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Of this issue of the Street Railway Journal, 8000 copies are printed. Total circulation for 1907 to date, 214,050 copies, an average of 8232 copies per week.

The New York State Convention

The Street Railway Association of the State of New York is one of the oldest, if not the oldest, organization of street railway companies in this country, and its meetings have not only always been enjoyable as social gatherings, but noteworthy on account of the value of their technical features. The twenty-fifth annual convention, which was held this week at Bluff Point, Lake Champlain, constituted no exception to the creditable history of the body, and testifies to the loyalty to the traditions of the association shown during the past year by the members and executive committee. It was somewhat of an experiment to hold a convention of this kind at a summer hotel in a comparatively inaccessible portion of the State, but the results justified the decision of the committee in this particular. With the exception of the time required by all the members to make the trip, Bluff Point proved a very satisfactory point of meeting, and during the weather which we have experienced during the past week was a very satisfactory substitute for city surroundings. The site also attracted to the convention a great many ladies and made the social features of the convention most attractive.

All of the papers presented were of a high order and will be found elsewhere in this issue. It should be remembered in this connection that the association also conducts quarterly meetings, and as those during the past year have been devoted to subjects connected with repair shop and maintenance of way practice, these topics were considered somewhat sparingly at the annual meeting. Especial interest attaches to the account of the inter-pole motor, which also formed the subject of an interesting paper by Mr. Anderson at the Niagara Falls meeting.

Exposed Track Construction

The prominence given to American track construction by recent events has formed the basis for a number of articles in different British engineering papers criticising the methods used in this country. It is well known that while the street railway companies abroad employ a rail with a flat base, like that used in this country, the steam railroad companies in Great Britain and quite generally those on the Continent use a chair construction. The standard English steam railroad rail has a double head, weighs 90 lbs. per yard and is carried in 40-lb. chairs screwed to the ties. Rail-chairs were generally used for street railway track construction in this country fifteen or twenty years ago, but for a different purpose. They were designed to lift the rail so that a 4½-in. to 5-in. rail could be used with 7-in. paving. The English chair, on the other hand, holds the rail only slightly above the tie, and is intended primarily to give a broader bearing surface on the latter.

There is no question that track construction for heavy traffic is a subject upon which engineers can well devote considerable attention. The best form of sub-structure in paved streets has not yet been satisfactorily settled, but the problems connected with it are not so great as those connected with exposed track. With the city road the question of track construction is principally that of durability. With exposed track in which rails are spiked to ties it will be more a problem of the cohesive strength of the structure if the present tremendous increase in speeds and weights of cars continues. It is very questionable, however, whether the desired results cannot be secured by the improvement of details of the present practice rather than by any very radical change.

High Temperature Feed Water for Boilers

In steam engineering a marked feature in Great Britain of late has been the attention that has been directed upon the heating of feed-water. A hot feed has from time immemorial been recognized as good for a boiler for structural reasons, because the boiler is not so much exposed to stresses of contraction and expansion. The economy of transferring to the feed-water the heat in the exhaust steam or from waste gases that were going away without further utilization of their heat is also generally recognized. But the abstraction of 1000 thermal units from either waste product was considered only as equivalent to the saving of the fuel otherwise necessary to be burned to give 1000 heat units, or as enabling a boiler to do just 1000 units more work. It was not regarded in any sense as equivalent to 1100 heat units—the view that is now held quite widely, and not from any belief in perpetual motion, such as might be inferred from the foregoing manner of statement. What is tacitly accepted is, that M. Normand, the celebrated French engineer, recently deceased, was probably right when he claimed, for feed heating to the full temperature of the boiler, a result in better efficiency and economy not at first thought possible. For Normand took the feed-water, and, whatever it lacked of boiler temperature, he gave to it by the aid of the steam from the very boiler into which the feed-water was about to pass. He claimed an economy from the practice and has been supported by others since. Not that he had any impossible conceptions as to getting out more than he put in. What he did believe was that he enabled the boiler surfaces to act better as heat transmitters, that perfectly hot and mobile water takes up heat more rapidly from the boiler plates and thus in some helps its efficiency and economy. The ideas have so far spread that two years ago the final full heating of feed-water was laid down as an essential stage in steam raising in a paper by Booth and Kershaw before the Institution of Electrical Engineers in London. This fact and the work of the Testing Bureau of the United States Government upon increasing boiler efficiency and capacity, referred to last week, are significant of the thought being devoted to the possibilities of improvement in steam generation.

In this connection it may not be amiss to call attention to the fact that the dryness of superheated steam has led some engineers to leave out provision for drips in plants where the mains do not carry saturated steam. When the temperature of the steam is kept at three or four hundred degrees above that normal to its pressure, as is not infrequent in European practice, it is doubtless safe to forego the use of drips and separators, but unless the operating conditions are remarkably well controlled condensation is almost sure to set in at some inconvenient time.

With the superheats used in this country, which commonly do not exceed 150 degs., it would be unwise to take chances on water being carried through the superheater to the engines or turbines, and, in any event, it is certainly safer to provide at least one separator with appropriate drain connections close to the throttle valve of each unit in the engine room. The condensation sure to develop when no steam is flowing will then be taken well in hand, and in warming up the steam piping before starting a unit or group of machines, the entrained water will be prevented from getting into the prime movers. The economies of superheating cannot be enjoyed without paying a certain toll, and the careful pipe arrangement and installation which insure good service in a saturated steam plant must not be relaxed at any point when dealing with the more nearly perfect gas represented by a superheated steam supply.

Track Layouts at Joint Surface Terminals

The general extension of through service in territory where dense traffic prevails requires special trackage facilities at points where different systems are joined if the business is to be handled with the least possible delay. A certain amount of hindrance to fast travel is inseparable from stops to change crews on through runs, especially if passengers are transferred between local and interurban cars at the same time. If a large city system occupies one side of a joint surface terminal, and a high-speed interurban line the other, it frequently becomes difficult to pass cars through on the proper schedules, on account of the inevitable irregularities of traffic in the congested thoroughfares of the larger road. A flexible track layout in such cases may often be worth all it would cost to install and maintain it.

Local conditions must obviously determine the detailed arrangement of tracks, but as far as possible these arrangements should provide for a number of fundamental needs. It is imperative that at all times the main line in each direction shall be free for inward or outward movements of cars hauling passengers on regular schedules. The higher speed cars with longer runs are preferably given the right of way past local cars which are being held at the end of their routes on the joint terminal tracks. It is destructive of good running time between distant cities to allow the movement of a fast, through interurban car to be blocked in the last three or four miles of its run by a local car of inferior power, though as the congested district is neared the interurban car cannot, of course, expect a clear track ahead unless such runs are brought into the terminal cities by less crowded routes on side streets.

The provision of a clear route at the junctions of important systems requires at least one extra track for bypassing local and through cars. This track may take the form of a middle siding with double connections at each end leading to the through tracks, or it may consist of a stub arrangement which will allow locals to be held clear of the main line pending the execution of through movements. The details cannot be properly worked out unless all the conditions are set forth, but, as a rule, the plan of spreading the through tracks to allow for one or more middle sidings with appropriate cross-overs affords the flexibility needed at all times, with special consideration of Sundays and holidays. Inspection of actual track layouts at joint surface terminals often leads to the conclusion that the arrangement of cross-overs and switches is needlessly complicated; but if dead mileage is to be cut down to the lowest possible amount, if local cars are to be brought to the end of their runs with the utmost dispatch and reversed quickly for the return trip, if passengers are to be transferred across short-width platforms without confusion and in perfect safety, if through cars are to make merely a way-station stop at the connecting points of the two systems, and if provision is to be included for the reversal of certain through cars without interference with the locals, it is clear that several hundred feet of extra track and probably over half a dozen judiciously placed cross-overs will be absolutely essential to smooth, clean operation.

On a large city system lay-overs must be allowed for cars which fall behind their normal running time, and this means the occupation of track space at the end of the routes. Lines operated upon long headway may find it possible to economize in the extra track installed where the systems join for car interchange, but as the traffic increases and the intervals diminish below fifteen minutes it becomes more and more difficult to hold cars on the main line without delaying those following. The danger of accident is also greater where no third track arrangement is provided. At important joint terminals one or more extra cars are usually held in reserve by each of the connecting roads to fill in gaps in the schedules, and these require a track space free from the routine movements of regular cars. When the traffic is heavy an inspector or starter from each company is sure to be needed to handle cars and men with promptness, and if a flexible track layout is at his command, with the telephone and signal facilities desirable, free movement is assured even in times of emergency.

Acceleration in Heavy Service

In the comparison of railway motive powers acceleration is the point upon which the fundamental difference between electricity and steam arises. It is safe to say that one of the most valuable qualities of the electric motor when applied to any class of railway service is its uniform torque throughout each complete revolution of the armature. Increased capacity for traffic springs from the quicker and more sustained acceleration of the electric locomotive and the motor car as measured against the slower and less even rise in speed of the steam locomotive under the same general conditions of loading and track. A larger volume of train movement in a given time can be handled on a given railroad section with electricity on account of the absence of smoke and steam, and independence of weather conditions which handicap the largest boiler in the production of the latter; but when all the points of advantage are set down, it is doubtful if all the other advantages of electric motive power added together balance the value of quick acceleration.

There has been no lack of appreciation of acceleration in electric railway circles during the past decade, and, as a result, the cost of securing high rates of speed increase has sometimes been overlooked. The best acceleration for a given service is a very difficult matter to determine, and it is well to bear in mind the limitations of the problem in these days of electrification on an increasingly large scale. High acceleration is intensely valuable to the engineer whose schedules are cut close to the physical limits of his motive power, but it is essential to realize that in very heavy service the demands of high acceleration are severe in the way of momentary power station output. The larger the number of train units, the less will be the immediate drain upon the power plant on account of acceleration beyond the modest standards of steam locomotive practice. An acceleration of 1 mile per hour per second is ordinarily regarded as slow work by an electric railway engineer accustomed to the currents demanded by small cars of moderate weight, yet such a rate applied to an electrified steam railroad division using motor-driven locomotives weighing from 75 to 100 tons and motor cars weighing from 40 to 60 tons means a very heavy momentary power station demand unless the traffic reaches a density which compares closely with street railway service on short headway in a large city.

A modern electric locomotive weighing 90 tons may be expected on direct current with four gearless motors to deliver a tractive effort in starting of about 30,000 lbs., assuming 25 per cent adhesion and allowing part of the weight to be carried on pony wheels. Assuming 10 lbs. per ton for train friction and a 400-ton train hauled, the total tractive effort available for acceleration becomes 51 lbs. per ton, or slightly over 0.5 miles per hour per second. Four motors going into multiple with this torque demand about 3750 amperes on that part of the acceleration line where the resistance is being cut out. It is clear from these figures, which represent values well within heavy modern practice, that the accelerations possible in elevated railway service and with the light cars operated on crowded city streets are scarcely desirable in steam railroad electrification under present conditions. Ample power station capacity is, of course, absolutely essential in heavy service; but with trains of the weight mentioned an acceleration of about ½ mile is certainly excellent work. The total energy consumption for a given run tends to decrease as the rate of acceleration increases, but the power station investment needed to back up fast acceleration with a comparatively small number of trains is something which it does not pay to overlook. An acceleration of 1.25 or even 1.5 miles per hour per second may be essential in urban rapid transit subway or elevated train service, but the fluctuations of thirty or forty such trains, composed, as they are, of smaller and lighter cars than are used in steam railroad service, are small considerations in relation to the total power demands and gradual load variations exhibited on a great city system operating from one to two thousand cars at any given moment. Here it is more a question of the comfort of passengers, coupled at times with the possible stripping of gears. Station distances are short, and the acceleration period is a large percentage of the total time of the runs. In heavy interurban service the question of voltage drop enters the case, and with increased emphasis since the price of copper became so high; and here, as in electrified steam service, more moderate rates of acceleration become desirable. The whole acceleration problem is a relative one, but the influence of high rates upon investment needs to be considered at practically all points in heavy service. Given duplicate power stations and storage batteries in the sub-stations, the question becomes less suggestive of limitations. Detailed studies of acceleration under specific conditions are certain to become instructive as heavy electric traction extends its field.

PAPERS PRESENTED AT THE NIAGARA FALLS MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, JUNE 25-28

THE CHOICE OF FREQUENCY FOR SINGLE-PHASE ALTERNATING-CURRENT RAILWAY MOTORS

BY A. H. ARMSTRONG

Owing to the success attending the several installations of single-phase alternating-current railway motors in this country and abroad, and the suitability of this type of motive power for the electrification of certain steam lines, the question has been raised whether the 25-cycle frequency thus far universally used is the frequency best adapted to alternating-current motor design and operation, or whether the benefits obtained by the use of a lower frequency are sufficient to justify its introduction. This paper is intended to open a discussion on the relative merits of 25 cycles and a lower frequency, and will touch briefly upon the advantages and disadvantages of the present standard of 25 cycles and any proposed standard of a lower frequency.

All the alternating-current railway motor installations thus far made in this country have employed 25 cycles, and, with one exception, the service has consisted of the movement of single-car units at maximum speeds of approximately 50 miles an hour at intervals of one hour headway over a single-track line. That is, all alternating-current roads have been designed to take care of interurban passenger business with the incidental movement of express matter and miscellaneous freight.

It has been found that the alternating-current single-phase commutator motor can be developed to a commercially successful stage at a frequency of 25 cycles, and although some benefits in respect to weight, efficiency and commutation are to be obtained with the adoption of a lower frequency, the advantages have not as yet seemed great enough to justify the standardization of a new frequency suitable to alternating-current commutator motor operation alone. Recognizing the enormous commercial advantage of offering an alternating-current railway motor which could operate from existing power plants, the manufacturers have perfected alternating current equipments for interurban service for the standard frequency of 25 cycles already universally in use for this class of work.

The introduction of a new frequency calling for the design and establishment of a complete new line of generating, transmitting and receiving apparatus is a most serious matter and one that should not be undertaken without very careful consideration of all factors, both commercial and engineering, entering into the case. With the coming electrification of steam roads there is a demand for motors of increased capacity, and the possible limitations of 25-cycle design in large alternating-current motors of certain types is more keenly felt, hence the inquiry at this time into the question of the proper frequency to be adopted when the alternating-current motor is selected as the type of motive power for steam road electrification.

The various points to be considered may be classed under the following heads:

The effect of frequency on design of motor equipment; the effect of frequency on coefficient of adhesion; the effect of frequency on generating and distributing systems; commercial considerations; and locomotive design and selection of motive power.

THE EFFECT OF FREQUENCY ON DESIGN OF MOTOR EQUIPMENT

Taking the weight of a direct-current motor as 100 per cent, it is probable that the values in the following table hold approximately true:

COMPARATIVE WEIGHT OF DIRECT-CURRENT AND ALTERNATING-CURRENT MOTORS

Direct Current	25-Cycle Alternating Current	15-Cycle Alternating Current
One-hour capacity 100..........	150	130
Continuous capacity 100........	125	120

These figures apply to motors designed to give in all cases the same output and heating at the same speeds, but with an admitted superiority in commutation in motors of direct-current commutating-pole design. While the weight of the 15-cycle alternating-current motor is less than that of the 25-cycle motor, this will be partly offset by an increase of 30 per cent in the weight of the step-down transformer on the car. Although the car transformer weighs but approximately 20 per cent of the complete equipment, including control and motors, an increase of 30 per cent in its weight will practically offset the reduction in motor weight when recourse is had to 15 cycles. Therefore, while there are other advantages in superior commutation, higher efficiency, etc., obtaining with the use of 15 cycles, there is no material reduction in weight of the complete alternating-current motor and control equipment.

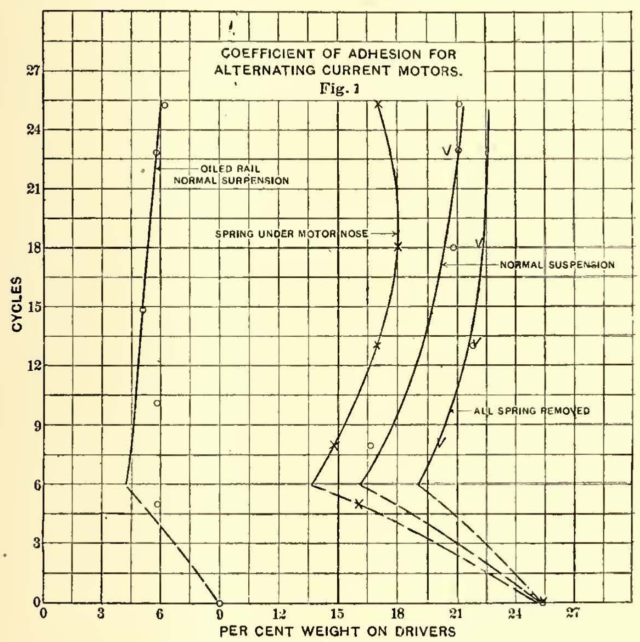
Until recently the commutation of alternating-current motors has been considerably poorer than that of direct-current railway motors in use. Various expedients, such as high-resistance leads, lower frequency, etc., have been suggested to improve the commutation and reduce the losses and heating at the brushes. Recent improvements in alternating-current motor design have resulted in the production of a single-phase motor which compares very favorably in commutation with any of the standard direct-current railway motors now in operation, although inferior in this respect to the commutating-pole type of direct-current railway motor. In fact, the commutation of the alternating-current single-phase motor has been so improved and the commutator losses so reduced with a frequency supply of 25 cycles as to make it unnecessary to adopt any of the above-mentioned expedients to eliminate commutator troubles.

Where it becomes necessary to design motors for the greatest output per cubic foot of space allowable, as in the case of very large motors designed for locomotives under the restrictions of 4-ft. 8.5-in. gage and reasonable wheelbase, it is possible that the adoption of a lower frequency than 25 cycles permits a greater latitude in design of alternating-current single-phase motors of certain types.

THE EFFECT OF FREQUENCY ON COEFFICIENT ADHESION

The torque delivered to the driving wheels by the alternating-current commutating motor is of a pulsating character, and its effective value is somewhat less than in the case of the uniform torque imparted by the direct-current motor. Experiments show that the effective torque is a function of the frequency of motor supply, and also depends upon the construction of the truck and the method of motor suspension. The values given in Fig. 1 express the relation between tractive effort and frequency for periods from 25 cycles down to zero; that is, direct current. The values given will hold true only with the combination of truck springs, motor suspension, etc., in the test, and the use of stiffer or lighter springs, more rigid or flexibly suspended motor, the use of springs between gear and axle, etc., might give results differing considerably in degree from those submitted herewith.

The three curves given represent normal motor suspension, additional spring suspension under the motor nose, and, with springs removed, giving practically rigid suspension except for the spring of the armature shaft, gear teeth, etc. While the tests are incomplete, they indicate a slight reduction in the coefficient of adhesion with lower fre-



quency; but so far as can be determined this reduction is not a serious matter in the consideration of 25 cycles or a lower frequency, say, 15 cycles. With normal motor suspension, the coefficient of adhesion as obtained with 25 cycles alternating current was 82.5 per cent of the value obtained under the same conditions with the same motor supplied with direct current.

THE EFFECT OF FREQUENCY ON GENERATING AND DISTRIBUTING APPARATUS

The question of generator design at 15 cycles is a serious one, and presents many difficulties which can only be partly overcome at an increased cost of the apparatus perfected for 25 cycles. In fact, while certain capacities of low frequency turbo-generator units may be constructed fairly comparable with 25-cycle units, it is very probable that the adoption of 15 cycles or less would seriously handicap the standardization of a complete line of such units, and will in any case increase the cost of those units which it is possible to construct. The steam turbine has shown itself a most excellent prime mover, and the adoption of 15 cycles is seriously handicapped by the difficulties opposing the successful contruction for this frequency of a complete line of generator units of all sizes.

Both step-up and step-down transformers are handicapped at 15 cycles by an approximate increase in cost of 30 per cent over that of 25-cycle design. This applies to step-up and step-down transformers used throughout the low-frequency system.

COMMERCIAL CONSIDERATIONS

Perhaps the benefits of standardization both to the customer and to the manufacturer have not been appreciated to any greater extent than in the electric railroad industry. The universal adoption of 25-cycle, three-phase supply feeding into the distributing system of railway networks constituted so strong a claim in favor of adopting this frequency when developing the alternating-current railway motor as to outweigh certain known benefits to be secured with a lower frequency supply. The great field for alternating-current motors of 150 hp capacity and smaller is on interurban lines acting as feeders to the surface, elevated and subway lines of large cities. And the ability of such motors to run from the same alternating-current generating and distributing systems without requiring the introduction of frequency-changer sets constitutes a strong argument in favor of continuing the present practice of installing 25 cycles on such lines.

The type of apparatus adopted for new installations must necessarily be largely dependent upon the apparatus already installed for similar purposes in its neighborhood, and it is a question whether, when considering the electrification of steam roads in and about large cities, engineers can afford to neglect this same principle and cut loose from standards already established and universally in use. Furthermore, steam railroad electrification often commences in station and signal lighting and car shops, and 25 cycles is already largely in use for such work. Small motors and transformers are much higher in price at 15 cycles; there is no line developed, and the station and car lighting is most unsatisfactory at this frequency.

LOCOMOTIVE DESIGN AND SELECTION OF MOTIVE POWER

One of the principal arguments in favor of the electric locomotive is that it permits the concentration of a very large amount of power on the driving wheels. In this respect the electric locomotive equipped with alternating-current series compensated motors does not compare favorably with other types of motors of both alternating-current and direct-current design. Furthermore, the successful exploitation of these other types of motive power do not demand the adoption of a frequency less than 25 cycles, and hence it is pertinent to inquire if, with our present knowledge of the art, the alternating-current, single-phase motor of the series compensated type possesses qualifications which make it so superior to other types of electric motors as to justify the introduction of an odd frequency of benefit only to that one type of motive power. The writer feels much gratified at the success attending the development and operation of the various alternating-current roads already completed, and it should be pointed out that this very success has been attained with a frequency of 25 cycles.

Admitting the coming of steam-road electrification, we have not had any demonstrations or even convincing figures submitted which would prove beyond doubt the desirability of adopting 15 cycles and the alternating-current series compensated motor to the exclusion of direct-current motors of all types and voltages, three-phase induction motors, or even single-phase, alternating-current motors of other types which can be built in large capacities at 25 cycles.

In the opinion of the writer, it becomes, not the choice of the best frequency for the alternating-current, series compensated type of motor, but a question of the proper selection of motive power for the exacting demands of locomotive construction designed for hauling trains of any weight at both high and low speeds over roadbeds of any gradient. The question of frequency might well be left in abeyance until the coming of fuller knowledge of the operation of electric locomotives equipped with motors of different types. Considered from the engineering standpoint of alternating-current series compensated motor design alone, the use of 15 cycles offers advantages in the betterment of commutation, efficiency and output per pound of motor which may justify its adoption, provided that type of motive power is best suited to the needs of the problem in hand. Taking into account, however, the commercial interests involved, and considering the serious claims that may be advanced in favor of other types of electric motors for which a frequency of 25 cycles is well suited, it appears to the writer that much stronger claims for recognition must be brought forth before the adoption of 15 cycles can be seriously considered.

TWENTY-FIVE VERSUS FIFTEEN CYCLES FOR HEAVY RAILWAYS

BY N. W. STORER

At the regular meeting of the Institute, on January 25 of this year, a paper was presented by Messrs. Stillwell and Putnam dealing with the electrification of steam railways and referring briefly to the question of the adoption of a standard frequency for single-phase railways. This question aroused a great deal of interest and was discussed at greater length than any other feature of the paper. The authors, while enumerating the advantages of both 25 and 15 cycles, drew the conclusion that the advantages were greatest on the side of the lower frequency, and this opinion was concurred in by most of those who discused the matter. Many good points were brought out, but all were more or less general; and while it is obviously impossible for the Institute to standardize at this time a frequency for railways using alternating current, a free and full discussion of the matter can hardly fail to produce good results and to furnish more definite information than was available at the time the paper was presented. The arguments in favor of 25 cycles may be reduced to the following: (1) It is a standard frequency which is in use in a great many plants throughout the country. (2) It is probably better suited for general power distribution and is certainly better for lighting than 15 cycles; therefore, any railroad having a 15-cycle plant for operating its road would be somewhat handicapped in power for lighting and shop purposes. (3) The higher frequency is better suited for speeds of steam turbines of small size, it being at present uneconomical to build turbo-generators for less than 2000 kw at 900 r. p. m., which is the maximum available for 15 cycles. (4) Transformers are lighter and cheaper for 25 cycles.

The principal arguments in favor of 15 cycles are: (1) An increase of from 30 to 40 per cent in the output of a motor of a given size and a consequent reduction in the total number of motors required to operate a railway and in the cost of equipment. (2) Better performance of the 15-cycle motors, including higher efficiency, higher power factor and better commutation. (3) Less dead weight to be carried on cars and locomotives. (4) Lower line losses.

The first argument in favor of 25 cycles, namely, that it is a standard frequency in use in a great many plants of the country, is certainly a good one. It is undoubtedly a very serious matter to consider the introduction of a new frequency for any purpose whatsoever. There are, as is well known, a number of frequencies in use at the present time for which there is no justification except that they are in use, and there is no class of service of which we know that cannot be handled with equal efficiency by one of the standard frequencies, with the exception of the alternating-current railway systems. Railway electrification, if developed as every electrical engineer hopes it will be, will mean an undertaking of such magnitude as to make it practically independent of other electrical interests, so that if a frequency differing from the standards now in use will be advantageous it should be adopted.

The second argument in favor of 25 cycles, namely, that it is better suited for power and lighting purpoes than 15 cycles, may be granted without admitting that it is a particularly valuable point. Satisfactory lighting can be obtained with 15 cycles by using a low-voltage lamp having a large filament with high thermal capacity. This will be entirely suitable for ordinary railway lighting. Fifteen-cycle induction motors, while not having as wide a range of speed as is possible with 25 cycles, can undoubtedly be used to accommodate practically any class of service required of them, and the fact that the single-phase commutating motor is more satisfactory on the low frequency may make the low frequency even more satisfactory for shop purposes than the high frequency. In the discussion of the Stillwell-Putnam paper one speaker called attention to the fact that railway companies would probably sell a large amount of power along their right of way to consumers for various purposes, and stated that 15-cycle current would be unsuitable for such service. In reply to this, it is only necessary to call attention to the fact that the voltage on any railway circuit is so variable as to make it absolutely unsuitable for lighting purposes, and it would, therefore, be necessary to introduce a motor-generator set to get good results. This might just as easily be made a frequency-changer to supply current at either 25 or 60 cycles, as might seem best for that particular locality. While this unquestionably destroys some of the simplicity of the scheme, it is undoubtedly what would be necessary in order to give satisfactory service, even if 25 cycles were in use on the railway, unless a separate generator were used for the lighting circuits. It seems, therefore, that the 15-cycle current would be little or no handicap to the railway company in this respect.

The third argument, namely, that the higher frequency is better suited for speeds of steam turbines, is undoubtedly true, but it affects a very small proportion of the work. Heavy railroads will require in practically all cases larger generators than 2000-kw units. In cases where they do not, high-speed turbines can be used and frequency-changers employed. At the same time, we must admit that the last word in regard to steam-turbine design has not yet been spoken, and it may shortly be an easy matter to make comparatively small units for use with 15-cycle generators.

The fourth argument, that transformers are lighter and cheaper for 25 than for 15 cycles is undoubtedly true. There will be a difference of probably 25 per cent in the cost of the transformers for any given service. This difference must be offset by the difference in the cost of the motors.

The meat of the entire argument for the lower frequency is in the greater output of the motors for a given size and weight. It was well shown in the Stillwell and Putnam paper that the cost of car equipments and locomotives would far overbalance the cost of power houses and transformer stations; and while I do not wish at this time to give a mass of estimates as to the saving, I will adhere to the statement previously made that the output from a motor of a certain size will be increased from 30 to 40 per cent by the use of 15 instead of 25 cycles. This has been proved by tests on several different motors.

A well-known 100-hp, 25-cycle motor operates with full load at a speed of 620 r. p. m., and in the regular one-hour test on the stand has a temperature rise of 89 degs. C. in commutator and 75 degs. C. in armature, other parts of the motor being well below 75 degs. C. This motor operated at the same speed on 15 cycles carried a load of 113 hp with a maximum rise in temperature in commutator of 76.5 degs. C. and in armature of 72.5 degs. C. It is safe to say it is good for 115 hp with the limiting temperature of 75 degs. C. in armature. This same motor with a larger number of turns on the field and run on 15 cycles carried at the same speed of 620 r. p. m. a load of 135 hp with a rise in temperature in commutator of 76 degs. C., in armature of 75 degs. C. and in field coils of 76.5 degs. C. It is quite safe to rate this motor at 135 hp on 15 cycles.

A larger motor carried a load of 225 hp with a temperature rise of 71 degs. C. in commutator and 76 degs. C. in armature, other temperatures being well below 75 degs. C. This motor, operated at the same speed under identical conditions on 15 cycles with a load of 300 hp, rose 73 degs. C. in commutator and 81 degs. C. in the armature. With new field coils having more turns the motor will carry at least 325 hp and probably 340 hp with a rise in temperature not exceeding 75 degs. C.

While these results are all based on the one-hour test, the continuous capacities will have the same increase on 15 cycles. The inference to be drawn from these results is, of course, that the temperature rise being the same for both frequencies, the losses must be approximately the same, and since the output is greater on 15 cycles, the efficiency must, therefore, be much higher. Further, the tests are all based on 25-cycle motors modified only in field coils. If the motors are designed especially for the low frequency, the results will be still better.

A comparison of the weights of car equipments for 25 and 15 cycles indicates that there will be an advantage in favor of the lower frequency, even with the same number of motors. For instance, a four-motor equipment of 100 hp, 25-cycle motors, with oil-insulated transformer, will weigh approximately 30,000 lbs. Such an equipment for 15 cycles would weigh approximately 28,500 lbs. The difference is small, but it is in favor of the lower frequency. If two 15-cycle motors of 200 hp each, such as are now building, be furnished, the weight of equipment will be reduced to approximately 23,000 lbs., or a reduction of 23 per cent in the weight of the car equipment. While it is perfectly practicable to furnish two motors for a 400-hp equipment for operation on 15 cycles, it will be necessary to furnish three or four motors for 25 cycles on account of the great increase in the size of the motor. It is, therefore, absolutely necessary that the 25-cycle equipment weigh considerably more than that for 15 cycles. In the case of smaller motors aggregating 280 hp it is possible to furnish a two-motor equipment operating on 25 cycles. There would, however, be a difference in weight of at least 1500 lbs. in each motor in favor of the 15-cycle equipment of the same capacity. This would offset the increased weight of the 15-cycle transformers by at least 1000 lbs. In every case, therefore, even where the same number of motors are in use for both frequencies, the 15-cycle equipment will be lighter, and on account of the smaller motors the motor trucks will also be lighter, the amount of saving here depending upon the size of the motor.

The greatest gain from the use of 15 cycles is to be found in heavy railroading where locomotives are used. In building locomotives it is desirable, on account of the weight, cost and maintenance charge, to concentrate the power in as few motors as possible consistent with weight on the drivers and the tractive effort desired. We have found that in virtually all cases the weight of useful apparatus on the drivers, even with 15 cycles, is sufficient to give the necessary adhesion without adding dead weight; therefore, the use of 15 cycles means that in practically all cases for the locomotive a smaller number of motors can be used than is possible with 25 cycles. It is frequently the case that three motors which are sufficient with a certain size of driver for 15 cycles would have to be replaced by four motors having the same dimensions. It would sometimes happen that three motors necessary for 25 cycles could be replaced by two of the same dimensions for 15 cycles. In the case of locomotives of very high speed the extra weight entailed by the use of higher frequency motors, and consequently heavier mechanical parts, would increase the weight of the train to such an extent as to call for a considerably larger output from the motors, simply to haul the extra weight. Such a case we have in mind in a high-speed passenger locomotive which has recently been built. This locomotive is designed to haul a 400-ton train both on heavy grades and at high speeds on level track. The locomotive as built for 15 cycles weighs approximately 140 tons and has four motors, each with a nominal rating of 500 hp. With a 400-ton train behind it this locomotive would thus have to handle a total of 540 tons. A 25-cycle locomotive built to handle a 400-ton train at the same speeds and on the same grades would require six motors of approximately the same dimensions, and these extra motors, together with the extra weight of mechanical parts, would bring the total weight of the locomotive up to approximately 185 tons. The total weight of train would thus be 585 tons, or an increase of about 8 per cent. The capacity of these motors would be in the neighborhood of 375 hp, which would be just about sufficient to handle the extra weight. It must be seen at once that the motors for this locomotive would cost 50 per cent more and the mechanical parts also considerably more. The only parts of the equipment which would cost less would be the transformer and preventive coils, and the control equipment would be enough more expensive to counterbalance this.

In this connection it may be of interest to give a brief description of the locomotive as built. It is of the articulated type, each half of which has two pairs of drivers and a four-wheel truck similar to the standard American type of steam locomotive, the two halves being coupled back to back. The drivers are 72 in. in diameter with 7 ft. 6 in. between centers of axles. On each axle is mounted a gearless motor having a nominal rating of 500 hp and a continuous capacity with forced ventilation of about 375 hp. The motors, weighing approximately 19,500 lbs., are spring-supported, mounted, and connected to the drivers in exactly the same way as the motors on the single-phase locomotive for the New York, New Haven & Hartford Railroad; this feature has been described so many times that it is unnecessary to repeat it. The frame of the locomotive is of the standard steam locomotive type placed outside of the wheels. It is of cast steel connected at the front and rear and at three places between the ends by heavy cast-steel girders. The truck, which is of the standard steam locomotive pattern, has 36-in. wheels, with a wheel-base of 6 ft. 2 in.

The electrical and other equipment in the cab is mounted on a raised platform which is about 2 ft. above the floor-line and occupies the middle of the cab, allowing for a passageway on either side. There are numerous windows along the sides of the cab which afford excellent light for the inspection of the apparatus. The equipment is extremely simple and accessible. The main transformer, which is designed for 11,000 volts, is mounted above the truck with the top just below the platform in the cab. Directly above the transformer is located the electropneumatic switch group to which the various taps in the transformer are carried. Back of the switch group are the preventive coils used in passing from step to step on the transformer, and from these preventive coils runs a single lead to the reverser switch group, which is placed directly above the main motors. On this raised platform are also placed the motor-driven air compressor, the motor-driven blower for furnishing air for ventilation of the motors and transformer, and the air reservoirs. Suspended from the structural work between the platform and the Z-bars in the roof of the cab are the oil circuit-breaker in the high-tension circuit leading to the transformer, the small switches used in connection with the auxiliary motors, and the 20-volt battery which is used for operating the valve magnets in the controller. The high-tension current is collected from the overhead wire by the standard type of pantagraph trolley. It will be noted that on account of the large drivers and the comparatively high position of the apparatus in the cab that the center of gravity of the locomotive is higher than usual in electric locomotives. The riding qualities of the locomotive are exceptionally good. The weight of the locomotive, as stated, is 140 tons, there being 50.000 lbs. on each driving axle and 40,000 lbs. on each truck.

In the case of geared locomotives for heavy freight service, there is still the advantage in favor of 15 cycles. Where the same number of motors is used for both frequencies, it will be necessary to use larger wheels for the 25-cycle locomotive. Low-speed locomotives are especially at a disadvantage with 25 cycles. It is possible to make a geared motor with a capacity of 400 to 450 hp for slow-speed freight service with 15 cycles, while with 25 cycles a 300-hp motor is as powerful as it is practical to use. This means that in the freight service we have virtually the same condition as in passenger service, namely, that about one-third more motors will be required to perform the service. The locomotive will weigh from 10 to 35 per cent more.

An examination of the efficiency curves for 15-cycle motors compared with those for 25 cycles will show differences in the losses in the motors alone which will mean a considerable difference in the capacity of the power station. This, when added to the power required to haul the extra weight, and the increased line loss due to the higher frequency, will make a difference of 5 to 15 per cent in favor of the 15-cycle equipment. Without giving estimates or long tabulated statements, I leave it to the judgment of the members of the Institute to decide whether it is not advisable, with these facts staring us in the face, to recommend a new frequency. It is well known that when the advent of the first successful single-phase railway motor was announced by Benj. G. Lamme in his historic paper before the Institute in 1902, the frequency which he advocated was 2000 alternations per minute, or 16 2/3 cycles per second. It was believed at that time that this frequency was the best suited to meet the many requirements of power plants for railway apparatus. However, owing to the experimental nature of the undertaking, it was deemed advisable to use the standard frequency of 25 cycles temporarily until the commercial success of the system was assured. At the same time, it was realized that the practical difficulties to be overcome in the single-phase system would be much greater with the higher frequency. Moreover, in the first equipments sold the motors were of comparatively small size, so that the space occupied by them was not limited. Furthermore, the number of motors in an equipment was fixed by conditions other than dimensions and weight, four-motor equipments being selected in nearly every case, partly on account of the prevailing fad for four-motor equipments and partly because most of the equipments were built for operation on both alternating current and direct current. At any rate, aside from the greater difficulties met with in the design of the high-frequency motor in order to secure good performance, the question of frequency was of comparatively small importance. Since that time some fifteen or twenty roads have been put in commercial operation with single-phase current at 25 cycles, and it has been proved beyond doubt that the single-phase motor is a thoroughly practical and commercial machine. At the same time, as was anticipated, all our experience goes to show the advantage to be gained by the use of a lower frequency. This frequency need not be fixed at exactly 15 or 16 2/3 cycles. As far as the motor operation is concerned, a variation of one or two cycles either way will have comparatively little effect; but we believe, for the sake of using proper ratios between this and existing frequencies, that 15, which is one-fourth of the standard 60-cycle frequency, or 16 2/3, which is two-thirds of the standard 25-cycle frequency, should be adopted for use, especially on heavy railroads. While this will undoubtedly make it necessary for the manufacturing companies to keep a larger variety of apparatus in stock (as there is no doubt that 25-cycle railways will be operated for a long time to come), the advantage to be gained from the lower frequency in the wider use of apparatus will far outweigh any slight disadvantage of this kind.

The mistake made by the blacksmith when he made the template which fixed the gage of the standard railways at 4 ft. 8.5 ins. is a matter of tradition. It is recognized as being one of the most far-reaching mistakes ever made, inasmuch as it has ever since placed a limit on the capacity of the railroads of our country, both by limiting the capacity of steam locomotives and the size of cars, and last, but not least, the capacity of electric railway motors and locomotives. What an enormous benefit would be gained from even a paltry increase from 4 ft. 8.5 ins. to 5 ft. What powerful machines could be built for a gage of 6 ft. But the mistake has been made, and it would cost so much to rectify it that the boldest of our railway magnates is staggered by the suggestion.

Electrical engineers have an enormous responsibility in deciding upon matters of detail, such as frequency, which will have an effect that will far outlast anyone who has a voice in the matter; and it certainly behooves us as engineers to consider carefully before recommending the continuance of the present standard frequency of 25 cycles, where it imposes such a handicap on the capacity of our transportation systems.

SINGLE-PHASE VERSUS THREE-PHASE GENERATION FOR SINGLE-PHASE RAILWAYS

BY A. H. ARMSTRONG

The introduction of the alternating-current, single-phase railway motor calling for a single-phase secondary distribution system makes it pertinent to inquire into the question of power generation and primary distribution for such systems. While the simplicity of single-phase generation and distribution is unquestioned, it is not always possible or desirable in these days of general power distribution to install a generating station and primary distribution system capable of taking care of alternating-current railway load alone to the exclusion of synchronous converters and other receiving machinery requiring three-phase input.

As the use of either single-phase or multiphase generators seems to be open to certain objections, various meth-

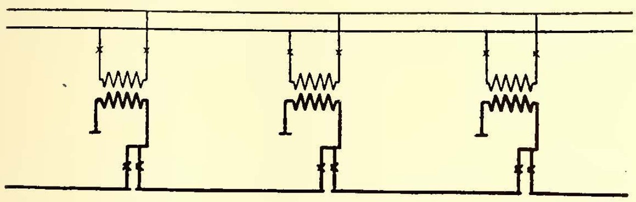


FIG. 1.—SINGLE-PHASE PRIMARY AND SECONDARY DISTRIBUTION

ods of distribution are presented herewith, with some of the advantages and disadvantages pertaining to each.

