

BRANCH DISCUSSIONS.

DISCUSSION AT CHICAGO, MAY 5, 1903.

Papers presented:

"Economical and Safe Limits in the Size of Central Stations," by H. A. Lardner. Abstracted by Prof. P. B. Woodworth, of Lewis Institute.

"Safety Devices in Central Stations and Substations," by Philip Torchio. Read by W. G. Carlton of the Chicago Edison Co.

"Multiple versus Independent Operation of Units and Central Stations," by Peter Junkersfeld. Presented by the author.

MR. B. J. ARNOLD:—I am very much interested in the question of the production and distribution of power, but I cannot comment on these papers for the reason that I have not had an opportunity to read them. I think, however, that in general for lighting work or for power distribution in large cities, I would incline toward the single central-station where it could be economically located, as it usually can be, with the power distributed to substations containing rotary converters and batteries.

European practice seems to favor motor-generators rather than rotary converters such as we use in this country. In Frankfurt, Germany, I saw 1,000 kilowatt motor-generators, of which the motors were single-phase, and the generators direct-current, running street railways very successfully, in conjunction with storage batteries, and this was soon after I had been told there were no large single-phase motors running anywhere. The Europeans claim that they get better efficiency out of their combination of motors and generators than we do out of our combination of step-down transformers, and rotary converters, for the motor-generators utilize the incoming alternating current at the line pressure, without the losses of transformation.

When we use alternating current, however, as in railroad work, where we have to go across country long distances, I am in favor of divided power stations. It has only been within the last two or three years that I have preferred them, but my judgment now is that we shall run our railroads with power houses of moderate size, generating high potential, and located approximately 20, 30 or 40 miles apart. This eliminates a large part of the equipment we are now using, and brings down the first cost. It is in line, I think, with the recommendation of one of the papers of this evening.

MR. W. L. ABBOTT:—Anyone who had the responsibility of supplying 1,000 tons of coal a day for power houses last winter would naturally have made up his mind long ago as to what was the most important feature of central-station operation. It is to get the coal there. To this part of the work my attention of late has been principally directed.

At our Harrison Street power house, which is now about ten

years old, the facilities for receiving coal were thought to be ample, since the Chicago River was on one side and the Alton switch tracks on the other. When the power house was first started fuel-oil was used, but that was soon abandoned and coal was brought into the boiler room by wheel-barrows; the wheel-barrow was superseded by a horse and dump cart, and later by a tramway with push car. Now we have automatic coal-handling apparatus and automatic stokers.

The cost of handling the fuel for all the labor connected with the boiler room has been brought down from about 40c per ton, under the first method—that is, with a wheel-barrow and hand firing—until now it is somewhere between 15c. and 20c. a ton. The difference looks like a very satisfactory saving, but it is probably larger than it should be, and on the consumption of 600 tons of coal a day, a saving of 10c. per ton would be very satisfactory.

In the larger power houses the matter of supply fuel is a serious problem. Some of the power houses now built and projected will require 3,000 tons of coal per day, which means perhaps two train loads. To get this amount of coal into the power house regularly is difficult. Storage facilities will have to be provided in the city for loaded cars, and means must be provided for shifting these cars about.

When dependance is placed on the railroads for rolling stock and for storage, there is continual complaint of unsatisfactory service. Therefore, a large power house should not only have storage tracks of its own, but undoubtedly rolling stock of its own. It should also have a large supply of stored coal nearby during the winter months.

There should also be coal and ash-conveying apparatus and automatic stokers whereby the coal can be moved from the mine to the ash-dump without being touched by workmen. This not only for the saving of expense, but for the reducing of the number of unskilled employees about a power house, which, in these troublesome times with labor agitators, is an important matter only fully appreciated by those who have had to do with it.

Where there are several power houses in one system, the economical way is to run only the larger one as much as possible. Storage battery auxiliaries are also desirable.

It is absolutely necessary to meet promptly an increased demand for power caused suddenly by the formation of dark clouds, the breakdown of an adjacent power house or other similar circumstance. This is not difficult with hand-fired furnaces, but it is impossible with an automatic stoker. The latter takes its own time to get into condition for service. Most of the recent power houses are now supplied with blowers, which put an air pressure under the grates, whereby the amount of coal burned can be doubled or quadrupled.

