

revolutions per minute, and with a maximum voltage of 240. It will be seen that the motor with the 2 to 1 field control and a single set of change gears is the smallest, requiring three amperes approximately when delivering 1 h.p., against six in the case of the multi-voltage at same speed. The figures for current used are, of course, approximate and are for the purposes of comparison only.

To get the lower range of speed, i.e., 400 revolutions per minute, the change gears with ratio 2 to 1 would be thrown in, and the motor put on full field, when it would run at 800 revolutions per minute. By decreasing the field strength its speed would be raised to 800, when the gears would be thrown out and the motor again put on full field. The further increase to 1,600 would be accomplished by again weakening the field.

#### SPEED VARIATION BY FIELD CONTROL.

Motors giving successfully a range of 2 to 1 by field control are at present not classed as standard motors, although there is no difficulty in obtaining them or motors which will give a much greater range. This distinction will, however, disappear as they

are more widely used, and there is no reason why motors giving such a range or greater cannot be made as a standard product if the demand is sufficient. A number of makes are now on the market which offer a much greater range than this; but at present, as shown by Table 2 it would not seem advisable to go far beyond 2 to 1, except perhaps in special cases.

#### RANGE OF SPEED CONTROL.

From the foregoing it is easily seen that the range of any of the above systems of speed control is somewhat limited, the four-wire multi-voltage having the widest for the same size motor. But even this is limited as here laid down to about 6 to 1 when using field control on the highest voltage. It is true that it can be extended by using either higher or lower voltages, both of which are undesirable. Now machine tools which require variable speed may have a range as high as 50 to 1. While, no doubt, many tools are furnished with greater range than absolutely necessary, 6 or 8 to 1 being found sufficient for many purposes, at present it is easily seen that none of the systems outlined will conveniently

cover such ranges. Resort thus, therefore, be made in most cases to gearing to finish out the range even with multi-voltage. When the range to be covered is very great this last system has an advantage, but for most machines the range required can be covered with a field control of 2 to 1 and two sets of gears, and for the larger ranges which are not so frequent, a field control of 3 to 1 can be successfully used.

#### PLANNING A NEW PLANT.

Where a three-wire system is already installed the application of variable speed drives is easily accomplished by the system outlined above. But when the case of a new plant is under discussion, careful consideration should be given to the foregoing principles, and the system selected should depend largely on the ratio of variable speed tools to constant speed tools. If the plant is large enough, an alternating system, with proper transforming devices, might prove the best, and in the writer's opinion, many large plants now equipped with direct-current distribution would be much more economically run if so provided.

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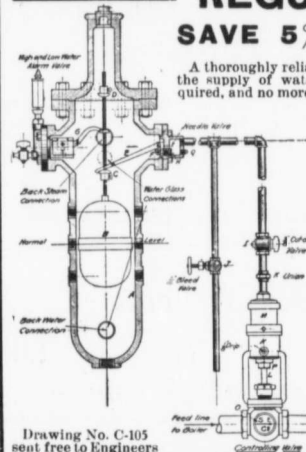
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