SINGLE-PHASE GENERATION

Single-phase generation and transmission makes it impossible to use synchronous converters, self-starting synchronous motors, or induction motors starting under load. It is poorly adapted to general power distribution and is largely limited in its application to alternating-current railway operation alone; its use is, therefore, open to grave objections of a commercial nature where there exists any possibility of selling power or in any way utilizing it for general converter and motor work.

The single-phase generator has an unbalanced armature

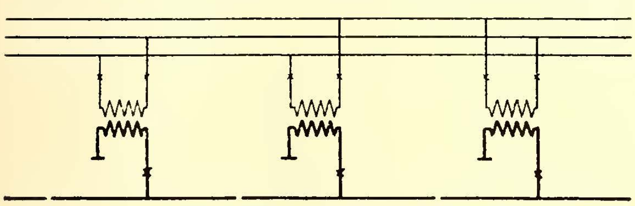


FIG. 2.—THREE-PHASE PRIMARY AND SINGLE-PHASE SECONDARY DISTRIBUTION

reaction which is the cause of considerable flux variation in the field pole-tips, and, in fact, throughout the field structure. Such generators must, therefore, be constructed with thinner laminations and oftentimes poorer mechanical construction to minimize eddy currents, resulting in increased cost of the generator. The large single-phase armature reaction results in a much poorer regulation than that obtained with three-phase generators; it calls for increased amount of field copper and more liberal design which, with the larger exciting units required, brings the cost of the single-phase generating unit throughout considerably in excess of that of a three-phase unit of the same output and heating.

The difficulties of single-phase generator construction appear to increase with any reduction in frequency, and the adoption of any lower frequency than 25 cycles may result in serious difficulties in construction for a complete line of machines of the single-phase type, especially of the two or four-pole turbine-driven type, where the field flux is very large per pole.

Against the difficulty of single-phase generator construction, its greater cost and poorer efficiency, there is the great advantage of simplicity in the entire generating, primary and secondary distribution system for single-phase roads. This advantage is so great that it justifies considerable expense; looked at from the railway point of view only, the single-phase system throughout may be considered as offering the most advantages.

THREE-PHASE GENERATION

Three-phase generation and distribution is in almost universal use. Many single-phase railways receive power from such systems, and the commercial advantages resulting from the use of such generators may in certain cases justify

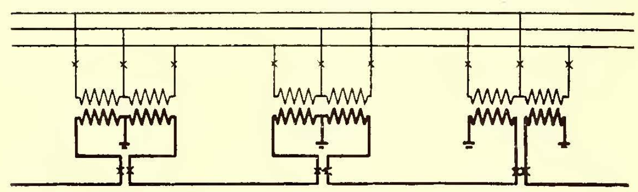


FIG. 3.—THREE-PHASE PRIMARY AND SINGLE-PHASE SECONDARY DISTRIBUTION

the complication of single-phase secondary distribution obtained from a three-phase source. As these commercial advantages are in many cases controlling, various combinations of three-phase-single-phase connections are presented herewith.

THREE-PHASE GENERATION AND PRIMARY DISTRIBUTION TO MOTOR-GENERATOR SETS FEEDING INTO THE SINGLE-PHASE SECONDARY DISTRIBUTION

This system has all the advantages of obtaining power from a three-phase distribution which may also feed synchronous converters and general power load, and is independent of the frequency of the generating system, being equally adapted to 60 or 25 cycles. Its disadvantage lies

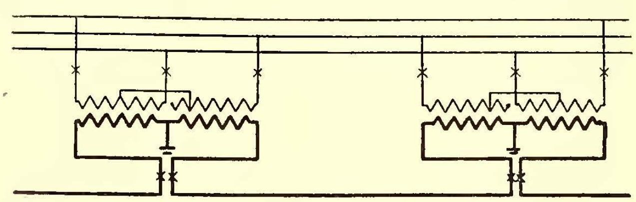


FIG. 4.—THREE-PHASE PRIMARY AND TWO-PHASE SECONDARY DISTRIBUTION

in the cost of the motor-generator sub-station, but it is the only system which will give perfect balance on a three-phase distribution system.

THREE-PHASE GENERATORS OPERATING ALTERNATING-CURRENT RAILWAY LOAD ON ONE LEG, THUS CALLING FOR BOTH PRIMARY AND SECONDARY SINGLE-PHASE DISTRIBUTION

Commercial considerations of possible future synchronous converter or power load may justify the installation of three-phase generators designed for single-phase output for railway load and three-phase output for general power distribution. This system is open to the objection of serious unbalancing due to railway load on one phase only, and this unbalancing may be so great as to cause undue heating in synchronous converters, synchronous motors and induction motors fed from the unequal potentials of all three legs of the three-phase generator. Tests have been made which indicate that receiving apparatus may have its capacity reduced from 30 to 50 per cent with normal heating with the unbalancing caused by single-phase railway load fed from a three-phase generator in commercial operation.

A three-phase generator run as single-phase is open to all the objections of excessive armature reaction, poor regulation, pulsating flux in field structure noted above for single-phase generators, and such generators must be rated single-phase at two-thirds or less of their output when operating on balanced three-phase load.

THREE-PHASE GENERATION AND PRIMARY DISTRIBUTION TO SUB-STATION, FEEDING SUCCESSIVE TROLLEY SECTIONS WITH SEPARATE PHASES

Where the length of the road is sufficient to permit sectionalizing the trolley into three sections, or multiples of three, having an equal load on each section, this method provides for balancing the three-phase load, thus securing full output of the generator, non-interference with power load, etc. Each sub-station must contain two sets of transformers connected to separate phases, so that adjacent substations may feed like phases into a common trolley section extending between them. The installation of a single transformer in each sub-station would necessitate the sectionalizing of the trolley midway between sub-stations, hence losing half the effective value of the copper as obtained with the trolley sectioned at the sub-stations and two adjacent sub-stations feeding a common trolley section.

This method of securing a balanced three-phase load is open to the objection of complication and possible ineffectiveness, with serious disarrangements of schedule such as take place in railway operation during different periods of the day and season.

TWO-PHASE GENERATION, GENERATING STATION LOCATED IN CENTER OF SYSTEM AND FEEDING ONE PHASE EACH WAY

So long as the load is balanced upon the two primary distribution systems, this method of connection is capable of good results; but operation under the necessities of commercial service shows it to be very difficult to balance the load upon the two phases, thus resulting in considerable unbalancing and extreme voltage variation on the less loaded leg. This same criticism holds true of the third method.

THREE-PHASE GENERATION AND PRIMARY DISTRIBUTION TO TRANSFORMER SUB-STATIONS CONNECTED THREE-PHASE-TWO-PHASE AND FEEDING SECONDARY DISTRIBUTION IN SUCH MANNER THAT ADJACENT SUB-STATIONS FEED LIKE PHASES INTO A COMMON TROLLEY SECTION

This method of connections is capable of giving good results in operation, although occasional series unbalancing may occur in the primary distribution with a disarrangement of schedule or improperly proportioned trolley sections. Each sub-station must contain two transformers for regular service, and possibly one spare, which, together with the necessary switchboard arrangement, increases the complexity and cost of such sub-station compared with simpler arrangement possible with straight single-phase distribution.

There are other methods of connection, such as independent transmission lines to several outlying sub-stations, thus giving the generating station operator the opportunity to balance the load on the several phases of the generators; but the methods outlined are those commonly proposed for single-phase secondary distribution used in connection with three-phase generation and primary distribution.

GENERAL CONCLUSIONS

The matter of proper selection of generating apparatus for single-phase roads seems to be closely connected with questions of a commercial character relating to a possible future load requiring a three-phase input. From a purely engineering standpoint, and considered from the point of view of the railway load only, the single-phase system of generation and distribution is to be recommended. The possible installation of generators having a lower frequency than 25 cycles would help this decision, owing to the unfitness of such a low frequency for general power distribution work.

Of the several methods of single-phase combinations proposed, the motor-generator set best protects the three-phase distribution system where power is purchased from foreign distributing systems, and such a method presents many advantages which may outweigh its increased first cost. Where the railway company finds it expedient to generate and distribute its own power from three-phase generators, the use of a single leg for the railway load or the installation of three-phase-two-phase transformer sub-stations—both seem to offer advantages justifying their recommendation, and the choice between the two may perhaps be left to the needs of local requirements.

COMMUTATING-POLE DIRECT-CURRENT RAILWAY MOTORS

BY E. H. ANDERSON

To appreciate the development and reasons for the existence of a commutating-pole railway motor, it is well to discuss in some degree some other developments. In the beginning, railway motor designers had many difficulties to contend with.

The question of gearing was possibly foremost, whether it should be single or double reduction or possibly gearless. All these were tried with more or less success. The pendulum swung back and forth from this point, but it has settled partly and is still settling. The small motor (automobile) is now more usually double reduction; however, in some cases, single reduction is used where weight is not of importance. The usual railway motor has settled down to single reduction. In the larger railway motor, where the work approaches that of a locomotive, it is often questionable whether single reduction or gearless should be used. When powers are small, as in the case of single-car units, the motor is naturally provided with single-reduction gearing. Then, again, for large locomotives and high speeds, obviously the motor should be of gearless construction, this being especially true in the light of what may be done with gearless bipolar motors of direct-current design.

Possibly insulation is next in order, various methods having been tried. The conductors have been covered with a variety of materials, but double or triple cotton-covered insulation has practically become standard. The slot insulation has been through various changes; for wire-wound machines it has settled down to a good varnished cambric with a protecting tape of cotton, although an all-asbestos insulation of armature coils is promising. Where bars are used as armature conductors, it is possible to insulate them entirely with mica. This type of insulation has been fully developed and may be considered as standard. The field insulation has long been in a state of evolution, but is pretty well standardized on a basis of mica in metallic shells for the larger ribbon-wound field-coils, and varnished cambric for the smaller fields wound with wire. Here also an all-asbestos insulation is promising.

The present method of lubricating the bearings with oil has resulted from a process of elimination, many forms of grease-cups, oil-cups, wicks, etc., having been tried; in fact, the preferred lubrication at one time was grease. With the advent of interurban trolley roads came greater speeds, giving rise to many more car-miles per day, and complaints arose of short life of bearings, injury to armatures, etc. The methods of lubrication underwent many changes, but are now well established as wool-waste and oil; no doubt a good solution of a difficult and important problem.

During this period of development the armature was changed from a smooth to a slotted core, and much thought was given to the size of commutator, number of segments, turns per coil, etc., in the effort to produce successful operation of the commutator. With all forms of copper brushes there was most destructive sparking and enormous local currents in coils short-circuited by the brush during commutation. The carbon brush was tried and found to be the greatest improvement yet discovered in producing successful commutation. The greater contact resistance decreased the local currents to reasonable values, yet the energy lost by the greater contact resistance in the main circuit was small. The carbon brush thus opened up possibilities in design not before thought of.

The inductance of coils was reduced by placing two in

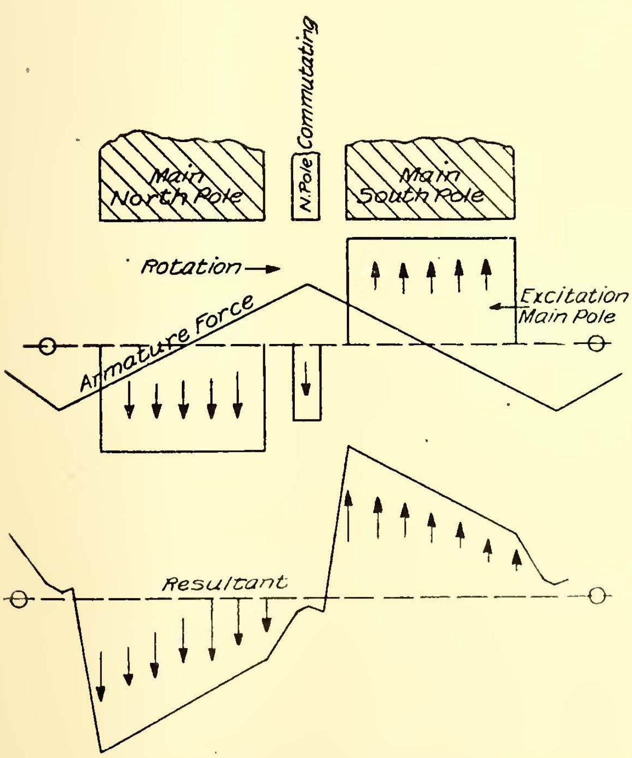


FIG. 2.—DISTRIBUTION OF MAIN FLUX IN THE POLE FACES

one slot instead of one, thus saving insulation and reducing the diameter of the armature. Later came the three coils per slot armature, this being the standard for many motors to-day.

As motors had to be built to fill a restricted space, not only for large power and small diameters, but with good commutation at higher potentials, it gave rise to the four and five coils per slot armature. Many coils per slot necessarily increased the slot width, and this in time called for a laminated-field pole structure in order to limit eddy-current losses. In the meantime the operator was demanding higher potentials, more work from the motors and better commutation, and the commutation had not kept pace with

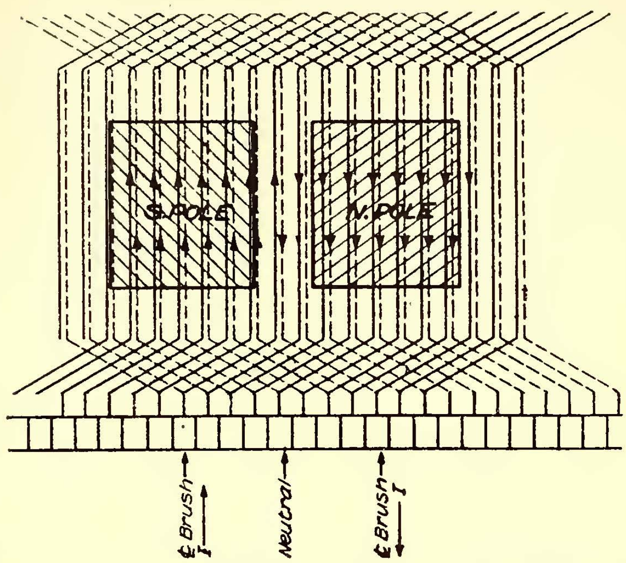


FIG. 1.—D. C. SERIES DRUM ARMATURE, THIRTY-THREE SLOTS AND ONE COIL PER SLOT

other developments; in fact, was becoming more troublesome as compared to other difficulties, largely on account of higher operating potentials. Some means had thus to be adopted for radically improving commutation, and the following pages deal more particularly with this subject.

The armature in its simplest conception is a drum, divided into four sections for four poles; under a north pole is a broad distributed sheet of current running parallel to the shaft; under a south pole is also a broad distributed sheet of current, but in a reverse direction.

This distributed armature current produces a magnetizing force which changes the distribution of the main flux in the pole-faces, as shown in Fig. 2. It will be seen that in the center of the pole there is no distributing effect, but in the center between poles there is the maximum magnetizing effect from the armature. This is where the conductors are commutated by the brush and the direction of the current reversed in passing from the zone of one pole to the zone of the next.

The magnetizing effect of the armature, being a maximum midway between poles, produces a flux through the air space to the frame. The conductors in motion cut this flux, producing a voltage in the coil to be commutated.

The combined result of armature and field magnetizing effect is to cause a flux to leak from the pole-tip over into the armature just where the conductors are being commutated.

The two leakage fluxes are alike and add to produce voltage in the coil which is being commutated. Thus there is a potential between commutator bars, and when these are short-circuited by the brush a local current is caused to flow in the coil under commutation. This local current adds to the line current already there. Any conductor carrying current has lines of force interlinked about itself caused by the current in the conductor. The conductors, imbedded in and surrounded on three sides by iron, have a good opportunity of surrounding themselves with a lot of leakage flux. The interleakage of leakage flux is similar to the inertia in mechanics.

The combined current (line and local) has still greater interleakage of leakage lines and becomes more difficult to reverse. The reversing has been done heretofore by the increasing resistance of contact between the brush and the commutator bar as the latter is passing out under the brush, the rate of change of current ever increasing. This causes the reactance or kicking voltage to become higher and higher. As the bar leaves the brush, the change in current in the coil becomes so rapid that an appreciable voltage is induced and arcs through the air from the bar to the brush, or vice-versa, thus producing what is commonly known as sparking.

The object is, then, to remove the sparking by counteracting one, or all, of its causes. Should we place midway between the main poles another coil, having the same magnetizing power as the armature, but so connected as to magnetize in the reverse direction to the armature, there would be nothing to cause a leakage flux from the armature to the

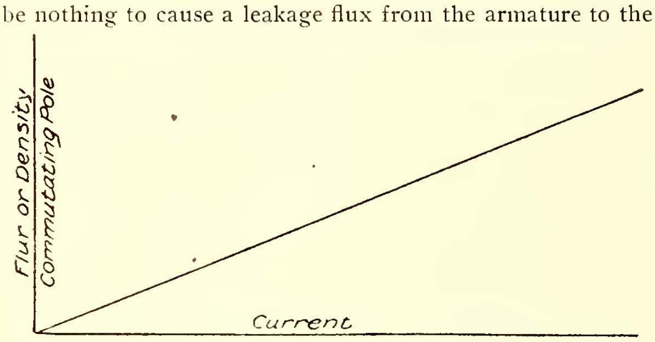


FIG. 3.—RELATION BETWEEN COMMUTATING-POLE DENSITY AND CURRENT

frame. Then, again, should we further excite this coil so as to overcome and balance the combined effect of armature and field forces, commonly known as distortion and leakage of the main flux from the pole-tip, we would annul this troublesome cause of sparking. After the above two effects are taken care of, there remains a force necessary to produce a potential sufficient to reverse the current in the armature coil.

To produce this potential there must be such a density of flux as will generate this required voltage by the conductors cutting same in revolving. The width of such magnetic density should be sufficient to embrace the conductors commutated by the brush when running in either direction or rotation.

The commutating voltage produced by the flux of the commutating pole is the accelerating force required to change the direction of current in the armature coils one by one as they come under the brush. It must be sufficient to accomplish this in the time that the coil, being connected to two adjacent commutator bars, is under the brush. When the commutator bar leaves the brush the current is already reversed, flowing in proper direction, and is of the proper amount, so there is no tendency to spark. Commutation may then be said to be perfect.

As stated before, an armature coil imbedded in iron is surrounded by a leakage flux, which is caused by the current in the coil, and may be said to have magnetic inertia or momentum. This is similar in mechanics to a revolving shaft bearing a mounted fly-wheel. The voltage induced in the coil by the flux from the commutating pole may be likened to a constant counter torque, this counter torque serving to slow down the revolutions, stop, and cause an increase in speed in the opposite direction.

It is evident that there may be a particular armature current, speed of motor and flux from commutating pole wherein the above described conditions will obtain. It will also be appreciated that the voltage induced by the commutating pole flux will vary directly as the speed; furthermore, the time that the coil is under the brush is shorter as the speed is higher, and vice-versa; also that the time required to reverse a current is inversely as the voltage. The conclusion is that the action is entirely automatic throughout the entire range of speed with the particular condition of current and commutating-pole density.

The next question is: Can the action be automatic for varying current as well as speed? The commutating pole may be excited by the main current of the motor, being connected permanently in series with the armature. The commutating-pole flux will then vary almost directly as the current, which is the desired result. When the current is half, the commutating-pole flux is half, and the commutating voltage corresponding thereto. Thus the action is entirely automatic for variation in current or speed, or both.

Fig. 3 shows that the relation between commutating-pole density and current should be a straight line, rising and falling directly with the current. It is well understood that an absolutely straight line between current and density cannot be obtained when a more or less saturated iron circuit carries the flux, but it can be approached sufficiently close for all practical purposes by careful design and experience in these matters. In a series motor the density of the whole iron circuit increases as the load comes on, and there is an increasing stability in commutation which serves to offset, partly, if not entirely, the lack of commutating-pole density on high load. The combined effect is to produce perfect commutation at all loads.

Since the commutation is automatically taken care of for variations in speed and current, it is possible to change the voltage impressed on the motor through quite a range without sparking. This is thoroughly borne out by motors of 50 to 250 hp, recently constructed in this country.

The only limitations in raising the voltage are: Armature speed and strength of binding wire; volts between bars, and insulation.

This brings us naturally to the question: What effect will this commutating pole have on designs for voltages higher than are now general for railway service?

Railway-motor commutators before being connected to the armature winding are tested from bar to bar with 400 to 500 volts, alternating current, which means a maximum of 40 per cent more, so that actual jumping of current from bar to bar on a clean commutator would not occur at less than 500 volts per segment. An ordinary commutator of 111 segments and four poles would, under these conditions, be good for 13,000 volts between brushes. The actual jumping of current across side micas of a clean commutator is not the limiting condition.

Our limiting condition is the voltage per bar which will maintain an arc already established. The allowable voltage per segment is largely dependent upon the condition of the commutator. The condition of commutator depends upon the deteriorating tendencies, such as sparking and other causes, like poor carbon brushes, hard side micas, etc.

If the sparking be eliminated, the etching of the commutator bars is largely reduced. The carbon brushes are required to carry only the line current, instead of the line and a large amount of local current; therefore, the brushes are not disintegrated so rapidly. The carbon brush has less mica to wear off, because the bars are not burned away.

The result is that the carbon brushes work better, and the commutator stays in a very much better condition. The conclusion from the above is that much higher average volts per segment may be used with commutating-pole motors than with motors not having commutating poles.

The usual non-commutating-pole railway motor, 40 to 50-hp, has a commutator about 9.5 ins. in diameter, with 111 to 125 segments. The average potential between segments is approximately 18 volts. Large motors, operating on 650 volts normal, have 155 to 165 segments, and the average potential between segments is approximately 17 volts. If the average volts between segments on commutating-pole motors be assumed as 24, and the number of commutator bars per inch of circumference as 5, we have the following possible voltages on various sizes of motors and commutator diameters:

H.P.	Diameter of Commutator	Maximum Volts Motor
40	9	850
75	11	1040
100	13	1230
150	14.5	1370
200	16	1510
250	18	1700

The above may be said to apply only as far as tendencies are concerned. Not all these various voltages would be practicable. It would be better, for various reasons, to adopt 1200 volts as the higher standard.

The propositions requiring higher potential than 600 volts are usually 30 to 50-ton cars with speeds of 40 to 60 miles per hour. These call for a motor of 75 hp or larger, so the sizes naturally fall where 1200 volts can be made with reasonable cost.

The commutating-pole motor, on 600 volts, makes possible commutation and general operation in service many times better than that of the non-commutating pole motor. On 1200 volts the commutation is decidedly better than with a non-commutating pole type motor on 600 volts. The 1200-volt motor requires proportionally more insulation than the present 600-volt motor. This extra insulation requires more diameter and more external dimension.

We have the possibility of 1200 volts per motor, the motor having four poles. Should the motor be bipolar and the speeds high enough to make the design possible, we may have 2500 volts per motor. Then again, if there should be two windings on one core, a commutator on each, and these windings connected in series, we have the possibility of a 5000-volt motor. Then again, should we have a double-track railway and the rail neutral, we might have 10,000 volts direct current between the two trolley wires.

It will be appreciated that more voltage means more insulation, more space, and more cost. It will also be seen that the control, car lighting and operation of auxiliary apparatus require special consideration.

The non-commutating pole motor has inherently a higher iron density, which serves as a compensating feature, improving commutation. The commutator pole compensates for armature reaction and takes care of troubles due to lack of compensating features; a lower iron density may, therefore, be utilized and lower iron losses obtained.

The absence of sparking makes the commutating losses very much less. The rating on the hourly basis may not be much greater than with the non-commutating pole motor. On account of core loss and commutator loss being considerably less, and these prominent features in heating, the commutating-pole motor has naturally a higher continuous rating; it is not only capable of taking large fluctuations of voltage and current, but will have a greater all-day service capacity. This latter feature becomes more pronounced as the distance between stops is greater.

There are several ways of making use of higher direct-current potentials. The most prominent of these are the following:

1.—City service, 600-volt trolley; maximum speed 25 to 30 miles per hour, with stops and schedules incident to city service; and interurban service, 1200-volt trolley; maximum speed 50 to 60 miles per hour, with few stops and high schedules. The motors would be wound and insulated for 1200 volts. Two motors would be connected in multiple, and the two groups of a four-motor equipment handled in series and in parallel.

2.—City service, 600-volt trolley; maximum speed 25 to 30 miles per hour, with stops and schedules incident to city service; suburban service, 600-volt trolley; maximum speed of 30 to 60 miles per hour, with stops and schedules incident to suburban business; and interurban service, 1200-volt trolley; maximum speed 50 to 60 miles per hour, with few stops and high schedule speed. The motors would be wound for 600 volts with a relatively low armature speed and insulated for 1200 volts.

On a 600-volt trolley two motors are connected in multiple, and the two groups handled in series and parallel.

On a 1200-volt trolley two motors are connected in series, and the two groups of four-motor equipment handled in series and parallel.

The armature speed and commutating features should be so designed that if one wheel slips and one motor has 1200 volts or so across its terminal, its armature speed will be reasonable and the commutation good.

Interurban cars with four axles and four motors usually accelerate at 1 to 1.5 miles per hour per second; this requires about 100 to 150 lbs. per ton, which is 5 to 7.5 per cent coefficient of traction. These are low coefficient values for interurban roads and are seldom met with; however, should slipping occur, the motor design should be such that no damage to equipment will result. In the city the dirty street may give a low condition of traction, but under these conditions the motors may be used in multiple or operated as any four-motor equipment is now handled.

Summing up, the advantages of commutating-pole railway motors as compared with non-commutating pole type are as follows: Sparkless commutation even on heavy overloads; flashing at commutator largely reduced and probably eliminated; less wear on commutator; cleaner and safer motor because of reduced carbon and copper dust from brushes and commutator; marked reduction in heating of commutator; greater current density in brushes; increased life of brushes; increased efficiency and free running capacity because of lower core and commutator losses; possibility of successfully using higher voltages; greater facility in design of large motors, especially as regards commutation, and possibility of increasing service capacity of motors by blowing.

REGENERATION OF POWER WITH SINGLE-PHASE ELECTRIC RAILWAY MOTORS*

BY WILLIAM COOPER

The conditions necessary that an electric motor may operate successfully in regenerating or restoring power to the supply circuit are: The counter pressure generated by the motor must be greater than the impressed pressure of the supply circuit; the value of this excess counter pressure must be under control and maintained in suitable relation to the impressed pressure; and there must be at the time other power-consuming devices connected to the supply circuit.

There is no difficulty in producing the first condition; the second is the one that is difficult to fulfil. There are two methods of regulating the counter to the impressed pressure; one is to increase the counter pressure and the other to reduce the impressed. The third condition, except in isolated cases, will be taken care of by the operating load.

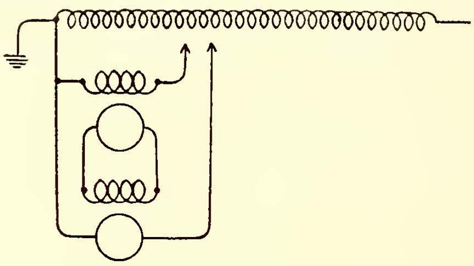


FIG. 1.—REGENERATION WITH SINGLE-PHASE MOTOR

Practically all variable-speed railway motors are of the so-called series type, and as this type of motor is the only one having the proper characteristics for general railway work, it alone will be considered.

The operation of a series dynamo electric machine as a series generator on a constant-potential circuit is a problem which many have grappled with, but none has solved. The machine must be given a shunt characteristic of a greater or less degree to make such operation possible. A machine having the shunt characteristic predominant is unfit for use as a railway motor, and as this characteristic must be predominant to operate successfully as a generator, it is at once evident that the motor must be changed in some manner before it can be used as a generator.

And this is not the only condition which the motor must fulfil to operate successfully as a generator in restoring power to the supply circuit. The motor must operate satisfactorily while the armature current is varied through a wide range with a constant field. This is evident from a very casual observation of the conditions.

Assume that the car or locomotive being driven by the motor under consideration has attained a balanced or free running speed under the conditions. The motor is then developing only sufficient torque to overcome the train resistances. The motor, being a series machine, has the same current in the field and armature. Under these conditions a very slight increase in the field current would increase the counter electromotive force of the armature to a value greater than the impressed electromotive force of the supply circuit.

Now assume an ordinary series motor in which the armature current cannot be increased materially above the corresponding field strength without disturbing the commutating conditions; it follows that the motor acting as a generator can only give a retarding force approximately equal to the train resistance. This added to the train resistance would give a total retardation so small that it could not be called a braking effect. From this it is obvious that the armature current must exceed the field current at times in order to produce a retarding effect which can be utilized in bringing the train to rest, or in holding the train on a grade. This, then, is another condition which the ordinary series railway motor does not readily fulfil.

From the foregoing it would seem that a motor, to operate successfully as a regenerator of power, must have the following characteristics: It must be capable of operating through a wide range of variation between field and armature current, and it must be provided with some means of producing a shunt characteristic.

The first characteristic exists to the fullest extent in a motor having some means of compensating for armature

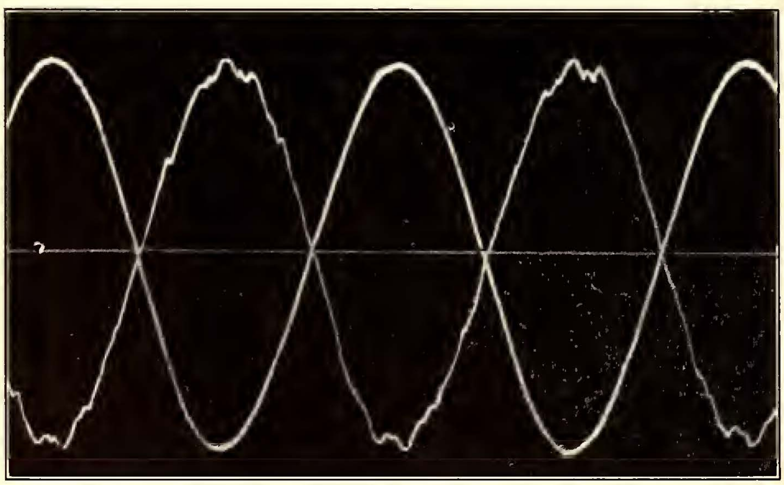


FIG. 2.—OSCILLOGRAM OF GENERATED AND TRANSFORMER ELECTROMOTIVE FORCES. THE GENERATED ELECTROMOTIVE FORCE IS THE CURVE WITH THE IRREGULAR TOP

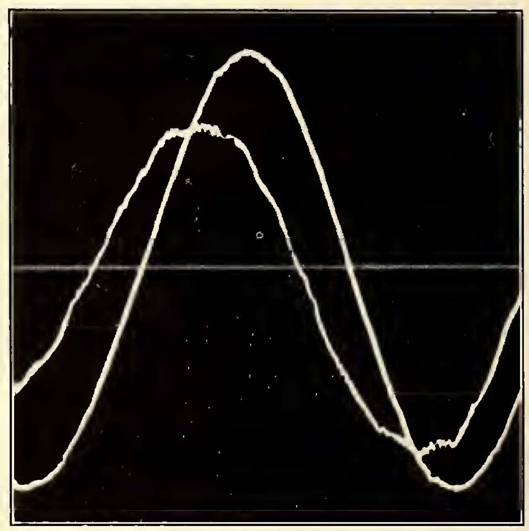


FIG. 3.—OSCILLOGRAM OF CURRENT AND ELECTROMOTIVE FORCE OF GENERATOR. THE LOWER CURVE IS THE CURRENT. POWER FACTOR 80 PER CENT LAGGING CURRENT

reaction, as well as a means of maintaining a constant commutating condition. This characteristic also exists to a limited extent in a motor having either one of these functions.

The second characteristic is not so easily provided. In the direct-current motor it can be obtained by providing the motor with both a shunt and series winding, either of which has sufficient capacity to operate the machine either as a shunt-wound generator or as a series motor.

Another method of furnishing the shunt characteristic is to provide a means of separately exciting the motor field independent of the line or motor voltage. There are several ways of doing this. In the case of four-motor equipments, one method is to use one motor as a generator to excite the other three motors which will operate as generators, being connected to the supply circuit.

Storage batteries may also be used to excite the fields, but this arrangement has its disadvantages in being complicated.

The great difficulty encountered in operating direct-current motors as regenerators of power is that the impressed pressure is a constant, and the means at hand for meeting it are very limited. As the ordinary series motor will not permit of any very great variation of armature current with a constant field, and as only a very limited number of combinations of the motors is possible, the range through which an equipment can be operated regeneratively is, under the most favorable conditions, very limited.

In the single-phase, alternating-current motor of the series type these necessary characteristics are inherent. Without entering into a description of this motor, the design of which is well known, it is sufficient to say that the machine is provided with a compensating winding to neutralize the armature reaction, and also has preventive leads between commutator and armature windings which assist in commutation. This construction yields the first characteristic; the second is easily obtained in connection with the transformer used in the voltage control of the motor.

The method of producing this result is to use one of the motors of the equipment as an exciter for the others. By providing the transformer with suitable voltage taps, the value of the field current of the exciter may be varied through a wide range, as well as the generated voltage of the restored power. In this respect the conditions are very much more favorable than in the case of the direct-current motor, in which the only variations that can possibly be made are in the series-parallel combinations of the motors which are being used as generators.

The exact arrangement of the motors and their connections is shown diagrammatically in Fig. 1.

Assume the car or locomotive upon which the motors are mounted to be in motion, the armatures turning at a corresponding speed. If the field of the first machine be connected to the transformer, an alternating electromotive force will be generated by its armature, the value of which will be directly proportional to the speed. If the field of the other motor be connected to the exciter armature, an alternating current will pass through it, and the second armature will, in turn, generate an alternating electromotive force the value of which varies about as the square of the speed—the excitation of the first machine remaining constant.

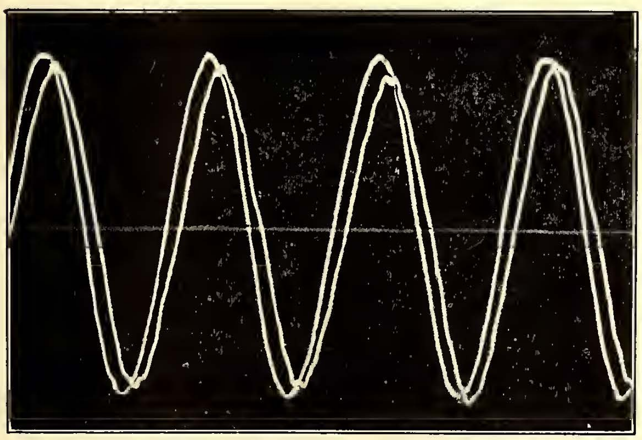


FIG. 4.—OSCILLOGRAM OF CURRENT AND ELECTROMOTIVE FORCE UNDER LIGHT LOAD. THE LOWER CURVE IS THE CURRENT. POWER FACTOR 98 PER CENT LEADING CURRENT

The electromotive force generated by the second armature will bear a very close phase-relation with the electromotive force of the transformer, for the reason that the current in the field circuit connected to the transformer lags approximately 90 degs., as does the current in the field circuit of the second machine. This combination throws the generated electromotive force of the second machine approximately 180 degs. back of the transformer electromotive force, or by reversing the connections in the same phase-relation.

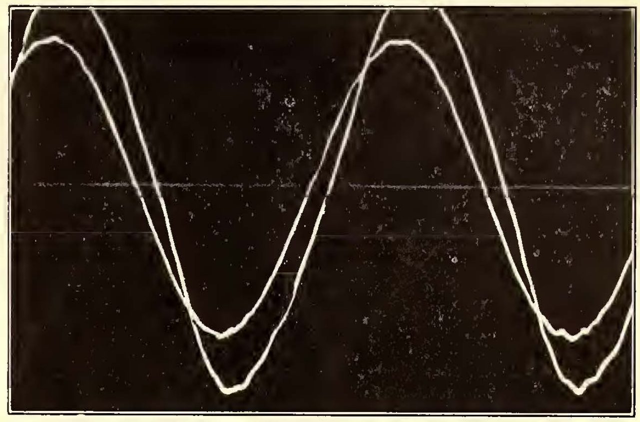


FIG. 5.—OSCILLOGRAM OF CURRENT AND ELECTROMOTIVE FORCE UNDER NORMAL LOAD. CONDITIONS AS IN FIG. 4. THE LOWER CURVE IS THE CURRENT. POWER FACTOR 99.5 PER CENT LAGGING CURRENT

The phase-relation between the generated and transformer voltages is shown in Fig. 2.

The record shows that the two electromotive forces are in exactly opposite phase. Under these conditions the current flowing after the circuit is closed with the connections reversed will be displaced from the electromotive force, due to the impedance of the armature circuit. Fig. 3 shows this displacement when the armature is carrying about 100 per cent current overload.

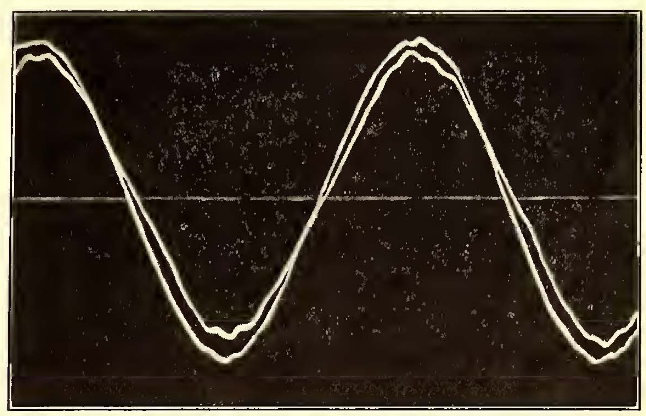


FIG. 6.—OSCILLOGRAM OF CURRENT AND ELECTROMOTIVE FORCE UNDER 100 PER CENT OVERLOAD. CONDITIONS AS IN FIGS. 4 AND 5. POWER FACTOR 97 PER CENT LAGGING CURRENT. THE CURRENT IS THE UPPER CURVE

This is at a power factor of 80 per cent. The power factor varies between this and 100 per cent as the load decreases to zero. The obvious method to improve the power factor is to shift the phase-relation of the generated to the line electromotive force. The result of this is shown in Figs. 4, 5 and 6.

Fig. 4 shows approximately the relation of the generated to the transformer electromotive force as it would be on open circuit, as the current in this case is small.

From these records, it is evident that there is no difficulty in restoring power with a single-phase commutator-type motor at practically 100 per cent power factor, the machine operating as a non-synchronous alternating-current generator.

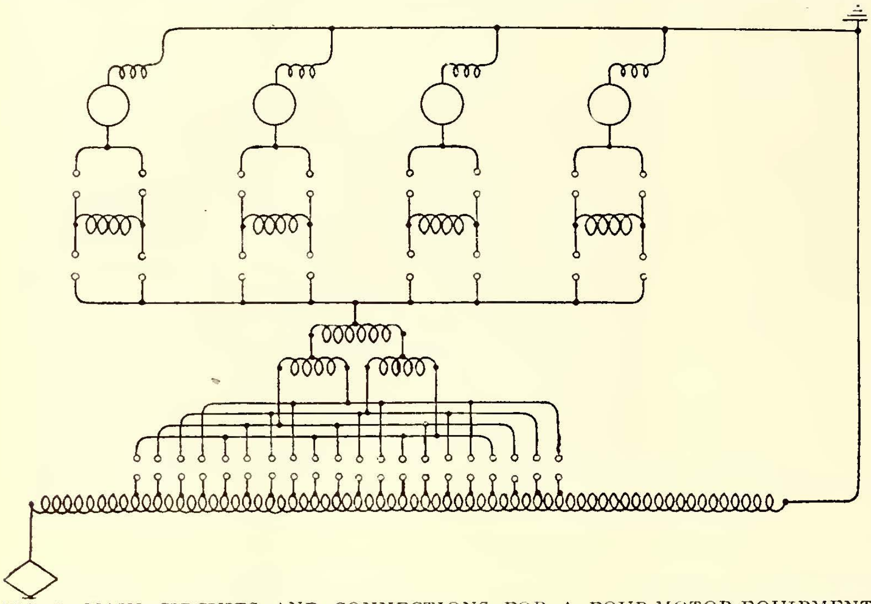


FIG. 7.—MAIN CIRCUITS AND CONNECTIONS FOR A FOUR-MOTOR EQUIPMENT

This condition being established, the next step is to see how it applies to actual operating conditions. From the foregoing it is evident that one of the motors of the equipment must be set aside for use as an exciter for the others, or a separate motor-generator set must be provided. If a separate source of excitation is provided, all the motors can be used to the fullest extent for regeneration of power, in which case the total capacity for regeneration will be increased over the capacity of the machines as motors by the increase in the power factor. If the regenerative function is to be used for braking in making frequent stops, it might be desirable to supply the separate excitation; but if it is to be used in holding the train on grades it is unnecessary, as the remaining motors, if the equipment consists of three or more motors, will have ample capacity to do the work.

