The first step in splicing the 63-conductor submarine cable was to strip back the outer protective covering of armour wire, jute and tape. Signalmen shown splicing individual conductors and grouping the same. Each group of the conductors was taped

Splicing a Submarine Cable

Chicago Rapid Transit utilizes special clamp in splicing damaged submarine cable, carrying interlocking circuits under the Chicago river at a drawbridge

APPROXIMATELY half-way between Van Buren street and Jackson boulevard in Chicago, the elevated system of the Chicago Rapid Transit Company crosses the Chicago river on a four-track lift type drawbridge. Interlocking facilities, including signals, switches, crossovers and derails, on the east and west sides of this bridge, are controlled from Market Street interlocking, an electro-pneumatic plant, which is located at the east end of the bridge. The control and power circuits for the interlocking facilities on the west side of the bridge extend in a submarine cable from a terminal box at the tower, down through a steel conduit to the river level, in a short ditch, under the river on the north side of the bridge, directly to the west shore of the river, in a short ditch, and into a similar terminal box on one of the bridge legs.

Construction of Submarine Cable

The submarine cable is a 355-ft., 63-conductor Kerite cable, approximately 3½ in. in diameter, placed in service about a year ago to replace a 19-conductor and a 27-conductor submarine cable. The 63-conductor submarine cable contains 57 insulated No. 12 stranded copper conductors and 6 insulated No. 6 stranded copper conductors. The No. 12 conductors are used for switch and signal control circuits, while two of the No. 6 conductors are used for a 110-volt, a-c. power circuit for feeding track circuits. Two more of the No. 6 conductors are used for a 14-volt, d-c. power circuit, used in connection with the operation of the electro-pneumatic switch movements, while two more of the No. 6 conductors are used for a 550-volt, a-c. power circuit.

The center core of the cable consists of 7 No. 12 insulated conductors. The next layer consists of 6 No. 6 conductors and 2 No. 12 conductors. This is followed by a layer of 21 No. 12 conductors, and another layer of 27 No. 12 conductors. Each layer of conductors is separated by a wrapping of insulating tape. The outer protective covering of the cable consists of a mummy finish, steel wire armour, two layers of jute and one layer of tape.

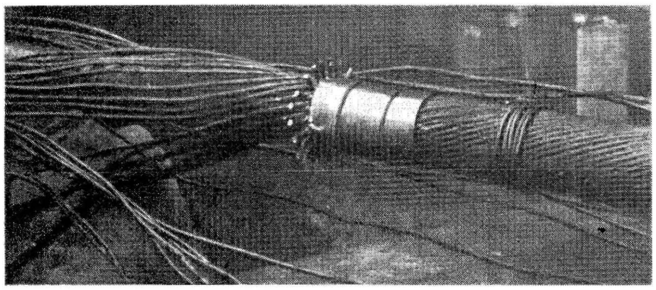
Cable Damaged by Steamship

At 12:45 a.m. on September 1, a northbound sand and gravel steamship, said to have been overloaded, damaged the submarine cable at a distance of approximately 9 ft. out in the channel. The steamship was headed towards the west shore of the river as it passed the "L" bridge, and the tug that was doing the towing was on the east side of the channel. In order to straighten the steamship on the course, it has been stated that the captain of the ship ordered the engines turned on in reverse. As the result, the ship crashed against a protective piling abutment, adjacent to the "L" bridge, breaking several piles. The submarine cable was cut and crushed from 3½ in. diameter to 1¼ in. thick by 5 in. wide. As a result, the interlocking signals and switches on the west side failed.

Immediate Action Taken

Following the accident, repair and emergency crews were called to the scene, the first arriving at 2:30 a.m. Thomas Nolty, acting interlocking foreman, arrived at 3:00 a.m. A 19-conductor and a 27-conductor submarine cable, which had been in service for 12 years, up until last year, when replaced by the present cable, was tested to determine which conductors could be used. Temporary parkway cables were used on each side of the river between the ends of the old submarine cables and cases on top of the bridge structure at each end. A 5:00 a.m., all interlocking facilities, including switches, crossovers and signals, on the west side of the bridge were back in normal operation, 4 hours and 15 minutes after the failure. In the meantime, trains were directed across the bridge by hand and lamp signals.

