DRIVING SYSTEMS OF ELECTRIC LOCOMOTIVES*

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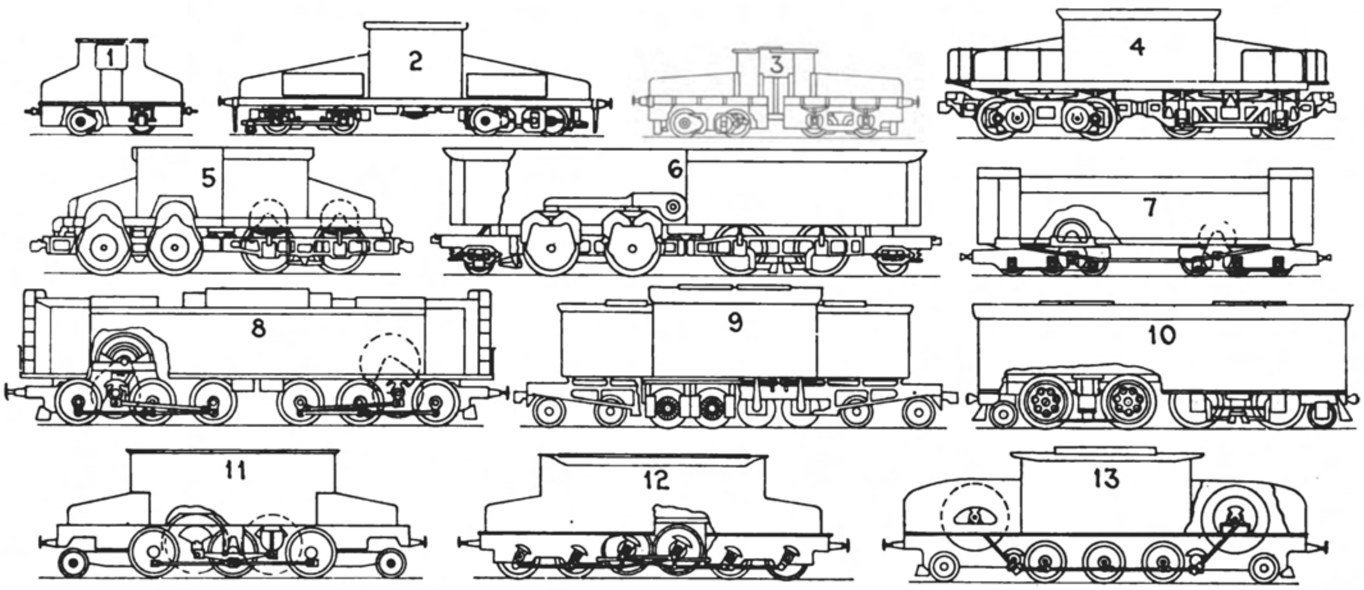
I propose to give a few details of the drive of various electric locomotives actually in service or in course of construction. The list does not pretend to be exhaustive, but it is intended to give an example of each different class of locomotive.

Fig. 1—Simple type of two-axle locomotive with central cab and sloping ends. The motors are supported with the tramway type of suspension and are geared to the driving axles.

Fig. 2—Simple locomotive. The body is built on a frame of steel channels, etc., and usually consists of a central cab between sloping ends. The body rests on a pair of four-wheel trucks, each equipped with two motors geared and suspended as on street cars. The illustration shows the freight locomotive supplied to the North-Eastern Railway by the British Thomson-Houston Company. This class can radiate. The locomotive body, which in this way is not required to transmit any draw or buffing stresses, is carried by the trucks in the ordinary way and provides accommodation for the driving equipment, the control gear and the brake apparatus. The drawing shows the Detroit River tunnel locomotives of the Michigan Central Railroad. Similar locomotives are in use in the Baltimore & Ohio Railroad tunnel, Baltimore. To insure easy riding the spring suspension system is specially designed with a view to flexibility. The bearing springs on one truck are equalized longitudinally; on the other truck the bearing springs of one axle are suspended from fixed points, those of the other axle being equalized transversely.

