of the car and supplies current to the other, which works as a motor, tending to turn the wheels in the direction opposite to that in which the car is moving. The production of current by the one motor and the reverse effort of the other give a powerful braking effect. The proper connexions are made by constructing the controllers with contacts additional to those required for motor control, which connect the machines in the desired manner when the controller handle is moved round past the “ off ’’ position.

Automatic brakes are always preferable to hand-brakes even though they cost much more, because the energy required to propel an ordinary tramcar is from 10 to 25 % more with hand than with automatic brakes. The cause is the constant pressure of the brake shoes of a hand brake against the wheel rims, the shoes being so held by the operator to avoid having too long a hand movement in applying the brake. The maximum pressure possible for any brake should be about 90 % of the weight of the car on the braked wheels. Less than this amount will give an inefficient brake; more will produce sliding or “ skidding” of the wheels, producing “ flats” on them, and also causing loss of retarding effect.

Of the numerous accessories necessary in the operation of electric railways one of the most important is the trolley. For an overhead system this consists in general of a metallic rod or tube mounted upon the top of the car and pressed upward against the trolley wire by springs. At the upper end of this trolley pole is generally placed a bronze wheel which runs along the under surface of the wire. Ou the continent of Europe considerable use has been made of bow-trolleys, which consist of light metallic bow-shaped structures, sustained in place by springs and running along on the under side of the wire against which they rub. The designs patented for trolleys are almost innumerable. Besides the trolleys, cars are ordinarily equipped with switches which are used to break the trolley circuit, with fuses or automatic circuit-breakers, with electric lamps, with lightning arresters, and with the necessary car wiring. The fuses or automatic circuit- breakers guard against an excess of current being passed through the motors, and when they are fitted the ordinary platform switch can be dispensed with. These automatic breakers can be set for any desired current.

The question of the generation and the distribution of the current belongs to this article only in so far as electric traction has introduced peculiarities in the type of apparatus or the methods of its use. In a continuous current station the current is generated at an approximately constant potential, varying from 500 volts to 700 volts on different systems. As the load is apt to fluctuate, except in large stations, within wide limits, the machinery must be designed to stand the most severe usage. The engines are more massive than would be necessary for constant loads, and the dynamos must be built to stand sudden overloads without destructive sparking; usually, indeed, they are considerably over-compounded, not so much for the sake of raising the voltage as to strengthen the field and prevent sparking on overload. When a number of machines are to be run in parallel—as is usually the case—they are provided with “ equalizing ’’ switches, which serve to throw the series fields in parallel. As a result, if one of the machines tends to increase its armature current beyond the proper amount, the current in the series fields does not increase with it, but retains its normal proportion. The armature reaction and resistance fall of potential, in this machine, would both tend to increase, thereby decreasing its armature potential, and therefore its current would return to its proper value. From the dynamos the current from each machine goes through an ammeter and automatic circuit-breaker to the main “omnibus’ bars, then through the station ammeter to the feeder “ omnibus ” bars, then through ammeters and circuit-breakers to the feed-cables. As a rule, watt-meters are provided to measure the output of the station, and, if an overhead system is being supplied, lightning arresters are installed. Where continuous currents are used to operate cars at considerable distances from the generating stations, "boosters ” are used. These are series-wound dynamos driven at a constant speed, through which is passed the current that is to feed the distant section of the line. Usually the characteristic of the booster is so calculated that the amount by which it raises the voltage for a given current just equals the fall of potential in the feeding-line for the same current. The result is that the potential at the end of the line will be the same as that at the station. The question of economy, as between putting in additional copper and wasting energy in the booster, is easily calculated; the advantage is more and more on the side of the latter as the distance increases and the car service becomes more infrequent.’ It is necessary to the satisfactory operation of a system that the variations of voltage should not be too great, so boosters sometimes become a practical necessity, irrespective of the question of economy.