After the signals and switches, on the west side had been restored to service, the control circuits in the old submarine cables were meggered to determine whether temporary service could be maintained safely for a short period. As some of the circuits meggered poorly, a temporary 19-conductor parkway cable was laid across the river, and cut into service by 12:30 p.m. on September 1.

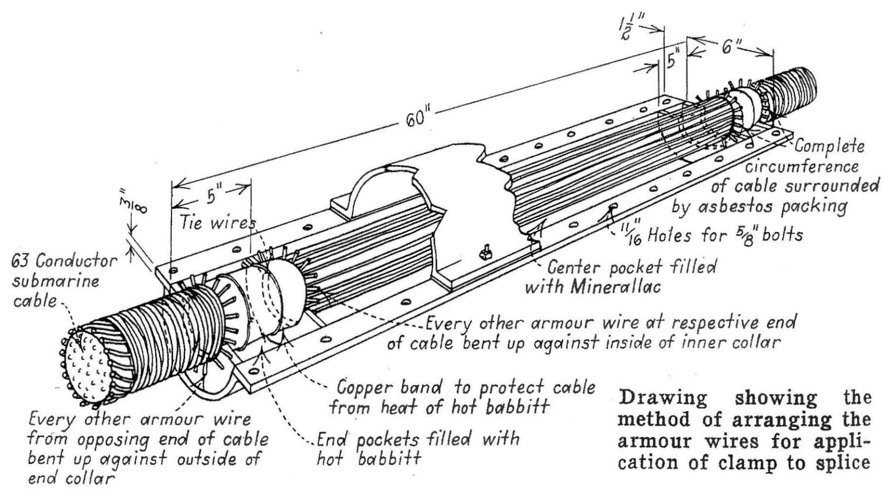


All of the conductors spliced, the next step was to arrange the armour wires for applying the clamp. Note the copper strip around the cable for protection against the heat of the hot babbitt

Splicing Cable

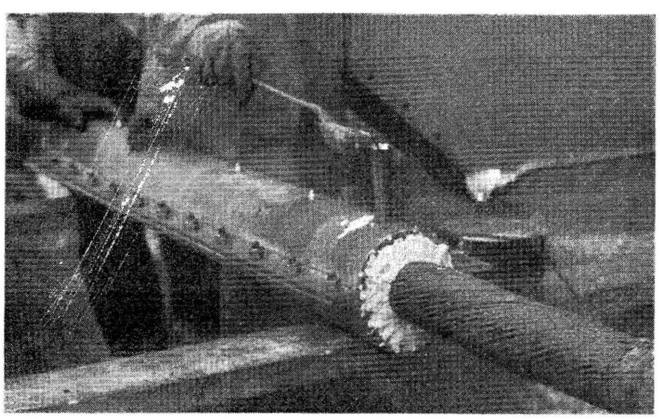
In order to splice the cut and crushed submarine cable, it was removed from the river, which required two days. The cable was sawed off at the terminal box at Market Street tower on the east side of the bridge, pulled down through the steel conduit, and removed from the short ditch on that side of the river. The cable was removed from the short ditch on the west shore of the river, and by means of blocks and tackle, the cable was pulled from the river until the crushed and cut portion was in a handy location where it could be worked on. A wooden platform was constructed to support the cable, and the river side portion of the cable was supported by blocks and tackle, attached to the bridge structure.

The total splice required taking up approximately 10 ft. of existing slack. A section of about 2½ ft., including the crushed and cut portion, was sawed out of the cable, leaving two ends to be spliced. Each end of the cable was stripped back approximately 9 ft., including the mummy finish, steel armor wire, jute and tape. After this was done, each one of the conductors was carefully spliced, soldered, taped with rubber and friction tape, and given a coat of splicing compound. Every splice was alternated, taking extreme care so as to not have any conductors longer than others. As each layer of the cable was remade, as in the original cable, it was taped. When all the conductors had been spliced, that portion of the cable, when wrapped with friction tape, was no larger in diameter than any similar section throughout the entire cable. The total distance covered by the alternated splice is approximately 3 ft. The next step was rewinding the two layers of jute, which took a short time.