Fig. 5—Locomotive with raised motors. The general arrangement of a locomotive of this class is shown in the drawing of the New York, New Haven & Hartford Railroad. The motors are geared to the driving axles, but instead of being in the usual position they are vertically above the axle. To allow the ordinary vertical movement of the axle boxes without any corresponding movement of



Figs. 1 to 13—Locomotive Drives—Diagrams of Arrangements

also be constructed with a sunk cab, provided there is sufficient space between the trucks.

Fig. 3—Articulated four-axle locomotive. Under certain circumstances the foregoing locomotive may fail when used for hauling trains round very sharp curves. Under such circumstances it is very probable that the buffers of the locomotive will get locked with those of the wagons. To overcome this difficulty there are two possibilities: first, to put the buffers and drawgear on the trucks; second, to construct the locomotive in halves articulated together with links, each half having two fixed axles with motors geared to them in the usual way. The latter alternative, at all events for moderate-sized locomotives, leads to a cheaper and simpler construction, but where powerful engines running at fairly high speeds are required the former alternative is probably to be preferred. The locomotive shown is one of those supplied to the Harton Coal Company by the Siemens Brothers Dynamo Works.

Fig. 4—Articulated locomotive. The difficulty of constructing a double-truck locomotive capable of exerting a tractive effort equal to the strength of standard drawbars, in such a way that the truck centers are not subjected to excessive stresses, can be met by articulating the two trucks at their inner ends and fitting buffers and draft gear on the outer ends. One truck center is fixed and the other is free to move within small limits so as to allow the trucks to

*Abstract of paper on "Electric Locomotives" published in the *Journal of the Institution of Electrical Engineers*, London, October, 1913.

the motors the wheels are driven by spring couplings attached to spiders carried by hollow shafts surrounding the axles. The gear wheels which mesh with the pinions on the armature shafts are mounted on these hollow shafts.

Fig. 6—Locomotive with twin geared motors. The drawing shows the articulated locomotives of the New York, New Haven & Hartford Railroad. This is a modification of the type shown in Fig. 5, each single motor being replaced by a pair of smaller motors gearing on to the same gear wheel on the hollow shaft. As the maximum speed is fairly high, each truck is fitted at its outer end with a pony axle.

Fig. 7—Locomotive with geared motors and connecting rods. The drawing shows the locomotive on the St. Pölten Mariazell Railway, Austria. The body is carried on two three-axle unsymmetrical trucks, each equipped with a single motor geared to a countershaft. The countershaft which carries the gear wheel is slightly above the driving axles and is connected with them by cranks and slotted connecting rods. The brasses of the crank pins on the countershaft cranks fit in the slots in the connecting rods, so that the driving axle boxes are free to move up and down without transmitting their vertical movement to the countershaft. The motor is mounted on the top of the truck frame and is situated between the center and the inner end of the truck, the truck pivot being displaced from the geometric center toward the outer end. The locomotive was designed for a narrow gage, the special advantage of the construc-

tion being that the motor is not limited in width by the space between the wheel flanges.

Fig. 8—Bogie locomotive with geared motors and connecting rods. The drawing shows the locomotive supplied by the Oerlikon Company for the Lötschberg Railway. This is very similar to Fig. 7, the principal difference in the mechanical arrangement being the substitution of the slightly inclined connecting rod between the countershaft and the inner driving axle of each bogie for the slotted connecting rod already described.

Fig. 9—Gearless locomotive with armatures built on the driving axles. The principal example of this construction is the d.c. locomotive of the New York Central & Hudson River Railroad. The special feature of this design is the construction of the motor as a two-pole motor, the armature being built direct on the driving axle and revolving between two vertical pole pieces. The pole tips are chamfered off just sufficiently to allow the axle with the armature and the wheels to be removed without in any way interfering with the field magnets. The field-magnet system of the four motors forms part of the frame of the locomotive. The locomotive has a leading and a trailing four-wheel truck to permit high-speed service.