Assume a 2 per cent grade of considerable length. The motors, all working, have sufficient capacity to haul the train up the grade. Assume the equipment to consist of four motors. Assume train resistance at 6 lbs. per ton. The total tractive effort will then be 46 lbs. per ton in ascending.

To hold the train at the same speed in descending, a retarding force of 34 lbs. per ton must be supplied. The retarding force necessary is then approximately 75 per cent of the force necessary to haul the train up the grade. It is evident from this that three of the four motors have ample capacity to exert the necessary retarding force, even if the power factor of the machines as generators is no better than when they are operating as motors. It has been shown that the power factor when operating as generators can be made better than when operating as motors; therefore, there is a surplus of capacity in four-motor equipment and in three-motor equipment about an equal capacity.

The characteristics and capacity of the machines being correct for the work, it only remains to provide suitable means for manipulating the circuits to adapt the apparatus to the conditions. This is accomplished by providing switching apparatus to connect the motors in the proper relation and for furnishing and controlling the field current of the machine used as an exciter.

Fig. 7 shows, diagrammatically the main circuits and connections for a four-motor equipment. From this it is evident that the switches used must have a current capacity the same as the motors, for there are four in parallel on the transformer and the switches used for reversing carry the current for one motor only. As shown, thirty-six switches are required for the entire control of the motor equipment.

Fig. 8 shows diagrammatically the same motor equipment arranged for regeneration in addition to the regular motor control. As shown, fifty-four switches are required of the motor-current capacity, and sixteen of one-fourth that capacity. Of the added switches of the motor-current capacity, ten have been added to the transformer to enable slow speeds on regeneration to be obtained, and eight are required to change the combinations of the motors. Besides the added switches, three small preventive coils and a few additional transformer taps are required. From this it is seen that the amount of additional apparatus required is insignificant compared with the result accomplished.

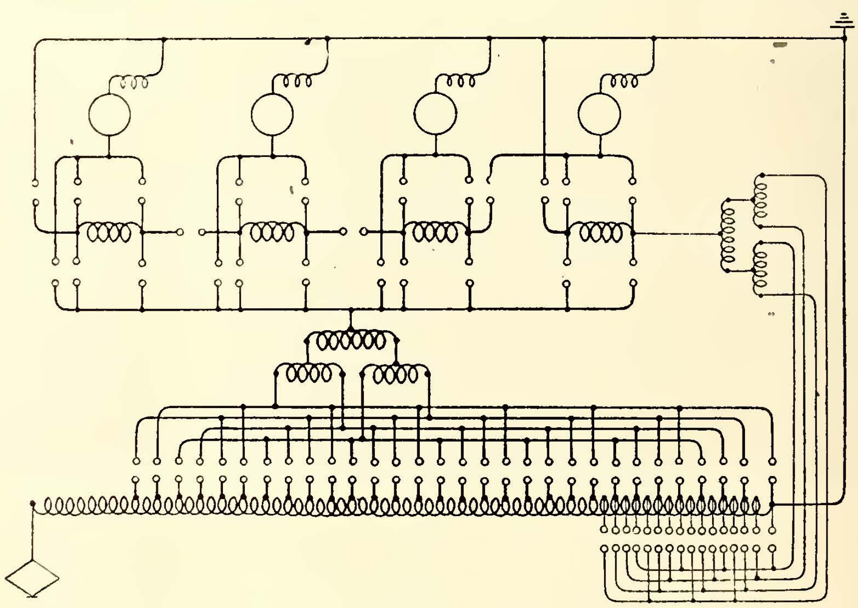


FIG. 8.—FOUR-MOTOR EQUIPMENT ARRANGED FOR REGENERATION IN ADDITION TO THE REGULAR MOTOR CONTROL

The curves shown in Fig. 9 give the relative tractive and retarding effect, both continuous and maximum, of a four-motor equipment.

As shown by the curves in Fig. 9, the three motors of a four-motor equipment acting as generators restoring energy to the line will let a train down a 2 per cent grade at any speed from 9 miles per hour to 30 miles per hour, that the motors have capacity to haul up the same grade at any speed up to 18.5 miles per hour. This is for continuous duty. At maximum duty for short periods the capacity is increased about 60 per cent. Between 9 miles per hour and 30 miles per hour there are forty operating speeds, the gradations from one to the other being such that at no time will there be any variation exceeding 10 per cent in torque. This necessitates, of course, a rather large number of switches being used, but seems to be a very desirable condition to fulfil in heavy freight traffic.

EFFICIENCY OF THIS SYSTEM OF REGENERATION

The efficiency of the system when the motors are operating as generators and restoring energy to the supply circuit is about the same as the efficiency when operating as motors, there being perhaps a slight advantage in the case of the generator, due to the improved power factor conditions. This, of course, assumes about the same load conditions on the machines in either case. However, the actual saving in power house output can never be a very large percentage. If the entire load consisted of 2 per cent grades and there was no switching to be done, the saving in power consumption might be as high as 50 per cent, while under ordinary conditions it could not be made to exceed one-half of this, and under unfavorable conditions or with a level track and long runs, using the regenerative function only for braking, the saving could not be more than a few per cent.

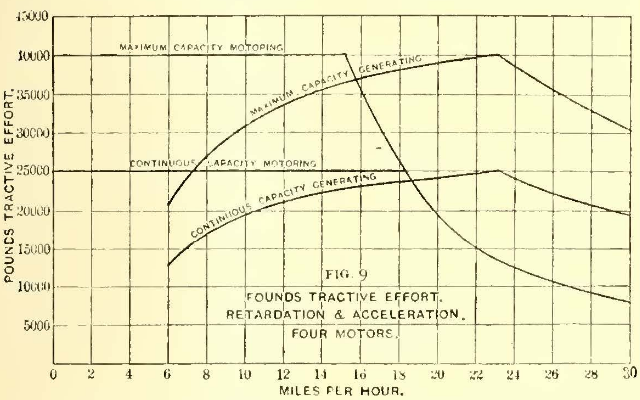


FIG. 9.—RELATIVE TRACTIVE AND RETARDING EFFORT, CONTINUOUS AND MAXIMUM, OF A FOUR-MOTOR EQUIPMENT

The value of this system of regeneration is not to be found so much in the saving of power as in the saving in wear and tear and the ability to operate over a wide range of speed, as well as the comparative safety of operation. In the case of running heavy trains down long grades, the braking apparatus of all cars in the train can be held in reserve, it being necessary to use it only in emergency or in making the final stop. Under these conditions the number of accidents due to the failure of the brakes would be very much reduced.

This is the only system of regeneration yet developed which can be operated at maximum efficiency over a wide range of speed. In the case illustrated forty speeds between 9 miles per hour and 30 miles per hour are obtained. This number can be increased if desired simply by the addition of a few switches.

The three-phase system is the only other one in which the regenerative function has been developed to any extent, but at most there are only a few widely separated speeds at which it can be operated efficiently. Generally, there is but one.

A system of electric traction in which the trains must go up-grade and down-grade at one fixed speed in order to operate efficiently is certainly at a disadvantage when compared with one in which the trains can be operated at any speed below a certain maximum speed up-grade and at any speed within safe limits down-grade, at all times, whether taking energy from the line or restoring it to the line, the apparatus operating with maximum efficiency.

It will be noted that in this system the impressed voltage is changed to adapt it to the generated, while in the direct-current or the three-phase system there is but one impressed voltage available. This wide range of working voltage, together with the ability to vary the armature current with respect to the field through a wide range, gives to the single-phase series motor the extreme flexibility as a regenerator of power that it has as a motor.

One other point that is worthy of note in connection with the operation of this system is the absolute safety and stability of the combination. While the machines being operated as generators are normally series machines, it will be noted that no one of the armatures is connected in series with its own field, and under no condition can there be any surging or building up of load. In case of momentary interruption of the supply circuit, the circuit again being restored, the system will again operate exactly as before the interruption, there being no surging or violent action of the machines.

The system of regenerating power here described has been used in testing locomotives to give a dead-load condition under a wide range of speed. Numerous stand-tests have also been made, so that the operation of the motors under the conditions is well established and there is no doubt about the scheme doing all that is claimed for it.

ABSTRACTS OF OTHER INSTITUTE PAPERS

INSULATOR FOR HIGH-TENSION TRANSMISSION LINES

A new type of insulator, especially designed for use on high-tension transmission lines, was described in a paper by E. M. Hewlett. Each insulator unit is a flanged or petticoated disk of porcelain with an enlarged central portion having two inter-linked semi-circular holes. It is termed a "linked insulator" because it is used to insulate the interlinked tie wires. The holes in the insulator are so arranged that the tie wires which pass through them exert a compression strain on the porcelain. If the insulator should break, the loops of the tie wires will still be intermeshed, and as several disks are used in series with a factor of safety, the remaining disks will prevent a short circuit being formed until the break can be repaired. Two types of the insulator were illustrated, one for suspension from the cross-arm and one for use as a strain insulator to be inserted in the main circuit, which is looped around the insulator. The mechanical and electrical features of the two forms of insulators are essentially the same. The petticoats and flanges are so arranged that one side of the insulator is always protected from rain.

HIGH-TENSION SWITCHBOARD PRACTICE

A paper by Stephen Q. Hayes touched briefly on the salient points of interest in connection with high-voltage switching practice. Under the heading of the general scheme of connections the switchboard equipment for a plant was summarized as follows: First, the type of plant;

second, the frequency; third, the transformers; fourth, flexibility versus simplicity, and, fifth, main connections. The author also discussed the relative advantages of switchboards of the panel type, of the pedestal type and of the bench-board type; and also the various types of oil circuit-breakers, disconnecting switches and protective apparatus, and he treated of the relative merits of using enclosed wiring and open wiring. The author stated that it is quite possible that in the not far distant future, where the climate is not too severe, the high-tension transformer houses with their breakers, bus-bars, etc., will no longer be used. The transformers, oil circuit-breakers, disconnecting switches, bus-bars, wiring and connections will probably be in the open air. The oil-immersed, water-cooled transformers and electrically operated oil switches are designed to withstand out-of-door conditions. Disconnecting switches have often been used in high-tension transmission lines mounted on the poles and the use of electrolytic lighting arresters with the choke coil combined with the transformer cases would readily permit of this out-of-door operation.

COMMERCIAL TESTS OF LIGHTNING ARRESTERS

A paper by Percy H. Thomas gave an outline of tests of lightning arresters which it was considered should be included in the standardization rules. The tests should be arranged to determine, first, the condition of individual arresters; second, the effectiveness of a particular design, and third, the characteristics of different types. The paper considered in detail the various types of arresters, such as arresters which offer no impedance to the discharge and arresters using series resistance and special forms of arrester. From an analysis of the advantages, disadvantages and limitations of the various possible tests of lightning protecting apparatus, the author concluded that certain tests are of great value in connection with certain types of arresters, but not with all types, and that some of the tests are difficult and awkward to make. He offered the suggestion that tests should be introduced into the standardization rules cautiously and gradually. On the other hand, if rules are adopted there will be a great advantage in many cases of testing lightning arrester apparatus. For example, they will afford a ready means for correctly comparing the numerous low-voltage arresters, especially railway arresters, which appear from time to time. Furthermore, the fact that certain tests have the stamp of approval of the Institute will do much to cause designers to put their apparatus in condition to meet these tests, even if the tests be so inconvenient as rarely or never to be imposed. The following tests were suggested for general consideration as suitable for the approval of the Institute:

1. The insulation strength of all lightning arresters should be able to withstand the abrupt application of the discharge of a condenser of at least 100th microfaric capacity, charged to a potential three times the normal arrester potential and not less than 50,000 volts without sparking between the parts or toward the ground.

2. Breakdown voltages at normal frequencies should be determined in all cases, in accordance with the requirements laid down in the standardization rules for the testing of insulation strength.

3. Where general considerations are not sufficient to determine the amount of impedance offered to a discharge, comparative tests between arresters may be made by noting the needle gap equivalents of two or more arresters by passing across the arresters separately or in series the discharge of a condenser of a few hundredths microfaric capacity charged to a potential of not less than 50,000 volts, nor less than three times the normal voltage of the arrester.

4. Where general considerations are not sufficient to determine the non-arcing feature of an arrester, a test may be made by passing sparks over the arrester when connected to a source of e. m. f. of sufficient power to supply without dropping its potential all the current which the arrester will take.

5. Endurance tests may be made in the same manner as tests of the non-arcing feature.

A PROPOSED LIGHTNING ARRESTER TEST

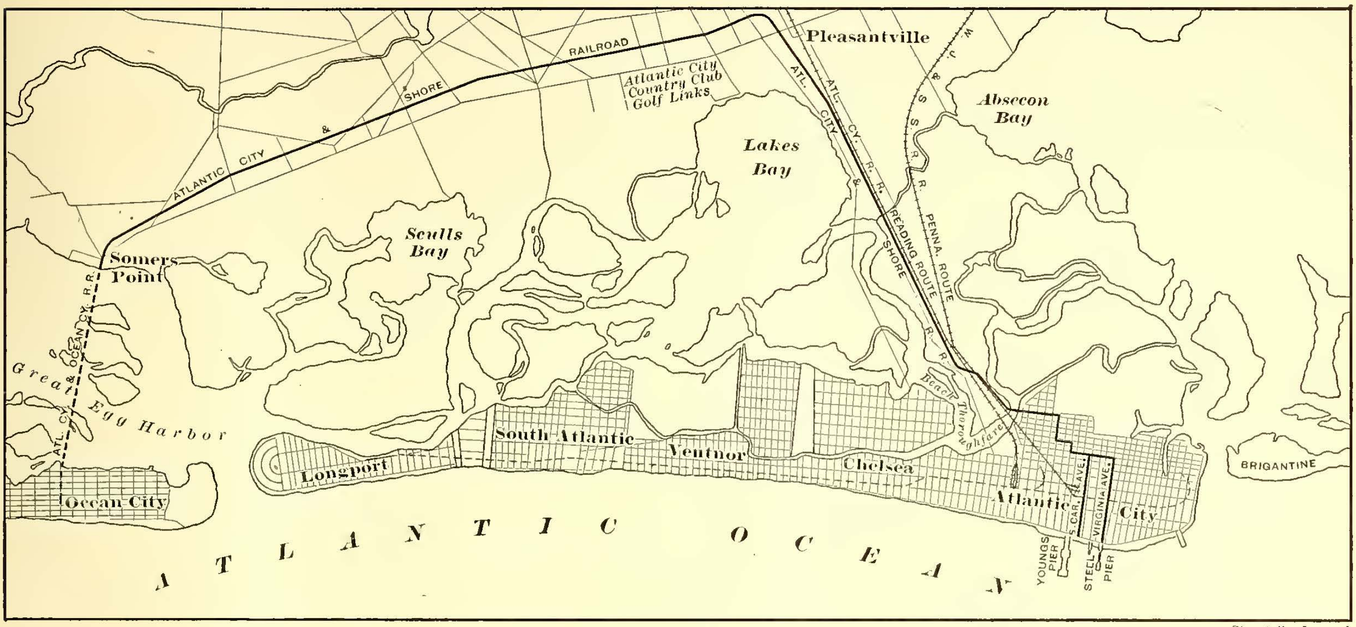
A paper by N. J. Neall outlined a lightning arrester test which he considered to be of value both to the operator of the line and to the manufacturer of lightning arresters. A spark from the induction coil is made to pass over all the gaps of the lightning arresters under test. The apparatus required consists of an induction coil operated from several cells of a storage battery by means of a mechanical vibrator. A small switch in series therewith enables the discharge to be controlled at will. A condenser is placed in series with each terminal of the induction coil, the one being grounded and the other being led through spark gaps to such a point of the series of the lightning arrester gaps that the spark from the coil will divide and pass over them simultaneously in the direction of the line and the ground, respectively. By means of this test, the effect of a disturbance can be estimated positively by the simultaneous use of tell-tale papers at all points where discharges are known to take place to ground. The intrinsic value of the method rests on the importance of knowing as far as possible how great the disturbance may be; how efficient is any given system of protective apparatus to handle them, and of discovering to what degree any given transmission system contains in its elements of length, arrangements and character of apparatus tending to prolong or increase the disturbances once initiated.

TRACK CIRCUIT SIGNALING ON ELECTRIFIED ROADS

A paper by A. L. Frederick Howard gave a brief outline of the various track circuit signaling systems now in use. There are three distinct types of signals according to the method of control, namely, the manual or non-automatic, the controlled manual or semi-automatic, and the purely automatic. Train order signals are of the first type, interlocking signals are of the first and second types, while block signals are of all three types. In the early signal circuits use was made of only one wire, which was set apart exclusively to this service, even in cases where such methods necessitated installing additional return conductors for the propulsion current in order to compensate for the rail given up for the signal system. A more recent method allows the use of both rails simultaneously for the propulsion current and for the signal current. A path for the propulsion current around insulating joints is provided for in the latter system in the form of impedance bonds indicated in the accompanying illustration. The propulsion current divides so that each part passes around the iron core of the bond in opposite directions, its magnetizing action upon the core being zero. On the other hand, the full impedance of the bond is offered to the signal current in preventing the passage from rail to rail of the alternating current used in the signal circuits. The principal difference in the relation between the elements of the track circuit as used on direct-current and alternating-current railway systems relates merely to a higher frequency of the signaling current.

ATLANTIC CITY & OCEAN CITY RAILROAD

A short account was published in the issue of this paper for Nov. 3, 1906, of the Atlantic City & Shore Railroad of New Jersey. This is one of the Stern & Silverman properties, and is probably unique among electric railway enterprises in that for a considerable portion of its route it has running rights over the tracks of a large steam railroad corporation, in this case the Pennsylvania Railroad. The accompanying map illustrates the situation at Atlantic City and gives the route of the company, as well as of an important extension which is being built under the name of the Atlantic City & Ocean City Railway, to connect Ocean City with Somers Point, the present southern terminal of the Atlantic City & Shore Railroad.

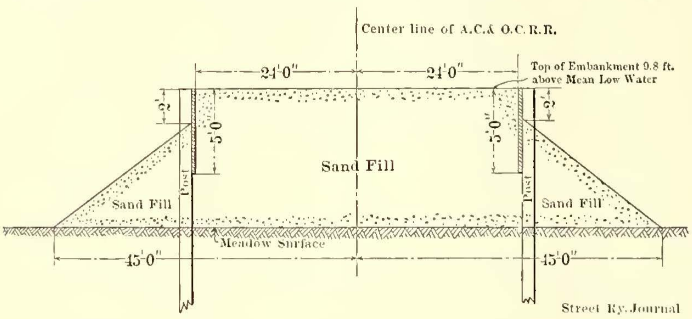


Street Ry. Journal

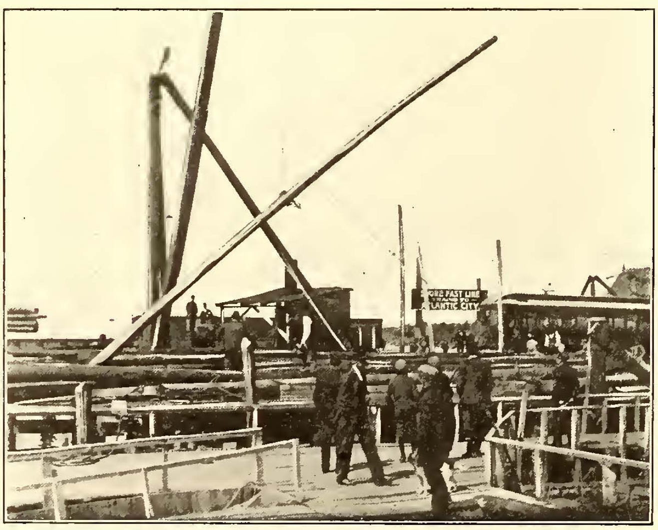
MAP SHOWING THE LINES OF THE ATLANTIC CITY & SHORE RAILROAD AND CONNECTIONS

HAULING AUTOMOBILES ON FLAT CARS BETWEEN SOMERS POINT AND OCEAN CITY OVER THE ATLANTIC CITY & SHORE RAILROAD

Some two years ago the Atlantic City & Shore Railroad consisted of a short loop, shown in the map, in Atlantic City, connecting the Board Walk at Virginia Avenue with the Board Walk at South Carolina Avenue. At this time transportation between Atlantic City and Somers Point was provided by the Pennsylvania Railroad, whose West Jersey & Seashore line extended to Pleasantville, from which point passengers were taken to Somers Point on a single track steam railroad branch. Some two years ago this branch was acquired under a long lease by the management of the Atlantic City & Shore Railroad and was double-tracked and converted to electric power. At the same time, running rights over the West Jersey & Seashore Railroad were secured by the Atlantic City & Shore Railroad from Pleasantville to the western limits of Atlantic City, and from this point a double-track extension with trestles and bridges to span the steam railroads at this point was built to connect with the city terminal of the electric railway company. In this way a high-speed electric railway service is conducted between Virginia Avenue on the Board Walk in Atlantic City and Somers Point. Within the city 550 volts are used on ordinary trolley wire. The Atlantic City & Shore Railroad commences to use the third rail on its own line at the thoroughfare and continues to operate on 650 volts over the trestles and bridges spanning the steam roads. Where it joins the West Jersey & Seashore Railroad that company's third rail is employed between Meadow Tower and Pleasantville. On the main land a catenary construction with 650 volts is used. Power is taken from the West Jersey & Seashore system through its sub-stations in Riga and Atlantic City, and the Atlantic City & Shore Railroad has its own sub-station at Somers Point. The line was put in operation Aug. 25, 1906.



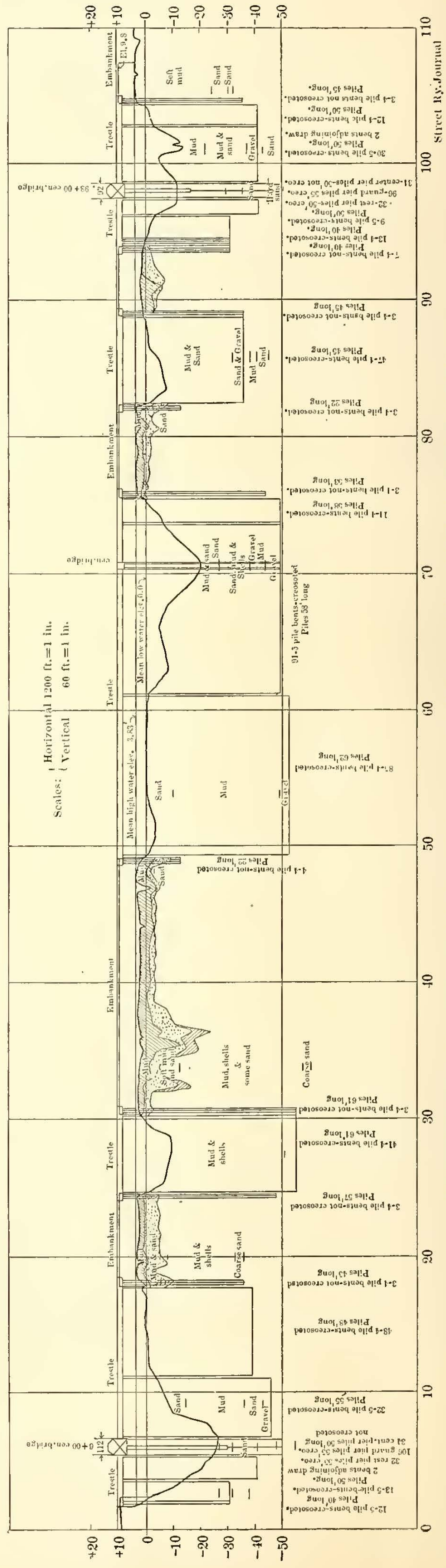
SECTION OF SAND FILL ON THE ATLANTIC CITY & OCEAN CITY RAILROAD



THE SOMERS POINT TERMINUS OF THE ATLANTIC CITY & SHORE RAILROAD

The cars make the run from Atlantic City to Somers Point of 14 miles in 36 minutes, and average about 400 miles per day. At present a 30-minute service is run between 5:30 a. m. and 11:30 p. m.

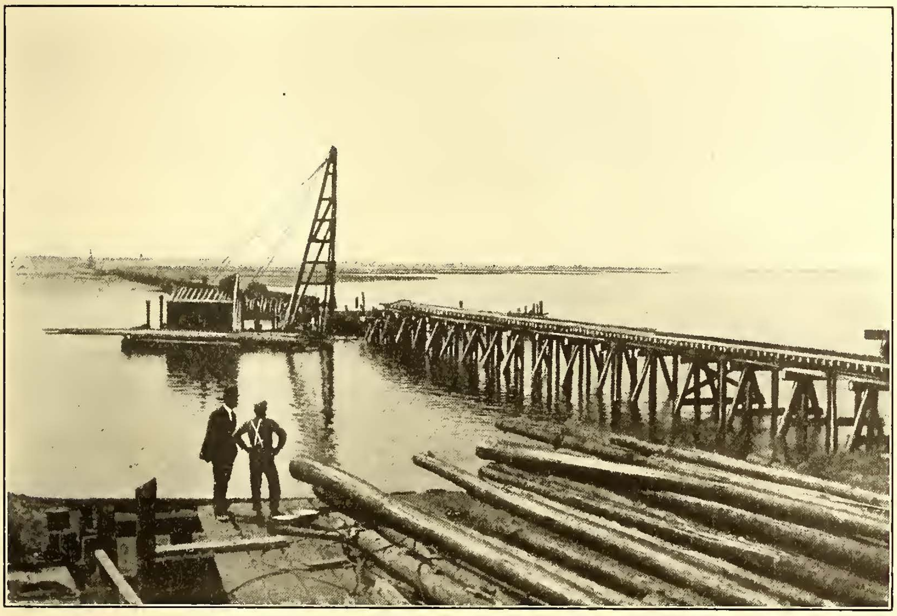
There is considerable travel between these points, as a great many provisions for the immense hotel population of



PROFILE OF ATLANTIC CITY & OCEAN CITY RAILROAD ACROSS GREAT EGG HARBOR

Atlantic City are raised on the main land, and the golf links at Northfield are well patronized during the season by the summer guests at Atlantic City.

The extension to Ocean City already referred to is being built by the Atlantic City Construction Company, and is one of the most extensive enterprises of its kind ever carried out by an electric corporation. The island on which Ocean City is situated is separated from Atlantic City by a wide inlet and from the main land by Great Egg Harbor Bay. It was necessary to install two drawbridges, and these, with the connecting trestles, have an aggregate length of nearly three-quarters of a mile. Near the center the line crosses a low island, where the right of way has been built up by sea sand, which has been pumped up from the bottom of the bay and deposited in a dyke built across the island. At this point it is the intention of the company to build a turnout about 1000 ft. in length, and later to install a pleasure resort with casino, boating, pavilion, etc.



TRESTLE UNDER CONSTRUCTION ACROSS GREAT EGG HARBOR

The drawing on page 1152 shows the section of the line between Somers Point and Ocean City, with the bridges, trestles, etc. The latter are built under steam railroad specifications, and the bridges are being erected by the Penn Bridge Company.

In the operation of this line an ingenious scheme will be employed for adding to the income of the company by hauling automobiles from Somers Point to Ocean City. The latter, like all of the South Jersey resorts, is a favorite visiting point for automobiles, which can run there from Philadelphia in two or three hours. The highway bridge, however, is a long distance away, so that it is proposed to run flat cars between Somers Point and Ocean City for hauling automobiles over the trestle. One of the illustrations shows a flat car of this kind carrying two automobiles and hauled by one of the standard motor cars of the company. S. S. Neff, the general manager of the Atlantic City & Shore Railroad, who originated this idea, was formerly connected with the Union Elevated Railway, of Chicago, and also with the Boston Elevated and the Brooklyn Elevated Railway Company, as well as with the Mexico City Tramways Company. The operation of the Atlantic City & Ocean City Railroad will be conducted by the Atlantic City & Shore Railroad. The line to Ocean City will be operated about July 1. The schedule will offer a half-hourly service from each terminal between 6 a. m. and 9 a. m., fifteen-minute headway between 9 a. m. and 9 p. m., and half-hourly headway between 9 p. m. and midnight.

POWER HOUSE IMPROVEMENTS AT NASHVILLE

The boiler capacity of the main power station of the Nashville Railway & Light Company is being increased by the installation of four 600-hp Stirling boilers. The new boilers are provided with Green traveling grates. They are designed for 200 lbs. pressure and 100 degs. superheat. To house them a brick extension has been built on the north end of the station. In the engine room there has recently been installed a 1600-kw railway generator and two 1000-kw rotary converters. The circuit breakers for these are located near the machines and are operated from the main switchboard by solenoids. A new a. c. and d. c. switchboard has also been installed. All of the main a. c. switches, with the exception of the switches on a 3000-kw generator, are of the distant control type.

A new 48-in. cast-iron intake is being extended into the Tennessee River. An ash handling plant for temporary use has been erected north of the generating station. Ash cars pushed from the boiler room basement are dumped into a bucket and a skip furnished by the Link Belt Engineering Company elevates them to an overhead reinforced concrete bunker having a capacity of about four steam road cars. Chutes from the bunker discharge the ashes into cars below.

OVERHEAD CONSTRUCTION AT HOUSTON, TEX.

A large portion of the overhead construction in Houston has been rebuilt in the last two years. In the new construction 30-ft. creosoted pine poles with 8-in. tops are being used. Glass insulators are being used, as trouble has been experienced with certain composite insulators. The span wire insulators are placed over the rails on single track and over the outside rails on double track. In this position they can be gotten at from a tower wagon. All new trolley is No. 00. About 10 miles of 350,000 and 500,000-circ. mil feeders have been put up since the reconstruction work began.

In connection with the opening of the electrified section of the West Shore Railroad between Utica and Syracuse, the Utica papers publish copies of letters written in 1901 to the New York Central officials by J. W. Boyle, then president of the Utica Belt Line Street Railway Company. In these letters Mr. Boyle suggests the electrical equipment of the West Shore tracks between Utica and Syracuse, and in behalf of his company offered so to equip and lease them, indicating that the plan had been under consideration for at least six years.

OCTOBER CONVENTION ANNOUNCEMENTS

Secretary-Treasurer Swenson, of the American Street and Interurban Railway Association, has just issued Convention Bulletin No. 2, giving the hotel rates and general program for the 1907 convention, to be held at Atlantic City, N. J., from October 14 to 18, inclusive.

RATES BY THE DAY, AMERICAN PLAN, UNLESS OTHERWISE STATED.

	Rooms Without Private Bath.				Rooms With Private Bath.			
	For One Person.		For Two Persons.		For One Person.		For Two Persons.	
	In Single Room.	In Double Room.	In Double Room.	In Extra Large Room.	In Single Room.	In Double Room.	In Double Room.	In Extra Large Room.
Abbey, American	$2.50	$4.00	$5.00	$6.00	$3.50	$7.00	$8.00	$10.00
Abbey, European	1.50	2.50	2.50	3.00	2.00	3.50	6.00	8.00
Acme	2.50	3.00	4.00	5.00	....	....	....	....
Albemarle	2.50	3.00	4.00	5.00	4.00	5.00	6.00	7.00
Algonquin, American	2.00	2.50	3.00	4.00	2.50	3.00	3.50	4.50
Algonquin, European	1.00	1.50	1.50	2.50	1.50	2.00	2.00	2.50
Archdale	2.00	2.50	4.00	4.50	....	....	5.00	....
Berkshire Inn	2 to 2 50	2 to 2.50	4.00	4 to 5	4 to 5	5 to 6	6 to 8	6 to 8
Bingham	2.00	2.50	4.00	5.00	....	....	....	....
Bothwell	3.00	3.50	5.00	6.00	4.00	5.00	7.00	8.00
Brighton	4 to 6	....	8 to 10	10 to 14	6 to 8	....	10 to 12	12 to 16
Carlton	2.00	2.50	....	4.00	3.00	3.50	6.00	8.00
Chalfonte	3.50	4.50	6, 7 to 8	10.00	....	6.00	10.00	12.00
Chatham	2.00	2.50	4 00	5.00	....	4.00	5.00	....
Chelsea	4 00	5 00	8.00	9.00	6.00	7.00	10.00	12 to 14
Colwyn	1.50 to 2	2 to 2.50	2.50 to 4	4 to 6	....	....	....	....
Continental, American	1 50	2 00	3 00	4.00	2.00	2.50	4 00	5 00
Continental, European	1 00	1.25	1 50	2.00	1.00	1.25	1.50	2.00
Craig Hall	2 50	3 00	5 00	5 00	3.50	....	6 00	7.00
Davenport	1.50	2 00	3.00	4.00	....	....	....	....
Dennis	3.50 to 4	4 50	6, 7 to 8	....	5.00	7.00	10.00	12.00
Earl Mar Hall	4.00	5 00	5.00	6.00	6.00	8.00	8.00	10.00
Edison, American	2.00	2.00	4 00	....	....	3.00	6.00	....
Edison, European	1.25	1.25	2.00	....	....	....	....	....
Elberon, American	2.00	2 50	3.00	4.00	2.50	3.00	5.00	6.00
Elberon, European	1.00	1.50	2.00	2 50	1.50	2 00	3.00	4.00
Elwood, American	2.50	3.00	4.00	6.00	3.00	4.00	6.00	8.00
Elwood, European	1.00	1.50	2.00	3.00	2.00	3.00	3.50	4.00
Fredonia, American	2 up	2 up	4 up	4 up	3.00	6.00	6.00	7.00
Fredonia, European	1 up	1 up	2 up	2 up	2.00	4 00	4.00	5.00
Garden, American	3.00	4.00	6.00	7.00	4.50	5.00	8.00	9.00
Garden, European	1.50	2.00	3.00	4.00	2.00	3.00	4.00	5.00
Haddon Hall	3.50	5.00	6.00	8 to 10	6 00	7.00	9 to 16	....
Holland	1.50 to 2	2 50	2.50	4.00	....	....	....	....
Iroquois	2.50	3.00	.....	5.00	3.50	3.50	6.00	6.00
Islesworth	3 00	4.00	5.00	6.00	4.00	5.00	7.00	8 00
Jackson	4 00	....	6.00	....	5.00	....	8.00	....
Kentucky, American	1.50 to 2	2 to 2.50	3 to 4	3.50 to 4.50	3 to 3.50	3.50 to 4	4 to 5	5 to 6
Kentucky, European	1 to 1.25	1.25 to 1.50	2.00	2.50	2 to 2.50	2.50 to 3	3 to 4	3.50 to 4
Larsen, American	....	1.50	2.00	2.00	....	....	....	....
Larsen, European	....	1 00	1.00	1.00	....	....	....	....
Loraine, American	2.50	3.00	5.00	6.00	4.00	4.50	7.00	8.00
Loraine, European	1.50	2.00	2.00	3.00	....	....	....	....
Majestic	2 50	3.00	5.00	6.00	....	5.00	7.00	8.00
Marlborough-Blenheim, American	4, 5 to 6	5, 6 to 7	8, 9 to 10	9, 10 to 11	6, 7 to 8	7, 8 to 9	10, 11 to 12	12 to 20
Marlborough-Blenheim, European	2, 3 to 4	3, 4 to 5	4, 5 to 6	5, 6 to 7	4, 5 to 6	5, 6 to 7	6, 7 to 8	8 to 16
Monticello, American	2.00	2.50	4.00	5 00	3.00	3.50	5.00	6.00
Monticello, European	1.00	1.50	2 00	3.00	2.00	2.50	3 00	4.00
Pennhurst	2.50	3 00	5.00	6.00	4.00	5.00	7.00	8.00
Pennlyn	2 00	2 50	3.00	5.00	....	....	....	....
Phillips House	2 to 2.50	2.50 to 3	4.00	4 to 5	....	....	....	....
Ponce De Leon, American	2.50	5 00	5.00	6.00	3.50	6.00	6.00	7.00
Ponce De Leon, European	1.50	2.00	2.00	3.00	2.50	3.50	5.00	6.00
Princess, American	2.50	3.00	4.00	5.00	3.50	4.50	6.00	8.00
Princess, European	1.00	1.50	1.50	2.00	2.00	3.00	4.00	5.00
Raleigh	3.00	....	5.00	6.00	4.00	5.00	7.00	8.00
Roman	2.00	3.50	4.50	5.50	3.00	4.50	5.50	6.00
Royal Palace	3.00	4 to 4 50	7.00	8.00	5.00	5 to 6	9.00	10.00
Rudolf, American	3.50	4.00	7.00	8 00	5.00	6.00	9.00	12.00
Rudolf, European	2.00	3.00	4.00	5.00	3.50	4.50	6.00	8.00
St. Charles	3.00	4.00	6 00	8.00	6.00	7.00	8.00	10.00
St. Clare	2.00	2.50	5.00	6.00	4.00	4.50	8.00	9.00
St. Elmo, American	1.50	2.00	3.00	3.00	....	....	....	....
St. Elmo, European	1.00	1.50	2.00	2.00	....	....	....	....
Seaside	3.50	4.50	7.00	....	5.00	7.00	10.00	12.00
Shelburne, European	1.50	2.00	2.50	3.50	3.50	4 00	5.00	6.00
Sothern	2.50	3.00	5.00	6.00	....	5.00	7.00	8.00
Strath Haven	1.50	2.00	2.50	3.00	....	....	....	....
Tracy, American	2.50	....	4.00	....	....	....	....	....
Tracy, European	1.50	....	2.00	....	....	....	....	....
Traymore	4.00	6.00	8.00	9.00	5.00 to	13.00	10.00 to	16.00
Vermont	1.50	2 to 2.50	3 to 5	6.00	2 to 2.50	2 to 3	4 to 6	6.00
Victoria	1.50	2.00	4 00	5.00	....	....	....	....
Warwick	....	4.00	6.00	7.00	....	5.00	7.00	....
Wenz, American	1.50	2.50	4.00	5.00	....	....	....	....
Wenz, European	1.00	1.50	2.00	2.50	....	....	....	....
Wiltshire, American	2.50	3.00	5.00	6.00	....	....	8.00	10.00
Wiltshire, European	1.50	2.50	2.00	3.00	....	4.00	....	5.00

The place of meeting in Atlantic City will be on the Steel Pier, which has been recently widened, strengthened and reinforced with concrete the entire length. It extends 1600 ft. into the ocean, and will be the general headquarters during the day for the meetings, and upon it will be held the exhibition of electric railway apparatus and appliances given by the Manufacturers' Association. Over 70,000 sq. ft. of net exhibit space on this structure is available, and all indications point to a manufacturers' exhibit which will be even larger and more interesting than the most excellent exhibit given in Columbus upon the occasion of the 1906 convention. In addition to the exhibits shown on the Steel Pier, there will be a fine display of cars within walking distance of the Pier. Along the Board Walk and near the Steel Pier are located the leading hotels of Atlantic City.

It has been decided by the official representatives of the various associations that each association shall have its own headquarters hotel for the Atlantic City convention. It is not the desire of those in charge of the convention that these particular hotels be patronized to the exclusion of others, but rather that they be used as general meeting places for those who are interested in specific lines of work. The Marlborough-Blenheim will, in general, be considered the headquarters hotel of the American Association and also of the Manufacturers' Association; the Chalfonte Hotel for the Accountants' Association, and, in like manner, the Engineers and Claim Agents will have their headquarters at the Dennis and the St. Charles, respectively.