Accumulators are frequently installed in power stations to prevent the heavy load fluctuations which arise from starting and stopping of cars and ascending or descending grades. The generators give an approximately unvarying amount of current. When the load demand is less than that delivered by the generators, the excess current goes into the storage battery, and when the load is greater than the power from the generators the additional current required comes from the battery. The generators, engines and boilers may thus be proportioned for the average instead of the maximum load requirements, and the sizes of these units are thereby reduced.

As traction systems have been combined and extended, the area of operation of many of the companies has grown so that a number of direct-current stations are used for a single system. The limit of distance to which electric energy can be economically supplied at the comparatively low voltages employed is not great, and the advantage of having one or two large stations to supply a system, in place of a number of smaller ones, is evident. This fact has led to the use of high-potential alternating currents for the distribution of energy, the voltage being reduced at the points of consumption, and in most cases changed to a continuous current by rotary converters. If alternating currents are used for the car motors, the economical distribution of energy is greatly simplified, the rotary converters being eliminated and their first cost and losses ana expense of operation saved. The expense of operating sub-stations containing rotary converters is necessarily large, and the capital outlay required for them is often greater than for the generating station.

As a rule, the cars used for electric traction have varied, but slightly from the type of tramway car prevalent in different localities. The tendency, however, has been to increase their size. For electric railway work, as distinguished from tram- way work, the cars generally follow the pattern that is standard on American steam lines. The trucks used for electric cars are made of steel, with heavy axles and suspension bars for carrying the electric motors. For smaller vehicles, a single four-wheel truck is used, the wheel base being limited by the curvature of the track, but not as a rule exceeding 7½ ft. For the longer and heavier cars, two four- wheeled bogie trucks are employed. If two motors are used on a double-truck car, and if the grades on the road are very heavy, the trucks are made on the “ maximum traction ” pattern, in which one pair of wheels in each truck is of smaller diameter than the other and the greater part of the weight of the car is on the larger motor- driven wheels. For very large high-speed cars, trucks are used of practically the same type and weight as are employed on steam railways. (See also Tramway.) **(L.** Du.)

**TRACY, ANTOINE LOUIS CLAUDE DESTUTT,** Comte de (1754-1836), French philosopher, son of a distinguished soldier, was born in Bourbonnais on the 20th of July 1754. He belonged to a noble family of Scotch descent, tracing its origin to Walter Stutt, who in 1420 accompanied the earls of Buchan and Douglas to the court of France, and whose family afterwards rose to be counts of Tracy. He was educated at home and at the univer­sity of Strassburg, where he was chiefly noted for his athletic skill. He went into the army, and when the Revolution broke took an active part in the provincial assembly of Bourbonnais. He was elected a deputy of the nobility to the states-general, where he sat alongside of his friend La Fayette. In the spring of 1792 he received the rank of *maréchal de camp* in command of the cavalry in the army of the north; but the influence of the extremists becoming predominant he took indefinite leave of absence, and settled at Auteuil, where, with Condorcet and Cabanis, he devoted himself to scientific studies. Under the Reign of Terror he was arrested and imprisoned for nearly **a** year, during which he studied Condillac and Locke, and aban­doned the natural sciences for philosophy. On the motion of Cabanis he was named associate of the Institute in the class of the moral and political sciences. He soon began to attract attention by the *mémoires* which he read before his colleagues— papers which formed the first draft of his comprehensive work on ideology. The society of “ ideologists ” at Auteuil embraced, besides Cabanis and Tracy, Constantin François de Chassebæuf, Comte de Volney and Dominique Joseph Garat (1749-1833), professor in the National Institute. Under the empire he was a member of the senate, but took little part in its deliberations. Under the Restoration he became a peer of France, but protested against the reactionary spirit of the government, and remained in opposition. In 1808 he was elected a member of the French Academy in place of Cabanis, and in 1832 he was also named a member of the Academy of Moral Sciences on its reorganization. He appeared, however, only once at its conferences, owing to his age and to disappointment at the comparative failure of his work. He died at Paris on the 9th of March 1836.

Destutt de Tracy was the last eminent representative of the sensualistic school which Condillac (*q.v*.) founded in France upon a one-sided interpretation of Locke. He pushed the sensualistic