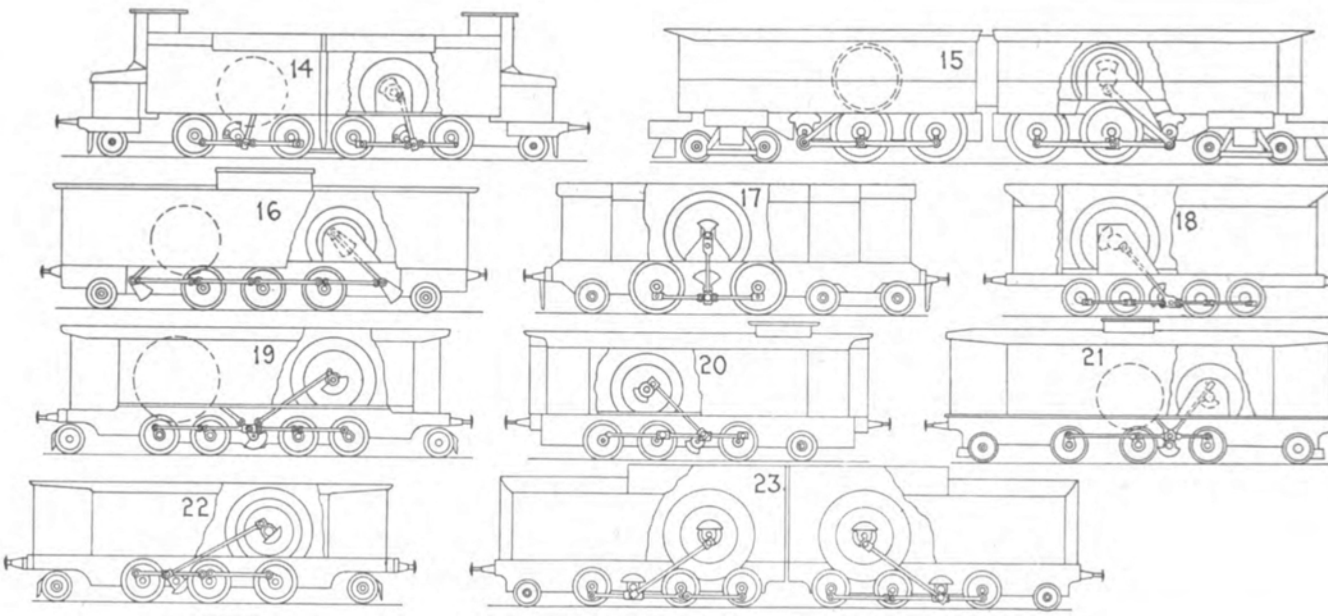
Fig. 10—Gearless locomotive with motors built on hollow axles concentric with the driving axles. The drawing shows a New York, New Haven & Hartford single-phase d.c. locomotive of this class. The hollow axle, or quill, on which the motor is built is bored with sufficient internal clearance to permit the usual vertical movement of the axle boxes in their guides without actual contact between the quill and the axle. The quill carries at each end a spider which forms a flexible coupling with the driving wheel. The locomotive is arranged as a double-truck machine, each truck having two driving axles and a single-axle sub-truck at its outer end.

Fig. 11—Class 1-C-1 locomotive with two motors coupled to three driving axles by one pair of slotted connecting rods and two pairs of ordinary connecting rods. This design has been worked out on the Continent, by Kando, and is used on several railways, including the Valtellina Railway in Italy and the Simplon tunnel line connecting Switzerland and Italy. A similar arrangement is used on the Giovi Railway locomotives, except that all five axles are coupled together. The drawing shows the Valtellina locomotives.

Fig. 12—Class 0-D-0 locomotive with two motors driving four axles by ordinary connecting rods. The principal feature of this design is the arrangement of the leading and trailing driving axles that are allowed to radiate and yet are coupled up with the other driving axles by standard connecting rods.

This is effected by mounting the outer pairs of wheels on hollow shafts surrounding the actual driving axles. The latter run in fixed bearings and are coupled up by cranks and connecting rods to the other driving axles. The hollow shafts are fitted at their centers with flexible half-couplings engaging with similar half-couplings on the fixed axles passing through them, so that the wheels are driven by the fixed axles but are at the same time free to radiate. The drawing shows the Brown-Boveri locomotives for the Simplon tunnel.