Arrangements for hotel reservations should be made directly with the hotels. It will aid greatly in avoiding mistakes if the members when writing will indicate that their reservations are made in connection with the convention. Each reservation will be carefully checked to avoid any misunderstanding and to insure that the hotels are making the most adequate practicable provision for convenience and comfort. In making reservations, explicit statements should be made concerning the kind of room desired—whether with or without bath—and the dates of arrival and departure from the hotel. The special rates are made with the understanding that the charges of the hotel will be for the full time of reservation. With one or two exceptions, all charges are on the American plan, including a room and private bath, where so stated, and three meals daily. Most of the hotels provide comfortable coaches to and from the station. When arriving, it is advisable to go directly to the coach of the selected hotel. The coach will be found at the side of the station platform. The charge to and from the station is 25 cents each way for each person. The charge for trunks is also 25 cents each way for each trunk.

The bulletin includes the published schedule of rates and accommodations guaranteed by the Atlantic City hotels.

The committees on subjects for the various associations have been actively engaged on the program for several months past, and there is every prospect of a convention at which will be presented a number of interesting papers of great value to the member companies and their officers. Each of the four associations will have a program which in itself will amply repay those in attendance. The complete programs of the various associations will be announced in a bulletin issued early in July.

The morning of Monday, Oct. 14, will be reserved for registration purposes, and the first meetings of the convention will be held on the afternoon of that day. The meetings of the various associations will continue throughout the week, closing on Friday, Oct. 18. Considerable attention has been given to the arrangement of the days upon which the various associations will meet. The following general schedule of meeting days has been decided upon:

MONDAY, OCT. 14

9:30 a. m.—Registration and Badges.
2:00 p. m.—Meeting of Engineering Association.
Meeting of Claim Agents' Association.

TUESDAY, OCT. 15

9:30 a. m.—Meeting of Accountants' Association.
Meeting of Engineering Association
Meeting of Claim Agents' Association.
2:00 p. m.—Meeting of Accountants' Association.
Meeting of Engineering Association.
Meeting of Claim Agents' Association.

WEDNESDAY, OCT. 16

9:30 a. m.—Open Session of American Association and Joint Meeting of Affiliated Associations.
3:00 p. m.—Meeting of Accountants' Association.
Meeting of Engineering Association.
Meeting of Claim Agents' Association.

THURSDAY, OCT. 17

9:30 a. m.—Meeting of American Association.
Meeting of Accountants' Association.

FRIDAY, OCT. 18

9:30 a. m.—Meeting of American Association.

The opening session of the American Association Convention, which is also a joint meeting with the affiliated associations, will be held in Casino Hall, a large audience room seating 800 people, and located at the Board Walk end of the Steel Pier. The Thursday and Friday sessions of the American Association convention will be held in the sun parlor, which accommodates about 250 people, and is located near the outer end of the Steel Pier. The meetings of the Accountants' Association will probably be held in a large audience room in the Chalfonte Hotel, which, as previously stated, is the headquarters hotel for the Accountants' Association. All meetings of the Engineering Association convention will be held in the sun parlor, near the outer end of the Steel Pier. The meetings of the Claim Agents' Association will be held in a suitable audience room in the St. Charles Hotel.

The usual arrangements are being made with the various passenger traffic associations whereby those attending the convention will be enabled to obtain round-trip tickets for one and one-third fare upon the certificate plan, that is, full fare going and one-third fare returning. More detailed announcements relating to transportation and railroad rates will be given in a later bulletin.

EXHIBIT ARRANGEMENTS

As previously announced, the Steel Pier has been secured for the exhibits. There will be available about 83,000 sq. ft. of exhibit space, exclusive of aisles, which is the largest area the association has ever had available for exhibit purposes. Of this total space nearly 60,000 sq. ft. will be provided with the same plant of inside and outside booths which were installed for the Master Mechanics and Master Car Builders' conventions just concluded, and on account of very favorable arrangements with the Atlantic City Bureau of Information and Publicity the Manufacturers' Association announces to its members that this space provided with booths can be had for the low rate of 20 cents per sq. ft., this charge being made entirely for the erection and use of the booths, with no charge for the floor space. In this way the majority of the exhibitors will be relieved of all the cares incident to booth building, and a plant of harmonious booths will be provided thoroughly protected from the weather and ready to receive the exhibits. The part of the space on which no booths are erected will be given free of cost; but, of course, it will be necessary for the exhibitors using this space to erect their own booths. There will also be track space for track exhibits in close proximity to the steel pier. Electric current, both a. c. and d. c., will be available, as well as steam and compressed air. The membership fee has again been fixed by the executive committee at $35 for the current year, and each membership entitles the member, without charge, to four (4) badges, each entitling holder and lady to all the privileges of the convention and to such entertainments as may be provided. While there is an abundance of space, it is desirable to give the exhibitors all the time possible in which to arrange their exhibits. Applications have, therefore, been mailed by Geo. Keegan, secretary of the association, 2304 Park Row Building, New York, it being proposed to start the allotment of space early in July.

PAPERS READ AT THE BLUFF POINT MEETING OF THE STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK, JUNE 25--26

SOME NOTES ON ELECTRIC RAILWAY SHOPS AND SHOP PRACTICE IN CENTRAL NEW YORK

BY W. H. COLLINS

The topic for this paper was suggested by the recent inspection of shops by master mechanics of companies in Central New York State. The plan followed was for the several master mechanics to visit each shop in turn, in a body, and submit a report in writing to their general manager.

This inspection demonstrated very forcibly that electric railway practice is rapidly changing. The buildings, tools and methods which have been sufficient in the past are inadequate to-day. It was also evident from the arrangement of these shops that they were not built with a view toward the rapid and economical handling of work. They are rather a series of additions, and the rest of the property has outgrown them.

The machine shops, whether in a separate building or located in a portion of one of the car houses, are so cramped for room that it is impossible to locate the tools to the best advantage. In some cases the tools are good, but in many cases they are inadequate, being nearly worn out. Even where there are good tools they are not, and, in a good many cases cannot be, arranged for the most economical working. As instances of this kind, the following might be cited: a wheel press between the pit and the wall of the building with no room behind it, and so close to the pit that wheels have to be handled across it; a tire-turning lathe at one end of the shop with the wheel press at the other end.

The blacksmith shop, as a rule, is near the machine shop, but instances were found where it is several hundred feet distant. This shop usually has a rather meager outfit, consisting only of tools for light work. Occasionally a power hammer, and in one shop a punch and shears, as well as a spring-tempering furnace, are among the tools.

The paint and carpenter shops are sometimes located in separate buildings at some distance apart. In one place they are on opposite sides of the city. In others they are combined, much to the detriment of the paint shop, as good painting and varnishing cannot be accomplished in a dusty carpenter shop. As an instance of an extremely poor arragement, one road has its paint, carpenter and overhauling shops all combined in one room. A desirable feature which appeared to be lacking in nearly all of the paint shops is a separate fireproof room for paint stock.

In the electrical shops is where the greatest divergence in practice prevails. The practice varies all the way from making repairs to fields and armatures only to producing many of the most used electrical parts. The outfit for this class of work ranges from a banding machine and a baking oven, situated in a corner of the car house called the armature room, to a shop fully equipped with the tools and apparatus for making electrical parts. It is noticeable, however, that some of the shops have discontinued the practice of making their own coils.

The storeroom is usually well stocked, and bears evidence of being well looked after; but it is, as a rule, inconveniently located with reference to the shops. One road has its storeroom ideally located in the center of its shops, with windows all around, thus giving easy access to the different departments.

There is apparently a lack of uniformity in the methods of inspection, but this is largely due to local conditions. At some places it is possible to arrange for doing nearly all of the inspection in the day time, but at other places the conditions are reversed, and it is necessary to inspect cars at night. The tendency, however, is toward a closer and more rigid inspection. The writer believes that inspection pays, and that the closer it is the better it pays.

In the matter of car cleaning there is quite a difference in practice. Some roads continue the old method of washing the exterior of cars with soap and water. Others use no water on the outside of the cars at all, but use instead a prepared oil cleaner, which is applied in liquid form. Both methods are effective so far as cleaning the cars are concerned, but there appears to be considerable difference of opinion as to which is the better method with reference to the cost of cleaning, preservation of varnish, etc. It is also the practice on some roads to give the interiors of cars a general cleaning, such as mopping floors, cleaning windows and wiping the woodwork each day, while on others it is done but once or twice each week. At one place there was a vacuum cleaning device for taking care of plush seats, which did very effective work.

There is no uniform method of keeping service records. Some roads keep few, if any, accurate mileage records. Others keep only the more important records, the mileage of wheels and axles, the oil report, etc., while still others keep the mileage of each part. This can be carried so far that it is cumbersome, besides being an item of considerable expense. It seems to be a good practice to keep records of the more important parts, and occasionally to follow up some particular part, the performance of which is not satisfactory. Anything beyond that appears to be in the nature of a luxury.

To summarize, these repair shops are very inadequate. On account of the lack of suitable tools and sufficient room, they are not in a condition to handle work with the greatest economy.

In the rapid development of these electric railway properties, proper provision does not appear to have been made for the upkeep of the equipment. It now seems that we have reached a point where it is economically practicable to reconstruct our shops. While it is true that electric railway practice is changing, and will continue to change, yet it is sufficiently stable so that plans can be made for providing suitable buildings and tools to handle work with the minimum loss of time.

The harmonious arrangement which prevails in large manufacturing plants, when the process is continuous and where there is so little waste effort, is what we should endeavor to approximate in our repair shops. The buildings should be so arranged that the work can be moved along continuously through the different shops, with the minimum amount of handling.

The organization at these shops seemed to be the redeeming feature. There is a sufficient number of foremen, and the distribution of forces is the result of careful planning. But while each foreman is capable in his own line, it is seldom that one is found who is versatile enough to take the position of head of the department. This is the element of weakness general to the organizations.

With the advent of the large interurban cars, a new element was projected into electric railway shop practice. These cars are usually equipped with steel or steel-tired wheels, solid gears, etc., and range in weight from 25 tons to 50 tons. This class of equipment cannot be compared with the ordinary electric railway equipment, but would seem to approximate more closely with steam locomotive practice. The writer believes that the methods and shop practices which will most successfully cope with this new problem in the traction field must be worked out along the lines which have proved so advantageous in the operation of steam railroads.

RECENT IMPROVEMENTS IN MOTOR AND CONTROL

BY G. H. HILL

A review of the development of the electric railway during its twenty years of history is particularly impressive on account of its marvelous growth. While recognizing as a prime factor in this growth the universal demand for transportation facilities, a generous measure of the success can well be credited to the sound and sensible engineering that has dominated the art from its inception. From the diverse and various methods proposed a uniform system was early settled upon, which time and experience have proven to be good and adaptable to a development far greater than could have been anticipated. The trolley distribution, the under-running collector, the series-parallel control of motors and the axle hung geared motor which are standard to-day were practically established fifteen or twenty years ago. Improvements, however, have been very marked, for the problem has not been barren of difficulties nor lacking in opportunities. Gratifying as may be the early wisdom, no less so is the consistent advance in reliability, efficiency and capacity of apparatus that has followed.

The progression of application from purely urban service to interurban has marked the most recent era of development, and it is toward this phase of railway work that a review of recent progress is chiefly directed. Interurban service primarily has required increased speed, larger cars, and consequently greater capacity in equipments; attendant on this are a higher voltage, greater mechanical and electrical strain and necessity for increased reliability. The improvements made to meet interurban requirements have naturally influenced the existing apparatus to a considerable extent. A review of each portion of the car equipment will, perhaps, serve best to illustrate what the recent improvements are and to indicate their relative value.

Probably no similar problem has presented more difficulties than railway motor design. Subject to exceptional and sudden electrical strains, extreme ruggedness is essential. Exposed to heat and cold, mud and dust, water and grease, its surroundings could hardly be worse, and unusual protection to its winding is required. Placed in a service where great refinement of attention is impossible, it must nevertheless be reliable and withal efficient.

Although improvements are mostly detailed in character, they are the results of painstaking study and are of much practical value. As an example of modern construction and one of the most popular of recent designs, may be selected the G. E. 80 motor of 40 hp rating, which is of the split frame design found most suitable up to 75 hp size. Above this the box type is usual, and of this form the G. E. 73 may be taken as typical.

The improvements in motor construction which may be considered as recent may be classed as follows: Field coil insulation, lubrication of bearings, shaft and gear strength, gear case design and commutation.

FIELD COIL INSULATION

The modern coil is of the "mummy" type heavily wrapped and made complete without any outside retaining spool. The insulation as now applied, instead of forming only an exterior coat, penetrates to the very heart of the coil. This effect is attained by the vacuum process, which exhausts all moisture and air entrained in the coil and replaces it with an insulating compound. The treatment is not only at a higher temperature than formerly, but for a longer time. A cross section of a modern G. E. coil (see illustration) shows how thoroughly this insulating compound impregnates the winding. In consequence, unless the coils are "roasted" by a too severe load, they are able for many years to resist the action of the water and oil to which they are bound to be exposed. The "mummy" coil is more compact than a spool wound coil, is less affected by a gradual shrinking of the covering, and can be held more effectively against vibration and chafing. Incidentally, the field coil terminal has been improved in strength and insulation and is provided with a shroud or guard to protect the lead from breaking by vibration.

LUBRICATION OF BEARINGS

The change from grease to oil lubrication has proven a most practical advance. The use of oil particularly in the armature bearings has greatly reduced the cost of inspection and maintenance, and has probably doubled the life of the bearings, with a corresponding reduction of damage due to the armatures getting down on the poles. Conservative experience indicates a life of 50,000 car-miles for a bearing with oil lubrication. The amount of oil required will vary somewhat with local conditions, but with systematic attention, one gill of oil for the commutator end bearing and one and one-half gills for the pinion end bearing have been found ample quantity for 1000 car-miles. The axle bearings may be treated the same as the car journals, and three gills for each 10,000 car-miles should ordinarily be sufficient.

SHAFT AND GEAR STRENGTH

Improvement here is largely a matter of quality, which has been steadily raised and now the tensile strength equals from 70,000 to 75,000 lbs. per square inch. The strength of shaft at the pinion end has been further increased by increasing the diameter of the taper to as near that of the shaft as possible.

Pinion material is now readily procurable with a tensile strength of 85,000 to 100,000 lbs. per square inch. The strength of cast gears is, of course, somewhat below this, but for the larger motors a solid gear or a gear composed of a forged rim shrunk on a cast steel center permits the use of a high quality steel in the teeth and has given excellent results. The split gear is almost exclusively used on the smaller equipments on account of its convenience. The four-bolt design, which has practically superseded the eight-bolt design, permits a more sturdy structure and a stronger bolt. Experience indicates that the bolts in the eight-bolt design were frequently weakened by too strenuous efforts in tightening them.

The adoption of a gear case with three points of suspension instead of two produced a most gratifying relief from breakage. Up to the present, malleable iron has been found the most satisfactory material for cases, but on account of the possible saving in weight some experiments have been conducted with the use of sheet steel riveted. The ordinary riveted case, of which there are several on the market, cannot be considered entirely successful, since with a very few exceptions on roads with unusually smooth track the vibration loosens the rivets and the case rattles itself to pieces. Appreciating the advantages and demand for a lighter case than is possible with malleable iron, careful study has been given the problem, and it is expected that a construction now being tried, in which the rivets and seams are welded by a special process, will prove satisfactory.

COMMUTATION

The commutator and brushes have usually required more care and attention than all other parts of the motor. The importance of brush quality as affecting commutator blackening, flashing and wear is frequently overlooked. Unfortunately the quality of American-made brushes has not been as high as it should be, and a better understanding of what is desirable would undoubtedly create the necessary demand for improvements, particularly in the direction of uniformity of product.

The chief ingredients of carbon brushes are hard gas coke and graphitic carbon with a suitable binder of pitch or similar material. The coke supplies an abrasive action which grinds down the mica and keeps the copper surface clean. The soft graphitic carbon is lubricating in nature and of lower electrical resistance than the coke.

The proper proportions of these two elements will vary for different motors, depending upon the proportional amount and quality of mica in the commutator, whether the commutator is grooved or not, the speed of the commutator, the thickness of brush, and, to a certain degree, upon the service conditions. The fineness to which the ingredients are ground, the thoroughness with which they are mixed and the compactness to which they are compressed, that is, the amount of cellular space existing, all have a most practical bearing on the quality and service results. The most frequent cause of chipping and breaking is the stratification of the brush, which is hard to avoid in the extruded or "squirted" type of product. The reduction of expense of motor upkeep would in most cases handsomely repay the attention necessary to procure brushes that conform uniformly to rigid specifications, as to hardness, specific gravity, absence of stratification and fineness of texture.

Recent investigations have aroused an interest in this subject that will, it is believed, make it possible to secure a much more satisfactory product if the railway companies will do their part in sustaining a demand for a superior article.

There is one recent departure in motor construction that merits particular mention. This is the addition to the motor of commutating poles. Motors so constructed are superior in commutation to the ordinary motor, and the limit of motor capacity for any service is no longer a matter of commutation possibilities, but of heating alone. Perfect commutation with extreme overloads, both as to current and voltage, is easily obtained. The commutating poles are small in size and are placed between the exciting fields. They permit a reduction in weight of the exciting fields and a greater freedom of electrical design without sensibly increasing the weight of the motor. Briefly, the function of the commutating poles is to counteract the armature reaction and consequent field distortion and produce a commutating field of constant strength and position with relation to the brushes, unaffected by load or speed of the motor. Many incidental but valuable improvements attend this new departure, which will undoubtedly become a standard construction. Among these are: Absence of flashing and burning of commutator and brush holders, less brush and commutator wear, absence of sparking, lighter and more easily handled field coils.

A complete line of motors of this type has been designed and several hundred have already been sold. A more complete discussion of the theory of this interesting development will shortly appear through appropriate technical channels.

CONTROL

The recent improvements in control and equipment devices may be classed as follows: Cylinder controller details, contactor attachment, rheostat construction, car wiring, train or type M control, circuit-breakers and main switches, fuses and trolleys.

CYLINDER CONTROLLER

As with the motors, the improvements of the cylinder controller have been more a matter of construction details than methods. The higher voltage usual in interurban lines and the general increase in station and feeder capacity, making it possible to sustain very heavy short-circuit arcs, have made it necessary to remodel the controller to provide greater strength of blowout, more complete isolation of arcs and insulation of circuits, and a more rigid fireproof construction.

The K-35 controller may be taken as representative of the most recent construction. The blowout magnet, instead of being a single coil placed at some distance from the arc points, is composed of individual coils, each placed close to the arc which it controls. The magnetic lines cross the arc so as to blow it outward from the contact tip into a chamber formed between the arc deflectors, instead of blowing it sidewise off the edge of the finger and against the arc deflector, as in the older forms of controllers, such as K-6 and K-28. The effectiveness of the new arrangement is many times greater than the old, and as the arc is ruptured much more quickly the burning and blistering of the contacts are much reduced.

The construction and shape of the arc deflectors are such as to separate the fingers and contacts more effectively than in previous designs, and the insulation of the frame and cover is very thoroughly carried out with fireproof and non-hydroscopic material.

The cylinder is made up of cast segments clamped upon an insulated hexagonal shaft by means of flat keys and set screws. This construction is quite a departure from the molded type of insulation for cylinder castings which has been in use for a long time. A distinct advantage is that the cylinder may be more easily repaired in case of damage to one of the contact segments. At the same time, the drive of the segments is more positive and a loosening of the castings less likely to occur from careless or vicious handling. If they should loosen, they may easily be tightened by the set screws.

The connections of the motors have also undergone some changes of importance. Some of the new type of controllers are arranged with the bridge form of transfer from series to parallel connection, which avoids the opening of the circuit of either motor during the transition and thereby continues the full torque of both motors throughout acceleration. For very small cars this refinement may not be entirely necessary, but for the larger equipments, particularly those geared for high speed and intended for drawing trail cars, the bridge form of control is very desirable in order to avoid the unpleasant jerk when passing from series to parallel. In accomplishing this arrangement several extra control fingers are required and a division of the rheostats into two banks is necessary. The slight complication is more than warranted.

Another change is that of reversing the motors by reversing the field connections instead of the armature connections. In doing this the fields are kept on the ground side of the motor, as is quite necessary. The advantage lies in the fact that the reversing cylinder is not subject to the full voltage, but has across its contacts only the drop of the field, which is not over 20 volts. This eliminates the burning of the reverser contacts, which is apt to occur on hand controls for four motors when the reversing switch is used in an emergency.

The attention of operators has been drawn to the controller difficulties very strongly on account of the burnouts with the attendant flashing and frightening of passengers, which seem to occur more frequently than some years ago. The difficulty has arisen on those controllers which were constructed for a 500-volt circuit and which are now made to operate on a 600 or 650-volt circuit. In order to make these controllers thoroughly safe on the higher voltages, an arrangement has been perfected for operating two contactors, of similar form to those used on train control, in connection with the cylinder, so that the contactors will make and break the motor circuits and thus take all of the arcing. The attachment for doing this is placed at the bottom of the cylinder and consists of a small contact which controls the circuit to the coils of the contactors, the contactors being placed under the car. The arrangement has been installed on several roads and has given such satisfaction that provision has been made so that all of the old cylinder controllers can be fitted with this attachment. The separate, magnetically operated contactor is able to handle high-voltage and heavy-current arcs without difficulty, and, in addition to the duty above described, may also be used as an overload circuit-breaker. In this way no motor current is broken on the platform of the car, a point which will be appreciated by all operators. The overload device consists of a tripping coil on the contactor, which is controlled by a small switch placed in the vestibule convenient to the motorman. This small switch opens only the circuit to the coil of the contactor, which, of course, carries only a small amount of current, but is tripped in case of overload by a coil carrying the motor current. It is closed by the motorman in the same way as the ordinary circuit-breaker.

The use of cast grid rheostats is so universal that no comment upon them is necessary. The advantages of the cast grid type over the wire or ribbon-wound type are: better insulation, better protection from moisture, more rugged construction, ability to withstand more severe overloads of current without damage, and greater ease of repair.

TROLLEYS

For city service the standard US-6 trolley with 4½-in. wheel has given splendid results, the average life being about 10,000 miles. For greater capacity of equipment and higher speeds, however, a trolley base which will swivel more readily is desirable and a different construction of wheel is necessary to secure a reasonable life.

The US-13 roller bearing trolley base has been designed to meet this demand. The base swivels on a roller bearing designed with ample margin for the strain of the pole. The height of the base when the pole is retracted is 5 ins., and its weight is approximately 100 lbs. Four sets of bearings are provided. Operating under tension with a 14-ft. pole, a pressure of 35 lbs. at an angle of 45 degs. can be given the trolley wheel, which, it is expected, will take care of the higher speed service.

The wheel used for high speeds is known as the form 21. It is 5¾ ins. in diameter and has a bearing 3 ins. long with a ½-in. pin. The diameter of the pin is made shorter than on the form 6, to reduce the speed of the rubbing contact, and this, with the increased length of bearing, has made the new wheel very serviceable on equipments as large as 500 hp. When operating at a maximum of 60 miles per hour under these conditions, it has an average life of 5000 miles.

It should be borne in mind in operating these high-speed trolleys that the side spring for conducting the current from the wheel to the pole is absolutely essential to satisfactory life of the wheel, and these springs must be provided with proper tension against the wheel. If this is not done, the current carried through the bearing will soon destroy it. The shape of the fork is such as to prevent its being caught in frogs and switches.

The pantograph form of trolley has many commendable features for catenary overhead construction which will undoubtedly come into general use on interurban roads. The results so far obtained in the use of this form of trolley will not justify us in making a complete recommendation for its adoption until further developed. Under special conditions where an ordinary trolley is extremely inconvenient its use is warranted, but it is believed that substantial improvements can be made in the pantograph type which will make it very satisfactory, and tests and experiments are now being carried on.

In this review no reference has been made to the more radical departures from standard practice which are being given much attention, i. e., the use of single-phase and high-tension direct-current motors. The reasons for using either single-phase or direct-current motors do not arise from consideration of the equipments, but from the desirability of reducing the cost of transmission and distribution of current over long distances. Of the two, the single-phase is the more radical departure, and the problems in the design of the single-phase motor are occupying the earnest attention of able designers. The 1200-volt, direct-current motor is more directly in line with standard practice, and the use of commutating poles has made such a motor thoroughly practicable. In fact, with such a system the problem of greatest importance is the method of distributing and collecting the current. The discussion of these broader subjects, however, would lead beyond the scope of the present review.

RECENT IMPROVEMENTS IN MOTOR AND CONTROL

BY CLARENCE RENSHAW

In dealing with the rather large subject of recent improvements in motors and control, I have not attempted to cover the matter broadly, but have devoted my time to three specific divisions with which I am most familiar, namely: Inter-pole motors, unit switch control and the single-phase system.

INTER-POLE MOTORS

Probably the most promising improvement in direct-current railway motors for many years is the introduction of the inter-pole motor. The commutation of high-voltage current in railway motors has always been a most difficult problem for the designers of such machinery to solve, and the care of commutators and brushes forms no small part of the duties of the mechanical and electrical force of a railway company. The larger the motors used, the higher the voltage, and the more difficult the service conditions, the greater is the importance of this matter. With large motors, flashing over from brush holder to brush holder or from brush holder to ground is sometimes experienced, and on a large system with great power capacity behind them, such flashes often cause considerable damage to motors and control and annoying delays to the service. Most commutator and brush troubles are due either directly or indirectly to sparking, and it is to correct them by correcting their cause that the inter-pole motor has been designed.

Sparking on a commutator bites away a small amount of copper and carbon at each spark, but does not affect the mica between segments. If the sparking is continued, the copper is soon eaten down, thus leaving the mica sticking up. This "high mica" in turn makes the sparking worse and causes a general roughening of the commutator, flattening of the bars, etc., with consequent rapid wear of the brushes, filling the motor with carbon and copper dust, and sometimes causing it to flash, ground, etc. Milling down the mica below the copper prevents some of this trouble, but does not go to the root of the matter.

In service a railway motor does not run continuously with power on, but the time that it is operating under load is varied by a certain amount of coasting and stopping. During this no-load running the roughening which has been caused by the action of the current is partly corrected by the scouring and polishing effect of the brushes without load. In many cases the scouring action predominates so that the commutators remain bright and clean and take on a good polish.

The action of the inter-pole motor in preventing sparking and thus greatly reducing the wear on commutator and brushes can best be understood by the aid of a few simple diagrams. In these a multiple-wound armature has been shown for the sake of simplicity and clearness, although on an actual motor a two-circuit winding would ordinarily be used.

In a motor without inter-poles, as shown in Fig. 1, there are three sets of magnetic fluxes produced; first, the lines "aa" due to the main field coils; second, the lines "bb" due to the current in the armature winding as a whole, and third, the leakage "cc" around each of the slots, due to the current in the conductors in that particular slot. The first set of lines may be regarded as the useful lines, and the second and third as incidental. It is to these last two that sparking is due. The coil "AA," which is just about to have the current reversed in it, lies in such a position that it is not cutting the lines "aa," and hence has no voltage generated in it from that source. It is, however, cutting the lines "bb," so that it has a voltage generated in it by them. When the coil is short-circuited by the brush, this voltage causes a local current to flow across the face of the brush in addition to the line current, which greatly increases the amount of current that the brush must carry. As the coil passes under the brush, also, from position "A" to position "B," the current in the conductors in the slots "A" is stopped preparatory to being reversed, so that the leakage lines "cc" are also stopped preparatory to being reversed. This causes an inductive voltage to be created in the coil in addition to the voltage of rotation generated by the lines "bb," and these two voltages added together produce a spark between commutator bar and brush.

In an inter-pole motor the inter-poles consist of thin poles, each carrying a coil inserted into the frame between

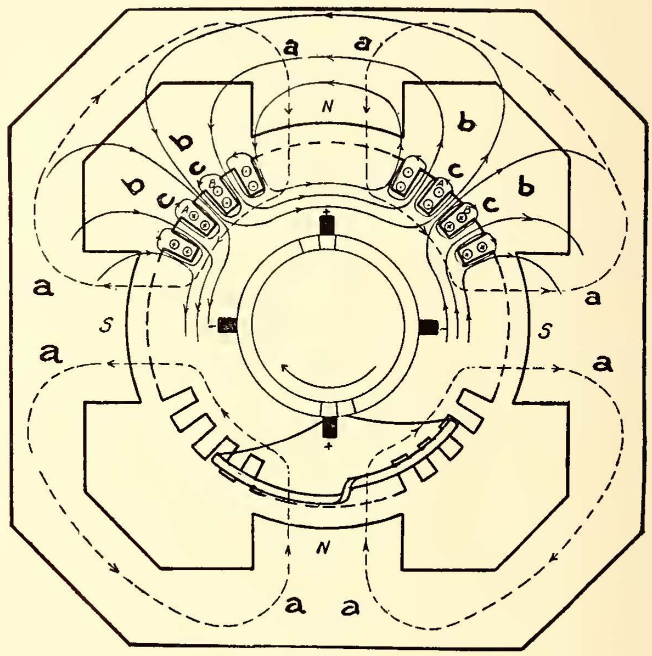


FIG. 1.—MAGNETIC FLUX IN ORDINARY MOTOR

the main field poles and projecting down to the points on the armature at which the sides of the coils short-circuited by the brushes lie. If the inter-poles alone were used without any coil, as shown in Fig. 2, their effect would be to concentrate and increase the lines "bb" due to the armature magnetization, and also the lines "cc," due to the leakage around the slots, owing to the additional iron in the path of those two sets of lines, and thus to raise the voltage in the short-circuited coil, and increase the sparking.

With coils on the inter-poles of sufficient number of turns to just neutralize the armature magnetization, the effect of the lines "bb" will be eliminated, as shown in Fig. 3, so that there will be no voltage generated in the short-circuited coil by its rotation, but the lines "cc," due to leakage around the slots, will still remain, and the increase in these due to the presence of the inter-pole would ordinarily give a sufficiently high inductive voltage to more than offset the advantage gained by the neutralization of the rotation voltage.

If, however, a greater number of turns be wound on the inter-poles, so that their excitation overbalances the armature magnetization instead of merely neutralizing it and sets up a flux in the opposite direction, as shown in Fig. 4, this flux can be made of such a strength that the leakage lines around the coil which is being commutated will also be eliminated, so that practically all of the voltage in the short-circuited coil is neutralized and sparkless commutation is obtained. Since the inter-poles neutralize the active voltage in the short-circuited coils, they also eliminate the extra local current in the brushes and thus reduce the total cur-

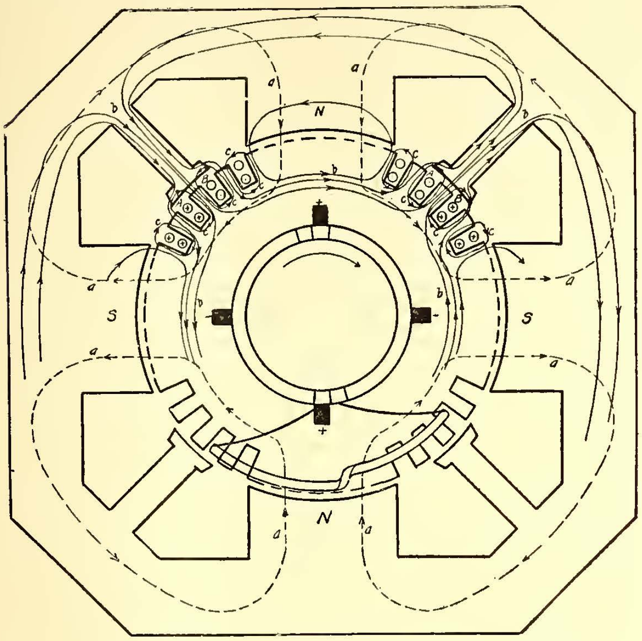


FIG. 2.—EFFECT OF INTERPOLES WITHOUT COILS

rent in the brushes to its minimum value, that is, to the line current. The elimination of sparking and of local currents in the brushes reduces the wear on the commutator and prolongs the life of the brushes to a remarkable extent.

The inter-pole winding is connected permanently in series with the armature winding, as shown in Fig. 5, forming the

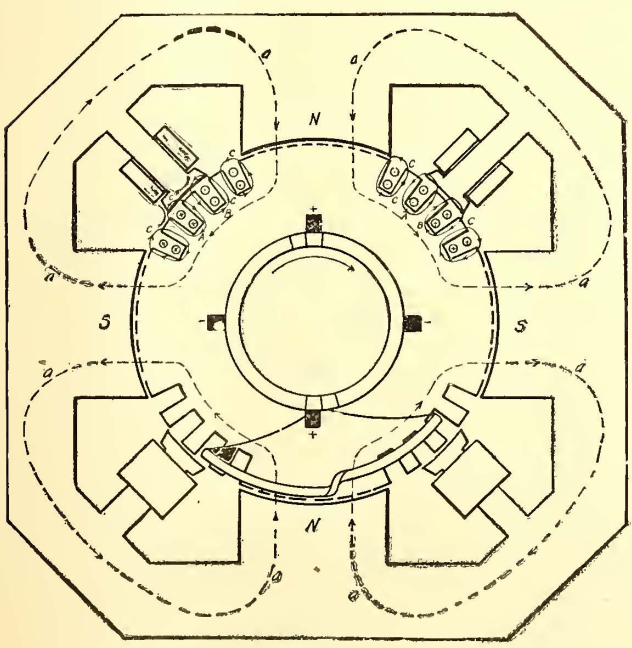


FIG. 3.—INTERPOLE MOTOR WITH ARMATURE MAGNETIZATION JUST NEUTRALIZED

"armature circuit," and in reversing the direction of rotation of the motor the armature windings and inter-pole windings are reversed together as a unit.

Aside from the general reduction in wear of commutator and brushes, the inter-pole motor has many incidental advantages. A properly designed motor of this type should run practically sparklessly from a load so light as to give treble the normal speed up to loads as heavy as double its ordinary one-hour rating. It should permit high voltages to be thrown on it, either at standstill or when running at high speeds, and its stability should be so great that it will

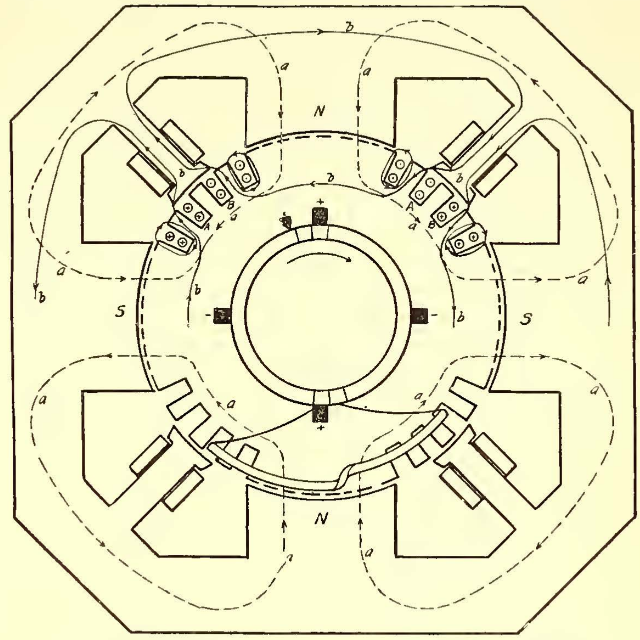


FIG. 4.—MAGNETIC FLUX IN INTERPOLE MOTOR

commutate without appreciable sparking rushes of current which in the ordinary motor would invariably cause flashing. This great freedom from sparking and flashing makes the inter-pole motor especially well adapted for high-voltage service.

The use of the inter-pole increases the scope of the de-

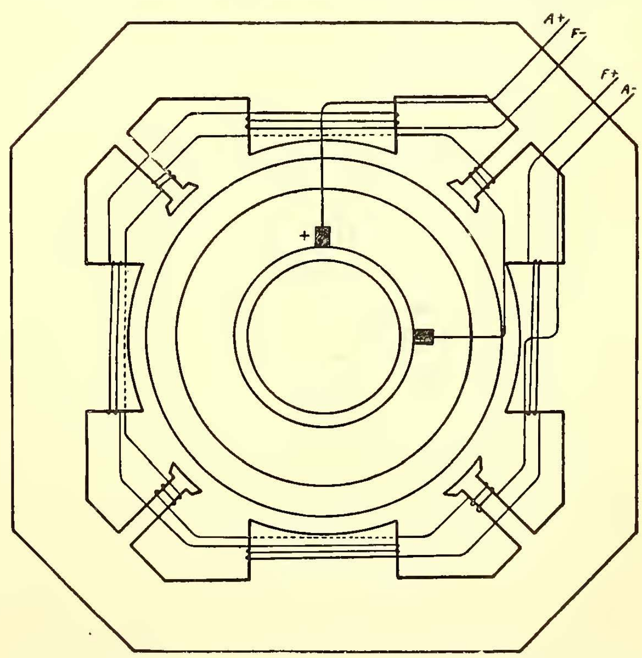


FIG. 5.—METHOD OF CONNECTING INTERPOLE WINDINGS

signer of railway motors in many cases where limitations of speed and weight determine the design, and in general it permits of a somewhat lighter motor. It gives less advantage in small motors than in large ones, as the commutating conditions in such motors are not so serious a problem. However, its general advantages will doubtless extend its use to sizes as small as 40 hp. Improving as it does those features of the railway motor which are universally acknowledged to be in greatest need of improvement, the introduction of the inter-pole motor is an important step in electric railway development.

UNIT SWITCH CONTROL

A most important development in control apparatus is the perfection and standardization of unit switch-control equipments for all sizes of motors. The ordinary drum type controllers, while in general satisfactory for small equipments, leave much to be desired where it is necessary to handle large cars and powerful motors. Such controllers of large capacity must necessarily be heavy and bulky in order to contain sufficiently liberal contacts and blow-out coils to handle the large currents which pass through them. The weight of such controllers, moreover, must be mounted at the extreme end of an overhanging platform where it is least desirable and a large bunch of heavy cables must be led out to it. On account of the size and pressure of the contact fingers also, the drum requires considerable effort to turn it, especially should the contacts become slightly roughened and quick movements are impossible. Finally, it seems impracticable to design a blow-out which will enable such controllers to break the current with certainty under all circumstances, and in certain parts of the country it is not an unusual sight to see a motorman nursing an interurban car along the streets of a city by means of the overhead circuit breaker and shooting out a stream of fire every time it is necessary to cut off power. The drum-type controller, however, is a rough-and-ready piece of apparatus, and when out of order its faults can be easily located and repaired by a comparatively cheap man if only a sufficient stock of spare parts is kept on hand.

The unit switch control system was originally designed with special reference to the operation of two or more motor cars in a multiple-unit train, and it was at first adapted only for use in connection with the larger sizes of motors. Its other advantages, however, in providing a positive and reliable control, in placing all main circuit contacts and heavy cable out of the way beneath the car and in reducing to a minimum the amount of high-voltage and heavy-current wiring, are now rapidly extending its use to single-car operation and to smaller sizes of equipments.

In the unit switch-control system the main or power drum of the drum type controller is replaced by a group of ten or twelve (according to the size of the equipment) independent or "unit" switches, each provided with a strong magnetic blowout and normally held open by a powerful spring. Each switch is closed when desired by a suitable pneumatic cylinder using compressed air from the brake system. This combination of switches is called a "switch group." The reverse drum of the controller is replaced by a similar drum except that it is more liberal in capacity, built in a separate case and moved to the forward or reverse position by one or the other of two cylinders having a common piston rod. This device is called a "reverser." The overhead circuit-breaker is replaced by a "line switch," which is essentially the same as one of the switches of the switch group, except that it is placed in a case by itself and is provided with an automatic trip, which causes it to open in case of an overload or short-circuit. These three pieces of apparatus effect the various necessary connections between motors, resistance and trolley.

Forming an essential part of the pneumatic cylinder for operating the switch group, line switch and reverser is a magnet valve which governs the admission or escape of air to or from that cylinder. These magnet valves are operated by means of a small 14-volt storage battery, and their opening or closing is regulated by means of a "master controller" to which their circuits are led. The switch group, reverser and line switch may thus be located in any convenient position, and nothing but the master controller need be located on the platform, and only the small low-voltage battery circuits need be carried to it.

For train operation the circuits from the battery and magnets are carried to "train line receptacles" at each end of the car, as well as to the master controllers, and when two cars are coupled together the corresponding receptacles on each car are then connected by a multi-point "jumper," so that the circuits are continued from car to car. When several cars are connected in this way the movement of a single master controller closes simultaneously the corresponding magnet circuits on all of the cars and thus operates also the corresponding main circuit switches.