The most wasteful pieces of apparatus about a power house are the boiler and furnace. The waste in them, counting the two

units together, may sometimes be as much as 50 per cent. of the fuel, and at least one-half of this waste is preventable. The operating engineer and designer should give their particular attention to the boiler and furnace, if great savings are to be secured. In a plant which is consuming two, three or four thousand dollars worth of fuel a day, a saving of even 5 per cent. would be a matter of very great interest to those who pay the bills.

MR. JUNKERSFELD:—I was interested in Mr. Arnold's remarks in connection with using a number of plants distributed twenty thirty or forty miles apart on a road through the country. It seems to me the number and distribution of such plants is dependent upon their size. For instance, if the load is heavy enough to require a fair-sized plant every thirty or forty miles, then perhaps it would be desirable to have them located about that distance apart. If, however, the plants are small, considerations of unproductive investment and unproductive labor would make it desirable to have them fewer and farther apart; that is, if still within the limits of economical high-voltage transmission, and if the reliability of service rendered is sufficient.

I fully agree with Mr. Abbott that the boiler room does not ordinarily receive the attention it should have, either in design or in operation. It must be remembered that the fuel and boiler room expense is a very considerable part of the total generating cost.

The use of forced draught to increase the generating capacity of the station in case of a sudden demand would often be very desirable. It would be the equivalent of storage battery capacity right in the boiler room, made available by starting the blowers. While this might involve either improved furnace construction or increased repairs to furnace and boiler setting, it would seem that a great deal of reserve capacity could be thus provided at a cost per unit of capacity less than that of storage batteries on a narrow peak. I do not mean that we are thus able to discount the value of storage batteries, which are distributed over the system and are, therefore, nearest the points where they can do the most good, but I do believe that under some conditions the use of auxiliary forced draught as reserve boiler capacity for sudden demands of short duration will be found advisable.

MR. H. B. GEAR:—I am chiefly concerned with the problems in connection with the 60-cycle, 2000 volt distributing system rather than the station and substation features of this discussion.

The principle of sectional operation has been generally applied to the 60-cycle distributing system in Chicago. The feeder system is operated separately; that is, a feeder supplies a section of the primary main system which is not interconnected with the mains of any other feeder, and that section of the city is, therefore, not affected by trouble in any other part of the city. In the same manner the secondary distributing system has been kept almost entirely separate. Each transformer, except in a few

cases where the load is very heavy, supplies a separate secondary usually about 800 feet in length. Interconnected secondaries are not desirable until the load reaches a density of about 40 k.w. per 1000 feet of line, or more.

MR. W. G. CARLTON:—I think practically all of the questions in connection with the high-tension, 25-cycle distribution system are treated by Mr. Torchio and I think he was wise in discussing only the electrical troubles and not referring to the mechanical ones. Considering cases of trouble occurring: Out of all the cases of trouble that we have had, here in Chicago on a 25-cycle 9000-volt system, fully three-quarters (probably more) occurred in the generating station and were mechanical; of the other one-quarter that were electrical, nearly all occurred in the generating station. The Chicago Edison Company has been operating at 9000 volts for about a year, and I do not recall now a single case of trouble that was due to a fault in the lines themselves, although one or two cases were due to the damaging of the lines by men working on them.

Mr. Torchio brought out the point of the separating of the lines for different substations. In accordance with this principle our down-town substations each have at least two lines—some more than two—and the machines in these substations are divided in two groups. In case of trouble at the generating station so that an engine has to be taken off and the 25-cycle load has to be reduced in a hurry, the operator knows exactly what lines to open, and in this way no one substation is shut down entirely. In a number of cases we have substations with batteries, and also with rotary transformers. In cases when it is necessary to reduce the load, the supply is cut off the substations where there are batteries.

There is another way that grounding the lead sheath of cables can be done in order to protect them from injury by stray current. This is by breaking the sheath at intervals, possibly every half mile, and grounding the sections at the middle point.

MR. ARNOLD:—I would like to ask Mr. Carlton if he has had any trouble with the breaking down of the insulation right where the cables leave the lead sheath?

MR. CARLTON:—We have had two or three cases not particularly serious—which were due to the ends of the cables not being suitably protected. We have since then taken more pains with the ends of the cables and have had no further trouble. Very careful work insulating the ends of the cable is required.