Fig. 13—Class 1-C-1 locomotive with two jackshafts, and two motors mounted in the ends of the body. The drawing shows the locomotive of this class built by the Maffei Company, Munich, and equipped by the Siemens-Schuckert Company for the Wiesental line of the Baden State Railways. Ten locomotives were ordered, but the one shown was built first in order that the design might be thoroughly tested before the others were put in hand. The tests were carried out on the electrified line between Dessau and Bitterfeld with very good results. The remaining nine locomotives are now being built to a slightly modified design, shown in Fig. 21.



Figs. 14 to 23—Locomotive Drives—Diagrams of Arrangements

Fig. 14—Class 1-C-1 locomotive with two jackshafts and two motors mounted near the center of the locomotive body. The drawing shows the locomotive supplied by the Allgemeine Elektricitäts Gesellschaft to the Chemin de fer du Midi in France. This experimental locomotive is one of six ordered in 1909 from six different electrical firms and set to work in 1912.

Fig. 15—Class 1-B + B-1 articulated locomotive with one motor and one jackshaft in each half. The motor is mounted in the body, nearly but not quite vertically above the jackshaft, the latter being coupled to the motor shaft and the driving axles by cranks and connecting rods in the ordinary way. The drawing shows the locomotive ordered from the Allgemeine Elektricitäts Gesellschaft for the Lötschberg Railway.

Fig. 16—Class 2-B + B-2 articulated locomotive with one motor and one jackshaft in each half. In this case the jackshaft is not immediately below the motor, but is between the driving axles and the leading bogie and is connected to the motor shaft by connecting rods inclined at about 45 deg. to the vertical. The drawing shows the ar-

rangement of the Pennsylvania Railroad locomotives as supplied by the Westinghouse company.

Fig. 17—Class 2-B-1 locomotive with a single motor and a single jackshaft vertically below the center of the motor. Three locomotives of this class have been supplied for the Dessau-Bitterfeld line of the Prussian-Hessian State Railways. The three locomotives are similar in many respects, the motor capacity of the different locomotives being as follows; Siemens, 1100 hp; A. E. G., 1200 hp; Bergmann, 1500 hp. The drawing shows the arrangement of the Siemens locomotive.

Fig. 18—Class 0-D-0 locomotive with single motor and single jackshaft. Five locomotives of this class have been supplied for freight service on the Dessau-Bitterfeld line. Three of these have single motors of 600-hp capacity, the remaining two having motors of 800 hp.

Fig. 19—Class 1-D-1 locomotives with two motors and a single jackshaft. Two locomotives of this class have been constructed for the Lauban-Königszelt line, Prussian-Hessian State Railways, one by the Siemens-Schuckert Company and the other by the Allgemeine Elektricitäts Gesellschaft. The two motors are mounted in the body of the locomotive symmetrically about the center line, and their shafts are coupled by cranks and connecting rods approximately at right angles to the single jackshaft, which occupies a central position midway between the two pairs of driving axles. The drawing shows the Siemens-Schuckert locomotive. The Allgemeine locomotive is similar but has two 900-hp motors and driving wheels of 1500 mm (59 in.) diameter.

Fig. 20—Class 1-C-0 locomotive with one motor and a single jackshaft. Nine locomotives of this class have been built by the Allgemeine Elektricitäts Gesellschaft for the Mittenwaldbahn, Austria, and eight are under construction by the same firm for the Vienna-Pressburg line. The locomotive has three driving axles with a single jackshaft about the center of the locomotive coupled to the motor, which is mounted in the body of the locomotive above the middle driving axle.

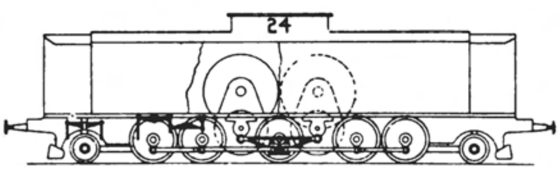


Fig. 24—Locomotive Drives—Lötschberg Railway Standard

Fig. 21—Class 1-C-1 locomotive with two motors unsymmetrically placed in the body connected to a single jackshaft midway between them. Nine locomotives of this class are under construction by the Siemens-Schuckert Company for the Wiesental line, Baden State Railways, in Germany.

