A. I. E. E. Holds Traction Meeting

The Papers at the Pittsburgh Meeting of March 12 Covered Substation Problems and the St. Paul Locomotive—They Were Abstracted in Last Week's Issue—The Discussion Is Abstracted in This Issue

ONE OF the best attended meetings of the American Institute of Electrical Engineers which has been held outside of New York City took place in Pittsburgh on Friday, March 12. The entire day was devoted to discussion of railway apparatus and equipment, including descriptions of the two designs of locomotive for the latest Chicago, Milwaukee & St. Paul electrification. The papers for this meeting were abstracted in the March 13 issue of this paper.

The morning was devoted to an inspection of the Westinghouse Electric & Manufacturing Company's works at East Pittsburgh, during which the visitors had opportunity to see one of the new automatic switchboards which are being built for operation in one of the Cleveland Railway's substations. The most interesting event of the morning, however, was the inspection of one of the ten St. Paul locomotives which the Westinghouse company is furnishing. After an interesting motion-picture exhibit of railway electrification, the Westinghouse company entertained the group at luncheon in the Women's Cafeteria. The afternoon session was devoted to two papers on short circuit and rotary flashing protection, and to two papers on automatic railway substations. The evening session, held after an informal evening dinner, was devoted to the discussion of the two designs of the St. Paul locomotive. Over 300 were seated at the dinner and nearly 500 attended the meetings.

> WE MUST LOOK at the subject of electrification broadly. Every heavy electrification so far installed has proved successful. No steam railroad operator who has an electrified section would consider reverting to steam. Electrical engineers must not becloud these facts in their discussion of types and details of locomotives. In the present instance, both locomotives will doubtless give satisfactory service on the St. Paul.
>
> CALVERT TOWNLEY
> President American Institute of Electrical Engineers

During the morning the board of directors held a meeting, at which, in addition to other matters considered, President Calvert Townley was authorized to appoint, after conference with W. S. Murray, a committee for the specific purpose of study and report on the super-power scheme for the Northeastern Atlantic Seaboard. It will be recalled that at a meeting of the Institute held in New York City on Feb. 20, a resolution was passed requesting the board to consider the advisability of appointing such a committee.

PROTECTION AGAINST FLASHING ANALYZED

In the discussion of the papers on "Short-Circuit Protection for Direct-Current Substations" by J. J. Linebaugh and on "Flashing of 60-Cycle Synchronous Converters and Some Suggested Remedies" by M. W. Smith at the afternoon session, F. D. Newbury made the point that a modern high-speed breaker is a greater potential danger than an ordinary breaker. Unless it clears the circuit before flashing occurs, it may cause flashing by its opening. If the circuit is not opened at all, there is less danger from flashing than if it is opened just after flashing occurs. That is, if on account of the high current there is sufficient gas generated to "short" the machine, then that "short" will continue even after the circuit is opened. Mr. Newbury also pointed out that the two papers do not agree as to the effectiveness of flash barriers as a protection against flashing. While perhaps the question is not finally answered now, it is hoped to find the answer of flash protection without the use of barriers, which form obstructions around the commutator and brush-holders. The high reluctance of the commutating pole is an improvement which will assist materially in the solution of this problem.

C. H. Jones, electrical engineer Chicago, North Shore & Milwaukee Railroad, quoted some interesting experiences with reference to flashing in its substations. From its experience, the new commutating-pole converters are apparently much more liable to flash than the older converters. Whether this is a bad effect accompanying better design in other ways, as compared with the older types of converters, or whether there is some other reason was not analyzed by Mr. Jones. He stated that he was merely presenting experience. New equipment has been installed with barriers and none of these rotaries have flashed. Sometimes the rotaries have been heard to "squeal" as though they were about to flash, but they have never done so. Two of the rotaries which had been installed without barriers flashed on occasion; since adding barriers there has been no record of a flash. The stresses imposed which have caused flashing, when flashing occurred, and "squealing," when flashing seemed imminent, have been as great as those involved in starting a four-car train in front of a substation, the train drawing 1,000 amp. per car at the start.