Connected to the piston rods which move the various switches are a number of small contacts which open or close auxiliary circuits between stationary fingers arranged to press on them. These auxiliary contacts are called "interlocks," and the circuits which operate the magnet valves of each of the various switches are carried through the interlocks of other switches in such a way that the switches cannot be closed except in the proper order.

The unit switch-control system, however, does not consist merely in replacing the ordinary controller with a set of pneumatically operated switches, which may be closed properly or improperly entirely at the discretion of the motorman, but the action of the switches is regulated so as to give a uniform current through the motors while operating on the resistance steps and to thus secure a smooth and even acceleration of the car and protect the equipment from abuse. This is accomplished by means of a "limit switch." The limit switch consists of a coil, placed in series with the motor circuits, which lifts an armature whenever the current exceeds a predetermined amount. To the armature of this coil is attached a disc which closes a secondary circuit between two contacts when the armature is down, and opens this circuit when the armature is raised. The circuits for closing the various switches of the switch group are so arranged that it is not necessary to move the master controller step by step to cause the closing of the different switches, but so that by placing the master controller in a single definite position and holding it there the circuits to the first switches are closed, and the closing of these switches then automatically closes the next ones, etc., by means of the inter-locks. The circuit from the battery which supplies power for this automatic operation is led through the secondary contacts of the limit switch, so that as long as the current through the motors does not exceed the desired value the different switches will close one after the other almost instantaneously. Should the current through the motors at any time exceed the desired amount, however, the armature of the limit switch will instantly raise and thus prevent the closing of any more switches until the current has fallen to the desired value.

The regulation of the current during starting is thus taken entirely out of the hands of the motorman, who simply advances the handle of the master controller to the last notch and holds it there, and the closing of the switches is then governed automatically by the limit switch. In order to provide for the handling of the car under special conditions, however, the apparatus is so arranged that the motorman may readily notch up more slowly than would be done by the limit switch, or may stop on any notch, and also so that by going to some extra trouble (enough to prevent his doing it unnecessarily) he can short-circuit the limit switch and notch up entirely independent of the current.

As ordinarily built, the master controller for use with the unit switch-control system contains three notches for forward running and three for reverse. If the handle is moved to the first notch a slow-speed resistance point is obtained which is used principally in shifting cars. On this account the first notch is called the "switching" position. If the handle is moved to the second notch, either with or without pausing on the first one, the switches close one after the other until the motors are connected in series. The second notch is therefore called the "series" position, and is, of course, a running point. If the handle is moved to the third notch, either at once or after pausing on one or both of the other two, additional switches will then close in sequence until the motors are connected in full parallel. The third notch is hence called the "parallel" position.

Fig. 6 shows a schematic diagram of the switches and main circuit connections for an equipment of four 90-hp motors, and indicates the sequence in which the various switches close. In addition to stopping the handle on any one of the three notches, as already mentioned, and obtaining the switching, series or parallel connection, the motorman may so manipulate the master controller as to hold the switches in any one of the series and parallel positions indicated on the diagram. In connection with the above diagram, it will be noted that instead of opening the circuit in changing from series to parallel, as is done in the large drum-type controllers, a special resistance connection is used for making the transfer without decreasing the current through the motors. The use of this connection avoids the jerk sometimes obtained with drum-type controllers in passing from series to parallel, and helps in maintaining a smooth and uniform acceleration.

An interesting detail in connection with this system of control is the method of charging the small storage batteries used for operating the magnet valves. Two batteries are carried on each car, and these are connected to the air-pump motor circuit, as shown in Fig. 7. The two double-throw switches are always thrown either both up or both down, so that one battery is connected to the control circuit while the other is being charged. Whenever the pump is running the battery which is being charged is connected by the "battery-charging relay" to the circuit of the pump motor. The resistance in series with the pump motor is so adjusted, in connection with the relative amount of time that the pump is running, and that the control circuits are closed, so that the battery will receive on the one hand sufficient current to charge it properly without, on the other hand, receiving enough current to make it boil or gas. When this adjustment has once been made, the batteries will require little attention other than the reversal of the two switches once each day.

Another detail of the equipment is the air-storage system. A separate "control reservoir" is piped to the air-brake system, as shown in Fig. 8, in connection with a "governor" or check valve and a three-way valve. Ordinarily the three-way valve is turned so that the air is drawn directly from the brake system, but in case of accident to the compressor or main reservoir the three-way valve may be turned 90 degs. and the reserve supply of air in the control reservoir is thus available to return the car to the car house.

Many other details might be mentioned, but the above are sufficient to indicate the completeness with which every feature of the equipment has been worked out.

In providing for the control of the different sizes of motors most commonly used, two sizes of switch groups are employed. The construction of the smaller of these is shown by the cross-sectional view in Fig. 9. A similar view of the larger group is shown in Fig. 10. Fig. 11 shows a reverser with the cover removed.

Unit switch control possesses many advantages, not only over the drum-type controller, but also over any other type of multiple control now on the market. One of the most important of these advantages is the powerful force which is available both for opening and closing the switches, so that their action is most positive. In the smaller switch

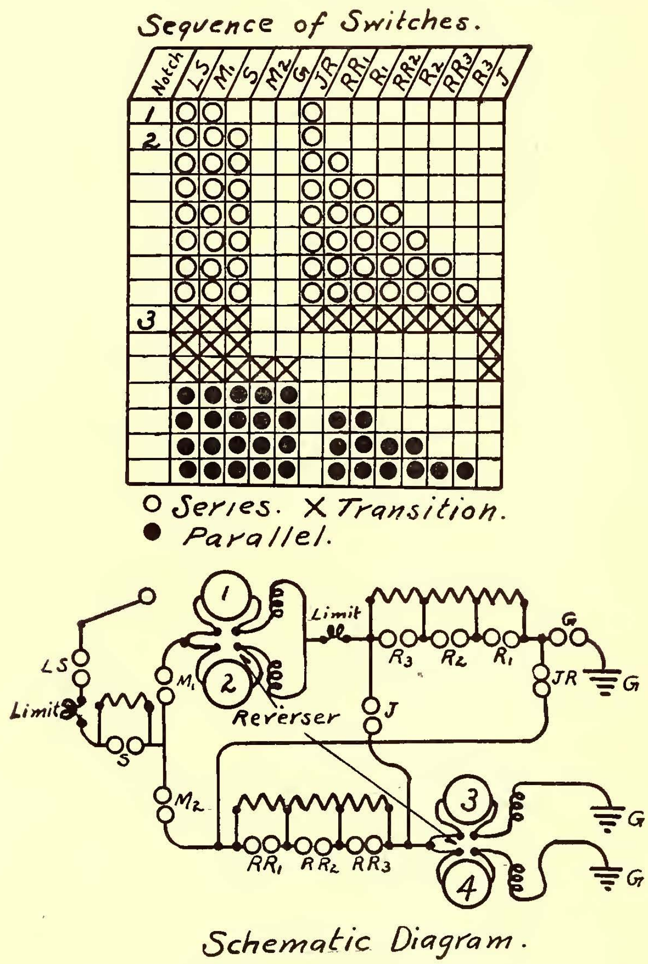


FIG. 6.—SCHEMATIC DIAGRAM OF UNIT SWITCH CONTROL SEQUENCE OF SWITCHES

group, for instance, a force of approximately 75 lbs. is available at the contacts for opening or closing them, and in the larger group this is increased to over 90 lbs., so that the chance of these switches failing either to open quickly, or to make a good contact, is extremely remote. To convince almost anyone on this point, it is usually only necessary to show him the switch group and have him try to prevent a switch from either opening or closing.

This positive action, moreover, is obtained without making the apparatus large or heavy. By using compressed air as a motive force, powerful action is obtained without undue increase in bulk or weight. As a concrete instance of this, it may be mentioned that a complete double-end unit switch outfit for controlling a quadruple equipment of Westinghouse No. 121 motors (90 hp each) weighs only approximately 1650 lbs., including the switch group, reverser, line switch, master controllers, control reservoir and all details except wiring and resistance.

Another advantage of almost equal importance is the use of a low-voltage battery for operating the control circuits and the fact that the operation of the control is entirely independent of the line voltage. This point is of especial importance on interurban lines where wide fluctuations in voltage are frequently met with.

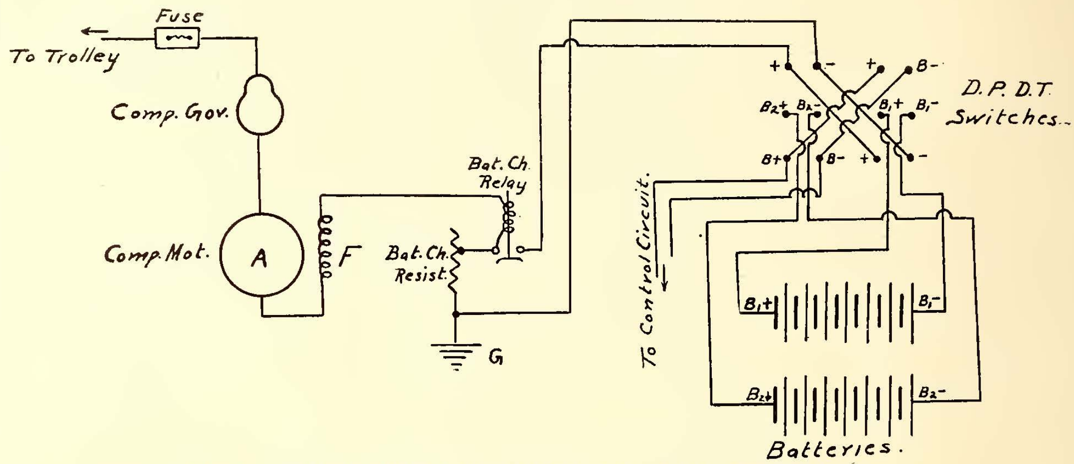


FIG. 7.—CONNECTIONS FOR CHARGING STORAGE BATTERIES

Although the elimination of bulky controllers and heavy cables from the platforms and the securing of control apparatus which will positively open the circuit under all conditions are in themselves sufficient reasons for the use of unit switch control, the ability to operate two or more cars together with a single motorman, when required, is no mean advantage. There are many instances where trailers are now used, overloading the equipment and slowing down the schedule just at the time when rapid car movement is most needed, where multiple-unit operation would give superior service at less expense. This is becoming widely recognized even in the case of comparatively small equipments for city service, as may be seen from recent orders for twenty equipments of unit-switch control for operating double 60-hp motors in New Haven, Conn., and for eighty equipments for operating quadruple 55-hp motors in Baltimore, Md.

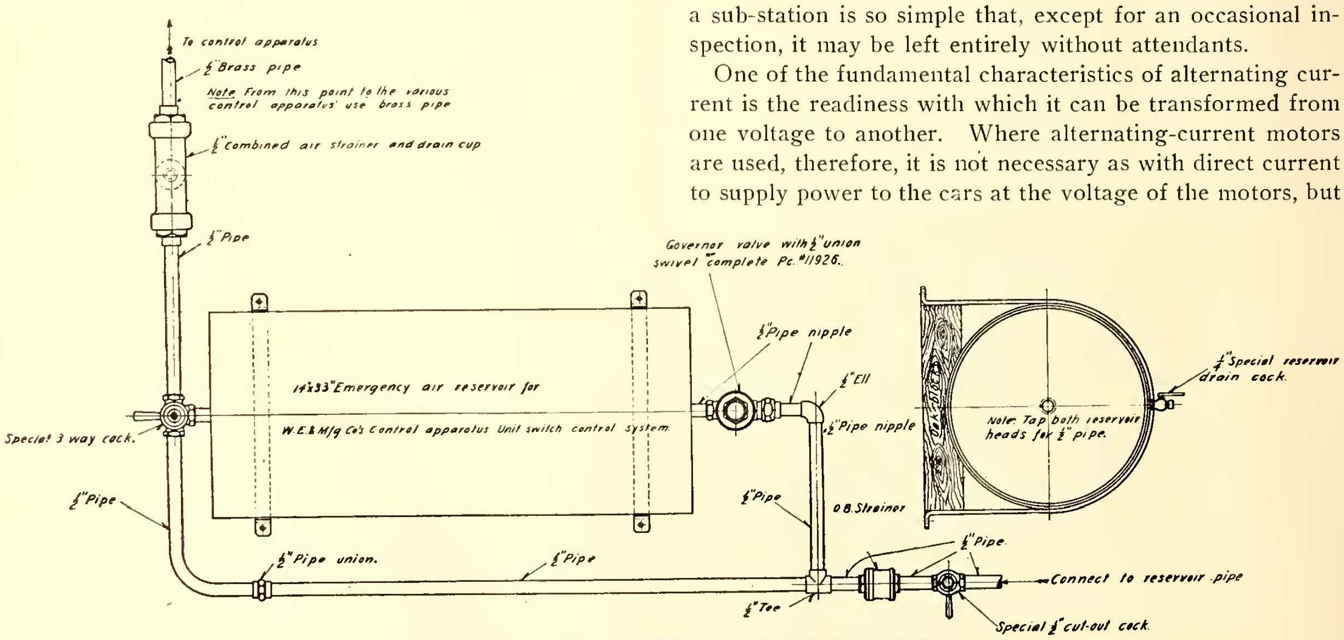


FIG. 8.—CONTROL RESERVOIR AND AIR PIPING

THE SINGLE-PHASE SYSTEM

A consideration of recent improvements in railway motors and control would be very incomplete if no mention were made of the single-phase system, although the essential economies of single-phase operation are effected not by the change in motors or control, but in the other parts of the system. In order to obtain these economies, however, car equipments differing from direct-current equipments in certain particulars must be used, and it is proposed to mention briefly the essential features of these.

The single-phase railway system accomplishes the same results in car movement that have heretofore been secured by the use of direct-current equipments, but it does this in many cases with less first cost, less operating expense, increased flexibility and greater simplicity. These advantages are obtained principally by a simplification of the sub-stations and the omission of sub-station attendants and by the elimination of practically all trolley feeders. At the sub-stations, the alternating-current power which is received from the generators is merely reduced in voltage by single-phase transformers and supplied at once to the cars, instead of being changed into direct current by poly-phase transformers and rotary converters. The equipment of such a sub-station is so simple that, except for an occasional inspection, it may be left entirely without attendants.

One of the fundamental characteristics of alternating current is the readiness with which it can be transformed from one voltage to another. Where alternating-current motors are used, therefore, it is not necessary as with direct current to supply power to the cars at the voltage of the motors, but by the use of a transformer on the car the voltage of the trolley and that of the motors may have any desired ratio. As it is entirely feasible to employ a voltage of 11,000 (which permits the distribution of a large amount of power with a very small current) on a properly insulated trolley wire, the single-phase system affords means of operating even the heaviest cars or trains from an ordinary trolley wire of moderate section with no additional feeders.

The one element upon which the entire single-phase system depends is the single-phase railway motor. This does not involve any particularly new or mysterious principle, but depends for its operation upon an extension of the well-known fact that reversing the current at the terminals of a series direct-current motor does not reverse the direction of rotation or interfere with the operation. This principle holds good no matter whether the current is reversed once every hour or once every minute. Since an alternating current gives merely the same general effect as a very rapid and continuous reversal of a direct current, it would be only natural to expect any ordinary direct-current railway motor to rotate if suitable alternating current were applied to it. Within certain limitations this is the case.

The single-phase railway motor is essentially a series-wound motor very similar to the direct-current motor. On account of the rapidity of the reversal of the alternating current, however, a number of new phenomena are introduced,

ordinarily wound for a voltage of from 200 to 250 instead of 500 or 550, as in the case of direct-current motors. The larger currents which must be handled on this account necessitate greater brush capacity than in direct-current motors, so that four brush arms are ordinarily required with a four-pole motor or six with a six-pole motor.

The performance of the single-phase railway motor is very similar to that of a direct-current series motor, the principal difference being that the speed curve is steeper. The general effect of this is to cause a car equipped with such motors to run slower on heavy grades and faster on the level than a car equipped with direct-current motors geared for the same speed at an intermediate load.

The single-phase motor differs from the direct-current motor also in that on account of its self induction it requires the application of a much greater percentage of normal voltage in order to send a given proportion of full-load cur-

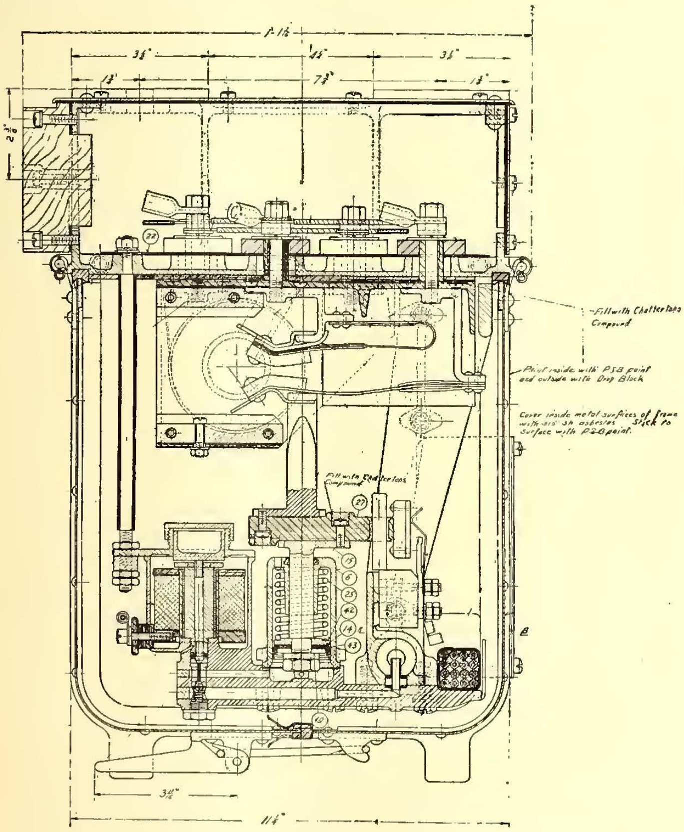


FIG. 9.—CROSS SECTION OF SMALL SWITCH GROUP

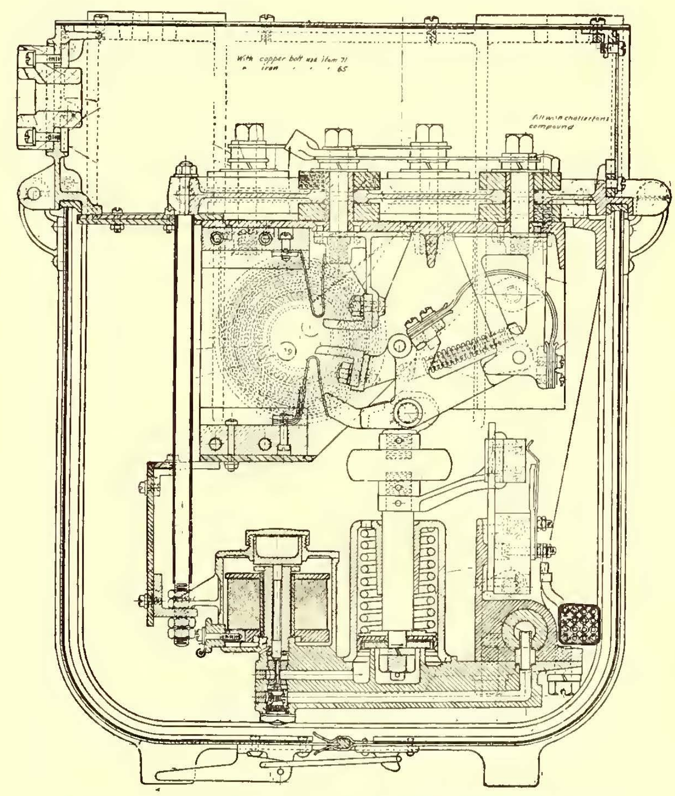


FIG. 10.—CROSS SECTION OF LARGE SWITCH GROUP

and in order to secure satisfactory commercial operation from the motor with this current, certain changes in the design of the ordinary railway motor must be made. One of these is to make the entire magnetic circuit laminated instead of merely the pole pieces, to prevent excessive losses, due to the rapid reversals of the magnetic flux. Another essential feature is the "auxiliary" or neutralizing winding which is wound in the slots between the poles in order to neutralize the magnetizing action of the armature and hence its self induction. This winding is connected in series with the armature in the same way as the inter-pole winding of the inter-pole motor. Instead of being located on definite poles, the auxiliary winding is distributed in slots in the faces of the main pole pieces so that the neutralization will be more complete and effective. Unlike the inter-pole winding, however, the auxiliary winding is not used to improve the commutation, but to improve the power factor of the motor.

Owing to limitations of design, the single-phase motor is

rent through it. On this account, it is not possible to allow as great a variation in the voltage at the car as is sometimes done with direct-current equipments, and to secure satisfactory operation the minimum voltage should never be less than about 80 per cent of the normal. Owing to the small currents used, however, this is a matter that is very easily taken care of. For the same general reason, the voltage on the motor may be varied in larger steps than with direct-current motors, so that fewer controller notches are necessary in order to secure a smooth acceleration, five notches, for instance, being ample for a quadruple 100-hp equipment. For the same reason also, the motors are much less likely to be damaged by too rapid feeding of the controller, and hence automatic acceleration is usually not necessary.

The standard trolley voltage for single-phase operation is 6600, although voltages of 3300 and 11,000 are also employed in some cases. In order to collect current at this voltage from the trolley wire, a pneumatically operated pantagraph trolley has been devised which can be readily raised or lowered by the motorman without leaving his cab. In multiple-unit equipments, moreover, the trolleys on the entire train may be simultaneously controlled from any one point. This trolley is normally held against the wire by means of a spring, but is lowered and automatically locked down by the application of compressed air. Application of the air to another point will then unlock the trolley and allow it to rise.

To reduce the trolley voltage for use at the motors an oil-insulated, self-cooling auto-transformer is used. As this is ordinarily the heaviest single piece of apparatus on the car, it is commonly mounted in the center in order to simplify the matter of balancing.

As with direct-current motors, the speed of the single-phase motor varies with the voltage at its terminals, and the motor is controlled in this way. In order to get a variable voltage for this purpose, however, it is not necessary, as in direct-current practice, to change the grouping of the motors or to introduce resistance into the circuit, but simply to connect the motors to different taps on the auto-transformer.

The various connections between motors and transformer may be made either by drum type controllers or by unit

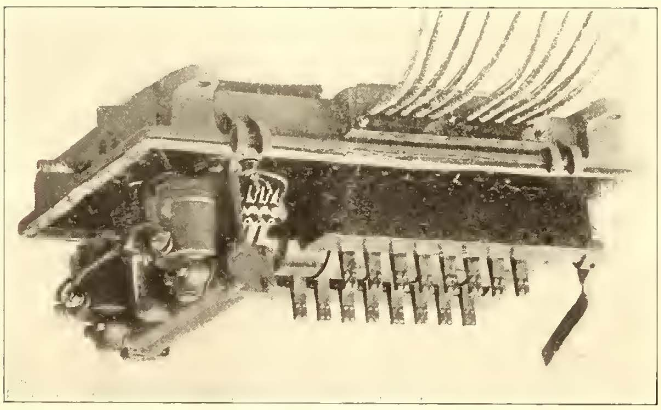


FIG. 11.—REVERSER WITH COVER REMOVED

switches, as with direct-current equipments. On account of the absence of any necessity for making series-parallel connections, both drum type controllers and unit switch groups for single-phase equipments are simpler than those for direct-current operation. For instance, a switch group for handling four 100-hp direct-current motors weighs approximately 760 lbs., while one for handling four single-phase motors of the same capacity weighs only 400 lbs. An entire equipment of single-phase motors, however, is considerably heavier than an equipment of direct-current motors of the same capacity, so that a car equipped with the former and carrying the same passenger load will ordinarily weigh from 10 to 15 per cent more than one equipped with the latter. Switch groups for single-phase operation are controlled by small storage batteries in the same way as those for use with direct-current equipments, but in this case the batteries are taken off of the cars at intervals and charged from a suitable source of direct current at the car house.

The qualities which make the single-phase motor suitable for operation on alternating current make it also an excellent direct-current machine, and such motors will operate beautifully on direct current of the proper voltage. It is often desirable to obtain the benefits of single-phase operation with cars which for a part of their route must run over the same tracks and use the same power as direct current cars, and by connecting two or more single-phase motors in series for such operation they can readily be arranged to run from a 550-volt trolley wire, as well as from a 6600 or other high-voltage one. Single-phase motors run somewhat faster with direct current of a given voltage than with alternating, while where operation on direct current is required of such motors, it is usually over city streets or in other places where only a moderate car speed is desired. On this account, equipments for operation on both alternating and direct current are usually supplied with four motors, which are permanently connected in two pairs of two in series. These pairs are run in parallel on alternating current and in series (so that all four motors are in series) on direct current. This arrangement usually gives a speed on 550 volts direct current about two-thirds or three-quarters as great as that obtained when operating from normal voltage alternating current. When running on alternating current, the motors of such an equipment are controlled in the usual way by connecting them to different taps on the transformer. When running on direct current, they are controlled by means of a resistance in series.

Equipments for operating on both alternating and direct currents are somewhat more complicated and expensive than those for operating on alternating current only, but they are equally satisfactory in operation, and the majority of single-phase equipments now in use are arranged in this way. In such equipments with drum type controllers, the controllers are made with two drums, and in changing from alternating to direct current, for instance, the controller handle is moved from the shaft of the a. c. drum to that of the d. c. drum. In multiple-control equipments, the circuits from the master controller to the various magnets are carried through a changeover switch. This is in the nature of a number of double-throw switches with the wires from the master controller connected to the middle points, so that with the changeover switch in one position a movement of the master controller operates one set of magnet circuits and closes the proper switches for alternating current operation, while with the switch in the other position, the same movement of the master controller operates a different set of circuits and closes the proper switches for direct-current operation. This changeover switch is governed by two relays, one connected to the transformer, and arranged to operate on alternating current only, and the other connected to the direct-current trolley and arranged to operate on direct current only. With such an equipment, therefore, if alternating current is supplied to the car, the changeover switch will automatically set itself in the a. c. position, or if direct current is applied to the car, it will set itself in the d. c. position. The movement of the same master controller in exactly the same way, therefore, closes an entirely different set of switches, according to the kind of current that is being used. Thus, in changing from a. c. to d. c., or vice-versa, it is only necessary to see that the proper trolley is on the wire.

During the past two and one-half years fifteen roads using single-phase apparatus have been put into commercial operation in this country, as well as several in Europe, using American apparatus, and many others are in process of construction. The equipment of the road now in operation ranges from double 50-hp to quadruple 150-hp motors, and the operating conditions cover an equally wide range. In some cases the roads are level, while in others they include grades as high as 10 per cent. In one case a slow-speed town service is given with a maximum speed of about 25 miles per hour and a schedule of about 10 miles per hour, while in another the road operates the fastest electric interurban service in the world and makes a maximum speed of over 60 miles per hour and a run of 58 miles in an hour and a half.

On a basis of the experience gained from these roads, single-phase equipments have been standardized to a remarkable extent considering the comparatively short time the system has been in use, and the advantages of the system have been so thoroughly demonstrated that at the present time no new railway line is laid out without carefully considering the advisability of using the single-phase system on it.

RELATION BETWEEN MAINTENANCE OF TRACK AND EQUIPMENT OF INTERURBAN LINES

BY W. R. W. GRIFFIN,
Operating Superintendent Rochester & Eastern Rapid Railway Company

It is a very noticeable fact that the majority of papers read before this convention, together with writings in the different journals upon the subject of maintenance of equipment of high-speed interurban lines during the past, very rarely take into account the condition of track as having any bearing upon the same.

In traveling over different interurban lines, noting the track conditions and also shop conditions of same, I have come to the conclusion that track conditions enter very largely into the cost of equipment maintenance. Rough track with low joints, bad surface and line certainly racks car bodies, trucks, and is hard as well as dangerous on car wheels. It is also hard on motors, armatures, and is continually tearing off motor cables.

Figs. 1 and 2 show views of pieces of track taken from a limited train making a schedule of 28 miles per hour. This road at the time the photographs were taken required about thirteen cars of heavy equipment to fill schedule. A visit to the shops showed seven busy men in the armature room and other parts of the shop were busy in proportion.

On a visit to another road, the superintendent was seeking advice on maintenance of equipment and ways and means of keeping up repairs sufficient to keep his cars out on the road. A glance at Fig. 3, which is a photograph of a piece of his track, ought to explain the cause of a large percentage of his equipment trouble.

An analysis of two years' maintenance of track and equipment of the Rochester & Eastern Rapid Railway makes a very interesting study. In 1905, the second year of operating the road, there was spent on maintenance of track $175 per mile of road, or $11.20 per 1000 car-miles, and the track was kept in none too good condition. On maintenance of cars (Acct. No. 6) there was spent $14.52 per 1000 car-miles. On maintenance of electric equipment of car, $5.20 per 1000 car-miles.

In 1906, the third year, there was spent on maintenance of track $245 per mile of road, or $15 per 1000 car-miles. Maintenance of cars (Acct. No. 6), $10.77 per 1000 car-miles, and maintenance of electric equipment $5.42 per 1000 car-miles.

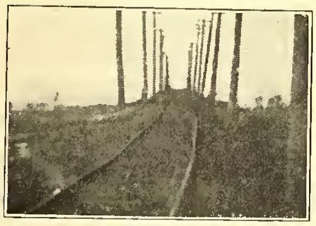


FIG. 1

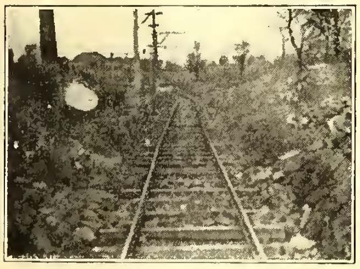


FIG. 2

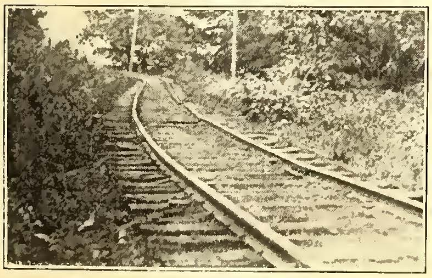


FIG. 3

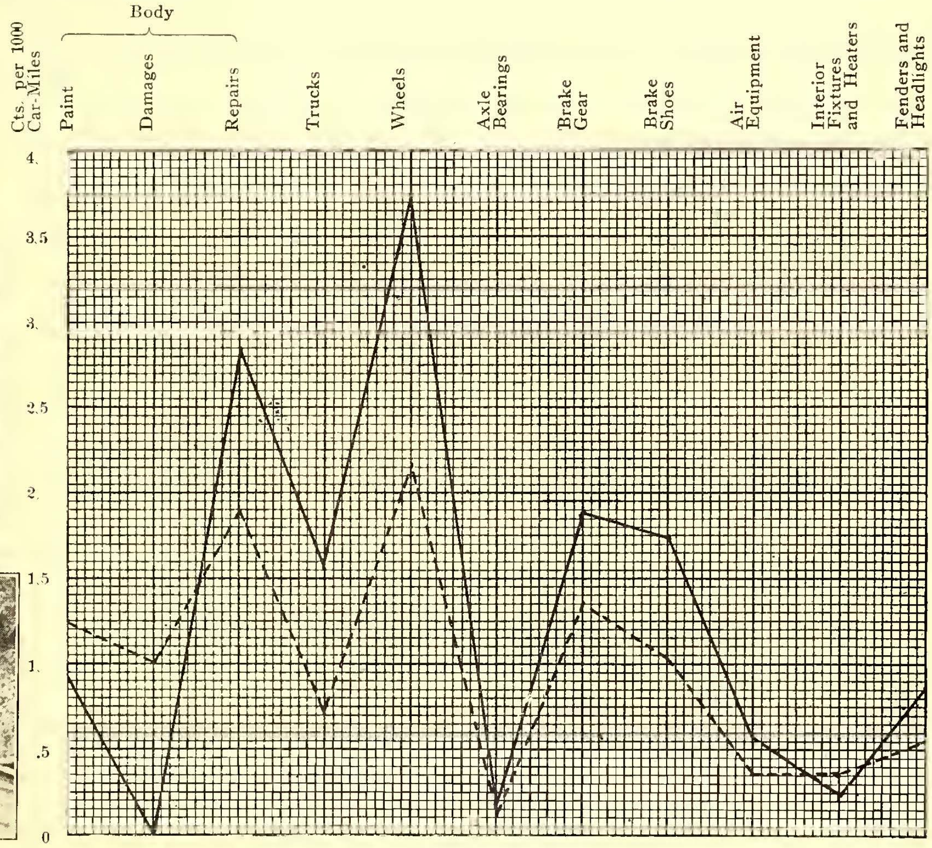


FIG. 4.—MAINTENANCE OF CARS

An inspection of Fig. 4 shows a large falling off of general repairs to car bodies, trucks, wheels, brake-gear and brake-shoes during the year 1906 over 1905, all of which is directly due to smoother track.

Fig. 5 does not show as decided improvement, except in the item of motor cables. At the same time, considering the fact that the average schedule speed was increased 12 per cent in the year 1906 over 1905, and also that the electrical equipment was a year older, we must admit that the improved track must have had a great deal to do with keeping the electrical repairs as low as they were.

In summing up: Eliminating painting and damaged cars, in body repairs, since these two items have no relation to track, we have

	1905—Per 1000 Car Miles	1906—Per 1000 Car Miles
Acct. 6....	$13.59	$8.53
" 7....	5.20	5.42
Track.....	11.20	15.00
Total....	29.99	28.98

making a total saving of $1.01 per 1000 car miles.

From the foregoing figures, it seems to me that it is good policy still to increase the ratio of total expenditure on

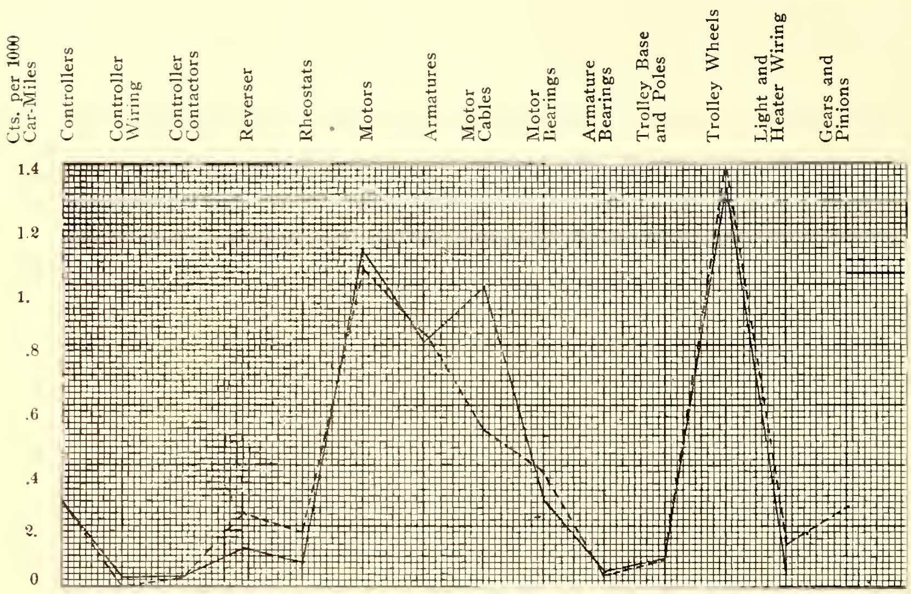


FIG. 5.—MAINTENANCE OF ELECTRICAL EQUIPMENT

track, since the track is the real permanent part of the railroad, and in so doing we not only build up a far better permanent way, but greatly extend the time of renewal of cars and electrical equipment.

COMMENTS ON SALE OF POWER

BY S. B. STORER
Manager of Sales, Niagara, Rockport & Ontario Power Company

In a paper presented before you last year on the "Sale and Measurement of Electric Power," the writer outlined a system of charging that he believed to be based on equity, and which was developed only after a careful study of the factors entering into the cost of power at the switchboard and of those pertaining to its wholesale and retail distribution. Since that time a more extended opportunity has been given for its study and adaptation to varied types of power plants, at the same time affording opportunity for criticism by those interested in the making of power contracts. In general, the criticism has amounted to unqualified condemnation of the contract, as submitted by the Niagara, Lockport & Ontario Power Company in its first reading by a prospective user of power, to be followed a little later by the reluctant admission that perhaps it was not entirely one-sided after all. Almost invariably the final judgment has been a complete approval of the system in so far as its intent and results under it are concerned, but the statement has frequently been made under just such circumstances that there was much room for improvement in the way in which it was expressed in the contract. This point has been well taken, and recently a new contract form has been prepared, in which, it is believed, many changes for the better have been made along those lines without in any way affecting the intent of the contract.

Practically every large power company is to-day embodying in some form in its contracts the agreement that the price at which power is sold shall be dependent on the load factor. In a number of such contracts the question of measurement of the maximum demand is left entirely open, thus avoiding, for the time being, any vexatious disputes about peak loads. All this tends to simplifying the contract very greatly, but it will be found that the disputes will come sooner or later, and, realizing that fact, the writer has taken the ground that all disputes or possible misunderstandings should be thoroughly settled previous to the execution of any power contract.

It is to be regretted that many delays in delivery of apparatus and line material have so far postponed the supply of power by the Niagara, Lockport & Ontario Power Company to its numerous customers that no adequate idea can be given at present as to the general working of the system. To the few customers, however, who are now being supplied it seems to be entirely satisfactory.

As might have been expected, considerable difficulty has been experienced in getting a meter that will successfully measure a 1-minute peak load. But this is only another example of the delays incident to the development of new instruments under existing manufacturing conditions. Such an instrument is entirely feasible and will certainly be on the market very shortly, regardless of delay and difficulties experienced in the past.

The question is often asked as to why so short a time as one minute should have been selected in the determination of maximum demands, but such questions are nearly always prompted by the desire of a prospective buyer to get just as much for as little as he can. One way of answering the question is by asking another one, i. e., why should so long a time have been selected? As a matter of exact justice there is no reason why power sold on a maximum demand basis should not be charged on the true maximum demand whether it lasted one second or an hour, or a day. Where power is sold on a kilowatt-hour basis, the consumer might just as well ask for an agreement whereby the kilowatt-hour should be calculated on the basis of seventy kilowatt-minutes as to ask that a maximum demand should not be deemed to have occurred unless it had lasted for several minutes.

Some power companies avoid disputes over duration of peak loads in determining the maximum demand by incorporating in their contract form an optional use of one-second peaks, one-minute, three-minute or five-minute peaks, with a different rate per horse-power per year for each case. This use is, however, optional only with the power company. This is exactly in accordance with a statement made by the writer in the discussion following the presentation of papers on power matters last year, in answer to a criticism offered at that time; that is, a longer period than one minute could have been selected, but it would have meant a higher rate for the power that a proper revenue might be realized by the power company.

It is also noticed that the highest maximum in the month is used in many places, rather than the average of the daily maximums, as the amount to be charged for. This also tends to simplify matters, but to the writer it does not seem to give an accurate or an equitable basis for charging. Of course, it may be equalized to a certain extent by the price, but it could not be made to apply alike to all classes of consumers, at a uniform schedule of prices, without working an injustice to some.

The better method seems to be to set aside an amount of power for each consumer, that may be termed "firm," power or "reserved" power, which fairly represents the ordinary daily requirements, and to permit demands in excess of this amount within specified limits, to be charged for only on the days on which they occur. In other words, it is much more equitable to charge for the average of the daily maximum demands for a given month than to make the single extreme maximum in the month the basis of such charge.

In conclusion, it may be said that the movement for a fair and consistent way in which to supply electricity for all kinds of purposes has reached such a proportion as to make it almost a certainty that within a comparatively short time it will be possible for any consumer, no matter what his needs, to obtain whatever he may require on such terms as to put him on an equality with all other consumers. Such an equality can never be obtained by the use of a straight kilowatt-hour charge, but only by the combined use of a kilowatt-hour charge and a maximum demand, or service charge.

