the rights and obligations of a transportation company must not rest with an administrative body subject to political influences, but must be determined by a judicial body which so far as may be is free from such political influences.

I believe in a monopoly of transportation. I believe that such monopoly should be required by law to furnish reasonable facilities at fair prices, and I believe that governmental regulation along the lines suggested is the surest safeguard of transportation properties.

THE SINGLE-PHASE SYSTEM IN THE YEAR 1909

BY N. W. STORER, RAILWAY DEPARTMENT, WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURGH

The single-phase system has made very substantial progress during the past year. It is reported that the commission appointed by the Swiss Government has decided in favor of single-phase alternating current for the standard railway system for the State Railways, and several projects are in an advanced state. In France the Midi Railway has adopted single-phase and ordered 30 multiple-unit car equipments and a number of locomotives, the latter to be built by as many companies. The German State Railways have adopted single-phase as standard, and are pushing the development rapidly. In Norway and Sweden substantial progress has been made along the same line. In most of the electrifications under way in Europe high voltage is being used, ranging from 10,000 to 15,000 volts on the trolley. The favorite frequency is 15 cycles. This frequency has been recommended most strongly in Switzerland and Germany, and has been adopted by the Midi Railway in France.

It is probable that the advantages secured for the motors by the use of 15 cycles will be sufficient to influence its adoption in this country for heavy work, except in instances where a large supply of 25-cycle power is available. The advantage for car equipments alone is not sufficient to pay for the introduction of a new frequency.

In this country single-phase has not had as smooth sailing. Equipments for only one new road have been sold this year, and several of the old roads have been changed from single-phase to direct current, with either 600 or 1200 volts on the trolley. Judging from this fact alone, it would appear that the single-phase system has received a backset. However, careful analysis of the reasons for the abandonment of single-phase on the lines that have changed shows that they were not properly single-phase propositions in the first place. On one line, for instance, it was necessary to have direct current at both ends of a road of moderate length, with connections for underground conduit as well as overhead trolley on d.c., resulting in complications which outweighed the advantages gained by the use of single-phase current for the interurban portions of the line. In another case a large part of the mileage made by the equipments was over d.c. lines. While in this case there was not as much complication as in the first instance, it was extremely expensive with the heavier and more expensive single-phase equipments to operate them so large a part of the time on direct current. The entire line might as well be direct current.

In the first years following the introduction of the single-phase system there were undoubtedly extremists who wished to apply single-phase everywhere. This over-enthusiasm has resulted in injury to the system, because of its misapplication. Further, the equipments on a large part of the roads over which they have been operated have been overloaded and overspeeded, performing heavier service than would be possible with direct-current equipments of the same capacity, because of the speed characteristics and the high voltage available at the motors. It is refreshing to see, however, that in spite of the abuses and misapplications of the system, the equipments have operated so well in so many instances. Examples of steam railway electrification, notably the New York, New Haven & Hartford and the Grand Trunk, have been conspicuously successful during the past year. The train delays have been greatly reduced over those formerly encountered with steam operation, and very little trouble has been experienced in any way. On the New Haven lines the locomotives are doing far more work than was ever contemplated by their builders. On some of the interurban lines the operation has been thoroughly successful, resulting in a low cost of operation. In others there have been troubles, due, as stated above, to abuse of the equipments, including overloading and overspeeding. In this connection it is significant to note that there has not been a single instance of change from single-phase apparatus to direct current where the equipments were furnished by the largest manufacturer of single-phase apparatus. On the contrary, several of the lines have ordered new equipments for extensions, and further extensions are probable in the near future.

The new railway for which equipments are now being built is the Rock Island & Southern Railway, a road designed primarily for freight traffic, which will also be used for frequent and high-speed passenger service. This line will be operated exclusively from single-phase alternating current, which makes it possible to use inductive rather than conductive compensation for the motors, thus rendering the most vulnerable part of the field winding perfectly safe from injury. The motors will also be operated from a two-coil transformer instead of an auto-transformer, so that the circuits will not be grounded, and thus the liability of breakdown of insulation will be much reduced. These equipments will possess a degree of simplicity which should be attractive to any one who is operating electric railways.