In closing the discussion on these papers the point was made that in order to prevent flashing by means of a high-speed breaker the circuit must be broken before one commutator bar can move from one brush to another, and this time element usually cannot exceed 0.008 sec. The General Electric Company experiments, in which a breaker was timed, included one test (which was verified by repetition) of breaking dead short circuit five times in seven seconds without any subsequent flashing. A high-speed breaker is particularly effective with a machine having high-reluctance commutating poles, and, if the development along this line is perfected, flash barriers may be done away with. A combination of a high-speed breaker, cutting in resistance, with a low-speed breaker which breaks the circuit completely somewhat later, has been used. However, the high-speed breaker upon operation, when it cuts in resistance, starts a cyclic variation on the alternating-

current side, and, if the low-speed breaker operates seven or eight cycles after this, the machine is still likely to flash due to the variations on the alternating-current side not having been damped. If, on the other hand, the low-speed breaker does not operate until seventeen or eighteen cycles, the operation is satisfactory.

AUTOMATIC SUBSTATIONS FAVORED

Much interest was evident in the discussion of "Automatic Railway Substations" by F. W. Peters, and "Automatic Substations for Heavy City Service" by R. J. Wensley. S. Q. Hayes related what seemed to him a coincidence, that only on the preceding day he had received information from Brown, Boveri & Company, that one automatic substation is now installed in Switzerland. This, however, is not automatic in the sense in which the term is used in this country, in that the station starts operation when the load approaches it, but rather that it starts and stops automatically by a clock arrangement, starting at a certain given time in the morning and stopping at a set time in the evening.

C. H. Jones stated that from the two and a half years' experience of his company the automatic substation is a success, at least in heavy interurban traction service, in fact, he feels that the automatic substation is more satisfactory than the manual. On this road there are five substations, three of 500-kw. capacity each, one of 300-kw., and one of 1,000-kw. All are 25-cycle, but one is being changed over to 60-cycle, and a new 60-cycle substation is on order. These five substations operate on an interurban system where 47-ton steel cars are used in from one to four-car trains. Mr. Jones emphasized, however, that an automatic substation cannot go forever without attention. It needs careful observation and maintenance, and he has found it necessary to make inspection once per day.

Mr. Jones made the additional point that he has found it desirable to know what the station has done between inspections. At the present time no recording instruments of any kind are furnished by the manufacturers to indicate what happens in the station between inspections. Manufacturers should provide some such equipment. In its absence he has installed Veeder counters on each piece of operating mechanism and, by checking up the number of times one piece operates against the number of times the others operate, some idea of the general action of the various pieces is obtained. But this is not sufficient.

Another speaker argued that the installation of automatic substations allows a road to carry over peaks with smaller installations on account of the inherent characteristic of intermittent operation. Continuous operation, even with low loads, keeps machine temperatures up, whereas intermittent operation, over the peak only, allows a greater peak load. Another feature is that the low trolley voltage, due to the inadequate system of distribution from manually operated stations, the number of which must be affected by the operator's wages, may be much improved by redistribution of substations on the automatic basis. As an inverse to the taking down of copper in Mr. Wensley's analysis, an automatic substation may prove its economy by savings realized by obviating the necessity for putting up copper. Many electric railways must also control auxiliary circuits, such as lighting, sometimes industrial power, and sometimes pumping, and this may also be done from the automatic substation. Another economic feature with reference to shut-downs due to labor strikes is that in many cases where some labor can be obtained, the main power house can operate and automatic substations will keep the system going, thus making a saving in preventing the loss of revenue which would occur through non-operation of the road.