SOME PHASES OF ELECTRIC RAILWAY ACCOUNTING

BY J. C. COLLINS

According to the program, I am to discuss "Some Phases of Electric Railway Accounting," but in considering what I should talk about it seemed to me that you would be better pleased if I confine myself to one of the many topics that interest the operating man, and if I could bring you certain facts relative to the experience of the Rochester Railway Company it would be not only more interesting for you, but more valuable. I shall, therefore, speak to you this morning concerning the job order system, which is, in my opinion, the best method to arrive at the detail of costs.

The standard system of accounting makes no provision for a sub-division of the thirty-nine operating accounts that go to make up the operating expenses; consequently, it is left to each road to devise some method that will give to the officials the details of cost in their respective departments, and at the same time give to the general manager or general superintendent the necessary detail to keep him in touch with what is going on. This is especially true of the track, line and mechanical departments.

In operating subsidiary accounts the tendency, in my opinion, is to go into so much detail that the system becomes cumbersome, in which event it becomes necessary to analyze the detail. It is not unnecessary complication that each road is looking for, but the shortest and simplest method that will place the facts in the possession of the department heads. It seems to me that the job order system of cost accounting affords the solution of the problem.

This system permits the separation of the details of cost of the various operations to any degree of fineness which may be thought necessary and is a great aid in preparing costs. The idea of preparing unit costs is daily becoming more popular with our department heads, as it is of immense service in the making of new estimates. It is also of great benefit in making comparisons, for with this information the man in charge can quickly tell which of his foremen is the most competent.

For instance, in a case of track construction at two or more locations it is very interesting to compare the cost per foot for track laying, cost per cubic yard for placing concrete, and so on. By this comparison the head of the department can base on facts his opinion as to the capabilities of his foremen, the facts being actual unit costs for work done under exactly similar conditions.

The day has passed when department heads are content to wait until the end of the month to know in their respective departments what it is costing to operate. For that reason the job order system must be such that this information can be given daily. It is obtainable by the system used by the Rochester Railway Company, and, as we

ROCHESTER RAILWAY COMPANY.

Job. No.............. Account..............

Department.............. Rochester,..............190....

Estimate for..............

Total Estimate							

Approved

Gen'l Manager. Head of Dep't.

Form 102.

FRONT OF ESTIMATE CARD, SIZE OF CARD 5 INS. X 8 INS.

have received a number of inquiries as to how we arrive at our detail of costs, I thought a description of our system might be of interest to the representatives of the different companies assembled here.

An estimate card, on which is noted the cost in detail of the proposed work and the account to be charged, is made out by the head of the department in which the estimate is prepared. When the head of any department makes an es-

Cost of Work Estimated on Other Side.

Items.	Labor.	Material.	
Totals			
Actual cost..............			
Estimated cost..............			
Increase or decrease..............			

BACK OF ESTIMATE CARD, SIZE OF CARD 5 INS. X 8 INS.

timate of the cost of some particular work he desires to do, the knowledge that the actual cost will be compared with the estimated cost, and with work in other departments, serves to make him careful to reduce the cost to the lowest possible figure consistent with good work.

After the estimate card has been prepared it is transmitted by the department head to the general manager, whose signature carries with it the authority to proceed with the work and the approval of the amount to be charged. The general manager, through his approval of the estimate cards, is constantly in touch with the work being done and the actual cost to date.

From the general manager the estimate card is forwarded to the auditor, who examines and verifies the charge, and then forwards the card to the job order clerk. The cards are numbered consecutively, beginning with No. 1, the first issued in the calendar year.

As soon as the job order clerk receives the card he numbers the job and places the card on file. The number is then telephoned to the department making the estimate, as well as to the storekeeper, and is confirmed as soon as possible by sending typewritten copies on which are noted the number of the job, the account charged and a description of the work to the heads of all departments. The foremen of the different departments, when necessary, are advised of the number, and instruct their men to use it on their time sheets, except in the track department. In that department, where we employ a number of Italian laborers, each track foreman makes one sheet covering the work of the men in his gang. These time sheets are then sent to the timekeeper, who posts the time and forwards the sheets to the job order clerk. The latter, in figuring out the costs of the various jobs, also makes a complete distribution of the payroll on a distribution sheet, the footings of which are posted on the back of the estimate card.

The job number is given on the requisition under which the material is drawn from the storeroom. These requisitions, when filled, are assembled daily by the storekeeper, and totals by accounts are posted on his distribution sheet. From this sheet at the end of the month the auditor gets his posting figure for materials charged to the different accounts. These requisitions are sent daily to the job order clerk, who sorts them according to job numbers, figures the cost of each job to date, and posts the cost to date on the back of the estimate card. When the job is completed the actual cost in detail is compared with the estimated cost, and the head of the department that prepared the estimate is given a copy of the record for his information.

The working out of these estimate cards requires attention to figuring the cost of the work, and at the same time the fact that an estimate has been made out, and that the estimate will be compared with the actual cost, is an incentive to the different heads to keep more closely in touch

ROCHESTER RAILWAY COMPANY
Job Orders.

Job.		
280	Equip car No. 490 with air brakes, estimate $280	Charge Acct. K.
281	Equip car No. 491 with air brakes, estimate $280	Charge Acct. K.
282	Install two Eureka signals on Sea Breeze Line, estimate $1,200	Charge Acct. Sub. 2.
283	Paint car No. 334, estimate $45	Charge Acct. 6.
284	Paint car No. 437, estimate $50	Charge Acct. 6.
285	Paint car No. 443, estimate $50	Charge Acct. 6.
286	University Ave. feeder, 1-600,000 C. M. U. G., estimate $4,000	Charge Acct. E.
287	Track work—acct. Saratoga Ave. Imp., estimate $4,000	Charge Acct. P.
288	Track work—acct. Jones St. Imp., estimate $1,350	Charge Acct. P.
289	Changing motors in 12 Sea Breeze open cars to 4-G.E. 90, estimate $16,000	Chg. Acct. Sub. L 4,000 Chg. Acct. Roc. 7-12,000
290	Paint car No. 42, estimate $35	Charge Acct. 6.
291	Installing auxiliary police call—cashier's office, State St. Bldg., estimate $600	Charge Acct. 3.

June 21, 1907. R. E. DANFORTH, Gen. Mgr.

SPECIMEN TYPEWRITTEN REPORT OF JOBS AUTHORIZED

Form 152.
Storekeeper. ROCHESTER RAILWAY COMPANY.

Deliver to.................................articles below. ....190....

Car No........................ Charge Account No........................ For Job No..........

Quantity.	ARTICLES.	Price.	Amount.		Bin.

O. K.......................... ....Approved ....

Order material for each account on separate requisition. Foreman.

REQUISITION ON STOREKEEPER. SIZE OF SHEET 9 INS. X 4¼ INS.

Form 89 ROCHESTER RAILWAY COMPANY.

Time Sheet. ....Department. Pay Roll Ending.................................190....

	DATE											
Car Number.	DESCRIPTION OF WORK.	Job Number.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Total Hours.	Amount.
	Rate per hour.................. Total											

......................................Workman
......................................Foreman
....
Approved

TIME SHEET. SIZE OF SHEET 10¾ INS. X 9½ INS.

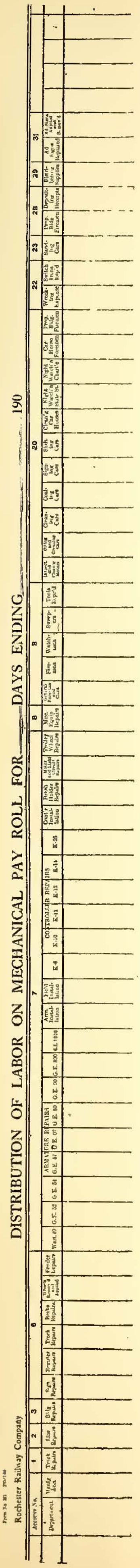
Form 88 ROCHESTER RAILWAY COMPANY

Daily Time Report.

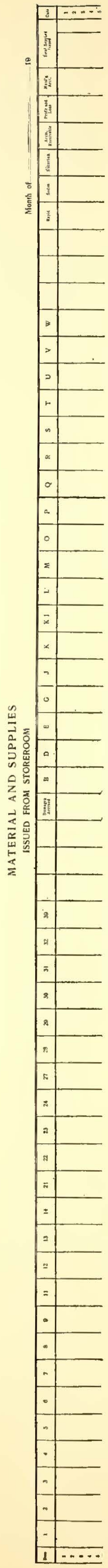
Date.................................190.... ....Department. ....Foreman.

No.	NAME.	Total Hours.	Rate.	HOURS.								Job No.	Description and Location of Work.

DAILY TIME REPORT. SIZE OF SHEET 9¼ INS. X 8½ INS.



UPPER PART OF SHEET SHOWING DISTRIBUTION OF LABOR ON MECHANICAL PAY ROLL. SIZE OF SHEET, 31½ INS. X 18 INS.



UPPER PART OF SHEET SHOWING DISTRIBUTION OF MATERIAL AND SUPPLIES ISSUED FROM STOREROOM. SIZE OF SHEET, 46 INS. X 11½ INS.

with the progress and cost of work. This record is constantly referred to, and has proved by practice to be a feature of great value.

The job order system also acts as a check on the timekeeper and storekeeper, as has been demonstrated several times within our experience. We have a system which we thought would not permit mistakes to be made by the timekeeper, but since adopting the job order system we have discovered where the timekeeper has credited too much time to a man or wrong rate, and the mistake has passed unnoticed until the distribution of detail costs has been made up. The same is true of the storekeeper, so while our real object is to make a complete analysis of each account, we are also making a very careful audit of both the timekeeper and the storekeeper.

Another highly important advantage is that the miscellaneous charge is brought down to a minimum. This charge, under other methods that we have used, is often of such dimensions as to cause remark, but apparently it could not be lessened; but under the present system, with the various items admirably separated, the charge is always so small as to be passed over by the most exacting official without comment. The system also provides order in procedure. Before it was put into effect, work was done and charged to its proper account before the exact amount involved was known. The bad effects of this plan are evident, and are avoided by the thorough method that is an essential part of the job order system.

A summary of the advantages of the system may be of interest. It provides for a fine sub-division of the operating accounts, and enables the general manager to keep constantly in touch with everything that is going on. It aids in preparing unit costs and permits comparisons to determine the relative efficiency of foremen. It gives the detail of the cost of operation from day to day, and enables the general manager to see at a glance the variation from year to year in such cost. It tends to increase carefulness in the preparation of estimates, and, through comparison of the estimate with the actual cost, assists the official making the estimate to avoid errors that lead to estimates that are too low or too high. It affords an incentive to heads of departments to keep very closely in touch with the progress of work, and requires order in procedure, with the additional advantages of reduction of miscellaneous chargings and a thorough check upon the timekeeper and storekeeper.

GOVERNOR HUGHES NAMES UTILITIES BOARD

Gov. Hughes, at noon, Friday, June 28, caused to be announced at the Executive Chamber the names of the members of the New York City and State Utilities Commissions. Postmaster William R. Willcox is the chairman of the New York City Commission, and Frank W. Stevens, of Jamestown, Chautauqua County, is the chairman of the State Commission. The members of the two commissions are: First District (New York City)—William R. Willcox, chairman, of Manhattan; William McCarroll, of Brooklyn; Edward M. Bassett, of Brooklyn; Milo Roy Maltbie, of Manhattan; John E. Eustis, of the Bronx. Second District (up-State)—Frank W. Stevens, Jamestown, chairman; Thomas Mott Osborne, of Auburn; Charles Hallam Keep, of Buffalo; James E. Sague, of New Hamburg; Martin S. Decker, of New Paltz.

When Gov. Hughes formally makes the above appointments on Monday he will announce the terms for which each of his first appointees is to serve, the longest term being five years. The idea is to have one member of each commission to go out each year. The salary of each commissioner is fixed by the bill at $15,000 a year.

Briefly, the Public Utilities bill puts under direct State control every public service corporation in the State of New York, with the exception of the telephone and the telegraph. Under the new law, four of the most important State commissions will pass out of existence. In their place are the two boards of five members each, all of whom have just been appointed by the Governor. These boards will have complete control of the regulations governing the transportation and lighting facilities of the State. As previously stated, one of the commissions will have jurisdiction in the four counties composing New York City, and the other will have under its direction all the other counties of the State. These two bodies will have complete and free-handed control, and will be held to enforce the regulations provided for in the measure.

PROCEEDINGS OF THE NEW YORK STATE CONVENTION

The twenty-fifth annual convention of the Street Railway Association of the State of New York took place at Hotel Champlain, Lake Champlain, N. Y., Tuesday and Wednesday, June 25 and 26, 1907. There was a large attendance.

TUESDAY'S PROCEEDINGS

President J. N. Shannahan, of the Fonda, Johnstown & Gloversville Railroad Company, called the convention to order at 10:30 on Tuesday morning. After the roll-call and the reports of the secretary and treasurer, President Shannahan delivered his annual address.

Wm. L. Pattisson, secretary and counsel of the Plattsburgh Traction Company, then extended to those in attendance the privilege of transportation on that line during the convention.

The secretary then announced that the association had twenty-six member companies, a gain of three during the last year. There are nine associate members and sixty-eight allied members. He then announced that letters of regret had been received from the president and secretary of the Central Electric Railway Association of Ohio and Indiana; Hon. T. C. Platt; Hon. Chauncey M. Depew; the general passenger agents of the Lehigh Valley Railroad and the New York Central Railroad; the president of the National Accountants' Association; the chief engineer of the New York Central & Hudson River Railroad Company; the general passenger agent of the Erie Railroad Company; Major-General Bancroft, president of the Boston Elevated; August Belmont, of the Interborough Rapid Transit Company, of New York; Charles R. Huntley, of Buffalo; C. L. S. Tingley, president of the Accountants' Association; C. S. Sergeant, vice-president of the Boston Elevated Railway; the general freight agent of the Delaware, Lackawanna & Western; the secretary of the Interstate Commerce Commission; President Loree, of the Delaware & Hudson; Governor Hughes, and various others.

President Shannahan then asked whether the committee on brakes and braking had any report to offer. The committee was composed of Messrs. Stanley, Fassett, Hanf, Millen and Harvie. In the absence of Chairman Stanley, Mr. Fassett announced that the committee had found local conditions so diverse that a standard system of brakes was impossible. The report was accepted.

Mr. Fassett was then asked for the report of the committee on rules.

Mr. Fassett replied that the rules for city service formulated by the association were now in general use throughout the State, and the committee saw no reason for changing them. He suggested, however, the appointment of another committee to draw up rules for interurban work. After a discussion of this subject, it was decided to discharge, with thanks, the present committee and to appoint two new committees, a city committee and an interurban committee of three members each. The committee on interurban rules was requested to report at the next quarterly meeting. In this connection Mr. Allen agreed to send to each member operating an interurban road a copy of the rules employed by his road. This will allow the member to write the chairman of the committee on rules any suggestions which might seem desirable.

The paper by J. C. Collins on "Some Phases of Electric Railway Accounting" was then read. This will be found elsewhere in this issue.

DISCUSSION ON ACCOUNTING

T. W. Wilson said that the Buffalo Company uses a sheet instead of a card for preparing estimates. On this sheet is a place for the job number and for the approval of the manager and president. About 4 ins. is left at the bottom where the auditor can record the amount of supplies and cost of labor. These items are posted from time to time. When the job is completed, the sheet shows a very accurate tabulation of the total cost, both of labor and material. Where the work authorized is track construction the total cost is reduced to the price per foot of single track.

E. S. Fassett said that the United Traction Company, of Albany, prepared an authorization in detail, stating the amount, which was sub-divided into labor and material, etc. This authorization is approved by the various officers of the organization under whose jurisdiction the work would be done, and is then authorized by the general manager of the Delaware & Hudson Railroad.

C. Loomis Allen, of Utica and Syracuse, asked Mr. Collins how far he carried the job order system in their maintenance work. For instance, in shop practice, when a car is pulled in for general overhauling, whether that would be a part of the job order system.

Mr. Collins replied that the job order system was not used for certain work that has to be done regularly, like cleaning cars, trucks, and so on, but for practically everything else.

H. M. Beardsley, of the Elmira Water, Light & Railroad Company, said that that company uses a system similar to that described by Mr. Collins, but does not apply it in exactly the same way. It had not been found cumbersome, because it was just as easy for the storekeeper, if he gets a requisition for some material, to charge that material to a job order, or a working order, as it is called in Elmira, say, "No. 201," as to charge it to "Account 6." The total, when the working order is completed, is simply transferred from Working Order 201 to Account 6, or from Working Order 203 to Account 7, and so on. He thought the system very convenient in checking up supplies.

E. F. Peck said that the Schenectady Railway Company had also practically adopted the Rochester system. On its jobs, or construction work, or extraordinary maintenance charges, the head of the department from which the order originates makes, first, a detailed estimate, which is submitted to the general manager. If the job is approved, instructions are given to apply for a working order, which the department head does, giving his estimate on this working order. That is sent to the auditing department and the working order is issued and again returned to the general manager for his signature. That gives authority to go ahead with the work. On all maintenance charges the Schenectady Company uses the regular job system similar to the Rochester system, and it works out very well indeed.

J. H. Pardee said that J. G. White & Company have a system of authorizations and cost analysis that is a little different from any others that he had seen, although the principle is the same. It would not be applicable to small jobs or jobs lasting only a very short time—less than a month, but in reconstruction or new construction that would last for a period of several months or through a season it is very convenient. The first of each year each of the White operating companies makes up a detailed statement of the construction or reconstruction required during the year. It is divided, if there are subsidiary companies, under the head of the different companies, or any other convenient division of the work is used, and the authorization is passed by the board of directors, or approved by the proper officers. Afterward, on the first of each month, a cost analysis sheet is prepared which shows the different authorizations, Nos. 1, 2, 3, 4, as the case may be. The first column contains the amount authorized to be spent; the next column, the money actually expended from the start of the job up to the first day of the month; the next column, amount of obligations covered by contracts; the next column shows the balance available; the next column shows the estimated cost to complete the job; the next column, either the gain or the loss. If it is a gain, it is entered in black ink, and if it is a loss—an estimated loss, of course—it is entered in red ink, so that the proper officers can see at a glance whether there is going to be an overrun or whether they are going to save money on the job. The last column shows the per cent of the work completed. The plans work out very well, and gives almost graphically a complete report on the whole job and on each individual job.

Vice-President Wilson here took the chair and announced as the next order of business the paper on "Some Notes on Electric Railway Shops and Shop Practice in Central New York," by W. H. Collins, of the Fonda, Johnstown & Gloversville Railway.

DISCUSSION ON SHOP PRACTICE

W. H. Evans, of Buffalo, said he was very much interested in Mr. Collins' suggestion about the master mechanics visiting different shops, but thought that when they visit a shop they should criticise. It is a great advantage to have some one come in and tell what is wrong. He had found that the best suggestions frequently came from master mechanics whose roads are poorly equipped and so who had found it necessary to devise some scheme to meet requirements which others did not find necessary. While the maintenance of records can be carried to an extreme, it is of vital importance that the actual record of the work as it progresses should be recorded and filed and in shape for ready reference and comparison. For this use he favored a tabulated record rather than a number of different sheets, as it frequently occurs that the latter become misplaced. He also thought it desirable to arrange the different equipments at different car stations or divisional points according to the character of the equipment and the style of the cars. This plan very much simplifies the matter of repairs. He did not quite agree with those who say that conditions vary in different localities. We are rapidly approaching a condition which very urgently requires the standardization of equipment, and outside of localities where there are excessively steep grades, or something of that kind which requires emergency brakes, and so on, the conditions to be met in different localities are very similar. With that in view, he believed it desirable for nearly all the roads to prepare for heavier equipment.

Wm. W. Cole, of Elmira, believed that in repair shops there is generally too much handling of material. In the manufacturing shops of the new design the article keeps going from shop to shop with absolutely no rehandling until it reaches the assembling room. The same conditions can be brought about in the design of a car house or a repair shop. The cars come in over the working pits where the general repairs are done. The machine shop should be located alongside, and the material should go direct from the repair pit to the machine shop. Then should come the blacksmith shop, and back of that should be the carpenter shop, so that the body of the car as it is taken from the truck goes through the machine and the blacksmith shop and is pushed right backward into the carpenter shop. On the other side of that is the paint shop. In that way the car would undergo absolutely no re-handling.

GROUP OF DELEGATES AT THE LAKE CHAMPLAIN CONVENTION

W. J. Harvie, of the Utica & Mohawk Valley Railway Company, believed that the conditions in New York State described by Mr. Collins was due largely to the fact that most of the men in charge of equipment have to deal with the immediate present. They are so busy with the conditions before them that they do not have time to consider the conditions that may exist perhaps six months or a year hence. These conditions are being gradually overcome, and one reason for it in his opinion is the meetings which have been had at the different shops throughout the State.

F. P. Maize, of Rochester, and F. M. DuBois, of Syracuse, concurred in the favorable opinion expressed by Mr. Harvie of the master mechanics' meetings.

Mr. Allen asked if it would not be possible to devise standard layouts for repair shops of different sizes but capable of extension.

Mr. Evans thought this hardly feasible just at the present time, when the companies are changing from the older to the heavier equipments, and it is rather difficult to tell what the requirements will be. He did think, however, that it might be possible to standardize the trucks, particularly on double-truck cars, to a greater extent, so that the body can be run in and changed over to another pair of trucks kept ready. The defective trucks could then be repaired and made ready for the next body. In that way considerable time would be saved in which the car is out of service.

President Shannahan also thought it might be difficult at present to standardize shop buildings, local conditions are so varied. After further discussion on this point, in which Messrs. Harvie, Collins, Evans, Benedict, Allen and Peck participated, it was decided to appoint a committee of three master mechanics to report as to the design of a model repair shop and report at the next meeting. The convention then adjourned.

WEDNESDAY'S SESSION

On Wednesday papers were presented by Messrs. Hill, Renshaw and Griffin. They are published elsewhere in this issue. There was no discussion. The following officers were then elected for the ensuing year:

President—Thomas W. Wilson, International Railway Company.

First Vice-President—E. S. Fassett, United Traction Company.

Second Vice-President—E. F. Peck, Schenectady Railway Company.

Treasurer—H. M. Beardsley, Elmira Water, Light & Railroad Company.

Secretary—J. H. Pardee, of J. G. White & Company.

Executive Committee—C. Loomis Allen, Utica & Mohawk Valley Railway Company; C. Gordon Reel, Kingston Consolidated Railroad; W. S. Darbee, Albany & Hudson Railroad Company; J. C. Calisch, Buffalo & Lake Erie Traction Company.

EXHIBITS AT THE CONVENTION

There was no attempt to have an elaborate exhibit at the Lake Champlain convention. At the same time, two or three manufacturers who have recently brought out new types of apparatus took occasion to show them in one of the rooms on the ground floor of the hotel.

The largest and most elaborate exhibit at the convention was made by the Westinghouse Air Brake Company, which showed a new combination automatic car coupler and air-pipe connector for electric cars. It is understood that this ingenious device is the latest invention of Mr. Westinghouse himself, and its design has received a very large amount of his personal attention during the last year or so. The coupler is intended especially for electric traction service where the difference in heights of cars, sharp changes in grades and short-radius curves make the application of an automatic coupler, especially one involving air connections, extremely difficult. The plan has been worked out very carefully, however, and the exhibit attracted a great deal of attention. For convenience in demonstration the coupler was mounted in a frame and the two draw-bars were brought together and separated by air power supplied from a motor compressor. One of the couplers was also arranged to be raised and lowered, to illustrate the perfect action of the coupler when the drawbars are at different heights. A section of the coupler was also shown. Briefly, the drawheads are pivoted to the drawbar to compensate for vertical movement, while the drawbars themselves are pivoted to the car body or truck in the ordinary way. When the drawbars are coupled together they are held rigidly in position by two cams. To release these cams, they can be thrown or kicked out by the trainmen. Of the two lines of air pipes, one is carried on the inside of the coupler and the other on top. Rubber gaskets thoroughly protected by collars make a rigid and permanent air line connection. Electrical jumpers can be hung below when required. The coupler has been in use for a considerable time on an electric surface train on Commonwealth Avenue, in Boston, in New Bedford and on the Westinghouse train on the Twenty-Third Street crosstown line in New York. An order has also been received for twenty couplers of this kind from the Consolidated Railway Company, of New Haven, for cars now being built for that company at the Wason plant at Springfield.

The Ohio Brass Company exhibited a model of its Lintern car signal system. Two good-sized models of the ends of cars were shown, one the rear end with the signal lights, the other the front end carrying the marker lights. Upon these models were mounted lamp sockets to correspond with the interior illumination of the car, and a painted diagram of the connections made the working of the system clear. The size of the models made it possible to show the system in actual operation. The company also had for distribution pamphlets on its crossing signal, Tomlinson couplers and other specialties.

The Taylor Electric Truck Company, of Troy, exhibited a steel-tired wheel with a malleable iron center, similar to that which attracted considerable attention at the Columbus convention, and which was described in these columns at that time.

In addition to the above, a few models were exhibited, among them one of a very ingenious screw jack shown by Giles S. Allison, and which will be described later in these columns.

THE BANQUET AND OTHER ENTERTAINMENTS

The annual banquet of the association was held on the evening of Tuesday, June 25, in the large dining room of the hotel, and was attended by about 160 persons, including a large number of ladies. The speakers' table occupied one side of the room, and the others in attendance were seated at smaller tables in parties of eight persons. The banquet was an excellent one and the speeches were in a particularly happy vein. It was expected that Hon. W. Caryl Ely would be able to come as toastmaster, but in his unavoidable absence the position was very ably filled by W. W. Cole, of Elmira, who was extremely happy in introducing the various speakers. After a short speech by President Shannahan, the addresses of the evening were given by Hon. Howard McSherry, of the Public Service Corporation; Hon. Miles T. Frisbie, of the New York Assembly; C. Loomis Allen, of Utica, and J. M. Wakeman, of the Street Railway Journal.

The other entertainments for which arrangements had been made were a trip to Au Sable Chasm on the afternoon of Tuesday, and a ball game between the railway men and the supply men on Wednesday. The trip to the Chasm was made by special train from the Point Bluff station to the junction with the electric road of the Keesville, Au Sable Chasm & Lake Champlain Railroad Company, where a third-rail electric locomotive hauled the two special cars to the entrance of the Chasm. The threatening weather at starting discouraged a number from attempting the trip, but those who participated were amply repaid by the beauty of this wonderful rift through the rocks. The afternoon was pleasant and the party reached the hotel on their return a little after seven o'clock.

Owing to the inclement weather on Wednesday afternoon the ball game was postponed. It is understood that Capt. H. N. Ransom, of the supply men, and Capt. Chas. H. Clark, of the railway men, had surprises in store, but what these were and the ability of their respective nines will not be disclosed for another year. At that time it is hoped that the base ball championship will be definitely settled.

DATA SHEETS ON MAINTENANCE & INSPECTION OF ELECTRICAL EQUIPMENT

The committee on maintenance and inspection of electrical equipment of the American Street and Interurban Railway Engineering Association has issued three data sheets for information to be used in the report of the committee at the Columbus convention. The committee consists of John Lindall, chairman; W. D. Wright, E. T. Munger, L. L. Smith, and replies should be sent to John Lindall, superintendent of motive power and machinery, Boston Elevated Railway Company, 439 Albany Street, Boston, Mass. The data sheets follow:

DATA SHEET NO. 1

Name of company, city, State.

(1) Number of cars; motor, trailer. (2) Weight of cars, (3) length of cars, (4) size and number of motors per car, (5) type of control.

(6) Frequency of inspection of control: (a) K type, (b) multiple-unit type. (7) Is inspection made by day or night? (8) State what determines frequency of inspection, whether brakes, control, commutator work or oiling.

(9) State what is done to maintain car wiring in safe condition. (10) How do you test car wiring, including light, heat, motor wiring? (11) How is light, heat and motor wiring installed—in canvas hose, conduit, cleats, molding or in transite?

(12) How often do you inspect trolley apparatus? (a) wheel, (b) bow, (c) shoe, (d) base. (13) What does inspection consist of? (14) How often do you replace bushings in trolley wheels? (15) State what is done by way of overhauling to maintain control equipment in a safe and reliable condition, and at what period of time or mileage.

(16) State what electrical safety devices are used for the protection of apparatus. (17) Type of fuse and location, (18) type of circuit breaker and location, (19) type of lightning arrester and location, (20) state methods of inspecting and testing same.

DATA SHEET NO. 2

Name of company, city, State.

(1) Do you manufacture armature coils? (2) Have you used asbestos-covered wire for same? (3) If so, are you satisfied that results obtained justify use of same at extra cost of the wire?

(4) Describe materials used in covering and insulating coils wound with cotton-covered wire, and methods of applying same; (5) describe materials used in covering and insulating coils wound with asbestos-covered wire, and methods of applying same.

(6) What test do you give coils for short circuits? (7) What insulation test do you give armature coils? (8) Have you any preference for rolled or drawn copper commutator segments over drop forged segments, or vice versa?

(9) How many sizes of shaft journals do you use on any one type of armature? (10) Do you allow 1-16 in. or 1-32 in. difference in diameter between sizes? (11) Do you sleeve worn shaft journals with steel tubing? (12) If so, do you apply same hot or cold? (13) What difference do you allow between inside diameter of sleeve and diameter of shaft journal? (14) Do you bore your babbitted armature bearing shells or babbitt to size?

(15) What grade steel wire do you use for banding armatures; also state specifications for same if you have any? (16) Describe any special piece of apparatus or tool that you are using that is especially interesting, useful and valuable for repair work on motors, or other electrical apparatus used in car equipment.

(17) Do you have evidence of old cores materially increasing armature temperature? (18) Do you rebuild and reinsulate armature cores? (19) What determines period at which core should be rebuilt and reinsulated?

(20) Do you manufacture field coils? (21) Do you use asbestos-covered wire for same? (22) If so, are you satisfied that results obtained justify the use of asbestos-covered wire at extra cost? (23) Describe materials.

(24) What test do you give field coils in shop? (25) What test do you give field coils in use in motors? (26) What experience have you had with field coils wound with cotton-covered wire impregnated by vacuum process with solid compounds? (27) What experience have you had in impregnating armature coils with solid compound by vacuum process?

(28) At what speed do you run field coil winding machine? (29) What is your opinion of the relative value of field coils wound with double cotton covered wire, covered with cotton materials, and vacuum impregnated with solid compound, and coils wound with asbestos-covered wire, covered with asbestos materials, and treated with liquid compounds and paste of any description? (30) How often do you test and recalibrate circuit breakers? (31) How often do you give air compressors shop overhauling?

DATA SHEET NO. 3

Name of company, city, State. (1) Describe, without mentioning the manufacturer's name, the characteristics of motor carbon brushes giving the best service. (2) Aside from requiring a brush to give satisfactory service, what specifications would you lay down to manufacturer to govern him in making up brushes to best meet your needs?

(3) What simple test or inspection do you have to determine, before using, whether brushes are of satisfactory quality? (4) Do you approve of boiling brushes in paraffine? (5) Is any other treatment of brushes beneficial?

(6) What do you regard as the principal cause of flat spots on commutators? (7) What is the most effective means of avoiding same? (8) Do you consider grooving mica below surface of commutator effective in improving commutation? (9) If so, on what motors and under what conditions is grooving commutators necessary or desirable?

(10) What proportion of your commutator and brush holder troubles do you attribute to: (A) Fast feeding of controller? (B) Quality of brushes? (C) Quality of commutator bars? (D) Quality of commutator mica? (E) Design or characteristics of brush holders? (F) Other causes. (11) Remarks concerning these various troubles and their remedies.

(12) Do you experience trouble with burnt or broken brush-holder springs? (13) If so, what means do you take to overcome the troubles? (14) What method do you use to avoid the grounding of brush holders?

(15) What period of days, or if on a mileage basis, how many miles run, between times of lubrication on: (A) Armature bearings? (B) Motor axle bearings? (C) Truck journal bearings? (D) Air compressors? (E) Motor gears?

(16) Do you inspect electrical equipment on the mileage or on the time basis? (17) What period of days, or miles, elapses between inspections on: (A) Brushes, brush holders and commutators? (B) Armature clearance from pole pieces? (18) What is the period or mileage from one thorough overhauling of motors to the next, where armatures are taken out, commutators turned, bearings renewed, fields revarnished and everything put in first-class condition?

(19) Give briefly the rules governing car-house men in the inspection work, both for light inspection and for heavy inspection and repairs, also enclose such forms or blanks as are used on inspection and remarks concerning their use. (20) How do you obtain car mileage, and in what form is this kept for use of the mechanical department?

A. S. & I. R. ENGINEERING ASSOCIATION ANNOUNCEMENT

The American Street and Interurban Railway Engineering Association announces that the meeting of the association will convene at 2 o'clock p. m. on Monday, October 14, the meeting to continue during Tuesday morning and afternoon. On Wednesday morning, October 16, the joint meeting of all the associations will be held at 10 o'clock and the closing session of the Engineering Association will be held at 2 o'clock on that afternoon. The headquarters for the Engineering Association will be at the Hotel Denis. A splendid program is well under way and every endeavor is being made to have all material printed and distributed to the members several weeks in advance of the meetings. The Question Box is provided as a means of bringing miscellaneous matters before the convention. Papers have been assigned on several subjects, and it is asked of each member that he assist in making the Question Box a success by indicating at least one question in which he is especially interested. The list of questions received will be printed and forwarded to the members the first part of July for answers, the questions and answers to be printed and sent out with the advance papers.

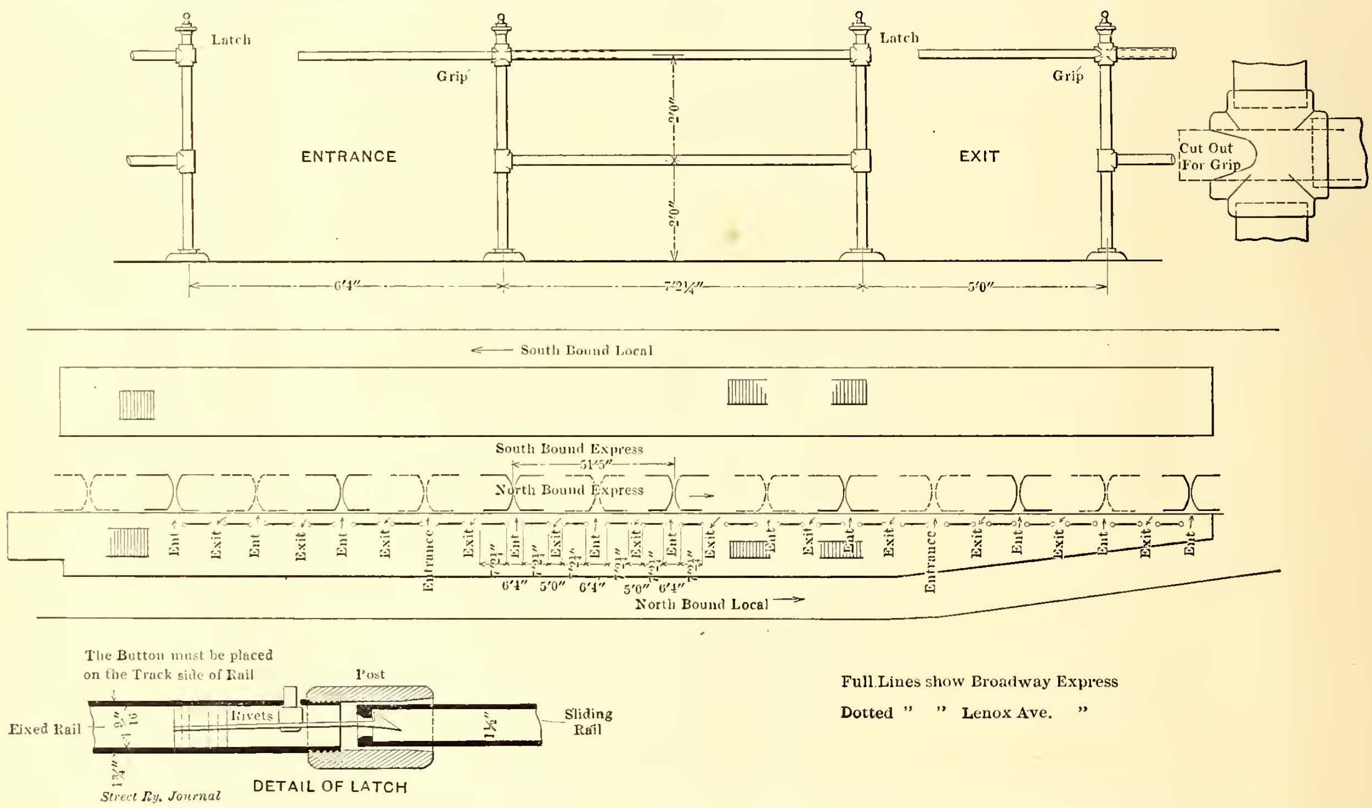
PLATFORM ARRANGEMENTS AT GRAND CENTRAL

The management of the Interborough Rapid Transit Company has been planning for a long time to introduce some arrangement of platforms at the Grand Central Station which would obviate the congestion of passengers at that point. At this station more passengers leave and board the cars, counting those who transfer from local to express strains and vice-versa, than at any other station on the system. During the rush hours it is often impossible for all passengers desiring to board a train to do so unless a stop should be made so long that it would delay the traffic on the rest of the system. For this reason it has been the practice to make a stop of a pre-determined duration sufficient to allow all passengers who wish to leave the train and to take in as many entering passengers as possible before the dispatcher sounds the gong to start the train.

The management has believed for some time, however, that if it were possible to divert the lines of entering and leaving passengers it would be possible to make a quicker stop. With this end in view it has been the practice of the company for some time to stop its Broadway expresses at one point on the platform and the Lenox Avenue expresses half a car length away from the point at which the Broadway expresses stop. These points are marked by signs so that passengers waiting for the Broadway expresses will congregate at one point and those for the Lenox Avenue expresses at another, and so will not interfere with each other. This plan, however, has not entirely settled the problem, and the company last week installed railings still further to separate the incoming and outgoing passengers.

This railing is 4 ft. high and is erected 4 ft. from the edge of the northbound express platform. It is in sections 7 ft. 2¼ ins. long, with entrances 6 ft. 4 ins. wide. The entrances and exits can be closed by a sliding bar with a latch. As shown by the diagram, a northbound Broadway express is stopping at the station. A platform guard stands at each entrance to keep back the passengers who wish to board the train, while those leaving the train have a clear exit, one to each side of each entrance. As soon as the last passenger leaves the platform the platform guard throws back the bar and admits the line of boarding passengers.

The dotted lines in the diagram show the position of the Lenox Avenue expresses. Here the former exits are used as entrances, and vice-versa. The plan is being tried during the summer months when the travel is not so great, so as to determine its efficiency before the winter rush commences.



