DISCUSSION ON "PROBLEMS IN TELEPHONE TRAFFIC ENGINEERING." CHICAGO, JUNE 28, 1911.

A. P. Allen: The "problems of telephone traffic engineering" used to be to *guess what was going to happen*—and we are only just a little bit better off today. As I listened to some of the other papers, I wanted to congratulate the light, power, and construction engineers because they could fix at least something and depend on it. This paper is, however, comforting to a man in my position, because it gives the idea that even in telephone traffic engineering things are coming around so that you can depend on them; so that you can say that an average operator's load ought to be so much, and expect to get it; you can say that the public will give you more calls between nine and ten in the morning than they will between three and four in the afternoon, and have it come true.

But in practice almost everything that the traffic engineer touches goes back on him sooner or later. He gets figures that show that the normal load in a city residence district is heaviest in the morning, and some day he gets the larger load in the middle of the afternoon—larger than he ever had in the morning. That is something that we cannot control. It is the same way with the handling of the toll traffic. The business between two towns will be, perhaps, only 15 per cent taking place in the busy hour, while the business between other towns that have apparently the same conditions will be 25 per cent in the busy hour. It is very hard to establish standards, or formulae, that you can depend upon on all occasions, when the conditions simply *look* similar.

A few papers out of my files illustrate that point. For instance, in Chicago, the long distance business—making a series of tests every day for one week: on Tuesday the busy hour, in the afternoon, was 103 per cent of the busy hour in the morning. (Of course we have to plan our operators for the busy hours.) The very next day the afternoon busy hour was only 64 per cent as heavy as it was in the morning. In the same way with long distance traffic of New York City, comparing different months. Taking April as 100 per cent; one year, the August business is 91 per cent while the next year it is only 85 per cent; but in both years December is 110 per cent of the April business.

All such figures demonstrate that the use of the service by the public is very uncertain. We get up formulas and say that if the average holding time is two minutes and fourteen seconds, a group of ten trunks will carry so many calls. As a matter of fact, our average is not a reliable average, because the variation between the shortest and the longest connection is very great. The formula holds true *if* they are all nearly alike, as to the average time; but as they are plotted out, they run from five-second calls up to about ten minutes. Can we, under such conditions, accurately foretell how many trunks we will need to give

instantaneous service to a given number of patrons? That is what we have to contend with in city traffic: we have to give instantaneous connection, we cannot wait for circuits. Between two offices a certain number of calls will require a certain number of trunks; between two other offices the same apparent load may take nearly twice as many.

FIG. 1

The charts shown in Figs. 1 and 2 are original, perhaps—at least I have never seen anything just like them. They show the “guessing” we have to do on the ability of the average operator. Each line represents roughly, a group of operators, graded as to what they can do in fifteen minutes, and also showing what

FIG. 2

they did do in the total hour. A total of 1250 operators were thus analyzed, their ability being represented by what they did in fifteen minutes. It is reasonable to suppose that they could do four times as much in an hour if they had it to do; and that

the fluctuation in their hourly load is due to the fact that the total loads vary so much during an hour. Due to that fact, the per cent of efficiency that all grades give is almost exactly the same. Girls that handle 55 calls per quarter hour reach 82 per cent efficiency for the total hour. Girls that can handle 50 per cent more in 15 minutes have only the same relative efficiency for the total hour.

I certainly hope that Mr. Valentine's paper gives the right idea, that in the end we will be able, by analysis and careful tabulation and watching of results, to get some real, accurate data on which to base fundamental plans; but it does not appear to me that we have yet reached that condition. And a great many of the problems that we have to contend with are not within our control at all—that is, they depend entirely upon the use of the service by the public.

W. Lee Campbell: In manufacturing, mining, bricklaying and similar occupations great advances have been made in the last few years by engineers studying efficiency methods and making motion studies with the idea of increasing the efficiency of the individual operator. To one who has been familiar with this, the question naturally occurs what can be done along this line, or what has been done in manual telephone work toward increasing the efficiency of the operators? I suppose the principal difficulty is in supplying each operator with as much work as she can do. As Mr. Allen has just brought out, in one moment the operator may have all she can do; the next moment she may not have as much as she can do. The result is that if standards were set, the operators could not be compelled to come up to them by force, nor could they be coaxed to come up to them by increased remuneration. Consequently, it would appear to me that if some device should be introduced between the subscriber's lines and the operator, which would furnish her with work at the greatest speed she could take it, as determined scientifically, that the operators could be brought to a very much higher standard of efficiency. The work could be distributed, starting at one end of the board, to the operators as far as it would go and at the other end of the board a certain per cent of operators could be kept for emergencies. I am not a manual telephone engineer, but I should like to ask of some of these gentlemen who are, if there are not possibilities in such a scheme.