Another speaker said that little had been said about high-tension switching. On interurban roads which are competitors of steam roads, continuity of service is of extreme importance. Where the road depends upon a long-distance high-tension supply line a steam station is usually kept in "hot standby" and, if the long-distance line falls, the steam station cuts in. Such interurban roads using automatic substations must then have duplicate lines with additional relays to cause automatic transfer from a disabled line to another line, so arranged that, when the disabled line is restored the station automatically returns to it. Another feature in the case of a "disconnect" due to overload is that a manual station's operator usually is told to make three trials to close the circuit, spacing these trials about a minute apart, and, if trouble still exists, to report to someone higher up. In automatic substations there must be something to take the place of this, and a motor-operated switch has been used to close the circuit three or four times at satisfactory intervals. Then, if trouble still exists, the switch is locked up and the dispatcher is automatically signaled.

FUTURE POSSIBILITIES OF THE AUTOMATIC SUBSTATION

Donald Bowman, Commonwealth Edison Company, raised a question in regard to the future possibility of the application of automatic substations to extremely heavy low-tension direct-current service. His question related to a system where the whole distribution plant is underground and the element of continuity of service is at least equivalent in importance to operating cost. In many substation operations it is satisfactory if everything is done as per schedule, but if on a large system a generating unit or a substation unit burns out, either of which seriously impairs continuity of service, then there must be emergency switching, both high-tension and low-tension. And in part the switching done must be developed by the needs of the moment and can hardly be scheduled in advance. Similar conditions arise when a manhole "blows out" or when some other heavy accident happens in the underground distribution system.

In closing the discussion on these two papers Mr. Peters stated he was in thorough agreement with Mr. Wensley on the analysis of concentrated city service. To be sure, most of the present installations are interurbans and there is no doubt as to the return on the investment in those cases. On the other hand, in heavy city service the equipment is not so cheap and the attraction to automatic stations in big centers must be based on an analysis such as Mr. Wensley has given and on more effective operation in general. If all engineers took the interest in automatic substations which Mr. Jones does they would be much better off. He said also that there are several automatic substations operating in Australia and one is now being shipped to New Zealand.

Mr. Peters said also that the application of automatic substations to industry has been urged, as these are

excellent in large factories. For example, in the case of an industrial plant having a long low-voltage distribution, the fixed charges on the actual investment in copper plus the heating losses will more than take care of the installation of small automatic substation units in the industrial establishment. One large manufactory is now installing several of these to replace its heavy low-voltage distribution.

Absolute Automatic Operation Improbable

Mr. Wensley first answered Mr. Bowman's question as to intensified low-voltage systems and stated that this was a real problem, perhaps the biggest problem in the application of automatic substations. There have already been developed as part of the standard product selective power relays to clear out from the tie bus feeders which are giving trouble. Power can be fed in through several buses from different directions and automatically relays can pick a satisfactory live bus. Many other operations like this can be performed. But, in Chicago, where there is one of the largest networks in the country, it will probably be impossible to make the whole system automatic. The system operator, however, might be enabled by some method of selection, such as is used in the automatic telephone system, to control individual switches in a substation and thus take care directly of the emergency switching.

On the other hand, the automatic substation has some inherent characteristics in the case of serious shutdowns which can never be equalled by the present manual method of operation. Reference here is made to a condition in which there is a complete, or very large partial, shut-down of service and in which service must be restored. Under manual operation, if the whole or a large part of the system is down it is frequently necessary to send out men to cut off individual buildings and large feeder sections, so that the load may be taken on a little at a time. Under the automatic system the feature of load-limiting resistance helps the system to come back gradually and pick up the entire load without any such universal disconnection. Mr. Wensley was willing almost to guarantee that an automatic substation system could pick up a full load within three minutes after power was supplied again, as compared with an estimated three hours under manual operation.

Of course the principle of load limiting resistance is not limited in its application to automatic substations, but it might be installed as an auxiliary to manual operation. However, the additional automatic features of the automatic substation are well worth while, for they tend to make the operation most rapid, in fact, some series of operations are completed in the same time that the station operator would be deciding as to which switch to throw first.

Referring to the necessity for applying high-speed circuit breakers to automatic substations, Mr. Wensley said that by the automatic introduction of three steps of resistance in cutting down a short circuit before opening up, the necessity for a high-speed circuit breaker is eliminated.

