It is the function of the balancer to maintain these voltages constant and to accommodate the unbalance of currents between the four wires of the distribution circuit.

As the conditions of machine tool operation will result in the various motors of the system being nearly equally distributed on the circuits, the unbalanced current will be but a small percentage of the total current taken by all the motors. The intermediate wires of the system are extended to the variable speed motors only, the constant speed and crane motors and the lighting being supplied in the usual manner from the outside wires at the generator voltage.

Those motors requiring variable speed are connected to the four-wire circuit by means of a controller of the drum type adapted for mounting on the tool in a place convenient to the operator. The action of this controller is such that as the drum revolves the armature terminals of the motor are connected to the six circuits—afforded by this system—in the proper sequence, and the travel of the drum from one position to the next is so quickened by the action of a spring that contacts are made and broken at a high rate of speed, preventing the formation of arcs and eliminating the possibility of the drum stopping between contacts. This gives six fundamental motor speeds which are subject to a further refinement by varying the motor's field strength sufficiently to cover the gaps between them.

The speed range obtained on the voltage points alone is 6 : 1, being proportional to the ratio of maximum to minimum voltages. The addition of field resistance points above the highest voltage points extends the total range of the controller to a value of 10 : 1. For exceptional cases the range may be increased to a maximum of 12 : 1, the proper range in any case being determined by the character of the machine and the work which it performs.

The Crocker-Wheeler system as outlined, has certain positive advantages of which the most important are the following :

1. Variable speed, under instant control, over any range.
2. Every speed constant regardless of the load.
3. Controllers simple and convenient of attachment.
4. The horse-power of the motor but slightly in excess of that required by the tool.
5. Output of machine tools much greater than when they are belt driven.
6. Easy of adaptation to existing shops with a 2-wire system of electric power distribution.
7. Employment of standard motors.
8. Ability to maintain high cutting speeds due to superior facilities for manipulation.

Motors used in an ordinary shop equipment may be divided in classes A, B, C or D, according to the nature of their duty.

Class A is constant speed motors such as drive groups of small tools by shafting, this class being kept as small as possible consistent with best judgment based on careful study of all of the advantages which should be credited to the individual drive idea in comparison with the one disadvantage which may or may not exist, that of a possible slight increase in first cost. This may be lost sight of entirely in the face of the advantages which are to be obtained through flexibility of location and ease of manipulation.

Class B, controllable speed motors, generally of the series wound type, as used on cranes.

The duties which the motors in both of these classes have to perform is such that their demand for current is intermittent and often excessive, consequently they are best suited for connection to the outside mains and such speed regulation as they may require can be obtained by rheostatic control.

The other two classes, C and D, are controllable speed motors for the drive of individual tools where the speed should be maintained constant at any one of a number of fixed values.

Class C covers motors driving pressure blowers, punch presses, planers, etc., which demand approximately constant torque at all speeds, the horse-power diminishing with the speed. This characteristic of the tool being identical with the power characteristic of the motor on this system, the normal horse-power of the motor need not be greater than the maximum demanded by the tool.

Class D covers those motors operating lathes, boring mills, etc., where the torque increases as the speed diminishes. If the range required by these tools is to be obtained by using a motor through its maximum range, the motor would be very large and unnecessarily expensive. For this class a speed range of approximately 3 : 1 has been selected as a basis for the determination of the most suitable sizes of motors with respect to the duty which they have to perform. A motor, therefore, to give a constant horse-power throughout this range, must have a normal rating of about twice the horse-power required by the tool. This range, however, may be extended to cover the entire range required by the tool by using one or more additional gear runs. The method is an advantageous compromise between the use of an excessively large motor with no gears and a constant speed motor with many gears.

The extreme facility of manipulation which this system affords enables the machinist to push his tool to the highest limit of cutting speed, thereby giving large increases in output. Results show that as much as 20 per cent. increase in output over a belt-driven tool may be obtained by this system of motor drive. As by actual test in commercial plants it has been shown that 2½ per cent. increase is sufficient to warrant the outlay necessary for individual drive, the possibility of large saving in operating expense through the adoption of this system is at once apparent.

PUTNAM A. BATES.

The Bain Wagon Co., Woodstock, Ont., have increased their capital from $250,000 to $500,000.

THE HEATING QUESTION.

At the sixteenth annual convention of the Ontario Association of Architects, held in Toronto, January 12, Professor R. C. Carpenter, of Cornell University, delivered an address on "Heating" in which he said that local conditions affected their problems. On the continent of Europe 60 degrees of heat is considered sufficient for a house. In America 70 degrees is required. A lack of moisture in the air results, which affects furniture. Sixteen per cent. of moisture is required for the saturation of air. Most of us live in houses whose air is dryer than the air of the driest resort. This draws moisture from the body, and results in a much higher temperature being required for comfort. In a moist atmosphere a lower temperature feels comfortable. It costs money to provide proper ventilation. But if people could be persuaded that the cost of ventilation is less than the cost of a physician, pure air would be as commonly provided as heat now is. The fan system of heating is usually employed in the States, pure air being driven over heated surfaces, ventilation and heating thus being to some extent combined.

In many respects the hot water system is an ideal one for heating. Hot water systems require less coal than steam, and supply the steadiest temperature. A permanent ratio has been worked out in New York in the comparative value of steam and hot water, 100 square feet of steam surface being considered equal to 166 of hot water heating. Steam is open to the objection that the heat cannot be changed by varying the quantity of steam admitted to the radiator. Steam is less costly than hot water systems, and smaller and less conspicuous radiators can be used with steam.

The fact that steam under a lower atmospheric pressure can be generated at a lower temperature than 212 degrees is being taken advantage of. In a vacuum steam can be generated of as low a temperature as 120 degrees. Houses can thus be heated by steam at a lower and more comfortable temperature than has hitherto been the case, and where exhaust steam is available it can be used as a pressure less than atmospheric. Professor Carpenter described several new systems embodying this principle.

The objection to hot water was the large size of radiators required. Certain substances added to water raise the boiling point of water. Glycerine mixed with water raises the boiling point to 300 degrees. If a sufficiently inexpensive salt can be found to add to water, which will not affect the pipes and radiators, this problem will be solved. In hot air heating the furnace should be installed as closely as possible to the windward side of the house.

The architects of Ontario have obtained a notable position in the world from the noble and artistic works they have produced, said Professor Carpenter, and he hoped they would not forget the elements of health and comfort in the construction of their buildings.