The net results of the experience with single-phase apparatus up to date are that single-phase equipments can unquestionably be built to operate successfully in either interurban service or on heavy railroads. The complication of making equipments operate interchangeably on direct current and alternating current is an undesirable one, but one which need not cause any trouble, provided the equipment is properly cared for.

Preventive leads between the armature winding and the commutator are still advocated as reducing the losses in the motor and making it possible to reduce the size of motors beyond those built for a given output without leads. All that is necessary to make the resistance lead construction satisfactory is to have the leads of sufficient thermal capacity to stand the current for the maximum length of time necessary for the motor to develop its torque at a standstill, and to make the resistances substantial, so that they may not be affected by the mechanical vibration to which all railway motors are subject. It is a well-known fact that the resistance leads of the armatures of the New Haven locomotives have never given the slightest trouble, even though they are subject to the most severe starting conditions, and the motors are required to develop at starting from 100 to 150 per cent overload torque. The worst that can be said of resistance leads is that they furnish an expensive addition to the armature winding; however, the total cost of the motor with resistance leads will not exceed that of the motor built for equal performance without resistance leads, since the number of armature conductors for the motor without leads must be very greatly increased, and frequently the number of poles increased on account of the lower inductions which are necessary.

A discussion of single-phase naturally raises some question as to the natural competitors of that system. These are high voltage d.c. and three-phase. The 1200-volt d.c. system has made considerable progress in the past year for interurban railway service, and while there is apparently not much to be gained in applying this to heavy railway work, it is undoubtedly receiving favor for interurban roads where a large part of the operation must be over standard 600-volt lines. The chief objection to this system is that the voltage is not high enough to meet the requirements for long lines, and it seems certain that if direct current is to be used for heavy work, the voltage must be very considerably increased.

The three-phase system has also made a start in this country in the Great Northern electrification. While apparently

nothing has been demonstrated by this installation, which could not have been foreseen, it indicates a tendency to develop all of the possible systems of electric traction to the fullest extent, so that each problem may receive the most careful consideration as it arises, and the best system for that particular one may be applied. Undoubtedly this attitude will make for the greatest progress in electrification of steam railways. The best part of it is that whichever system is adopted it is certain that it can be made thoroughly successful from an operating standpoint, the main difference between them being questions of first cost and cost of operation.

ADVANTAGES OF SINGLE-PHASE

The reasons for favoring single-phase system are just as strong at the present time as at any period in the past 10 years. The simplicity of the distribution and the possibilities for extremely low first cost make it most desirable from that point of view of any of the three systems. The speed possibilities of the motor make it extremely desirable from that point of view. The handicap is, of course, that the locomotives must in all cases, except where very slow speeds are required, be heavier and more expensive than for either of the other systems. Consequently, the maintenance must be higher. However, this extra cost of maintenance for the locomotives will for lines of any considerable length be more than offset by the decrease in first cost and cost of operation of the distribution system.

The matter resolves itself, as has frequently been said before, into a matter of dollars and cents, to decide which of the three systems will be the proper one to install for any given set of conditions.

Judging from the great interest which is being manifested at the present time in railway electrification, there will be sufficient comparisons made before long, which will determine the particular field that each system is best adapted to serve. At the same time, it is possible that new developments may arise which will very materially change the outlook. At present the outlook for still further extensions of the single-phase system is very good.

PERMANENT FRANCHISES AND REASONABLE RETURNS

BY ARTHUR W. BRADY, PRESIDENT, INDIANA UNION TRACTION COMPANY

The most striking phase of the electric railway situation of to-day is not found in the progress or development of the art of constructing, maintaining and operating electric railways, highly important as this is, but in the growing recognition by street railway interests and public alike of the necessity that electric railway companies be placed on a basis of permanence with respect to franchises and of reasonable compensation and return with respect to fares. Both electric railway interests and the public have been driven to recognize these facts by the pressure of experience, frequently unpleasant, and in some cases disastrous.