Drawing showing the method of arranging the armour wires for application of clamp to splice

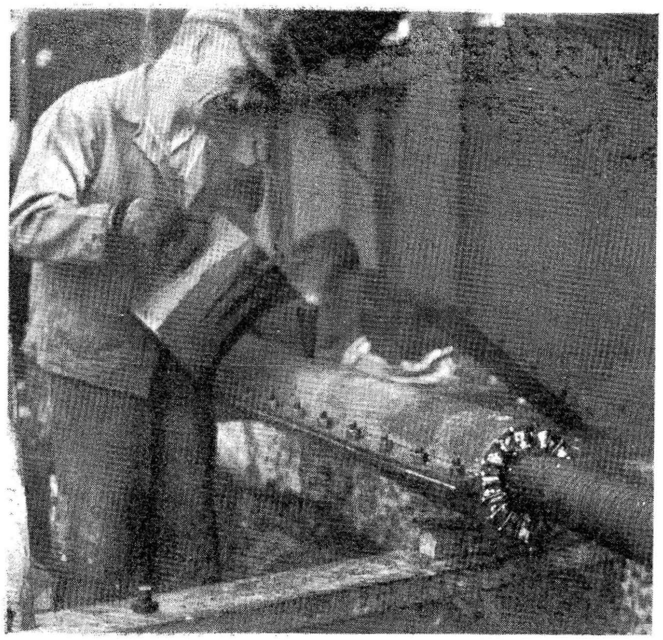
Having spliced the insulated conductors of the cable, the next problem was, not only to cover the splice so that it would be waterproof and protected mechanically, but also to connect the outside armour wires through the splice to withstand pull on the cable equivalent to the tensile strength of the armor wires. As a means of accomplishing all of these results a special splicing clamp was made at the Wilson Avenue blacksmith shop. A piece of 6-in. steel conduit 5 ft. long, was split lengthwise into two halves. A ⅜-in. by 1½-in. steel flange was welded to each side of each piece of the conduit. At a distance of about every 5 in., an 11/16-in. hole was drilled in each of the four flanges. Four steel collars were prepared to fit the outside of the cable, and were welded in each end of both of the two halves of the clamp. Another four identical steel collars were welded on the inside of each of the halves of the clamp, one 5 in. from each end of the conduit. Therefore, when the two halves of the clamp were bolted together around the cable, three pockets were formed, one at each end of the clamp and the center cavity which included the length of the splice. The two parts of the clamp are identical except that in the top half, a ¾-in. hole was drilled at each end through to the pockets, and three ⅛-in. tapped holes and one ¾-in. tapped hole were drilled through the top to the center pocket. The small holes were fitted with Alemite fittings, while the ¾-in. hole was fitted with a bolt plug.



The clamp bolted in place, hot babbitt was poured into the end pockets through a ¾-in. hole in the top

Armour Wires

The next step in splicing the cable was to arrange the steel armour wires for fitting on the clamp. The bottom piece of the clamp was placed under the cable on the platform so as to de-



The final step in the splicing operation was filling the center pocket with hot Minerallac through a ¾-in. tapped hole in the top. The bolt plug for this hole is shown on a plank in the lower left.

termine how the armour wires should be bent and cut off. When this information was acquired, every other armour wire of each end of the cable was cut off, allowing approximately 1 in. to be bent so as to fit against the center pocket sides of the collars located 5 in. from the ends of the clamp. The bending of these wires was accomplished by temporarily bolting the clamp on the cable on each side of the splice, allowing approximately 1 in. of the cut-off wires to protrude. These were then bent up against the ends of the clamp with a hammer.

