Canadian Westinghouse Company, Limited

Hamilton, Ontario

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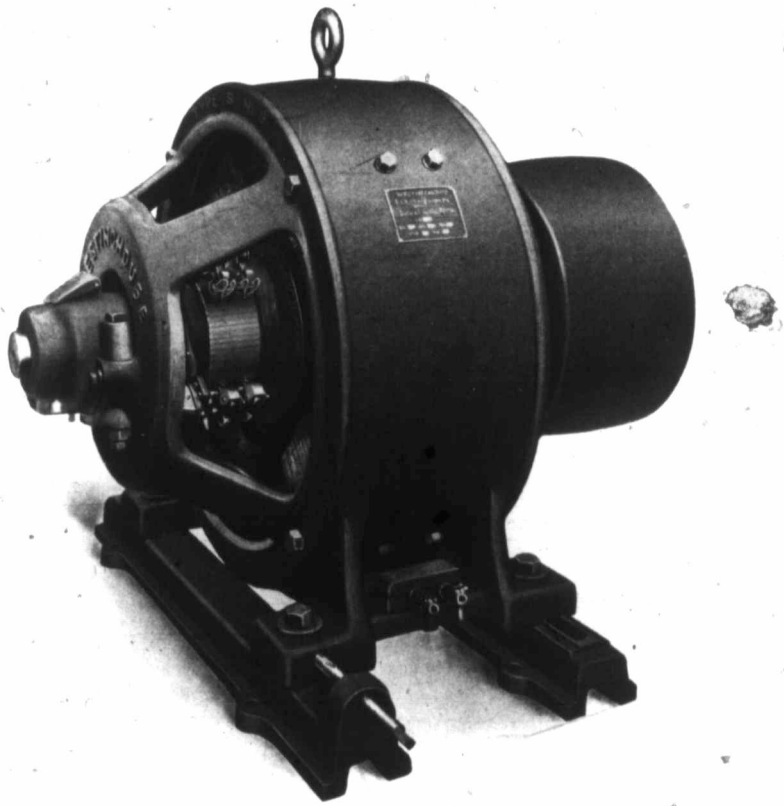


D.C. Motors Types S and SA

Constant, Varying and Adjustable Speed

SPEED CLASSIFICATIONS OF ELECTRIC MOTORS

The electric motor may assume practically an infinite number of different forms and may be applied to an almost unlimited number of uses. Each motor, however, possesses certain inherent speed characteristics by means of which it can be classified in one of several groups. The following classification is practically that adopted by the American Institute of Electrical Engineers, June 27, 1907, the wording being slightly modified for the sake of a more definite interpretation as applied to the standard motors of Canadian Westinghouse Company, Limited.

(a) CONSTANT SPEED MOTORS in which the speed is either constant or does not materially vary, such as synchronous motors, induction motors with small slip, ordinary direct current shunt motors and direct current compound wound motors, the no load speed of which is not more than 20 per cent higher than the full load speed.

(b) MULTISPEED MOTORS (two-speed, three-speed, etc.,) which can be operated at any one of several distinct speeds, these speeds being practically independent of the load, such as direct current motors with two armature windings and induction motors with primary windings capable of being grouped so as to form different numbers of poles.

(c) ADJUSTABLE SPEED MOTORS:

(1) SHUNT WOUND MOTORS in which the speed can be varied gradually over a considerable range, but when once adjusted, remains practically unaffected by the load; such as motors designed for a considerable range of speed by field variation.

(2) COMPOUND WOUND MOTORS in which the speed can be varied gradually over a considerable range as in (1) and when once adjusted, varies with the load similar to compound wound constant speed motors or varying speed motors, depending upon the percentage of compounding.

(d) VARYING SPEED MOTORS or motors in which the speed varies with the load, decreasing when the load increases such as series motors and heavily compounded motors. Examples of heavily compounded motors are those designed for bending roll service and mill service, in which a shunt winding is provided only to limit the light load operating speed.

WESTINGHOUSE DIRECT CURRENT APPARATUS

For information concerning other Westinghouse direct current motors and starting and controlling devices ask for the following publications:

Small power motors	1/20	to	1/8 h.p. Circular	1128
Type R power motors	1/8	" 10	" "	1099
Type K crane and hoist motors	2	" 50	" "	1097
Mill motors	25	" 150	" "	1147
Type EM large power motors	85	" 500	" "	1138

Full ratings, dimensions, etc., are given on separate leaflets, which will be sent on request.

