ate systems of speed control for individual motors may be justified. If each operator has a constant incentive to keep the output of his machine up to its full rated capacity for a given grade of work—and it is possible to vary this output by changing the speed of the machine by easy steps through a wide range—then the results obtained by the most efficient operation of the tool at all times may make insignificant the question of the extra investment required to install the control system.

On the other hand, there are situations in which an easy method of controlling the speed may be a disadvantage. For a large printing establishment, it was found necessary to design a device to lock the speed controllers so that if the press was run at all it was operated at a given speed, which speed was determined by the foreman for each job. In this way, it was made impossible for the feeder to soldier on his work behind the bosses' back. This incident is intended to emphasize the idea that if full advantage is to be taken of refined methods of electrical control, the operators in charge should also be worked up to their highest efficiency.

The practice at the present seems to be to put all tools requiring 5 h.p. and over on the individual motor basis and group all the smaller tools. There is certainly a tendency toward equipping even smaller machines with separate motors, down perhaps to 3 h.p. and also a corresponding tendency to reduce the size of the shafting motors driving groups, with the idea of having, as far as possible, one standard size for shafting motors all through the plant.

BRANCH DISCUSSIONS.

DISCUSSION AT PITTSBURG, DEC. 4, 1902.

The meeting was called to order by P. M. Lincoln, who read extracts from the President's introductory remarks at the New York meeting, November 21, 1902.

The papers presented at the New York meeting were then abstracted as follows:

N. W. Storer abstracted his own paper, "The Three Wire System in Variable Speed Motor Work," and F. O. Blackwell's paper, "Motors for Machine Tools."

H. P. Maxim abstracted paper by H. B. Coho, "The Storage Battery as a Factor in Speed Control."

W. A. Dick abstracted paper by Geo. W. Fowler, "A Series-Parallel System of Speed Control."

E. M. Tingley abstracted paper by H. Ward Leonard, "Multiple-Unit Voltage Speed Control for Trunk Line Service."

R. W. Stovel abstracted paper by R. T. Lozier, "The Operation of Machine Shops by Individual Electric Motors."

G. H. Gibson then gave a resumé of the New York discussions upon the above papers.

The discussion as to the advisability of supplying tools with individual variable speed motors was participated in by Messrs. Stovel, Storer, Dusingberre, Dick, Lincoln, Campbell, Winslow Tingley, Stevenson and Barr. In this discussion the fact was brought out that where individual motors have been installed, the testimony is universally in favor of the system. The advantage of the individual motor system over the group system is not so much a question of efficiency as of greater convenience and increase of shop output. Numerous cases were cited of plants that had been equipped with individual motor-driven tools where the output had been very considerably increased and the quality of the work improved.

The discussion of Mr. Leonard's paper was participated in by Messrs. Storer, Tingley and Barr. It was generally admitted that the smoothness of speed control obtained by this system was ideal, and that a single trolley was the most feasible method for conducting current to the car. It was, however, pointed out that a single phase motor is difficult to start and time is required to synchronize. It may be started by means of a storage battery or by a split phase starting motor. A change in line voltage, the jumping of the trolley, etc., is almost sure to throw the motor out of synchronism. The motors on the different cars of a certain section are in synchronism and therefore rigidly connected together. Should one motor get out of step the remaining motors on the section would also get out of step. The single-phase motor is more subject to "pumping" than the polyphase motor and in general it is much more difficult to operate and is more liable to trouble. The apparatus on the locomotive is very expensive, notwithstanding that it may be driven at high speed. On account of the heavy starting current demanded from the generator with low field charge, it is necessary to make the generator with large overload capacity.

A number of claims are made in Mr. Leonard's paper as to the advantages of his system. It was pointed out that the reason for these different claims was not clear from the paper; and exceptions were taken to many of them as follows:

Second Claim: "A material reduction in the cost of maintenance of locomotives as compared with steam locomotives."

It was pointed out that the depreciation of the direct current generator operated at very high speed would be large on account of the fact that it must deliver heavy starting currents at low voltage, which would make good commutating conditions extremely difficult to obtain.

Sixth Claim: "A material reduction in the dead load necessarily hauled by a steam locomotive, represented by the part of the steam locomotive and tender not on drivers."

It was pointed out that the weight of the electrical equipment of the locomotive would be extremely heavy and at least 50 per cent. greater than would be necessary to give the necessary tractive weight on the driving wheels.

Seventh Claim: " * * * a very much higher rate of accel-

eration with the same maximum output from the power house, the same conductors, the same weight per train and the same watt-hours per ton mile, than is possible with the series-parallel or cascade systems."

Exception was taken to this claim on the ground that even if the claim is true on a trunk line railway, the gain of acceleration is of no material importance.

Ninth Claim: " Fifty per cent. of the energy now wasted on friction brakes can be saved in the form of useful electrical energy restored to the system."

Regarding this claim, it was thought that while it was possible that 50 per cent. of the energy expended in braking might be returned to the system under certain favorable conditions, it would ordinarily be very much less than 50 per cent., and for trunk line service the amount of power saved by this feature would be negligible.

Tenth Claim: " The first cost of equipment will be very much less than that of any system for equivalent service which involves the use of sub-stations."

The first cost of the equipment will depend upon the number of locomotives employed. If the number is large, the first cost will probably exceed that of a system involving sub-stations, as the cost of the locomotive equipment will be very high and the cost of motors will be higher than the cost of series motors for the same service.

In the discussion of Mr. Coho's paper, Mr. Maxim was asked for information regarding the operation of a series of storage cells when the load is drawn from only a portion of the cells in the series. Mr. Maxim stated that the cells from which the load is taken would be discharged more than the remaining cells, but that this difference was ordinarily not serious and when the batteries were again charged, the cells from which the load had not been taken would be slightly overcharged.