Bancroft Gherardi: I feel that we are all very much indebted to Mr. Campbell for raising the question which he has and for pointing out to us such an interesting problem concerning traffic engineering. It is a most valuable illustration of the type of problem which traffic engineers are sometimes confronted with because it requires not solely the work of traffic engineers, but also the work of plant engineers and requires the coöperation of these two sets of engineers to obtain satisfactory results. The traffic engineer can point out what kind of call distributing system he would like to have from an operating standpoint, and the

results which he would expect such a system to attain. Based upon this, the plant engineer would undertake the design of suitable apparatus, and would, in general, sooner or later be confronted by some traffic requirements which could not practically be met or which could only be attained at such great cost or such excessive complications as would not be warranted. So the working out of this problem and similar problems requires coöperation between the traffic engineer and the plant engineer in order that from the general idea at first proposed there may be finally evolved the best arrangement, taking into account all of the circumstances of the case—operating savings, maintenance, character of service, first cost of apparatus, etc. While a discussion of the specific problem which Mr. Campbell has mentioned would carry us somewhat beyond the scope of this paper, I might say in reference to the matter that while a good deal of work has been done on this question by a large number of people and extending over many years, so far as I know no large application of the principle of call distribution has ever been made anywhere. I do not feel that we are now warranted in saying that we can ignore this problem and say there is nothing in it. It is my opinion at the present time that it is a problem which has not as yet been worked out and that there are certainly no data available at the present time to permit us to give an affirmative answer to the question "Is call distribution a satisfactory and economical feature of a telephone switchboard?"

Mr. Valentine has, I think, placed us all under obligations to him in presenting to us his paper dealing with traffic engineering problems. While traffic engineering does not deal with volts and amperes, and in that sense is not electrical engineering, it is nevertheless a most important and interesting class of engineering work, the nature of which is but little appreciated at the present time except by those who come in direct contact with it in their work.

A. P. Allen: What I wanted to make clear was that, regardless of any system of distributing, no one can tell in advance what the load is going to be—that is, how many calls the public is going to give to us—at any particular period of the day; and even if we had a perfect distributing system for those calls, we would not know whether to put on one set of operators, or more, in order to give a certain grade of service.

W. Lee Campbell: It is found in manufacturing practice as shown by the studies of Mr. Harrington Emerson, Mr. F. W. Taylor and others, that the efficiency of the average operator paid by the day, is only about 67 per cent of what is attained if an operator is paid in proportion to his or her efficiency. It is impossible to bring an operator up to the highest efficiency unless she is supplied with all the work she can do. The work must be, in some way, gauged and the operator must have before her definite standards to which she will be expected to rise. As Mr. Allen says, in the use of switchboard operators, the trouble

is that the public does not furnish a regular amount of work but if some of the automatic or mechanical devices should be used between the public and the operators to distribute the calls to each at her best rate of speed and the efficiency of the operators could thus be brought from 67 per cent up to 100 per cent, a great saving would be secured. A certain percentage of operators could be held to take care of the irregularities. With the present plan, each operator is given a fixed number of lines to handle, and consequently all of them are subject to irregularities of load with the result that each has an excuse for not doing her best.

F. P. Valentine: While this discussion has brought out one or two typical problems which the traffic engineer has to face, it also indicates that there is not a general understanding of how far these studies have been carried. It is perhaps not generally known that for some years telephone traffic problems have been receiving constant study as the result of which many of the apparently intangible factors have been reduced to known quantities and their inter-relation established, so that due weight may be given to variations. The analytical work of the past few years has been merely outlined in brief form in this paper to point out that the work can be carried on intelligently having accurate knowledge of values and their relations.

We cannot today consider all the problems solved, but by the methods pointed out and with the facts and laws already established as a foundation the way seems fairly clear to the ultimate solution of the various elusive problems which constantly confront the traffic engineer. Traffic engineering in itself is a comparatively young branch of engineering work, in which developments have come very fast within the last few years, and in regard to which there is comparatively little knowledge or appreciation outside of the comparatively few who have been fortunate enough to participate in the comprehensive studies which have been carried on. It is safe to say that the developments of the next few years will bring about a better realization of the fundamental importance of the study of these problems as well as a better appreciation of the progress already made.