

400, 500, 600, 700, 800, 900 and 1,000 ft. ahead of the focal centre. Three points were taken for each station, one corresponding to the centre of the track, and one corresponding to 20 ft. each side of the centre, the three points being in the same straight line at right angles to the beam.

RECOMMENDATIONS AND CONCLUSIONS.—In order that a headlight shall be of such intensity as not to cause a misreading of signals, obscuring of hand signals, fuses, red lanterns and classification lamps by opposing headlights, and be of such intensity as not to temporarily blind the engineman looking into the same, it must have an apparent beam candle power not greater than 3,000, referred to the centre of the reference plane, from 500 to 1,000 ft. ahead of the locomotive.

In order that the engineman shall have sufficient illumination ahead of the locomotive to allow him to readily perform his duties while operating in and out of passenger terminals and industrial sidings, while switching in yard, and to readily locate whistle posts, yard limit and crossing signs and such other landmarks en route, a headlight, due to depreciation or

to variation in the intensity of the source, must not at any time during service have apparent beam candle power less than the following:—

Central readings.		Readings 20 ft. each side of centre.	
Distance	Apparent c.p.	Distance	Apparent c.p.
500	450	50	30
600	490	100	110
700	500	200	225
800	500	300	315
900	500	400	350
1000	500		

The above readings are to be considered independent of the location of the headlight, the source and intensity of the light, the design of reflector, etc. To design a headlight to meet the above requirements, the height of the headlight above the rail must be decided on; then, with a given kind of light, the design of reflector, the relative arrangement of reflector and source of light, the intensity must be such that the readings will fall below the designated maximum with sufficient margin above the minimum requirements that they will not at any time, during the depreciation in the source of light, reflector, etc., fall below the minimum requirements.

The Use of Electric Motors in Railway Shops.

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No hard and fast rule can be laid down as to just what system should be used in any particular shop until the local conditions have been thoroughly studied and analyzed. There are two great divisions: the alternating current and the direct current systems. Each has certain advantages and its champions, but before adopting either system the actual cycle of operation of each individual machine must be carefully considered before a selection is made.

Considering direct current for railway shop service, the voltage automatically established as 500 v.d.c. is unsuitable for use on account of its tendency to hang on after an arc has once been formed, and the severity of a flash, shock or burn that an attendant might receive; 110 v. is too low on account of the amount of copper required and also the brush, commutation and contact requirements of the motors, controllers, etc. 220 v. seems to be the ideal for d.c. motor drive, and with a mixed load of motors and lighting, 3 wire d.c. generators can in many cases be used to advantage. The 3 wire d.c. distribution also has its advantages for motor drive in that a wide range in speed can be secured and the motor will be operating very efficiently at all times.

The type of motor to use in any particular case must necessarily depend on the operation to be performed, thus on cranes and hoisting work the motors should in most cases be series wound, but there are some cases in hoisting and conveying work where it is necessary to use either a compound winding or an interpole motor, as it is possible under certain conditions for a straight series wound motor to run away with a light load, and this would not be possible where the motor is provided with a shunt winding to prevent the speed of the motor reaching the danger point. This type of motor is also suitable for use on transfer tables and turntables. There are other operations which require a heavy starting torque from the motor and, when in operation, require that the motor drop off in speed as the load comes on, such a cycle of operation, for instance, as occurs on a punch or shear, or any other tool provided with a fly wheel, and for this class of service a compound wound motor should be used. Other drives require comparatively small starting

torques but require constant speed after being put in operation, such as driving line shaft or any similar operation; a shunt wound motor should be used.