PLATFORM AND RAILING LAY-OUT AT THE GRAND CENTRAL STATION OF THE INTERBOROUGH RAPID TRANSIT COMPANY

BROOKLYN SUBWAY APPROVED

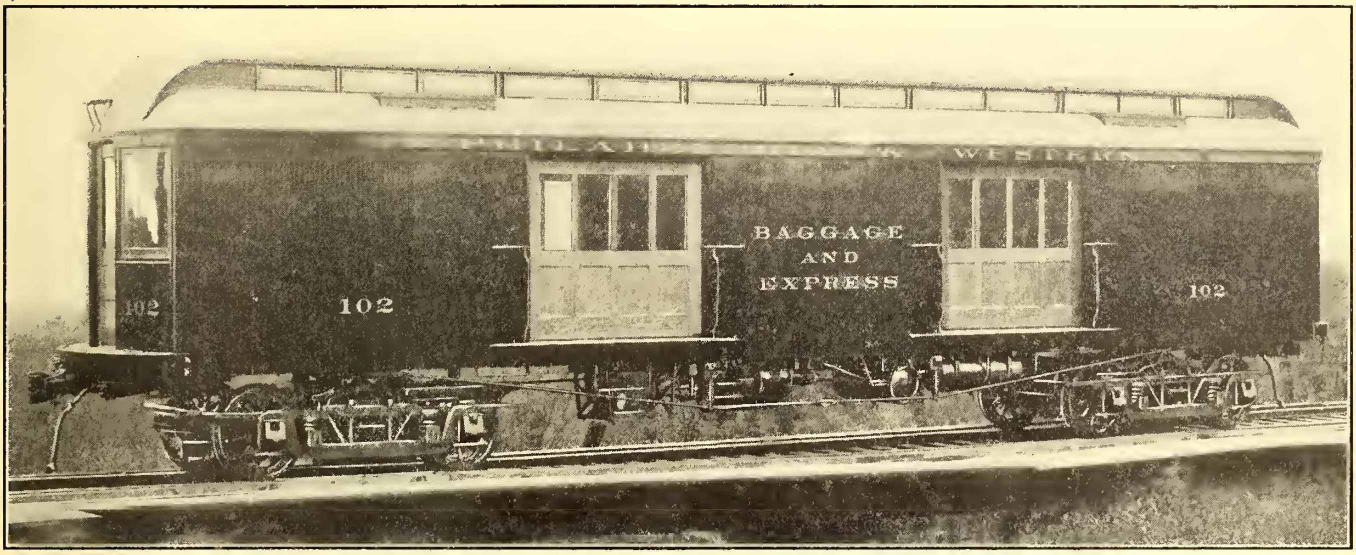
The Rapid Transit Commission of New York adjourned sine die Thursday, June 27, after a little more than thirteen years' service. Before ending its final session it passed resolutions practically insuring the construction by the city of the Fourth Avenue (Brooklyn) subway and authorizing the construction by the Interborough of additional tracks at Ninety-Sixth Street in the present subway. Legal forms of contract for six of the fourteen sections of the new Brooklyn subway were ready for the board's approval. The plans and specifications for the whole route were ready, but only the contract forms were acted upon. When these sections are completed Brooklyn will have a subway running from near the approach to the new Manhattan Bridge to the outskirts of the thickly populated part of the borough. The whole line, when built, will extend to Fort Hamilton and Coney Island. The estimated cost of the road is set at $23,000,000.

The most the board could do was to approve the contract forms and authorize the holding of a hearing. This was done, and July 13 was set as the date for the hearing.

EXPRESS CARS FOR THE PHILADELPHIA & WESTERN RAILROAD

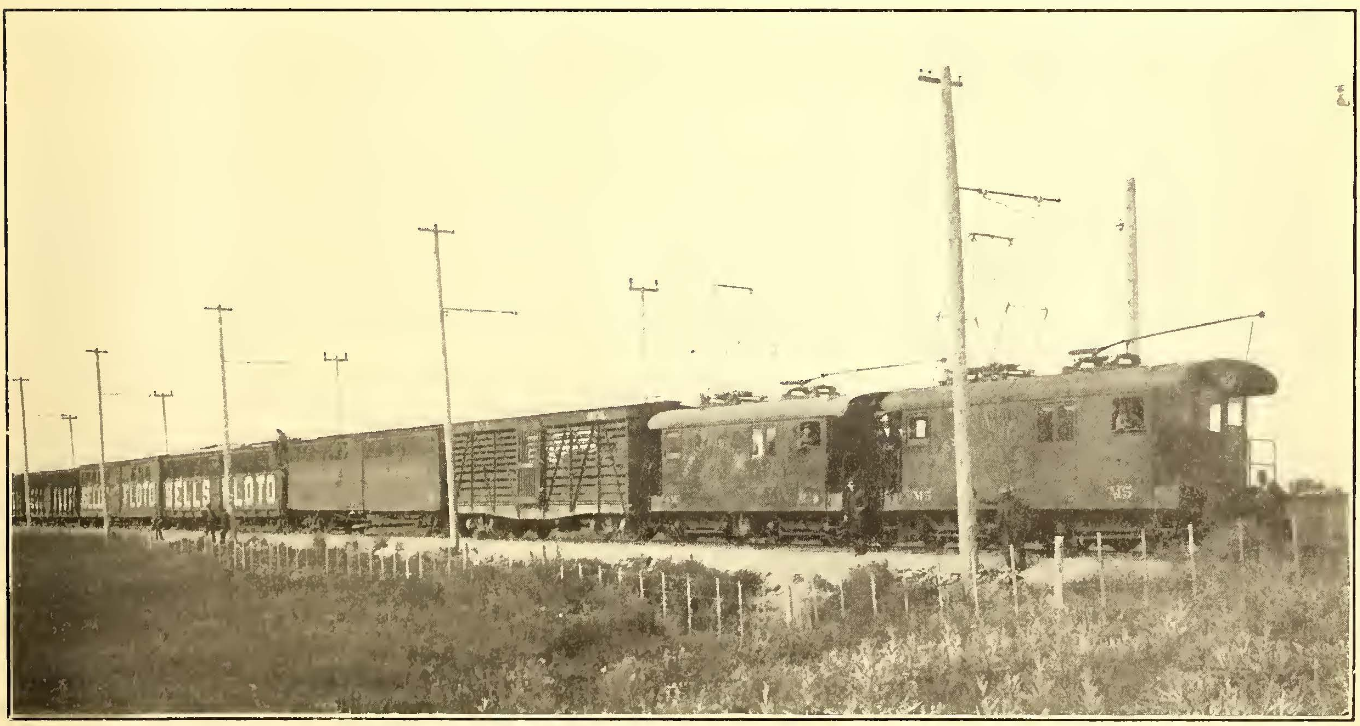
Announcement has already been made in this publication of the formal opening of the Philadelphia & Western Railroad. This brief description of the express cars used built recently by the St. Louis Car Company may be of interest.

The cars are 50 ft. long over all, 9 ft. wide, and have the steam coach type of hood. The side sills are made of



BAGGAGE AND EXPRESS CAR FOR THE PHILADELPHIA & WESTERN RAILROAD

5-in. x 8-in. long-leaf yellow pine timbers and reinforced with steel channels. The center sills are of 6-in., 12½-lb. I-beams with wood fillers. The interior is one large com-



A TWENTY-THREE-CAR CIRCUS TRAIN IN THE NORTHWEST BEING HAULED BY TWO SINGLE-PHASE LOCOMOTIVES

partment, no partition being made for the cabs. The side of the car contains two large sliding doors, and the interior is fitted with twenty electric heaters to guard against damage to perishable freight.

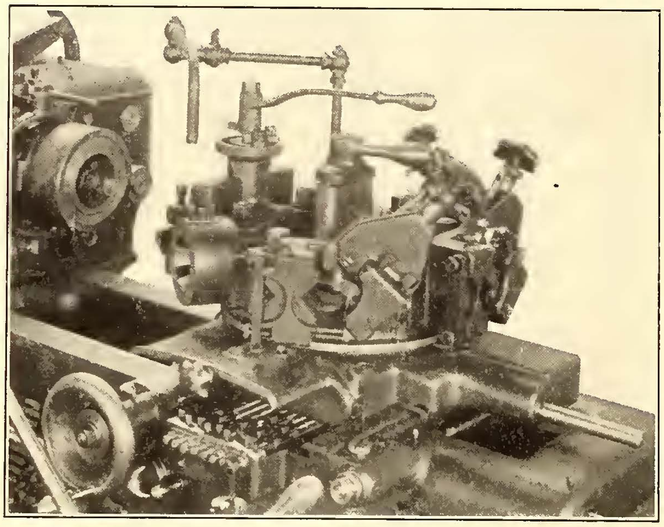
The car is built for operation in either direction. Both pilots, which are of the locomotive type, are fitted with snow plows. As the road is operated by a third rail, the trucks are provided with third-rail contacts. Trolley connections are also provided. All of the wiring of the car is in conduit.

HAULING A TWENTY-THREE CAR CIRCUS TRAIN

The Sells-Floto Circus train was taken over the Spokane & Inland division of the Inland Empire System, of Spokane, Wash., on Sunday, June 8, the circus being hauled from Palouse, Whitman County, to Spokane, a distance of 76 miles. This is the first instance of a circus being transported by electric power in the Northwest. The circus consisted of five 60-ft. Pullman coaches, seven standard stock cars and eleven 60-ft. flats, aggregating 2300 tons. The Spokane & Inland division is equipped with the single-phase system, 50-ton, 600-hp Westinghouse locomotives being used for heavy hauling.

A NEW OPEN TURRET LATHE

A new Pratt & Whitney open turret lathe suitable for doing a variety of work, in which are combined a number of new features, including a cross sliding turret, is announced by the Niles-Bement-Pond Company, of New York. The machine has a stiff head, with constant speed arranged for either direct-connected motor or countershaft drive by means of a single pulley, and is said to possess practically all the flexibility of the engine lathe. The turret is mounted on a slide, having both positive power and hand longitudinal and transverse direction, and the machine is recommended for bar work up to 2½ ins. diameter by 26 ins. long, for castings up to 14 ins. diameter, and for cylindrical operations on work within these dimensions. The gears are of extra heavy pitch and of ample width safely to withstand the hardest usage. The head, which is stationary, is of box construction, the gears running continually in oil.

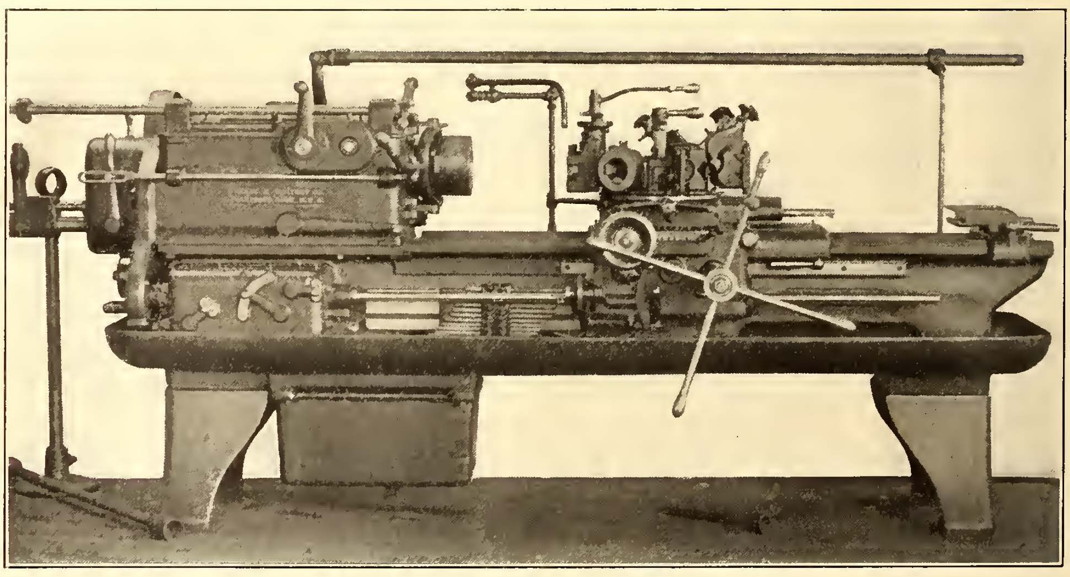


LATHE, SHOWING CROSS SLIDING TURRET

Eight variations of speed are provided, and by using the two-speed countershaft these may be doubled. All of the controlling levers and connections are within easy reach of the operator, and the spindle can be instantly stopped by the movement of any lever on the head stock. The rod chuck may be operated while the machine is running. The collect jaws are supported up to their outer end. The complete chuck can be readily removed from the spindle when combination lathe chucks or special face plates for castings are to be substituted. A positive screw feeding device automatically feeds the rod forward to its stop and the bar may be round, square or any irregular cross section, and need not necessarily be free from scale, as there are no delicate parts or complicated gearing to become clogged. A follower bar is furnished which enables short pieces of stock to be as conveniently handled as long bars, and at the same time serves to keep such piece concentric with the spindle. An efficient stock stop for gauging the length of stock is provided, which, when not in use, can be moved forward and swung upward, so as not to interfere with the turret tools.

One of the most important features in the new lathe is the compound turret with power and hand feeds and adjustable stops, which are conveniently located. The longitudinal turret slide travels on large raised "V's," is provided with gibs its full length, and a binder which permits the slide to be firmly clamped to the bed at any point within its travel. The power longitudinal feed is positive in both directions, and has six changes, any one of which can be instantly set. The six automatic longitudinal stops and the six supplementary stops give two positions to each turret tool, and make it possible to use all twelve stops for one or all tools in the turret. The stops are held in a heavy steel bracket, which may be moved along the front of the bed and clamped where desired. In case it is desired to run through a few special pieces of work, the automatic stops may be dispensed with and the supplementary stops used in their place without the necessity of disturbing adjustments.

The distance from the axis of the spindle to the turret tool is altered by traversing the turret slide. This arrangement permits ample support for long bars, and if the machine is belt-driven gives an unvarying belt tension. The cross slide has both hand and power feed, and there are six variations of the power feed in either direction. Eight distinct adjustable cross stops are provided, which may be used in any combination desired. The bed and pan are made in one single casting and have "U"-shaped cross webbing, insuring rigidity. A variety of turret tools is designed to meet practically all the various requirements of the machine.

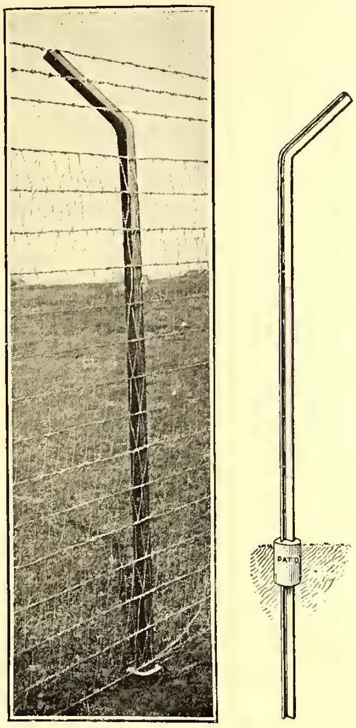


OPEN TURRET LATHE

Theodore P. Shonts, president of the Interborough Rapid Transit Company, says that the type of car to be adopted in replacing the rolling stock on the company's surface lines has not been decided upon. Among the cars under consideration are the pay-as-you-enter car used in Montreal and cars equipped with the Minneapolis gate. Both types have been described in detail in the Street Railway Journal.

A NON-CLIMBABLE FENCE POST

A non-climbable fence post has been designed by J. H. Downs, of New York, that should prove especially advantageous for use at trolley terminals, street railway parks and such other grounds or tracts as companies desire to fence and make positively inaccessible except by the regular entrance. This post is all in one piece, and, as shown in the accompanying illustration, is made to carry woven wire with barbed wire on the top which is bent at an angle of 45 degs. Corner and end posts are, of course, bent to the peculiar requirements of each installation. In the same way posts are punched to order, so as to suit any kind of fence. The posts themselves are made from high carbon steel angle, and are painted with waterproof paint. They can be driven, thus saving the labor and expense of digging post holes. An adjustable collar of vitrified clay, burned hard, is provided, which can be slid down the posts after they are driven, leaving about 1 in. of the collar above ground. By tamping them well the posts will remain rigid.



FENCE POSTS WIRED AND SHOWING COLLAR

PORTABLE SUB-STATION

An interesting feature of the equipment being installed by the Los Angeles Pacific Company is a portable sub-station designed by C. M. Warnecke, chief electrician of the company, which resembles a freight car. It is 30 ft. long and 8 ft. wide, and weighs, including apparatus, 100,000 lbs. As it is built in sections, any piece of apparatus can be removed without disturbing the remainder of the structure. For controlling the high-tension line a Hartman type C, 100-amp., 22,000-volt, automatic oil switch was installed. This switch, which is shown in Fig. 1, is of the wall mounting type and is controlled by means of a ¼-in. steel tiller rope running over pulleys to the operating handle shown on the right-hand side of Fig. 2. The switch is entirely self-contained, the series transformers for operating the overload coil being mounted on the supporting frame with the switch cells. This makes a very compact layout and one which is easy to install. In addition to the apparatus just described, the sub-station contains one MP 6/400-kw, 550/600-volt, 415 r. p. m. induction motor-generator and three 150-kw, 15,-000/2400-volt, single-phase transformers. This equipment enables the Los Angeles Pacific Company to deliver 1200 amps. at 550 volts as a booster at any point along the line. Hartman oil switches, furnished by B. F. Kierulff, Jr., & Company, of Los Angeles, the Pacific Coast agents of the Hartman Circuit Breaker Company, are being used throughout the system of the Los Angeles Pacific Company.

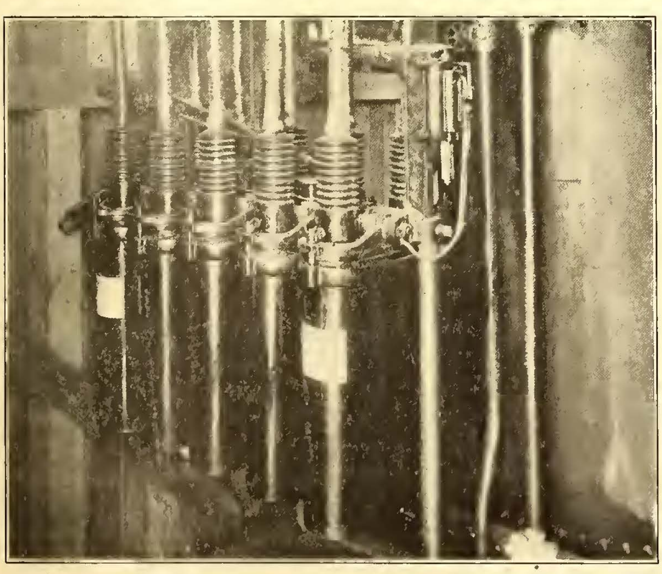


FIG. 1.—OIL SWITCH FOR 22,000 VOLTS

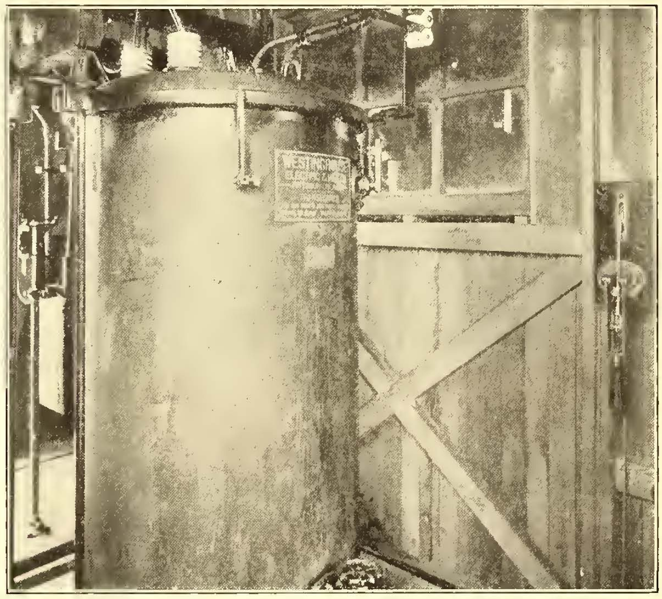


FIG. 2.—OPERATING HANDLE OF OIL SWITCH, SHOWN TO RIGHT OF TRANSFORMER

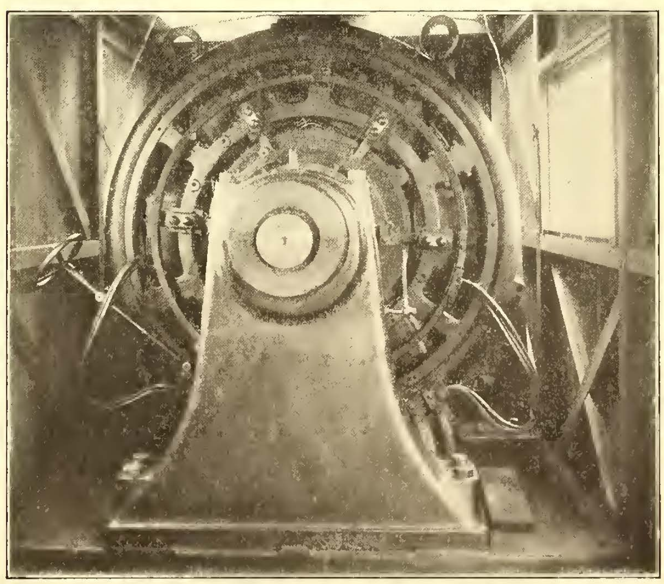
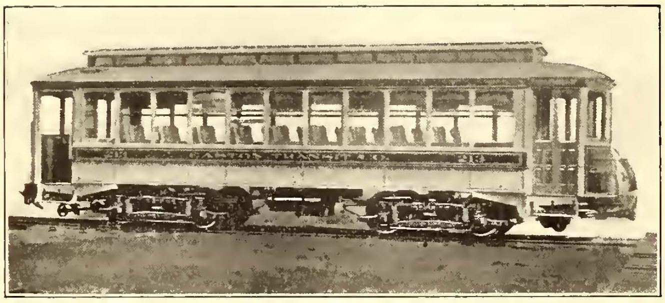


FIG. 3.—MOTOR-GENERATOR SET IN PORTABLE SUB-STATION

NEW EQUIPMENT FOR EASTON TRANSIT COMPANY

The Easton Transit Company has added eight ten-bench open cars built by the J. G. Brill Company, and seven 20-ft. closed cars built by the John Stephenson Company, to its rolling stock. These cars will be operated over the local tracks in Easton. A still more important addition to the equipment of the company is a lot of six 30-ft. 8-in. Brill grooveless post, semi-convertible cars, which will do service on the new Easton & South Bethlehem road, which is one of the six operated by the Easton Transit Company. This



EXTERIOR OF EASTON TRANSIT CAR

is a through line between Easton and South Bethlehem, 12½ miles in length, 7 miles of which are built over private right of way 15 ft. to 50 ft. in width. It is proposed to operate the section over this private right of way on a fast schedule, and the cars will make 7 miles in eleven minutes. The line will go through the villages of Wagnersville, Middletown and Shirmersville and the boroughs of Freemansburg and Northampton Heights. The fact that the lines also skirt for a distance of about 2 miles the plant of the

INTERIOR OF EASTON TRANSIT CAR

Bethlehem Steel Works, now under construction and partly in operation, will have a most important bearing on the traffic returns. The track is laid with 70-lb. T-rail on 6-in. x 6-in. x 8-ft. ties, stone ballasted. The overhead work is of bracket and span construction.

The new semi-convertible cars measure 30 ft. 8 ins. over the end panels and 40 ft. 1 in. over the vestibules. The width over sills, including sheathing, is 8 ft. ½ in.; over posts at the belt, 8 ft. 4 ins.; side sills, 4 in. x 7¾ in.; end sills, 5¼ ins. x 6⅞ ins.; sill plates, 12 ins. x ⅜ in. The bodies are mounted on the 27-E1 truck with 6-ft. wheel-base. Four motors of 40-hp capacity are installed on each car. The interior of the cars are of cherry and the ceilings of birch. High roll-back seats are provided. Other specialties that go to make up the equipment are "Dedenda" gongs, "Retriever" singal bells, etc.

THE SECOND DELAWARE & HUDSON GASOLINE MOTOR CAR

The General Electric Company has just made available some data on the second gasoline-electric car which it has built for the Delaware & Hudson Railroad. The car body is 50 ft. long and constructed of steel, but a small amount of wood is used as interior trim. The roof is of the Mann type, equipped with globe suction ventilators. The ends of the car are rounded to decrease the wind resistance. The car body is divided into an engine compartment, a small baggage compartment, smoking, main, toilet, and operating cab at the rear end. The seating capacity is forty, and if baggage compartment were included, approximately forty-eight. The trucks were constructed by the American Locomotive Company, and are of the standard swing bolster type, special attention being paid to obtain the minimum amount of weight. Thirty-six-inch wheels are used, with a 6-ft. 4-in. wheel-base. The passengers enter at the end of the car through a vestibule entrance on either side.

The main generating set is installed in the motor compartment and consists of a gasoline motor of 150 hp to 175 hp, of eight cylinders of the V construction. The gasoline motor is directly connected to an eight-pole commutating pole, 90-kw generator mounted upon the same shaft, and an exciter of 3½-kw capacity for exciting the fields of the main generator and affecting the variable potential control. From the generator leads are conducted to two motors situated one upon each truck at either end of the car. These motors are of 65-hp capacity, and are always connected in parallel. The required torque or speed at any moment is obtained by varying the field current of the generator through a controller, embodying essentially the required resistance arranged in fifteen steps.

To return to the gasoline motor. This motor is of the four-cycle type, equipped with two separate systems of ignition, high tension by plug, and induction coil connected to a four-volt storage battery. The make and break is connected to a direct driven Simms-Bosch low-tension magneto. The carburettor is of the single-nozzle, hand compensated type, gasoline being supplied to it by means of a diaphragm pump. The cooling is effected by fin type radiators situated upon the roof directly over the engine compartment. The circulation is by thermo-siphon. The gasoline motor is controlled by one lever superimposed over the controller handle. The normal speed is 550 r. p. m. For acceleration a higher rate of speed is attained, and for slowing down and stopping at stations the engine speed is dropped.

The car is lighted electrically from a small floating storage battery across the exciter. One light is provided for each seat. The car is heated by by-passing as much as required of the exhaust gases through pipes suitably installed, approximately in the same position as steam pipes are installed in a standard railway coach.

The rate of acceleration of a mile per hour per second will be obtained to approximately 25 to 28 miles per hour. From this point on acceleration will fall off gradually until full speed is attained at approximately 50 to 55 miles per hour. The total weight of the equipment is 30 tons.

FINANCIAL INTELLIGENCE

Wall Street, June 26, 1907.

The Money Market

Apart from a slight advance in the rates for short-time accommodations the local money market failed to reflect to any appreciable extent the continued drain upon the resources of the New York City banks. Gold to the amount of $7,400,000 was exported to Europe, during the week, of which $2,750,000 went to London and $4,650,000 went to Paris, bringing the total shipments on the present movement up to $24,800,000. In some quarters it is believed that further shipments of the metal will be made later in the week, but there are strong indications that the outward movement is nearing an end. For the first time since the beginning of the export movement the rates for foreign exchange show a declining tendency, and at the close the exchange situation both here and at Paris was decidedly better. It now looks as though the demand for the precious metal at Paris has been about satisfied. The last statement of the Bank of France made a very strong exhibit while the gold holdings of the Bank of England were considerably larger than in recent weeks, that institution absorbing practically all of the gold arrivals from South Africa during the past fortnight. The heavy withdrawals of gold, however, have reduced the reserve of the local banks to a rather low level, and it is expected that the cash holdings will be further reduced as a result of this week's gold shipments. In addition, corporations have again entered the market for money, but so far the borrowings from this source have been comparatively light. The United Railways of St. Louis has sold $1,200,000 two-year 5½ per cent notes, the proceeds of which will be used to refund $1,500,000 Citizen Railway first mortgage 6 per cent bonds, falling due on July 1. The balance of $300,000 will be made up in cash now held in the company's treasury. The Chesapeake & Ohio, it is understood, will be in the market for the sale of an issue of $25,000,000 or $30,000,000 bonds, while the St. Louis & San Francisco will also need considerable cash under its new financial plan.

The demand for money from stock exchange houses has been extremely light, borrowers generally being disposed to draw their immediate requirements from the call loan department rather than to enter into contracts for fixed periods. There was, however, an improved demand at the close of the week for the short maturities and rates for thirty to sixty days advanced about ¼ per cent to 4½ per cent. Otherwise the rates for time money remained absolutely unchanged. Four months' money was obtainable at 5 per cent, five and six months at 5½ per cent, and 6 per cent for seven and eight months. The banks, however, were not disposed to offer with any degree of freedom and the bulk of the week's supply of time money came from outside sources. During the current week preparations will have to be made for the July 1 interest and dividend disbursements, which are now estimated at close to $185,000,000, but it is expected that the bulk of these disbursements will soon find their way back to the banks and may result in a somewhat easier market. Another factor that is receiving more or less consideration is this season's supply of Klondike gold. The first shipment of $1,000,000 was made early last week, and it is expected that the total receipts from this source will be fully as large as in former years. Rates of exchange on New York at the interior points indicate that the movement of money in this direction is rather free, but relief from this source will be only temporary, and within another month or six weeks it is expected that New York will, as in former years, begin to send money in volume to the West and South for crop-moving purposes.

The bank statement published on last Saturday was unexpectedly favorable. Loans decreased nearly $5,500,000, indicating that the higher rates for call money have induced trust companies and other institutions to enter the market. Deposits were $7,290,300 smaller than in the preceding week. The decrease in cash of $710,600 was considerably less than expected in view of the heavy shipments of gold to Europe. The reserve required was $1,822,375 less than in the preceding week, thus increasing the surplus reserve by $1,111,975. The surplus now stands at $5,626,600, compared with $10,912,925 in the corresponding week of last year, $15,094,675 in 1905, $38,452,675 in 1904, $12,923,850 in 1903, and $12,978,350 in 1902, $6,611,250 in 1901, and $15,526,850 in 1900.

The Stock Market

There was a decided improvement in the securities market during the week. Trading at times was intensely dull, and although operations were confined almost entirely to the professional element the feeling in financial circles was more optimistic than for many weeks past. During the first half of the week trading sank to extremely small proportions, but the price movement showed no decided tendency in either direction, fluctuations generally being confined to the small fractions. The market disregarded the unfavorable developments. The continued outflow of gold to Europe resulting in slightly higher rates for money here, the failure of the Reading directors to increase the dividend rate on its stock, the internal disturbances in France, and the depression in British government securities, which under ordinary conditions would have resulted in a rather sharp decline in values failed to exert the slightest influence. Operators for the fall were not disposed to take advantage of these unfavorable factors to force prices to a lower level. The belief was generally entertained that the market being heavily oversold, they would probably be unable to repurchase stocks without bringing about a sharp advance in prices. During the last half of the week the market developed greater activity and strength. The failure of the money market to reflect in appreciably higher rates the heavy outflow of gold, the belief that money will work easier after the mid-year settlements are completed, and that a considerable portion of the moneys disbursed on July 1 for interest and dividends will be reinvested in securities were doubtless responsible for the pronounced strength prevailing in the market at the close of the week. Other important factors included the weakness in the foreign exchanges both here and abroad. For the first time since the beginning of the gold export movement the foreign exchange market reflected the outflow of the precious metal by an abrupt fall in the rates for sterling here and a corresponding advance in sterling at Paris, indicating that the demand for gold at that center has been practically satisfied. The crop news coming to hand was very encouraging. Warm weather has prevailed in all of the grain States during the past week, and conditions of both wheat and corn have been materially improved. Railroad earnings continue to show substantial gains over those for the corresponding periods of former years, and according to the traffic managers of the large transportation companies there is every reason to expect a continued heavy movement of freight for some time to come. The upward movement was undoubtedly helped by the improvement in the foreign situation. The declaration of the regular quarterly dividend on Anaconda, and the improvement in the London copper metal market were reflected in sharp advances in the copper shares. Other stocks to respond to the better condition were Reading, Union Pacific, Southern Pacific, the Hill shares and the United States Steel stocks, the buying of all these shares being characterized as better than has been witnessed for some time past.

The local traction stocks followed the course of the general market, Brooklyn Rapid Transit and the Interborough-Metropolitan issues scoring sharp advances in prices over those prevailing at the close of a week ago.

Philadelphia

There was a decided improvement in the market for local traction issues during the past week. Dealings were confined to a comparatively small number of stocks, but the individual totals were considerably larger and prices in most instances ruled fractionally higher. Philadelphia Rapid Transit was the leading feature in point of activity, more than 15,000 shares changing hands. At the beginning of the week the stock advanced to 24⅜, but later there was more or less selling to realize profits on the announcement that the Select and Common Councils had approved the rapid transit ordinance, giving the company a franchise in perpetuity to operate surface lines. This selling carried the price off about a point, but subsequently there was a recovery to 23¾. Philadelphia Traction and Union Traction were strong in sympathy, the first named rising to 93½, while the latter advanced to 58¼. Other sales included American Railways at 48½ and 48⅝, United Companies of New Jersey at 241⅛, Philadelphia Company common at 39¾ and 40 and the preferred at 44.

Chicago

There were no important developments in the local traction situation during the week. The Western representatives who were in New York conferring with Eastern interests have returned to Chicago, and it is understood that a further modified plan will be presented to the minority holders of the Chicago West Division and the North Chicago City Railway Companies. If this plan is accepted, and it is believed it will be, it will be possible to go ahead with the reorganizing of the Chicago Union Traction Company.

Trading in the local tractions was fairly active, but prices displayed some irregularity. City Railway opened at 160 and dropped 5 points to 155, and North Chicago, after selling at 40, advanced to 42. West Chicago sold at 33½. Union Traction common ran off from 3¾ to 3⅛, and the preferred sold at 17½. Early in the week Metropolitan Elevator preferred sold at 62½, ex. the dividend, but later it rose to 63¾ and then reacted ½. Metropolitan common sold at 23½ and 24. South Side Elevated sold at 80½ and 80⅛, ex. the dividend of 1 per cent.

Other Traction Securities

Very little activity developed in the Boston market, and apart from Boston & Worcester common, which advanced nearly a point to 24, on the purchase of about 500 shares, prices showed very little change. Boston & Worcester preferred sold at 71½. Massachusetts Electric common brought 16, and the preferred 56. Boston Elevated was steady at 134. West End common fluctuated between 85 and 84, and the preferred changed hands at 101. Trading in the Baltimore market was extremely dull. United Railway issues were practically at a standstill, but prices were not materially changed. The stock sold at 11. The 4 per cent bonds sold at 85, and the incomes at 50⅛ and 50¼. The funding 5s declined a small fraction to 78¾. Knoxville Traction 5s brought 104½, City & Suburban 5s sold at 106⅞, and Baltimore City Passenger 5s at 101½.

Comparatively few sales of any kind were made on the Cleveland exchange. Eighty shares of Aurora, Elgin & Chicago preferred changed hands at 75, and later a six-share lot went at the same figure. Two ten-share lots of Northern Ohio Traction & Light sold at 24½, which is ⅜ lower than former sales, and Tuesday two blocks of twenty and thirty shares, respectively, went at 25¼. Cleveland & Southwestern preferred was offered aa a small reduction this week. No transactions were noted in Cleveland Electric, the last sale being at 48.

Security Quotations

The following table shows the present bid quotations for the leading traction stocks, and the active bonds, as compared with last week:

	June 19	June 26
American Railways	48	48
Boston Elevated	a134	133
Brooklyn Rapid Transit	52¾	55¼
Chicago City	155	150
Chicago Union Traction (common)	3	3½
Chicago Union Traction (preferred)	14	16½
Cleveland Electric	47	45½
Consolidated Traction of New Jersey	71	72
Detroit United	63¼	—
Interborough-Metropolitan	16	16¾
Interborough-Metropolitan (preferred)	44½	47
International Traction (common)	—	45
International Traction (preferred), 4s	—	69
Manhattan Railway	129¼	130
Massachusetts Elec. Cos. (common)	15	16¼
Massachusetts Elec. Cos. (preferred)	56	57
Metropolitan Elevated, Chicago (common)	22	23
Metropolitan Elevated, Chicago (preferred)	63	63½
Metropolitan Street	81	—
North American	66	67⅞
North Jersey Street Railway	40	40
Philadelphia Company (common)	39½	41
Philadelphia Rapid Transit	24⅛	23⅞
Philadelphia Traction	92	93
Public Service Corporation certificates	64	—
Public Service Corporation 5 per cent notes	92	—
South Side Elevated (Chicago)	83	*80
Third Avenue	105	105
Twin City, Minneapolis (common)	92	92
Union Traction (Philadelphia)	58	58

* Ex-dividend. a Asked.

Metals

The "Iron Age" says that again evidence is cropping up that smelters have not covered their requirements of pig iron as fully as was claimed, and they appear in the market for early deliveries. So far as the finished iron and steel trade are involved, the outlook for a peaceful continuance of work is good. The sheet and tin plate scales for the coming year are settled, and the puddling and bar mill scales are under negotiations.

Copper metal remains unchanged, the large selling agencies still quoting 25½c. for Lake, and 24¼c. for electrolytic.

C. S. MELLEN AND THE NEW HAVEN RAILROAD SYSTEM

Under the title of C. S. Mellen and his railroad system the "Wall Street Journal," of Thursday, June 20, devoted almost an entire page to a review of recent operations in the New England railroad field, including the acquisition of the electric railway lines by the New York, New Haven & Hartford Railroad. A very valuable feature of the article was a map of the transportation lines Mr. Mellen has brought under the control of the New Haven company. Of the trolley purchases made by the company the "Journal" had this to say:

Mr. Mellen next went to examine his outposts. He found he had none! Word came that the New Haven road had purchased a trolley line. People said, "What does Mellen want of that?" Before they could get any answer the news came that he had bought three more. Hardly a week went by in which the New Haven road did not buy a few miles of trolley line, first in Connecticut, then in New York, then in Rhode Island, and then in Massachusetts. Not only would it buy, but it would build and connect up lines previously purchased. To-day the New Haven road has upward of 1400 miles of trolley lines in New England.

"This man will ruin the New Haven road," said the pessimists. "What does Mellen want with hundreds of miles of trolley lines?" The reason for the enormous trolley acquisitions of the New Haven road can best be explained by the following hitherto unpublished extract of a letter by C. S. Mellen to a friend:

"The thought of our company when it first acquired an interest in Massachusetts trolleys was not the suppression of competition, for we do not believe there is any serious competition between the two systems of traction, electric or steam. Rather, it is our thought that all systems will ultimately develop into the electric, and the street railways, so called, become adjuncts to or supplementary to the present trunk lines, which are now operated by steam, but which we believe are later going to be transformed into electric lines.

"When the question of rapid transit between congested communities is ultimately solved, and as the public will in its exasperation demand that it shall be solved, the solution to my mind is going to be the use of what are now the trunk or steam lines between the cities, and circuits for collection and distribution by street railway tracks within the cities. In that way more than any other is the rapid transit the public desires to be provided, although I confess the public seems slow to appreciate it."

AN IMPORTANT RIGHT-OF-WAY DECISION IN INDIANA

The Indiana Supreme Court has rendered an important decision relative to the right of an interurban railway company to condemn a right of way across farms for a transmission line from its power house to another or leased interurban line. The question was raised by the condemnation of a way from the power house in Rushville of the Indianapolis & Cincinnati Traction Company across the country and farms to the road from Greensburg to Indianapolis, which the company operates under lease. L. H. Mull objected to having the high-voltage wires cross his field and appealed to the Circuit Court, where a decision was recorded against him. He then appealed to the Supreme Court, where it was held:

(1) The power conferred on interurban railroads by acts of 1903, page 92, to condemn lands for uses appurtenant to all roads "acquired" by them includes power to condemn a right of way for a transmission line of poles and wires appurtenant to a leased line.

(2) Said acts of 1903 is constitutional.

(3) Said right of condemnation is not affected by the fact that the transmission line extends across country from a power house on the road leading east through Rushville to the road leading southeast to Greensburg.

(4) The rule that a lawful business or structure is never a nuisance per se applies to a high-voltage electric line built across a farm by authority of law.

ACCOUNTING BLANKS WANTED BY ACCOUNTANTS' ASSOCIATION

The demand on the American Street and Interurban Railway Accountants' Association for blanks from companies that operate both railway and electric lighting properties is so frequent that the secretary, E. M. White, of Birmingham, Ala., has asked all companies that operate these various properties to send him with as little delay as possible a duplicate collection of all blanks used by them. The present collection of the association is not up to date and is not arranged so as to give the best results to the members. These collections Mr. White will arrange by companies in suitable binding, one set to be used at the convention and the other to loan to members. This appeal is made especially to the small company, whether it has worked out a satisfactory set of blanks for itself or not. As the subject of electric light classification will receive considerable attention this year, it has seemed a very suitable time to take up this matter of forms as used by the public service corporations, and Mr. White therefore asks all companies that are interested to give this request for blanks early and careful attention.

The data sheet asking for information in reference to the operation of street railway, electric lighting and other public utilities by the same organization contains the following questions:

Does your company operate both street railway and electric light?

Does your company indirectly, through lease or stock ownership, control and operate both street railway and electric light?

Does your company through a common ownership and operation, control and operate both street railway and electric light?

Does your company operate, either directly or indirectly, any other public utilities than street railway and electric light?

If so, what?

At the convention of the National Electric Light Association the question of a standard classification of accounts for electric lighting companies was discussed, and the matter re-referred to the committee for further consideration.

