construction drawings were prepared by Vielé, Blackwell & Buck, New York City. The wooden-stave pipe was built by the American Wood Pipe Company of Tacoma, Wash.; the surge tank by the Chicago Bridge & Iron Works; the steel penstock by the M. H. Treadwell Company, Inc. The major portion of the construction was done by the company's own forces.



THREE-POLE WOODEN STRUCTURE USED FOR SUPPORTING 4,437-FT. SPAN

Wooden Pole Towers for Long-Span Construction

Details of the Installation of Two Spans More Than 3,000 Ft. Long—How the Installation Was Made—Steel Wires Used

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WHAT are believed to be the longest spans supported by wooden-pole structures were recently installed by the San Diego Consolidated Gas & Electric Company near Alpine, Cal., in connection with the construction of an 11,000-volt transmission line. The longest of the two spans is 4,437 ft., while the other is

BILL OF MATERIAL FOR WOODEN-POLE SPANS FROM 2,500 FT. TO 3,500 FT. LONG

Item	Description	Quantity
1	Class A cedar poles, per drawing	3
7	⅜-in. x 5-in. galvanized lag screws	5
13	Spring clevises	3
14	Suspension insulator units	75
19	Ohio Brass Company suspension wire clamp No. 10755	3
23	⅜-in. galvanized-steel strand ground wire	95 ft.
24	1½-in. galvanized fence staples	16
25	4-in. x 30-in. No. 26 galvanized-iron pole collars	18
26	Ground wire molding	65 ft.
27	Molding straps	18
28	3-in. No. 13 galvanized screws	36
29	Grounding pipe	1
34	Extra-galvanized high-strength steel strand	785 ft.
35	½-in. x 3½-in. galvanized lag screws	34
36	⅜-in. extra-galvanized 5,000-lb. standard steel strand	450 ft.
37	Three-bolt guy clamps	105
38	5½-in. brown porcelain strain insulators	14
39	Cement anchor blocks	14
40	¾-in. x 8-ft. anchor rods with ⅜-in. galvanized thimbles	14
41	Anchor boxes	14
44A	Special multiple strain yokes	3
46A	2-in. x 8-in. x 22-ft. O. P. rough boards	1
46B	2-in. x 8-in. x 20-ft. O. P. rough boards	4
48	¾-in. x 14-in. galvanized machine bolts, two round washers and one nut	8
49	¾-in. x 16-in. galvanized machine bolts, as in item 48	2
50	¾-in x 18-in. galvanized machine bolts, as in item 48	10
51	¾-in. x 20-in. galvanized machine bolts, as in item 48, but with four washers	6
61	⅜-in. galvanized thimble	3
67	⅝-in. x 10-in. machine bolt with round washer and nut	3
S1	Pin-type porcelain insulator	3
S2	No. 3020 Hubbard channel pin	3