MR. CRAVATH:—In looking over the plans of several large steam-turbine stations which are under consideration at the present time, I have been impressed with the enormous amount of boiler room required in proportion to the turbine room. As one engineer put it, "I do not know but that we are coming to the time when we shall design our stations in the form of a number of radial units, each unit with a turbine in the middle and boilers on all sides of it." This humorous remark rather serves to call

attention to the fact that it is a nice problem in the designing of a steam-turbine generating station to preserve the symmetry of the station so it can be enlarged section by section, and at the same time get a large enough battery of boilers within reasonable piping distance of the turbine unit which they are to supply, without introducing objectionable features in the boiler arrangement.

MR. ARNOLD:—When I made my previous remarks I had in mind heavy trains, and when you consider a train that takes 1500 h.p. continuously you can have your stations thirty miles apart and have plenty of use for them if you have a number of these trains to pull. I should have expressed myself more clearly. On an ordinary interurban road with trolley cars, of course you would not need a power house every 20 miles, but when you consider the heavy trains, you will, in my judgment, need the segregated stations, and the complete elimination in the substations of step-up and step-down transformers.

COMMUNICATION AFTER ADJOURNMENT BY CARL SCHWARTZ.

The tendency in recent years is towards the erecting of single large power stations, not only supplying the growing demand for current, but absorbing smaller stations. It is evident that the arrangement of such stations must be made as perfect and safe as possible.

In the large modern central stations, even partial shut-downs occur very seldom, but influences of any kind affecting only a single part of such a station may lead to its complete shut-down, while were the same aggregate power delivered from several separate stations, if one should be disabled the others would be able to maintain the service at least on part of the system.

The growing demand on the central stations has required the use of larger and larger generator units, but a practical limit in the extension of central stations and the size of units is soon reached. For this reason it will be absolutely necessary to operate large systems in independent sections.

The most serious objection which could be made against independent operation of the generating units and the transmission systems is that the load cannot always be equally divided between the different units, and requires, therefore, a larger number in operation, some with uneconomical loads.

A suitable switching arrangement and a proper distribution of the feeder lines will, however, insure a reasonably economical load on all units, especially at time of heavy load.

The difficulty of uneconomical load with ordinary steam engines loses its importance with steam turbines whose efficiency we are told varies only about 3 per cent. from half load to 50 per cent. overload.

Independent arrangement and operation of generating units and transmission lines with a flexible switching arrangement, thus giving all the advantages of a large power station in erection,

operation and management, without running the risk of connecting these extremely large amounts of energy together continuously, is of great importance in the further development of large electrical distributing systems. The extension of large central stations and the extension of high-tension distributing systems both at present limited in regard to safe operation, are practically unlimited with an independent arrangement.

The question of one or several power stations, located far apart from each other, but all supplying a common system, is often influenced by circumstances of peculiar kind and depends therefore in every case, on particular local considerations.

DISCUSSION AT PITTSBURG, MAY 11, 1903.

The meeting was called to order by the Chairman, Mr. Lincoln, who introduced President Scott.

Mr. Scott made a few remarks concerning the proposed Union Engineering Building, and called upon Mr. C. W. Rice, Chairman of the Building Committee, for a statement regarding the present standing of the matter.

Mr. Rice gave a very interesting account of the efforts of the Committee to interest Mr. Carnegie, these efforts finally resulting in his offer of one million dollars for a Union Engineering Building. Mr. Rice said that great credit was due to both Mr. Scott and Mr. T. C. Martin for their persistent efforts to interest Mr. Carnegie.

Mr. Scott then opened the subject of the evening by a discussion on "Tendencies of Modern Central Station Development."

The papers presented at the New York meeting of May 24th were read in abstract.

MR. HODGKINSON:—In the paper by Mr. Lardner reference was made to steam turbines applied to large central stations. There is no doubt that steam turbines are every day establishing themselves as reliable units.

The difficulty of multiple operation of alternators as pointed out by Mr. Lardner is entirely at an end. I know of 400 k.w. Westinghouse turbines at the Westinghouse Air Brake Company's works having a $2\frac{1}{2}$ per cent. variation of speed between no load and full load, and whose parallel operation through all variations of load has never left anything to be desired.

Some comparisons have been made of floor space occupied by turbines and it has been shown that the Curtis turbine, by reason of its main shaft being vertical, occupies less floor space than the Westinghouse turbine. If, however, we consider the cubical contents of the machine, this difference in some cases disappears and in others is much less in evidence.

Another point, however, should not be lost sight of, that by reason of the shaft being vertical and having considerable top weight it would be supposed that much more massive and better foundations are necessary than would be the case with the shaft horizontal.