sion circuit breaker in main circuit, fuse in auxiliary high tension and low tension circuits, contractors and control gear. The motors are ordinary series compensated without any special commutating device other than the commutator resistance leads. It is said that the commutating performance of these motors on the line is as good as, if not better than, most heavy direct current traction motors, while the commutator remains in quite as good running order as that of any such motor. The same good qualities are claimed for the Siemens motors as the result of trials. Similarly with the Siemens equipment, the most satisfactory results have been obtained on test, the temperature rise at the end of one hour's full load of 150 horse-power with single-phase current being well within the limit, whilst overloads up to 1,200 amperes, corresponding to 195 horse-power at full voltage and 2¼ times normal full load torque were applied without causing injurious sparking.

With regard to the forced ventilation for the motors on both types of car, it may be mentioned that on the Siemens equipment a suction duct has been carried inside the car under one of the seats. The Westinghouse car has a similar duct, but as their motors require more air there has also been fitted in this case a suction duct with a filter taking air from the outside. In both cases this duct comes direct into the suction eye of the fan, and the delivery duct after leaving the fan splits into two pipes, one of which crosses to the other side of the coach and comes up under the longitudinal seat on that side, thus getting across the cross member of the underframe, and coming down again above the motor, to which the air then proceeds through a rubber concertina pipe. The other half of the duct proceeds direct up under the longitudinal seat on its own side, coming down in a similar way to the other motor. It may be pointed out that on the Westinghouse car there is no interlocking of the high tension chamber with the bow, the high tension circuit breaker and fuse being put in locked cases, and the train staff are not permitted access to these chambers at all.

With regard to the performance of the trains on the road, in a test with a two car train weighing approximately 58 tons, made incidentally in the course of ordinary running, one of the Siemens cars attained speeds of 30 miles per hour in 41 seconds and 48 miles per hour in 80 seconds and a free running speed of 60 miles per hour in 160 seconds, starting, and running for 440 yards, on an up-grade of 1 in 200, there being, however, thereafter about 100 yards of level and then a down grade of 1 in 500 for 1½ miles; this portion of the line is also very considerably curved with curves of 30 and 40 chains.

The power supply for the line is furnished from an existing gas driven generating station at Heysham, used in connection with the lighting and power requirements of the railway company at its large depot there. Mond gas producers are used, and the equipment of the station hitherto has been three 250 horse-power three-cylinder Westinghouse gas engines driving 150 kw. direct current 460 volt generators. In connection with the traction scheme, however, an additional 350 horse-power Westinghouse gas engine driving a 235 kw. generator of the same make has been installed, in conjunction with two motor generators. From the nature of the traffic the demand on the station will be of a very "peaky" character. During these "peaks" the whole possible output of the machinery at work in the station must be utilized, and the intention is for the engines, whatever the actual load they may be working on previous to heavy loads coming on, to work up to their full overload capacity, which is about 20 to 25 per cent. in the case of the old, and 10 to 15 per cent. in the case of the new sets, before the battery is called upon to discharge heavily. The latter will, however, be called on to work up to its full one-hour rate of 750 to 1,000 amperes. The old battery booster not being large enough for these discharges, a new one has been installed, built by the Lancashore Dynamo and Motor Company, whose machine is particularly suited for this method of working. A difficulty was, however, found in that the generators were working on a very falling portion of their characteristics and their pressure dropped badly as their loads increased, this having been compensated for by hand regulation of their excitation, or else during "peaks" they continued to work at their previous loads, and the battery supplied the excess, both courses being inadmissible under the new conditions. Compound winding in the usual way was an extremely expensive remedy since, as the copper necessary for full excitation was already on the fields, new series coils would be excessively large and heavy, added to which was the trouble of entirely dismantling the machines. A very simple solution was found in fitting exciters, each mounted on the engine bed-plate, and compound windings being fitted on these exciters and varying their voltage and consequently that on the main generator fields, so that the existing copper on the latter was fully utilized. This not only proved a very much cheaper arrangement, the exciters being only of 3 kw. capacity and of fairly high speeds, but enabled the whole change to be made in the course of a week, obviating any dismantling or any serious stoppage of the generating sets.

The new booster, with a comparatively low continuous rating, satisfactorily commutates the "peak" discharges up to 750 to 2,000 amperes; and it can be set to make the engines work up to their overloads as above, or to work under practically any other conditions, without any serious drop on the busbar voltage.

The new generating set is of the Westinghouse latest type of gas engine, having three cranks with three sets of cylinders, two in tandem in each case. Its speed is 300 rpm. and its lubrication forced.

The specification for the motor generators called for the machines to be each capable of a continuous output of 150 to 200 kw., with a temperature rise of 80 degrees Fahr., but they were also called upon to be capable of safely carrying output overloads of 900 kw. instantaneous, 600 kw. for half a minute, 500 kw. for three-quarters minute and 300 kw. for 2½ minutes, and were required to be also tested under a regular cycle of these overloads, with underloads in between, for 8 hours. The internal driving losses were also required to be kept down, while on the alternating current side they were required to regulate within 6 per cent. on throwing off a non-inductive load equal to the full continuous load, and within 20 per cent. on throwing off a similar, but inductive load of 0.8 power factor. Further, they were required, with the assistance of external means, if necessary, to restore the pressure to normal within seven seconds of the coming on or throwing off of loads up to 600 kw. at 0.8 power factor, or 300 kw. at power factors down to 0.3. Widely varying proposals were received in connection with these machines, those of the Electric Construction Company being finally selected, their machines being very compact and requiring a small amount of driving current as well as having a high efficiency.

The makers specification was 175 kw. on continuous rating, the machines on test being well within the specified temperature rise, but not excessively so. During the running of the trains at Heysham experimentally each of the sets were several times subjected to loads up to 900 kw. input without commutator troubles of any kind whatever, whilst smaller overloads have been very frequent and have been carried with just as satisfactory result. The alternating current regulation is such that after the switching on or throwing off of a heavy load the voltage is restored to its normal of 6,600 volts within three seconds, while the voltage even then only varies about 300 volts each way. The direct current motor is compound wound with commutating poles, the series winding being a vary slight one, and put in principally to assist the two sets to run in parallel satisfactorily.

The alternator has a three-phase star winding, so that if one winding breaks down the other two may be used for the single-phase supply, otherwise no use is made of the three-phase connections. The machine is of the standard internal revolving field type, and is excited from an exciter which is carried on the end of the bed-plate and spur geared up to about 1,100 revolutions. This exciter has laminated fields and is compound wound, its series winding carrying a portion of the main motor current, so that (so far, at least, as varying loads of equal power factor are concerned) the tendency of the alternator to drop in volts is thus compensat-