The sanguine hopes of the pioneers in electric railway construction and development that the low rates of fare originally adopted for both urban and interurban properties would so stimulate travel as to overcome the apparent inadequacy of return as compared with service have been largely disappointed. The unit of service furnished by urban companies has been greatly expanded through extensions of lines and enlargements of transfer privileges, as well as abuses of those privileges. This increase in the service unit has reduced the financial return to a point dangerously near, and in some cases below, the point of actual compensation. The correctness of the electric railway position in this respect has been publicly demonstrated within the past few years in the case of some of the largest and most important properties in the country through investigations made in connection with franchise negotiations or complaints before public commissions, and through reports of public supervisory boards.

In the case of the interurban companies of the country the same result has become widely apparent. The extension of the length of the ride paid for by the unit fare is not a disturbing factor in the case of the interurban lines, but it is generally true that the basic rates of fare originally fixed by the interurban companies—in some cases as little as 1 cent per mile—were unduly low. These rates were fixed when lines were first put in operation, and when the amount of travel that would be obtained was purely a matter of conjecture. Furthermore, the heavy expense of renewals and replacements was disregarded, or minimized, when these lines were first constructed, and track, rolling stock and power equipment new. Interurban cars cannot be operated at the speed which the traveling public demands and service cannot be satisfactory in other respects unless these properties are maintained at a high standard. The original rates have, therefore, in many cases, been found non-compensatory, and increased rates established. In a number of instances, notably in Massachusetts, these increased rates have been attacked, but have been almost uniformly upheld by the public tribunal passing upon them. In the course of these attacks exhaustive investigations have been made of the revenues and expenses of the companies in question, and the result has been to demonstrate the fairness, and even the necessity, of most of the increases that have been made. While the notoriety of these attacks has doubtless been highly annoying and unpleasant to the companies immediately affected, the general result has been most helpful to the electric railway interests of the country. The fact that public tribunals, the bias of which would naturally be against rather than in favor of electric railway inteersts, have found these advances justified has done much to convince the public of the fairness of such fare changes as have been elsewhere made.

The result of the various investigations and reports that have been made touching both urban and interurban companies, as well as of a few very instructive object lessons, is that what before the managements knew, but the public could not be made to accept, the public now knows and believes. The idea encouraged by the rose-colored prospectuses of a few years ago, than an electric railroad is a mine of wealth, constantly enriched by unreasonable profits filched from the public, is largely dissipated. Electric railway interests themselves universally recognize to a greater extent than ever before the necessity of adequate fares and the danger of gradually rendering inadequate fares originally adequate by an enlargement, through extensions and transfers, of the service rendered. At the same time, the public is more than ever disposed to take a reasonable and dispassionate view of conditions, and to recognize the unsoundness of the demands for reductions in fares and enlargement of privileges prevalent a few years ago.

With respect to franchise rights, there can be no doubt that we are in a period of transition, and that the final outcome will be to place these rights on a higher plane of permanence. A few years ago the individual who would contend that an electric railway franchise should be for other than a brief period of years was regarded as corrupted by corporation bias, and an enemy to the community. A remarkable recent development is that the defects and weaknesses of short-term franchises from the standpoint of public welfare are now widely recognized. Among the most revolutionary of the public utility laws recently enacted are those of Wisconsin and New York. Yet the Wisconsin law provides for an indeterminate franchise, and in New York, Commissioner Maltbie, of the Public Service Commission for the First District, has made to that commission a report in which, after discussing the merits and defects of the various forms of franchises, the indeterminate form of franchise is advocated.

There is doubtless serious objection to the indetermine franchise as defined and limited by the Wisconsin act, and as described and advocated by Commissioner Maltbie, but this is generally true of pioneer work. The important fact is that the Wisconsin act and the New York report alike indicate a realization on the part of the public authorities that under short-term franchises electric railway properties cannot be developed to the point of rendering the greatest possible service to the pub-