In applying motors to machine tools, one must again carefully consider the cycle of operation before selecting the winding for a motor, and many of the motors used on machines tools are combinations of the three different types of motors described above. On some machine tools a small amount of variation is sufficient and increases in speed from 10 to 15% may be secured on the straight shunt motors, but where the range in speed would amount to 2 to 1, 3 to 1, or 4 to 1, motors for such operation should be of the shunt wound interpole type. These motors commute very successfully over the whole range in speed. Wherever a cycle of operation is peaky, as in the case of a planer, motors of the interpole type should be used. Just to point out what can be done in this matter of speed variation, I would state that there are in use today motors of 100 h.p. capacity that have a range in speed from 100 to 1,200 r. p. m., this variation in speed being secured without keeping in service any series resistance.

The d.c. motors of the compound wound, shunt, and interpole types are generally provided with starting devices equipped with overload and no voltage release coils, this being a simple and effective means of protecting the motors and tools from injury due to an overload or to the failure of power and its sudden restoration to the line before an attendant might have an opportunity to cut the motor out of circuit. D.c. machines have their commutators and brushes which require care and attention, but commutator trouble has been reduced considerably owing to the fact that motor manufacturers have adopted one method or another to increase the commutating capacity of their motors. It will be seen from the foregoing that the d.c. system has certain advantages, particularly in its flexibility, for it is possible to secure a d.c. motor that will efficiently meet almost every conceivable cycle of operation.

The a.c. motors are divided into three general divisions: the short circuit induction motor, the slip ring induction motor and the synchronous motor. The short circuit

type requires from $3\frac{1}{2}$ to $4\frac{1}{2}$ times full load current from the line while developing full load torque at starting; the slip ring type will draw $1\frac{1}{2}$ times full load current from the line while developing full load torque at starting, and the synchronous motor will draw approximately 3 times full load current from the line while developing 3-10 full load torque. The short circuit type does not lend itself to variations in speed as does the shunt wound d.c. motor and it is, therefore, suitable for constant speed operation only. The resistance of the motor, however, may be varied so as to give almost the same characteristics as the compound wound d.c. motor. This type of motor is especially adapted to punches, presses, etc., of moderate sizes, but there are cases where extremely large presses are used where it is desirable to use the slip ring type induction motor rather than the short circuit type. The slip ring type induction motor is used for hoisting, conveying, cranes, etc. The beauty of the short circuit type is that it has no moving contacts, the only rubbing parts being two bearings. The short circuit type are normally also provided with no voltage release coils in their starting devices and are also provided with overload release coils or fuses. The series wound d.c. and the slip ring type motors are also provided with fuses or circuit breakers, as the case may be, depending upon the class of work they are being called upon to do. Other features that have been developed for different controls are the remote control which allows the operator to start or stop a motor which may be located some distance away. Then we have the master type controller, in which the operator simply operates the master control and the controller itself is operated by electromagnets, thus relieving the operator of all the manual work. There has also been developed the push button type controller, which simply requires that the operator to start a machine press a button and the machine will automatically come up to speed, the current being limited at all times by the controller so that there is no unnecessary jar or strain as the tool starts from rest and comes up to its normal speed.

In the woodworking department, in many cases, the motors can be direct connected to the machines, and in most cases high speed motors can be used. If d.c. motors are used for this class of service, they should be shunt wound and entirely enclosed, and the starting box enclosed in metallic case lined with asbestos. If the short circuit type induction motor is used for this class of service they need not be dustproof, but the bearings should be dustproof and arrangements should be made to have the sawdust and shavings blown out of the motors at regular intervals and the motors should be provided in large sizes with oil immersed compensators, and in small sizes where they are thrown directly across the line the starting switches should be enclosed in asbestos lined metallic cases. As a general thing motors in the woodworking department should be provided with shaft extensions on both ends, for there are many cases where it is important that each machine be provided with its own blower for carrying away the sawdust. Where machines are equipped in this way with their own individual blowers, a great saving is effected, as the blower is in use only during the time that the machine is in service, whereas if one common blower is used for the whole woodworking department the load is practically the same, whether a few machines are in operation or all the machines in operation. Individual blowers are saving some woodworking departments a steady load of between 40 and 50 h.p.