Sheet Copper Strip

At the same time, a strip of sheet copper 6 in. wide was wrapped around the cable adjacent to the bent-up wires at each end. These were placed so as when the clamp was bolted together they covered the entire cable surrounded by the two end pockets of the clamp. Every other armour wire that was not cut off was then straightened out and intermeshed with every other armour wire that was not cut off from the opposing side. With all the armour wires neatly arranged, the entire areas around the wires, that were first bent up to fit inside the center pocket, were packed with an asbestos compound and taped on the center pocket side. The clamp was then permanently set in place, and bolted together with 24 bolts, ⅝ in. in diameter, with a rubber gasket between the flanges. This left every other one of the armour wires from each end of the cable sticking out the opposing end of the clamp, these wire ends being bent up against the ends of the clamp with a hammer. The main purpose of bending the wires on the inside and outside of the clamp was to carry through and maintain the tensile strength of the cable, and to prevent any undue strain on the individual conductor splices in the clamp. The pockets at the ends of the clamp which include complete armoured cable plus every other one of the armour wires from the opposing end, were filled with melted babbitt. This babbitt was heated to a temperature which would not scorch brown paper. The pieces of copper, heretofore mentioned, were used to protect the cable from the heat of this hot babbitt metal. Before deciding to follow this method of splicing, a special heat test was conducted on a piece of short cable of the same type, the babbitt metal being heated to a blue color, which is a great deal hotter than when the same material was used in the actual splicing. Examination of the test cable showed that the heat of the hot metal had not affected the conductors or insulation of the cable.

Minerallac Used

The center pocket of the clamp was filled with hot Minerallac through the ¾-in. tapped hole with the Alemite fittings out. When filled, the three Alemite fittings and the ¾-in. plug were screwed in place, thus completing the splice of the submarine cable. The cable was placed back in the river, rejoined at the tower end, and cut back in service on September 12. The work was done by the regular signal department forces of the Chicago Rapid Transit Company, under the supervision of William Linn, construction foreman, and under the direction of Matt Van Lennep, general signal supervisor.

Collision on the Alton

ON JUNE 23, there was a head-end collision between a freight train and a passenger train on the Alton, at Wilmington, Ill. An abstract of the report of the Bureau of Safety follows:

At the point of the accident single track is in service, over which trains are operated by time-table, train orders and automatic block with a train-stop system. At Wilmington, a siding, 4,541 ft. long, parallels the main track. The north switch of the siding is 3,653 ft. north of the station. A facing-point crossover for southbound trains connects the main track and the siding. The north switch of the crossover is 958 ft. north of the station. Signals 91 and 93, governing southward movements, are located, respectively, 9,548 ft. and 2,982 ft. north of this switch.

Northbound passenger train No. 14 left Bloomington, 74.1 miles south of Wilmington at 6:10 a.m. on time. At Braidwood, 4.8 miles south of Wilmington, the crew received copies of train order No. 16, stating that train No. 14 was to wait at the crossover in the Wilmington passing track until 8:20 a.m. for train No. 103. Train No. 14 left Braidwood at 8:06 a.m., 6 min. late, arrived at Wilmington at 8:13 a.m., where the crew received copies of a clearance card, stating that the block signal was at Stop for train No. 14, and to wait at the crossover until 8:20 a.m. for freight train No. 103. Train No. 14 left Wilmington about 8:21 a.m., and about 8:22 a.m. it reached a point 540 ft. north of the crossover, on a curve, where it collided with train No. 103. Southbound freight train No. 103 left South Joliet, 14 miles north of Wilmington, at 7:15 a.m., 30 min. late. At Elwood, 6.7 miles north of Wilmington and the last open office, the crew received copies of train order No. 16, previously mentioned. This train left Elwood at 7:55 a.m., 40 min. late, stopped at Prairie Creek spur, about 2.46 miles north of Wilmington, at 8:03 a.m., left about 8:10 a.m., passed signal 91 at Approach and signal 93 at Stop-and-Proceed, and while moving at a speed estimated at 4 or 5 m.p.h. when it collided with train No. 14.

This accident was caused by the failure to obey an automatic block signal indication, failure to properly control the speed of the freight train after forestalling operation of an automatic train-stop device, and failure of an inferior train to clear time of opposing superior train and then furnish flag protection.