A Musical Treat at the Dinner

After the informal dinner in the evening, short addresses were made by E. H. Sniffin, manager of the power department of the Westinghouse Electric & Manufacturing Company, by A. W. Thompson, president of the Philadelphia company, which owns and operates the local electric light and power company, gas company and railways and by Calvert Townley, president of the Institute.

During the dinner the guests were very pleasantly entertained by a musical treat by Phillips Thomas of the Westinghouse Company. Mr. Thomas produced his music electrically. By means of a convenient keyboard mechanism he connected various values of inductance and capacity in a resonating circuit whose source of energy was a mercury vapor lamp and to a piano accompaniment played a large number of popular and even classical airs. A loud speaking transmitter served to make the music audible to all in the large dining hall.

Locomotive Discussion Lacks Excitement

At the evening session the two papers by A. F. Batchelder and S. T. Dodd of the General Electric Company and N. W. Storer of the Westinghouse company were presented in discussion of the two designs of locomotive for the Chicago, Milwaukee & St. Paul Railroad. Judged from the tenor of previous Institute meetings on matters having to do specifically with methods of trunk line electrification, the discussion at this meeting was, as Mr. Storer expressed it, exceedingly tame. None of the lively discussions between representatives of the two schools of thought developed, as might have been anticipated from earlier traction meetings.

Mr. Storer, after reading his paper, made the additional remark that it would be difficult to imagine two results or two locomotives differing more than these do and yet made to fill the same specifications. On the other hand, this very difference shows the flexibility of the application of electricity, not only to traction, but to industry in general.

R. L. Wilson, recalling his practical experience in the beginning of heavy electric traction on steam roads, said that the early impression was that the electric locomotive was so complicated as to be not readily accepted by steam railroad operators. It still appears to some railroad men to be a complicated piece of machinery, but its reliability has been proved. There is quite a divergence mechanically between these two locomotives. The Westinghouse locomotive is the well-known Pacific type, but what led to the other type is not apparent. It seems that the General Electric Company expected its locomotive to react on the track and that certain devices have been introduced to overcome this tendency. One of these is the use of rollers under the cab. On the New York, New Haven & Hartford locomotives a roller is used under the cab, but, while similar to the one now adopted on the St. Paul locomotive, it differs in that all rollers continue to bear weight, whereas there is a possible objection in this one in that the roller on one side rolls up an incline and is active, but the roller on the other side may be left without weight on it and thus prove a weak point.

The slow speed motor on the General Electric locomotive would naturally call for high copper losses. The question was raised as to the reasonableness of the amount of heat which would be produced in the motors on the long grade which these locomotives must negotiate on the St. Paul. Another question related to the temperature rating, the paper having given 266 hp. as the rating of the motor at 120 deg. temperature rise, but having said nothing as to the maximum operating temperature expected. Considerable stress having been laid upon the efficiency of the gearless motor at high speed,

the question was raised as to what would be the average speed at which these locomotives would operate.

Mr. Storer was asked as to possible contemplated difficulties with the exciter, which is mounted like an ordinary interurban motor. The point was brought out that this means a reversal of the ordinary drive between gear and pinion in this type of mounting, in that the usual drive is a small pinion driving a large gear, whereas in this case the large gear drives the small pinion. Mr. Storer's reply was that the size of the axle-driven generator was so much over the amount of power it would be called upon to give that no trouble with this was anticipated.

A. M. Candy, in discussing the complexity of the modern locomotive, related his experience in connection with the Pennsylvania electrification. In this case a man was placed on each locomotive to help the engineer in case of trouble and these men vied with each other in finding quick answers to hypothetical troubles and stayed up late at night familiarizing themselves with all the various details of the locomotive, but in no case was there any opportunity to test their ability. The complexity is apparently over-emphasized. Another speaker called attention to the fact that in comparing the electric locomotive with the steam, if every little detail of the steam engine from the chemistry of its coal to the final mechanics of its valve motion were taken into consideration, it might be found as complex in its way as the electric locomotive is in its own.