Fig. 22—Class 1-C-1 locomotive with a single motor and a single jackshaft. A number of these locomotives are under construction for the Prussian-Hessian State Railways. Three are equipped with a 1000-hp motor in each, one with a motor of 1250 hp and one with an 1800-hp motor. The last mentioned, which is a Siemens locomotive, is shown in the drawing.

Fig. 23—Class 1-C + C-1 articulated locomotive with one motor and one jackshaft in each half. Thirteen locomotives of this class intended for heavy freight service on the Kiruna-Riksgraensen Railway are under construction by the Siemens-Schuckert company.

[Fig. 24—Class 1-E-1. This drawing was not a part of Mr. Lydall's paper, but is added to show the latest Oerlikon locomotive which has been made standard on the Lötschberg Railway. It is of the geared jackshaft type with a drive composed of a double helical gear, two jackshafts, a joint triangular yoke and crank connections to five pairs of driving wheels.—EDS.]

CHICAGO, MILWAUKEE & PUGET SOUND ELECTRIFICATION

The management of the Chicago, Milwaukee & Puget Sound Railroad has definitely decided to electrify the Deer Lodge-Three Forks section of its Rocky Mountain division, using 2400-volt d.c. propulsion current. This division contains 113 miles of main line, or the equivalent of 168 miles of single track including sidings and yard tracks. Overhead trolley, suspended from mast arms on wooden poles, will be used on tangent track and span-wire construction on wooden poles over curves. This type of construction will be changed to steel poles and overhead bridge trolley construction in yards containing four tracks or more. It also has been definitely decided that the transmission voltage will be 100,000 volts a.c., feeding five substations ranging in capacity from 3000 kw to 4500 kw, depending on their relative location to heavy grades. Essentially, the entire electrification, including the rolling stock, will conform to that installed by the Butte, Anaconda & Pacific Railroad. C. A. Goodnow, assistant to the president Chicago, Milwaukee & St. Paul Railway, authorizes the statement that no contract for the equipment has been let.

BROOKLYN RAPID TRANSIT INSURES ABROAD

The Brooklyn (N. Y.) Rapid Transit Company has transferred all its fire insurance—$22,000,000—on which the premiums have been about $100,000 a year, from the companies represented by the New York Fire Insurance Exchange to Lloyds, of London, thereby saving about $27,000 a year. President Timothy S. Williams of the transit company says that this was done because the higher rates recently prescribed were discriminatory and unjust.

President Williams makes the following statement: "Our insurance was placed last year through the companies represented in the New York Insurance Exchange at an average rate of about 34.7. This insurance expired Nov. 15 last. Early in September we were suddenly notified that the Fire Insurance Exchange had increased the average rate from 34.7 to 62.3. This came as a great surprise to us, for in ten years we had paid the insurance companies over $1,000,000 in premiums and had called upon them to pay in losses only about $27,000.

"Feeling that, in view of our experience and the condition of our risks, the new rate promulgated by the New York Fire Insurance Exchange was discriminatory and unjust, we sought for several weeks to procure a reduction, and were able, if certain changes were made, to get the average rate reduced to about 43.8. This decision did not come until about nearly a month after the policies taken out last year had expired, and in the meanwhile our agents took the usual form of binder subject to the fixing of a satisfactory rate. The rate finally fixed at 43.8 was not satisfactory, and we therefore placed the entire schedule of $22,000,000 in London Lloyds, saving $27,000 in premiums. We regretted the necessity of going outside our own country for insurance, but there was no other proper course."

President Williams also disclosed the fact that the Brooklyn company for several years past had been gradually setting aside an insurance fund of its own and that it eventually hoped to carry its own insurance. The accumulations in the fund now amount to over $600,000.

Willis O. Robb, manager of the Insurance Exchange, in defending the higher rates, says that there would have been no raise in rates if the Brooklyn Rapid Transit Company had not failed to make improvements which were promised. Although the transit company has not replied to this statement, it is believed that the basic charge is that the rate reduction received, even if the improvements referred to had been made, would have amounted to but a fraction of 1 per cent. The ease with which the low rate was obtained abroad speaks well for the character of the risk.