tion, and therefore on the basis of a larger percentage of profit per horse-power installed.

In concluding this paper, and for the benefit of those who are not especially familiar with the Wagner single phase motor, a description of that motor may prove of interest. A great amount of time and thought has been devoted to the production of a commercially successful single phase motor. Early efforts to produce such a motor were broadly confined to two characteristic types—the synchronous motor, and second, the direct current motor, slightly modified to operate on alternating current. These efforts proved futile and no large degree of success in the production of a single phase motor was attained until the present form of induction motor, built by the Wagner Electric Mfg. Co., was placed upon the market. The motor consists essentially of a primary or stationary element, commonly referred to as the field, and a secondary, or revolving element, commonly referred to as the armature. These elements are entirely independent of each other. The current from the source of supply is fed into the field, and this induces all currents set up in the armature windings. In general terms, the armature may be said to be of the well-known direct current form, a progressive winding being connected to a radial commutator in the usual direct current armature fashion. Brushes are

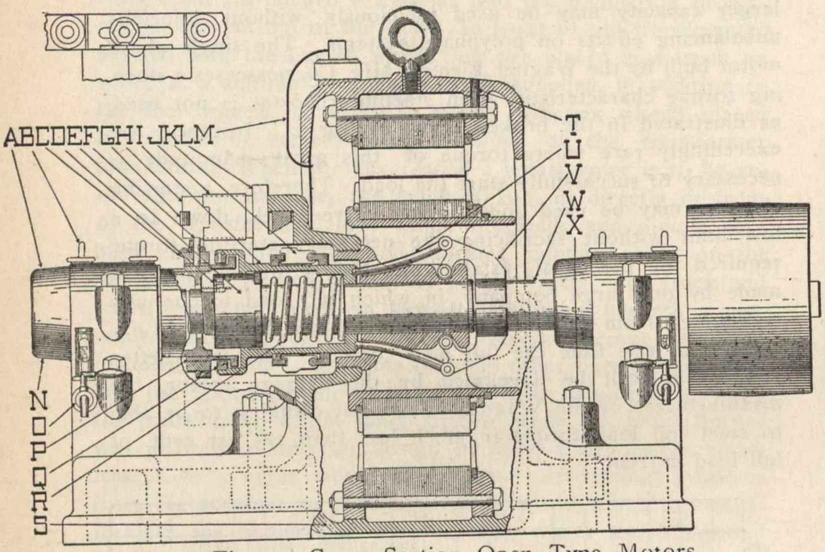


Fig. 4. Cross Section Open Type Motors.

A—Pillow block cap. B—Oil cover. C—Rocker arm. D—Spring nut key. E—Spring nut. F—Adjustment stub. G—Brush holder spring. H—Carbon brush. I—Spring barrel. J—Brush holder. K—Short circuiting ring. L—Commutator. M—Terminal cable. N—Pillow block. O—Oil cock. P—Rocker arm tube. Q—Spring barrel ring. R—Governor spring. S—Field clamp. T—Dowel pin. U—Governor weight pin. V—Governor weight. W—Shaft. X—Strap bolt.

provided which, under usual circumstances, are short-circuited through the rocker arm, carrying them. In addition to these brushes there is placed within the annular opening of the commutator a short circuiting device, centrifugally controlled, the purpose of which device is to completely short-circuit the commutator, and through the commutator, the armature windings, when the armature has attained a predetermined speed of rotation. The motor is designed to operate in two distinct ways. First, with one combination of elements at starting, and second, with another combination of elements in the running condition. In starting, the induced currents of the armature windings are given a directional control through the brushes which results in a rapid acceleration of speed, up to what may be termed the normal operating speed. At this point the centrifugal device comes into play, forcing the short-circuiting links into the annular commutator opening. Simultaneously the brushes are removed from the commutator, and thereafter the armature revolves, performing its function in a manner quite similar to the ordinary polyphase motor. The motor is shown in cross section in Fig. 4. The perfection of mechanical and electrical design of this motor is evidenced by its successful operation over a period of a number of years on almost all the leading central station systems of distribution. That the commutator arrangement meets satisfactorily the requirements of the service, is evidenced by the fact that the Wagner Company has been building this form of motor for almost six years, and has not supplied up to the present time, more than half a dozen renewal commutators, and this limited number of commutators was supplied to a single customer, who had installed a number of 30-h.p. motors to perform a special service involving an enormous number of stoppages daily.

At a number of conventions enquiry has been made as to the number of motors small stations can successfully operate. Instances are on record as follows: One station, having a 75-K.W. generator has installed 100-h-p. in single phase motors. Another with 180-K.W. in generators, has 140-h.p. in single phase motors, and a third with 75-K.W. generator capacity, has 45-h.p in motors. This form of motor adapts itself to all the usual kinds of small power work, such as pumping service, air compressors, printing presses, blowers, and small factory driving, coffee mills, belted elevators, storage battery charging, through the medium of motor-generator sets, etc. The type of single phase motor built by the Wagner Electric Mfg. Co., at the present moment is limited in application in only two ways; first, in the handling of work requiring a variation of speed, and second, in the handling of work calling for a great number of starts daily.

## HEATING AND VENTILATING THE MACHINE SHOP.

BY J. I. LYLE, M.E.

I very vividly remember, while serving my apprenticeship as a machinist in a railway shop that the temperature in the shop often dropped below 40 degrees and frequently to freezing, if the outside weather was within 15 degrees of zero. With a temperature of 40 degrees a workman's hands become numb, and it is almost impossible to do good work with hand tools. This shop was considered by those in charge as being amply heated with an overhead direct steam system. The employees, instead of working to keep warm, as a rule, chose to loaf to keep warm, and I do not believe that the amount of work produced on such cold days, when estimated very conservatively, amounted to more than 75 to 80 per cent. of the normal output. In this building there were about 150 employees earning approximately $2.50 per day; considering, however, the output to be 85 per cent., the loss on cold days amounted to something like $37.50. An efficient heating plant for this shop would cost about $3,750 complete. Without considering the cost of steam, of which there was plenty of exhaust going to waste; allowing for depreciation, etc., making a liberal total of 12 per cent. or $450 per year, as the amount that the cost of the heating plant should earn, it would take only twelve days with the thermometer below 15 degrees above zero to make the expenditure a paying investment.

Practically all railway shops have exhaust steam from the shop and electric lighting engines and air compressors, which is available for heating, so any system not adapted to the economical use of exhaust steam should not receive serious consideration. In considering the advisability of utilizing exhaust steam and returning the water of condensation to boilers, the questions of back pressure and cylinder oil carried over with the steam should not be overlooked. Regarding the question of back pressure and the minimum required for the various systems of heating, it will be found that ordinarily five pounds is carried, and while this could be reduced in moderate weather, the general practice is to establish this as the minimum and increase the pressure in extremely cold weather. With a carefully designed plant, however, this is higher than should be necessary unless there are some adverse conditions. The minimum pressure required for circulation depends more upon a proper proportioning of the supply main, and the distributing branches, than upon the return main. The question of expansion of the steam and the proper removal of the condensation at the required points in the supply main should receive careful consideration. A great many plants require a higher pressure to secure circulation than would otherwise be necessary had proper consideration been given to the dripping of the main and its