Success of Electrification Emphasized

President Townley emphasized the fact that the electrification of the steam road must be looked at broadly; that so far every electrification of a steam road had been successful; that, to be sure, these electrifications had all been with different types of locomotives, varying in design and efficiency, but that electrical engineers must emphasize the uniform success of electrification. No steam railroad operating man who has an electrified section would discard it now and replace it with steam. When electrical men argue too much about the types and locomotives, steam railroad operators may grow skeptical. What will probably happen in the present instance is that both of these locomotives will perform to the entire satisfaction of the Chicago, Milwaukee & St. Paul Railroad, and while electrical engineers may learn something from the comparison of the two designs for a given specification, the argument about these two designs should not be emphasized in such a way as to throw any doubt upon the intrinsic value of either. Electrifications now planned and to be executed in the near future will call for so many locomotives that all the facilities of all the manufacturers will not be enough to satisfy the demand.

In closing the discussion Mr. Dodd said that he did not know the temperature at which the motors would operate, but that he knew the motors would perform service and called attention to the successful operation of similar motors on the New York Central. As to complexity, he stated that if it were desired he could show diagrams much more complex than those showed by Mr. Storer but emphasized again the point made by Mr. Townley that the first thing to look toward is service. With reference to the center of gravity, he stated he did not see that it made much difference where it is, so long as the weight is properly distributed to make a locomotive ride the track satisfactorily. In this connection he called attention to a previous discussion of this point by Mr. A. F. Batchelder before the American Society of Mechanical Engineers at its annual meeting in December, 1916.

He brought up another point of Mr. Townley's that there is a big job ahead in electrification and it is splendid to have these two designs upon which to base further developments. At the present time there are about 350 heavy traction electric locomotives and about 63,000 steam locomotives, so that the work of electrification is just beginning and there is much to work out before electricity comes into its own.

Mr. Storer said he was sorry the meeting had been so tame. He said he tried to start a few things but could not get any reaction. He did emphasize that he was very glad that the two companies were both working on the same job, that both locomotives would probably perform good service for the railroad, and that, as a result of the divergent designs, the whole art would benefit from the results of the study of the service of the two locomotives.

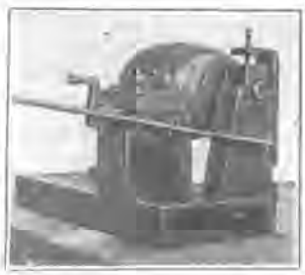
Light, Hand-Hammer Drill

HAND HAMMER DRILL

A SMALL, light, hand-hammer drill has been developed by the Ingersoll-Rand Company, New York, N. Y. This machine is known as the "Bar 33 Jackhamer." Its weight is 21½ lb. and it is recommended for drilling holes in concrete or other foundations, where a machine of extreme light weight is necessary. It is not recommended for drilling deep holes or for use in hard rock.

Commutator Slotter for Small Armatures

THE accompanying illustration shows a small, simple commutator slotting machine which was made up in the shops of the Georgia Railway & Power Company, Atlanta, Ga., to do the slotting work on the air compressor armatures. As there are only about two armatures to be repaired each week, it was not considered worth while to devise a power-driven machine using a revolving saw for cutting away the mica.



SMALL HAND-OPERATED COMMUTATOR SLOTTER FOR SMALL ARMATURES

In this machine a sharpened piece of hack-saw blade is held in the tool post by two yokes fastened to the tool head by four bolts and nuts. The tool head is shifted toward and away from the commutator by means of a crank and a §-in. screw. This tool post is also machined so that it may be moved laterally or axially by means of a lever having its fulcrum on the pedestal which supports the armature. This handle is attached to the tool head as seen, and a slot in the lever permits of oscillating the tool back and forth by means of the lever. The lever is 5 in. long from fulcrum to the point of tool head attachment and 12 in. long from this point to the end.