President Tingley, of the American Street and Interurban Accountants' Association, is of the opinion that it would be unfortunate for the lighting companies to adopt a standard classification which would differ in its fundamental principles from that adopted by the American Association; particularly, as many companies, members of the American Association, are also members of the National Electric Light Association, and a classification divergent in principle would be apt to create confusion, particularly among the smaller companies where the same officers would be obliged to deal with both classifications. In order that he may have the data necessary intelligently to consider this matter, and bring it to the attention of the association at the next convention, Mr. Tingley asks that the data sheet be promptly filled out and returned to him at Philadelphia.

AFFAIRS IN CHICAGO

N. W. Harris & Company, of New York, together with the Harris Trust & Savings Bank and the First National Bank, of Chicago, have purchased $6,000,000 first mortgage 5 per cent twenty-year bonds of the Chicago City Railway Company. The bonds will be offered to investors at a price slightly under par.

The purchase of the $6,000,000 bonds above referred to will enable the company to undertake the first extensive work to be started under the direction of the new Chicago Board of Supervising Engineers provided for in the traction ordinance approved by the voters of Chicago at the recent municipal election.

Differences between the Union Traction Company and the North Chicago and West Chicago Street Railroad Companies on the one side, and the Chicago West Division Railway and the North Chicago City Railway Companies on the other, over the terms on which stocks shall be deposited for acceptance of the traction settlement ordinance to the Chicago Railways Company, apparently disappeared on Saturday. The protective committees of stockholders in the underlying companies issued a circular letter strongly advising and asking the right to deposit stocks of these companies in escrow. The escrow proposition is set forth as follows in the letter:

We now expect to conclude an arrangement whereby the underlying stocks will be deposited in escrow with the Chicago Title & Trust Company, the deposit to become absolute, provided a certificate signed by Judge Grosscup and Mr. Gray shall be thereafter filed with that company, in the following form:

"We hereby certify that a plan of reorganization formulated by the authority of the Chicago Railways Company has been filed with us and that in our judgment said plan makes full provision, all things considered, for the execution of whatever finding may be hereafter made by the arbitrators in the matter of the issuance and distribution of the securities of the Chicago Railways Company."

In case the certificate is filed, whereby the deposit of the underlying stocks becomes absolute, then Judge Grosscup and Mr. Gray, the arbitrators named in the deposit agreement, are to set a time for the full hearing of all the parties in interest—the plan to be given to all the parties in time to enable them to get ready for such hearing.

Accompanying the letter is a form of authorization, directed to the Merchants' Loan & Trust Company, for the deposit in escrow and for absolute deposit in case of fulfilment of the condition. The letter is signed by Cyrus H. McCormick, Thos. Templeton, Charles W. Ware and John F. Bass for the West Side Company, and by Leon Mandel, Charles A. Mair, James F. Porter, John A. Chapman and John F. Bass for the North Side Company.

This plan of deposit in escrow is said to have been proposed by Judge Grosscup, and to be acceptable to Union Traction and its allied interests. The committees expect to have prompt response from stockholders so that within the next four or five days it will be possible to make the escrow deposit.

It is expected also by both sides that the required certificate by Judge Grosscup and Prof. Gray will be given soon after the deposit in escrow. In that event the unconditional deposit can be made many days before the date of expiration of the time limit for acceptance of the ordinance July 26.

In the current number of the "Journal of Finance," Dickinson MacAllister, former president of the West Side Metropolitan Elevated Railway Company, is quoted as saying that, although he has no business interests as an officer or stockholder in any Chicago traction line, he intends to live in Chicago for the sole purpose of watching the improvements in the city's local transportation lines.

More than 100,000 shares of preferred and 200,000 shares of common stock in the Chicago Union Traction Company were brought to Chicago from New York by Receiver Marshall E. Sampsell, and General Counsel W. W. Gurley, of that company, and deposited with the Chicago Title & Trust Company, early this week, to insure acceptance of the traction settlement ordinance as soon as the deposit of the stocks of Chicago West Division Street Railway and North Chicago City Railway Companies is assured. The conferences in New York in the last week are said to have been over differences between the Union Traction Company and the North Chicago Street Railroad and West Chicago Street Railroad companies, as well as the deposit of underlying stocks. These differences, it is said, will be settled without imperiling the ordinance. The deposit of stocks, it is taken for granted by traction men generally, will be made by all the companies named in the ordinance to the Chicago Railways Company.

STONE & WEBSTER PLANS IN WASHINGTON

The Puget Sound International Railway & Power Company, having for its purpose the carrying out of plans for the interurban electric railway between Seattle and Bellingham, Wash., proposed by Stone & Webster, has been organized and incorporated. The foregoing announcement was made by C. D. Wyman, of Stone & Webster, who is vice-president of the Seattle Electric Company, vice-president of the Puget Sound Electric Railway Company and president of the Whatcom County Railway & Light Company. Mr. Wyman is quoted as follows:

"Our interests are negotiating an affiliation with the Everett street railway properties, which will give us control of them. The new company will immediately begin carrying out its plans for the building of interurban roads from Bellingham to Seattle. It has always been our plan to afford the Puget Sound cities an interurban service eventually from the international boundary to Olympia and Chehalis, and perhaps finally to Portland and the Grays Harbor country.

"Our first step was the Puget Sound Electric Railway, between Seattle and Tacoma. That has developed the valley through which it runs. Another region to the north, with Bellingham as the center, we shall develop with similar lines as rapidly as conditions permit, as the money is raised, the franchises and rights of way acquired and other plans perfected.

"The interurban project necessarily involved Everett's necessities and led to the negotiations which will give us the control of that system. The statement that we have bought the road there is not true, but the arrangement under way will give us the control. We shall build such extensions and connections as the conditions in that city seem to justify, giving it the advantage of a more elaborate interurban system. We shall put surveyors in the field with the idea of locating accurate and positive routes for lines through to Seattle. Our engineers have already made surveys 30 or 40 miles south of Bellingham, and these will be continued in this direction.

"The Nooksack power plant will be used to operate the northern portion of the system, and will probably soon be increased in capacity. It is our policy to develop the interurban system from each center, until we shall have completed a through line from the boundary south. Thus we commenced from Seattle. We have already extended from Tacoma south to American Lake, and will continue to Olympia. Our next step is the system from Bellingham, and we shall make plans for reaching out from Everett.

"We also expect to push the extension of our Puget Sound Electric Railway Company's system from Brookville to Puyallup, thence to Sumner, and finally to Orting and up that valley."

THE CLEVELAND SITUATION

The Cleveland Electric Railway Company has refused to negotiate with the Low Fare Railway Company regarding the compensation for the use of its tracks in so-called free territory. The reasons assigned for the action is that the basic ordinance granted the Low Fare Railway Company is invalid, and that the City Council has no power to fix such compensation. This makes it necessary for the City Council to fix the compensation. The Low Fare Railway Company proposed to pay a gross sum for the use of the tracks and a fixed sum for repairs, taxes and maintenance. The Cleveland Electric claims that the amount paid should be in proportion to the use of the tracks. While the small company would have but few cars to operate over them now, later on the business might increase and the use become greater and more burdensome to the owners. For this reason, the Cleveland Electric says that, even if it is wrong in supposing that the franchise is invalid, the manner of compensation is not satisfactory. So far no compensation has been fixed for the use of the streets on which the franchises of the old company have expired. Secretary H. J. Davies, of the Cleveland Electric, and A. B. DuPont, of the Low Fare Railway Company, were to fix the amount. They held a meeting or two and failed to agree. Since that time little has been done. The City Council appointed a time for them to report, and in case they did not do so, said that a third man would be named to go over the work with them. They did not report and the third man has not been appointed. Both Mr. Davies and Mr. DuPont have been busy with other things and have not had the time to take the matter up.

At the Council meeting Monday evening, H. P. Bradbury, who has been in charge of the work of securing consents on Quincy Street and Central Avenue for City Clerk Peter Witt, reported that he had consents for 7,524.81 ft. on Quincy Street and 7,978.59 ft. on Central Avenue, which he filed. In order to have a majority of consents on Quincy Street a little less than 10 000 ft. must be secured on Quincy, and a trifle less than 13,000 ft. on Central Avenue. Mr. Bradbury claimed to have a lot of other consents which he was not ready to file, as he had not been able to verify the ownership of the property. It is claimed that these include those that have been revoked and all others about which there is doubt. On Tuesday, Cleveland Electric representatives were refused access to these consents by City Clerk Witt.

At a special meeting of the City Council, Tuesday afternoon, to discuss the failure of the Cleveland Electric Railway Company and the Low Fare Railway Company to agree upon terms by which the cars of the latter may be operated over the tracks of the former in so-called free territory, a note from the Cleveland Electric was read, which stated that its stand in the matter was contained in a communication to the Low Fare Railway Company. Although invited to be present the officials of the Cleveland Electric did not attend the meeting.

It has been announced that the Circuit Court, made up of judges chosen from outside districts, will render its decision in the Isom injunction suit on July 15. The case has been reviewed by the court and arguments presented covering the points that were taken up in Common Pleas Court.

PLANS FOR THE PROPOSED MEMPHIS INTERURBAN

The Clarksdale, Covington & Collierville Interurban Company recently incorporated by R. F. Tate, W. A. Gage, G. W. Agee, James S. Robinson, Dudley S. Weaver, H. E. Craft, W. E. Craft, W. E. Willett, A. Walsh, W. A. Percy, Ed. Manigan, M. J. Roach, Walter Goodman, I. D. Block, Louis Sambucetti, R. B. Nebhut, H. D. Minor, C. F. Farnsworth and W. C. Knight, proposes to build a system of interurban electric railways to extend out of Memphis.

The charter authorizes the construction of a street railway in the city of Memphis, and lays out a number of north and south routes, and a number of east and west routes and two crosstown routes. Among the routes asked are north and south on Front and Third Streets, east on Washington Street and Pontotoc Avenue, and across town on McLean Avenue. The south routes work out to Riverside Park and South Memphis, crossing Nonconnah east of the Illinois Central. The north routes proposed are out the Randolph Road to Wolf River, and also out Looney Street and Vollentine Avenue to the property of the Union Land & Improvement Company to Wolf River, where it is crossed by the New Raleigh road. The east routes go out Harbert Avenue, and other lines on the north side of the Southern Railway, and another line out Walker, Trigg and Carnes Avenues on the south side of the Southern Railway. The capital of the company is fixed at $50,000, with the privilege of increasing same.

R. F. Tate, the president of the Lake View Traction Company, an affiliated company, has this to say in regard to the companies:

"The capital of the Lake View Traction Company has been increased to $1,000,000 of preferred and $1,500,000 of common stock, and the company has been steadily at work acquiring rights of way, real estate, franchises and doing engineering and location work. We hope to begin the work of construction to Lake View by September. Our charter is taken out under the laws of Maine, whose corporation laws are very favorable, but we have been advised that it is desirable to incorporate also locally, because of the facility in condemning rights of way where they cannot otherwise be obtained. A street railway of another State cannot condemn in Tennessee, though it may in Mississippi. But under the legislation passed at the last session in favor of the interurbans, the power to condemn for rights of way, power houses and parks is given to any street railway company in Tennessee. This is the prime reason why the stockholders of the Lake View Traction Company have applied for a charter for the Clarksdale, Covington & Collierville Interurban Company.

"In order that these lines may enter the city of Memphis over their own rails we will ask the grant of a franchise from the city of Memphis which will admit of our getting routes out south, east and north."

STANDARD CLASSIFICATION OF THE ACCOUNTANTS' ASSOCIATION

It will be remembered that at the last convention of the American Street and Interurban Railway Accountants' Association the secretary of the association was authorized to reprint the standard classification of accounts from the report of the association, and to sell the book to non-members for $1 per copy. Acting under these instructions the secretary, Elmer M. White, of Birmingham, Ala., has issued the pamphlet, which in addition to the classification and form of report includes the reports of the committee on classification for the last three years. These reports contain answers to questions asked by the members, and in this way amplify the instructions on classification.

COMMITTEE ON ACCOUNTS OF ACCOUNTANTS' ASSOCIATION MEETS IN CLEVELAND

The committee on standard classification of accounts of the American Street and Interurban Railway Accountants' Association held a meeting in parlor O of the Hollenden Hotel, Tuesday, with Chairman W. F. Ham, of Boston, presiding. The committee had under consideration a report of a sub-committee on interurban railway accounts, of which W. H. Forse, of the Indiana Union Traction Company, is chairman. This involves a possible change in the classification of accounts as now used by the companies, and the members spent the day in discussing the matter. As nothing final was expected at this meeting, however, Chairman Ham said that no detail of the work done could be made public and that possibly nothing would be given out until the annual meeting of the association. Those attending the meeting are as follows: W. F. Ham, chairman, of Boston; C. N. Duffy, of Milwaukee; F. R. Henry, of St. Louis; W. G. McDole, of Cleveland; C. L. S. Tingley, president of the association, of Philadelphia; W. H. Forse, of Indianapolis; A. B. Bierck, of Long Island; A. C. Henry, of Lake Shore Electric, of Cleveland, and Henry J. Davies, secretary of the Cleveland Electric, of Cleveland.

CLEVELAND, ALLIANCE & MAHONING VALLEY PERFECTING PLANS FOR BUILDING

The Cleveland, Alliance & Mahoning Valley Railway Company will within a short time finally close up the lease for the old track of the Baltimore & Ohio Railroad between Ravenna and Newton Falls. The bonds of this company have been sold and everything is now in readiness to take care of the arrangements that have been made for building. Nothing has yet been done toward electrifying the old steam road, although the track and roadbed have been straightened up in some places. As soon as the papers are signed the work will begin in earnest. In the first place, the steam road will be put into first-class condition and electrically equipped. It will be straightened at Newton Falls, so that the line will touch the edge of the town and connect with the private right of way from that point to Warren. This short section will be new road altogether. After this section is put into operation the branch from Ravenna to Alliance will probably be built. These lines are both direct and pass through thickly populated territory. At Alliance the line will connect with the Stark Electric for Canton and at Ravenna connection will be made with the Northern Ohio Traction & Light Company for Akron and by that route for Cleveland until its own line is built.

INDIANA RAILROAD COMMISSION SEEKS INFORMATION

Interlocking devices, block signals and highway and street crossings—under the authority granted to the Indiana Railroad Commission by the amended law of 1907—are the points covered in blanks the Commission has prepared and is sending out. It is supposed that the information gathered on these blanks will be used as data in any proceedings with reference to the placing of the different safety devices. Most important, perhaps, is the information concerning Indiana highway crossings. The blank asks for the number of grade street crossings on each line; number of grade highway crossings; number of overhead street and highway crossings, number of undergrade street and high crossings, and the number of all the crossings named above protected by watchmen, gates, bell or otherwise, or not protected at all. The interlocking blank asks for the number of such devices in which each road is concerned; the year constructed or rebuilt; whether it is mechanical or electrical; name of the company operating it; average daily train movement; the number of laborers employed, and the total number of their hours of labor, also the number of levers operated. The block signal blank is divided into three sections: one concerns the lines now equipped; the second the lines to be equipped, and the third lines not to be equipped. With reference to the first two, information asked for concerns the date of the construction of the system, actual or contemplated; the number of miles of automatic block; number of miles of manual telegraph block; miles of controlled manual block, and the total number of miles of all kinds in the State, actual or contemplated. In addition there is space for the railroad to outline the expenses of construction, maintenance and operation; the questions asking for the average cost a mile for the construction of each kind; average cost a mile for the maintenance of each kind, and the average cost a mile for the operation of each kind.

THE PLAN FOR ISSUING THE BOSTON ELEVATED BONDS

The $5,800,000 4 per cent Boston Elevated bonds approved by the Railroad Commissioners on June 15, will probably be sold by the road in instalments of varying amounts from time to time as the progress of the construction work or the condition of the company's treasury requires. The Boston Elevated Company is in no pressing need of funds and is in shape to take care of all its capital requirements out of its present cash balances for a long time to come. The management for several years has closely adhered to the policy of keeping the company financed ahead of actual requirements and provided with a working capital sufficient to meet all reasonable demands upon it. The $5,800,000 bonds will be used mainly for three purposes: Payment of new rolling stock, estimated at about $2,000,000; cost of power house enlargements, say, $1,500,000; Forest Hills extension and purchase of real estate, about $4,000,000. This makes a total of $7,500,000. The difference between this figure and the $5,800,000 bonds will be borne by the West End Street Railway, which will pay by issues of its own securities for the major part of the new rolling stock and a large part of the power house additions. The road has already sold a block of these bonds to R. L. Day & Company and Estabrook & Company. These bonds are a direct obligation of the Boston Elevated Company, mature May 1, 1935, and are being offered at 97 and interest, at which price they show an income return of about 4.18 per cent.

MERCHANTS' PLAN ACCEPTED BY THE PHILADELPHIA COUNCIL.

The Councils of Philadelphia have passed the Retail Merchants' Plan, which is designed to put the entire street railway system, as far as possible, on a firm foundation, with definite limitations and under a measure of municipal control. The basis or starting point of the "Merchants' Plan" was in the provision for a sinking fund to be set aside by the company out of its gross earnings, for the purpose of retiring its entire capital, so that at the end of the term its property and holdings should pass unencumbered to the city. This has been amended as follows:

"The city reserves the right at any time after the said sum may have reached the sum of $5,000,000 to require by ordinance of Councils that the same shall be paid over to the City Treasury and become the absolute property of the city, at the same time requiring that further payment toward said fund as provided for hereunder shall be made directly into the City Treasury."

STREET RAILWAY PATENTS

[This department is conducted by Rosenbaum & Stockbridge, patent attorneys, 140 Nassau Street, New York.]

UNITED STATES PATENTS ISSUED JUNE 11, 1907.

856,253. Safety Guard or Fender for Tramway Cars and the Like; Gustav Hauff, Kimberly, Cape Colony. App. filed Oct. 15, 1906. The front of the fender is adapted to fold up when an obstruction is encountered, thereby tending to pick up the obstruction.

856,266. Brake Construction; Van Buren Lamb, New Haven, Conn. App. filed Oct. 28, 1905. A brake-shoe having upon its rear surface a projecting part of decreasing thickness toward its ends and provided with undercut lateral surfaces converging toward the ends of the shoe. A supporting member is adapted to fit said projecting part and be connected thereby to the shoe, and dissimilar connecting means adapted to secure the member to the head.

856,273. Railway Switching System; William Macomber, Buffalo, N. Y. App. filed Feb. 20, 1905. Provides for moving and locking a rail switch and producing an indication of the movement thereof and the fact of its locked condition.

856,290. Signaling Mechanism; Walter A. Pearce, London, England. App. filed Nov. 28, 1906. Provides an improved form of electrically controlled coupling between the operating rod and the rod which is connected to the signal.

856.293. Trolley Pole Controller; Andrew L. Prentiss, Buffalo, N. Y. App. filed Sept. 24, 1906. A crank or arm extending downward from the pole has a link connection with a pneumatic retrieving cylinder horizontally mounted at the base of the pole. Provides tripping means for admitting air to the retrieving cylinder.

856,324. Railway Switch Operating and Signaling System; Asbury G. Wilson, Wilkinsburg, Pa. App. filed Sept. 6, 1905. Details of the operating mechanism for switches of the interlocking type.

856,285. Insulating Covering or Sheathing for Contact-Rail Conductors; William H. Baker, Lockport, N. Y. App. filed March 21, 1906. An insulating covering for third rails formed of overlapping sections which make provision for the enlargements' due to the fish-plates.

856,435. Pressed Steel Car; William G. Wagenhals, St. Louis, Mo. App. filed April 16, 1906. Details of construction.

856.437. Switch Lock; William Anderson, Memphis, Tenn. App. filed Sept. 24, 1906. Provides a switch lock with a compound lever comprising two members, one of which is always locked against movement when the other is unlocked and vice versa.

856,440. Block Signal System; Elmer F. Bliss, Schenectady, N. Y. App. filed Dec. 5, 1906. Provides, among other features, an arrangement for closing the circuits of the transformers ahead of the train whereby a plurality of the transformers may be controlled through a single conductor or pair of conductors.

856.448. Control System for Electric Vehicles; William Cooper, Wilkinsburg, Pa. App. filed Oct. 3, 1906. Means dependent upon a material difference in the speeds of the several motors for automatically interrupting the supply of energy to the motors of an electric vehicle.

856,461. Railway Brake; Cornelius Furman, Decatur, Ill. App filed March 18, 1907. Relates to the construction of the hanger bracket and the incorporation of anti-rattler springs at the ends of the links by which the shoe head is supported.

856,465. Block Signal System; Laurence A. Hawkins, Schenectady, N. Y. App. filed Dec. 3, 1906. A signal system having brake rails energized by transformers connected in a special way across the leads of a three-wire system.

856.466. Block Signal System; Laurence A. Hawkins, Schenectady, N. Y. App. filed Jan. 11, 1907. Relates to modifications of the above.

856,467. Block Signal System; Laurence A. Hawkins, Schenectady, N. Y. App. filed Jan. 10, 1907. The system is so arranged that current is supplied to a block only when it is necessary to clear a signal, or to maintain it at clear position in front of an approaching train.

856,535. Trolley Pole for Conducting Electric Current to Vehicles; Robert Lindsay and John Lindsay, Dunedin, N. Z. App. filed June 26, 1905. The trolley pole is formed of longitudinally telescoping sections, spring pressed outward, whereby the pole may be reversed without removing the trolley wheel from the wire.

856,583. Block Signal System; Laurence A. Hawkins, Schenectady, N. Y. App. filed Nov. 8, 1906. The rails of this system are conductively continuous for all currents. Transformers and signal-controling relays are connected to the rails and normally open switch contacts in circuit with the transformers and arranged to be closed by an approaching train.

856,598. Steel-Tired Wheel; Isaac E. McCracken, Wilkinsburg, Pa. App. filed Feb. 25, 1907. Comprises an inner frame and a tire, interlocking parts thereon preventing relative rotation thereof, and means not piercing the frame and tire at said interlocking parts for fastening the tire to the inner frame.

856,670. Block Signal System; Charles C. Anthony, Philadelphia, Pa. App. filed Nov. 28, 1906. Provides a system in which only one of two main signals employed in each block, one at each station, may be moved out of the danger position at one time to permit a train to pass by it into the block and then only when the block contains no trains moving toward the signal operated.

856,715. Tramway Switch; Malcolm C. Matthews, Chicago, Ill. App. filed Nov. 10, 1906. A partially rotatable switch carrying diverging track sections.

856,737. Electric Controller; Richard Van R. Sill, Newark, N. J. App. filed March 6, 1907. Details of construction of a controller for street cars, etc., including roller contacts spring pressed together and which embrace sector blades on the controller shaft.

856,765. Track Sanding Device; Arthur A. Churchill, Portland, Ore. App. filed Feb. 23, 1907. A vertical pipe arranged adjacent the sand-box and a horizontal pipe leading from the sand-box into the vertical pipe. The horizontal pipe has a V-shaped opening in its top for the admission of sand and an air delivery nozzle behind the sand admission opening.

856,782. Third Rail Cover for Electric Railways; William F. Kemper, Chicago, Ill. App. filed Jan. 21, 1907. An insulating cover for third rails and means for shifting the cover during the passage of a train.

856,882. Rail-Joint; Jefferson D. Jones, Temple, Tex. App. filed Feb. 1, 1907. Comprises a pair of rails, a supporting member located under the abutting ends of the rails, and main and auxiliary retaining means on the supporting member arranged to engage over the bases of the rails.

856,899. Valve; Alfred D. McWhorter, Atlanta, Ga. App. filed Feb. 6, 1907. A valve casing provided with inlet, atmosphere, brake cylinder and auxiliary reservoir ports and valve mechanism therefor, operating to bring said ports into communication in the following sequence: auxiliary reservoir and brake cylinder, inlet and brake cylinder; and on release brake cylinder and auxiliary reservoir and brake cylinder and atmosphere.

856,983. Track Sander; George Nugent, Toronto, Can. App. filed May 20, 1907. Relates to the construction of the discharge pipes.

PERSONAL MENTION

MR. G. E. PECK, formerly with the Waterloo, Cedar Falls & Northern Interurban Railway at Waterloo, has accepted the position of auditor and cashier of the Mason City & Clear Lake Interurban Railway and the People's Gas & Electric Company, of Mason City, Ia.

MR. B. B. WINCHESTER, who has been superintendent of the New York & Long Island Traction Company, with headquarters at Hempstead, L. I., has been transferred to the central office of the company at Long Island City. He is succeeded as superintendent by Mr. J. P. Kineon.

MR. ROBERT LONG, of the National Brake & Electric Company, has just returned from South America, where he has spent a year in the interests of his company. While in Montevideo he equipped with air brakes eighty-five cars of the electric railway described in the issue of this paper for May 4, 1907.

MR. CHARLES R. McKAY, for some time connected with the General Electric Company at Cincinnati, has been appointed superintendent of the lighting department of the Toledo Railways & Light Company, to succeed Mr. E. J. Bechtel, who has become consulting engineer for Hodenpyle, Walbridge & Co.

MR. CHARLES E. WARWICK, superintendent of transportation of the Galveston Electric Company, has resigned, and Mr. F. C. Randall is acting superintendent. Mr. Warwick came to Galveston two years ago, succeeding Mr. Lawson as superintendent. Mr. Lawson is now manager for the Oklahoma City Electric Company.

MR. J. M. McELROY, general manager of the Manchester Corporation Tramways, is planning to reach New York next week for a trip of inspection of the electric railways of this country. Mr. McElroy has been very prominent in the electric railway developments in the United Kingdom, and is president of the Municipal Tramway Association of Great Britain.

MR. C. H. MATHEWS has been appointed claim agent of the Georgia Railway & Electric Company, vice Mr. W. H. Williams, resigned. Mr. Williams has been connected with the street railway systems of Atlanta continuously for the past twenty years. Mr. Mathews has been connected with the Georgia Railway & Electric Company for the past six years as claim agent.

MR. WILLIAM FINDLAY SHUNK, for a time chief engineer of the old Metropolitan Elevated Railroad, of New York, under whose supervision work was begun on the elevated railroad, died at his home near Harrisburg, June 22. Mr. Shunk was born in Harrisburg in 1830, and was graduated from the United States Military Academy. He became an engineer for the Pennsylvania Railroad and later entered the service of the Metropolitan Elevated in New York. He was also at one time connected with the Kings County Elevated Railroad, of Brooklyn.

MR. LEWIS B. STILLWELL, of New York, was the recipient of two honorary degrees at commencement exercises this year. One was from Lehigh University and was the degree of Master of Science. It is said that this is only the third honorary degree ever given by Lehigh. The second degree was that of Doctor of Science, which was conferred on June 26 by Wesleyan University, at Middletown, at which Mr. Stillwell took part of his undergraduate course. The recognition by these two universities of ability in the engineering field will be generally appreciated by engineers.

MR. J. F. DAVIDSON, general superintendent of the United Railways Company, of St. Louis, has resigned, and Mr. Joseph Crafton, his chief clerk, has succeeded him. Mr. Davidson is one of the oldest street railway men in point of service in St. Louis. He ran car No. 1 of the old Olive Street line. Prior to the consolidation of St. Louis companies, Mr. Davidson was general superintendent of the Missouri Railroad, which included the Olive, Laclede and Market Street lines. Mr. Davidson will withdraw entirely from street railway work, and will devote his time to the improvement of property which he recently acquired in Oklahoma.

MR. THOMAS W. WILSON, who has just been elected president of the Street Railway Association of the State of New York, is general manager of the International Railway Company, of Buffalo, N. Y., to which position he was appointed in March, 1905, to succeed Mr. Thomas E. Mitten. Mr. Wilson was born in New York City in 1872, and was graduated from Lehigh University in 1894. From the first he has been connected with street railway work, and while at Lehigh served during his vacation periods in the drafting room of the Pennsylvania Steel Company. After finishing his course at Lehigh, Mr. Wilson entered the permanent employ of the Pennsylvania Steel Company as engineer of survey and special work. The following year he became assistant engineer of the Charleston Street Railway Company, of Charleston, S. C., of which he later became chief engineer. Under Mr. Wilson the lines at Charleston were equipped with electricity and much new construction carried out. Early in 1897, Mr. Wilson returned to the employ of the Pennsylvania Steel Company, but soon resigned to enlist in the Eighth Regiment of Pennsylvania Volunteers. After a few months service with the Pennsylvania Steel Company following his muster out Mr. Wilson accepted the position of assistant engineer of the International Traction Company. In this capacity he served for four years, being then made chief engineer. It was from this position of chief engineer that he was promoted to be general manager of the company.

THOMAS W. WILSON

MR. ERNEST GONZENBACH, vice-president and general manager of the Sheboygan Light, Power & Railway Company, has also been appointed manager of the Milwaukee-Northern Railway, with which the Sheboygan company has a joint operating agreement, preparatory to a complete amalgamation of the two properties. The Milwaukee-Northern Railway is building a street railway system in the city of Milwaukee and a double-track interurban line between Milwaukee and Cedarburg, Wis., at which town it branches to Sheboygan, where it will connect with the local city system and existing interurban railway to Plymouth, Wis., which is being extended to Elkhard Lake, Wis. The other branch of the Milwaukee-Northern will go from Cedarburg to Fond du Lac, Wis., where it will connect with the Fox River Valley system, which is connected with electric railways under various ownerships all the way from Fond du Lac to Green Bay, Wis. The total mileage of the consolidated system which will come under Mr. Gonzenbach's management, in operation and actually under construction, amounts to 165 miles of single track, and includes a local system in the city of Wilwaukee and a local system in Sheboygan, Wis., and an extensive electric light and power system in Sheboygan. Mr. Gonzenbach was born at Schloss Hauptwyl, Switzerland, in 1870, and attended the "Technisches Gymnasium" at the city of St. Gallen, Switzerland. Immediately after leaving school he came to the United States and settled in the far West. After some little experience in ranching, Mr. Gonzenbach went to Chicago, where he entered electric railroading, as an assistant in one of the power houses in that city. Finally, he was admitted to what was then called the "Expert Course" of the Thomson-Houston Company, at Lynn, Mass., where he remained for three or four years erecting apparatus of every description. In 1895, Mr. Gonzenbach engaged for himself as an electrical engineer at St. Johnsbury, Vt., and during the three years that followed he constructed a number of electric light and transmission plants throughout Northern Vermont and New Hampshire. In 1898 he entered the employ of the Westinghouse Electrical & Manufacturing Company, from which company he resigned in 1900 to become electrical engineer of the Albany & Hudson Railroad. From the Albany & Hudson Company Mr. Gonzenbach went to the Aurora, Elgin & Chicago Railway as electrical engineer, after which he was engaged for two years as consulting engineer, principally in the construction of the Youngstown & Southern Railway. On Jan. 1, 1905, he was appointed general manager of the Sheboygan Light, Power & Railway Company, and last fall was made vice-president and general manager of the Sheboygan company, and appointed to the same position with the Greensboro Electric Company, of Greensboro, N. C. Mr. Gonzenbach is the author of "Engineering Preliminaries for an Interurban Electric Railway," and has contributed articles on interurban railways to the STREET RAILWAY JOURNAL, the "Railroad Gazette" and other papers. In 1903 he was awarded the Chanute medal of the Western Society of Engineers. Mr. Gonzenbach, furthermore, has patented a number of railroad devices, including a cable terminal, third-rail insulator, air brake improvements, pneumatic train control apparatus, etc.

E. GONZENBACH

MR. GUSTAVE MULHAUSEN, general manager of the Evansville, Suburban & Newburg Traction Company, celebrated the eighteenth anniversary of his connection with the company as general manager a few days ago by a banquet to twenty of his immediate personal friends. These gentlemen, Mr. Mulhausen took over the Evansville, Suburban & Newburg property which, as recently noted in the STREET RAILWAY JOURNAL, is now equipped with electricity. At Booneville the guests were invited to board a large express car for the return to Evansville, and were surprised to find that Mr. Mulhausen had prepared for them an elaborate dinner, which was spread on an improvised table stretching practically the entire length of the car.

NEWS OF THE WEEK

CONSTRUCTION NOTES

Items in this department are classified geographically by States, with an alphabetical arrangement of cities under each State heading.

For the convenience of readers seeking information on particular subjects, the character of the individual items is indicated as follows:

* Proposed roads not previously reported.
o Additional information regarding new roads.
† Extensions and new equipment for operating roads.

Numerals preceding these signs indicate items referring to:

1. Track and roadway.
2. Cars, trucks and rolling stock equipment.
3. Power stations and sub-stations.
4. Car houses and repair shops.
5. Parks and amusement attractions.

1†FLORENCE, ALA.—Vice-President J. W. Worthington, of the Sheffield Company, which operates the Florence, Sheffield & Tuscumbia electric line, was in Florence recently looking into a proposed extension of the line in East Florence to take in the manufacturing district. Several of the leading members of the Young Men's Commercial Club were in conference with Mr. Worthington, who spoke very favorably of the extension. The proposed route is east on the Huntsville road, thence south to the Florence wagon works.

oLITTLE ROCK, ARK.—The mass meeting of citizens which was held recently to assist in the building of the interurban line between Hot Springs and Little Rock was attended by several hundred citizens and several prominent business men of Hot Springs. Twenty thousand dollars was raised in a few minutes and committees were appointed to canvass the city to sell the stock. It is now believed that the line is an assured fact. H. L. Remmel, who presided at the meeting, explained that $500,000 in preferred stock at 6 per cent was needed to make the interurban a sure go. He explained the common stock feature of the proposition, whereby every subscriber for preferred was to receive $1 in common stock for every $1 paid for the preferred.

oNAPA, CAL.—From the rate at which work is now being rushed on the extension of the San Francisco, Vallejo & Napa Valley Electric Railroad from this city to St. Helena, 18 miles north of here, it is said that cars will be running to the up-valley town by the middle of August. Nine hundred tons of steel rails, months overdue, have just reached here from the East. The work of stringing the trolley wires was commenced recently. The grading and bridge building are practically finished. The track will be laid at the rate of a half-mile a day. J. W. Thurber, of Los Angeles, has been awarded the contract for this work.

†OAKLAND, CAL.—The City Council has passed ordinances granting franchises along Wood Street to the Western Pacific, the Santa Fe and the San Francisco, Oakland & San Jose Railway (Key Route) Companies. The line of the Key Route will parallel the Western Pacific track from the Key Route yards at Fortieth Street to Wood and Seventh Streets. From this point it is the intention of the Key Route Company to run a line to the west on land that will be filled in and used for wharves.

1†SAN DIEGO, CAL.—Announcement has been made that on or before July 1 the contract between the Columbian Realty Company and the city for the grading of University Avenue from University Boulevard to the city limits will have been completed, and that the San Diego Electric Railway Company will then commence the construction of the University extension car line.

oSAN DIEGO, CAL.—The City Council has granted the petition of E. Bartlett Webster for a street railway franchise from Fourth and B to Sixth, down Sixth to F Streets and in due time the franchise will be advertised for sale.

oSAN FRANCISCO, CAL.—It is announced that the Peninsular Railroad, now being constructed between this city and San Jose by Southern Pacific interests, will be in operation by electricity in about twelve months. The road, it is said, will make the run between San Francisco and Congress Springs in one hour and a half. The railroad people intend to make a magnificent mountain resort at this place.

*SONORA, CAL.—Articles of incorporation of the Sonora Lime Belt Railroad Company have been filed, the purpose of the corporation being to build a standard gage railroad, to be operated by steam, electricity or other motive power. The estimated length of the railroad is 2 miles. The principal place of business is Sonora. The three directors are: James E. Lennon, Albert and Thomas Knowles. The capital stock is $25,000.

oVALLEJO, CAL.—Recently Melville Dozier and Attorney T. T. C. Gregory, of the Vallejo & Northern Railroad, arranged for the purchase of $110,000 worth of rights of way in Solano County alone. The company is also preparing to press its suits for condemnation in Yolo County. Dozier has stated that in about two weeks the engineers of his line and those of the Northern Electric will hold a joint conference in Sacramento with the government engineer, the Board of Supervisors of Sacramento and Yolo Counties and the city trustees of the Capital City to determine the location of the bridge across the river whereby the electric road will enter Sacramento. Whether or not the Vallejo & Northern line will use the steamers of the Monticello Steamship Company between this city and San Francisco is still a question which Dozier refuses to confirm or deny.

oVALLEJO, CAL.—The Vallejo, Benicia & Napa Valley Railroad Company has received 900 tons of rails and other material for the extension of its line up the Napa Valley, and it is intended to commence work at once. With the material which has just been received it will be possible to complete the extension of the road as far as Oakville, and it is expected that by the time this section of some 14 miles is finished shipments will have been received here in sufficient numbers to permit of the work on the line to St. Helena being taken up.

*DENVER, COL.—Incorporation papers for the new electric railway to connect Denver and Greeley, which will be called the "Denver & Greeley Railroad," were taken out a few days ago. Among the Greeley men interested are Mayor Frank J. Green, John C. Mosher, who is president; E. J. Decker, first vice-president; George M. Huston, second vice-president; H. H. Hake. The Denver promoters are J. D. Houseman, general manager; J. F. Church, John S. Flower, Max Strauss, James Williams. R. S. Sumner, the locating engineer retained, will start work immediately on the surveys. The company was incorporated for $50,000, but over $1,000,000 will be expended on the line when it is completed. The towns in Northern Colorado in addition to Greeley through which the road will run are Longmont, Loveland, Johnstown, Hillsborough, Fort Collins, Windsor, Severance and Eaton. Eventually it will extend into Denver.

*GRAND JUNCTION, COL.—Interurban electric connection between Grand Junction, Palisades, Fruita and all other towns of importance in the Grand Valley is one of the possibilities in the formation of the Electric & Hydraulic Company, incorporation papers for which were recorded here recently. The capital stock is $100,000, and the incorporators are chiefly capitalists of Colorado Springs. They include John Hays Hammond, John S. Bartlett, Irving W. Bonbright, Henry Hine, Leonard E. Curtis and others. The incorporation papers state that the company intends first promoting power and electric railway schemes in Colorado, and in Mexico.

†BRIDGEPORT, CONN.—The Naugatuck Valley Electric Railway Company, which has been building an electric line south from Naugatuck through Beacon Falls to Seymour, is practically completed. Special cars have been run over the line and the road is to be opened for public traffic by July 1.

oHARTFORD, CONN.—The chairman of the railroad committee, Senator Thompson, reported favorably on a resolution incorporating the Norwich, Colchester & Hartford Traction Company. The resolution authorizes the company to lay tracks in the towns of Norwich, Bozrah, Lebanon, Colchester, Marlborough, Glastonbury and East Hartford. The tracks are to begin at the tracks of the Consolidated Railway Company on West Main Street in the city of Norwich and continue through the towns named to connect with the track of the Consolidated Railway Company at the village of Silver Lane, in the town of East Hartford. The company is authorized to take land or other real property that may be necessary for the construction or operation of the railway in the manner provided by law. The capital stock is $100,000, with the right to increase to $1,000,000.

oCOEUR D'ALENE, IDAHO.—Charles Sweeny, president of the Exchange National Bank, and the Federal Mining & Smelting Company, of which he is the head, are reported to be financing the projected electric railway between Wallace and Coeur d'Alene, Idaho. The line is to extend through Fourth of July canyon, in which a survey was made by the Federal Mining & Smelting Company some time ago, but it was not satisfactory, and H. F. Robertson, formerly locating engineer for the Inland Empire system, has been employed to secure a more satisfactory route. It is believed the purpose of the company in building the railroad is to establish a smelter near Spokane, in which event the line will be extended to that city.

oCOEUR D'ALENE, IDAHO.—The Spokan Wallace & Interstate Electric Railway Company, which proposes to connect Coeur d'Alene with Wallace, has filed a plat of definite location. A tunnel 4000 ft. long will have to be constructed. The road will be 51 miles long. Grading will begin Aug. 1.

*CHICAGO, ILL.—The Paris & Northern Traction Company, with the principal office at Paris, has been incorporated with a capital of $5,000 to construct a railway from Paris, Edgar County, Ill., through the counties of Edgar and Vermilion to Ridge Farm and Brocton, in Vermilion County, Illinois. The incorporators and first board of directors are: F. L. Kidder, L. L. Caninne, John J. Cummings and J. E. Parrish, of Paris, Ill., and George E. Fair, of Chrisman, Ill.