For starters and controllers (both manual and automatic) ask for motor control leaflets, series 9000.

Types S and SA Motors

Direct Current

Constant, Varying and Adjustable Speed

Of the many services performed for mankind by electricity, probably none has had a greater influence on modern progress than the supply of an efficient, reliable, and convenient source of power. For industrial applications of almost every description, the electric motor so far surpasses all other forms of power that its field of usefulness is rapidly broadening. The advantages of electric motor drive have been demonstrated by a great variety of successful installations; and the enthusiastic commendation of this form of power by those who have adopted it is the strongest possible reason for still further extending its use. Wherever power is required in large or small quantities the electric motor is applicable.

Westinghouse type S and type SA direct current motors were designed and built especially for general power purposes, and they have stood the tests of practical service, as is proved by their steadily increasing use. Type S motors are adapted for **constant speed service** and for **adjustable speed service** within moderate ratios—1 to $1\frac{1}{2}$ or 1 to 2; type SA motors have auxiliary commutating poles and are adapted for speed adjustments within the ratios of 1 to 3 or 1 to 4. The efficiency and durability of these motors, their reliability under the most severe service conditions, their great overload capacity, and low operating temperature are some of the reasons for their very extensive use. A considerable stock of both types in standard capacities is always available for immediate shipment and orders can be promptly filled.

Type S Motors

Capacities and Types. Standard type S constant speed motors are made for the following outputs:

From 2 to 75 horse-power	110 volts
From 2 to 150 horse-power	220 volts
From 2 to 150 horse-power	500 volts
From 6 to 100 horse-power	600 volts

Special motors for higher voltages up to 650 can be supplied on order. The fields are either shunt or compound wound, but in special cases will be supplied with series windings only. The motors are suitable for floor, wall, or ceiling mounting and can be belted or direct connected in any practical way to the device to be driven.

These motors can also be supplied with vertical shafts (type SV) or with back gears (type SG). All type S motors are so arranged that they can be provided with either perforated or solid covers, making the motors partially or wholly enclosed.

Type S motor frames are numbered consecutively, according to size, from 1 to 13. Leaflets, giving complete ratings and dimensions will be sent on request.

Motor Frame With Pole Pieces and Field Coils

Speed Adjustments. For driving machine tools and similar apparatus where moderate speed adjustments are necessary, type S motors have given excellent satisfaction, since by varying the motor field strength the speed can be adjusted between reasonable limits.

Construction

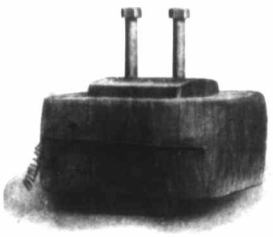
All materials entering into the construction of type S motors are of standard Westinghouse quality and are such as long experience has shown to be best suited for the purposes they are to serve. The machines are multipolar, compact, and of pleasing general appearance; the construction is rigid and substantial; every detail has been given the careful consideration necessary to produce machines that are capable of fulfilling the exacting requirements of modern service.

Frame. The frame consists of a cylindrical cast iron yoke machined on each end to receive the brackets, which carry the bearings. Inside the frame are machined seats to which the pole pieces are bolted. For horizontal shaft motors, supporting feet are cast solid with the frames. The motor feet can be bolted to a floor or to the frame of the driven

machine, or they can be fastened to the slide rails for floor, wall, or ceiling mounting.

For a vertical shaft motor, the frame is not provided with feet but is bolted to a circular flanged supporting frame that is adapted for mounting on a floor, a foundation, or on the frame of the driven machine.

When specially ordered, frames Nos. 7 to 13, inclusive, and their bearing brackets, can be cast in halves, the dividing plane being horizontal and passing through the center of the shaft.

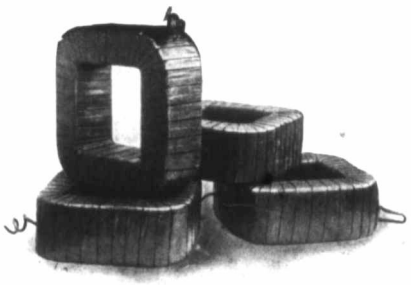


Field Coil and Pole Piece

Pole Pieces. The pole pieces are built up of soft sheet steel punchings. Overhanging tips or pole corners, help to hold the coils in place and also help to distribute the magnetism so as to aid commutation. Each pole piece is held by two bolts that pass through the frame and are screwed into threaded holes in the pole piece. By removing these bolts any pole piece with its field coil can be withdrawn without removing the armature.

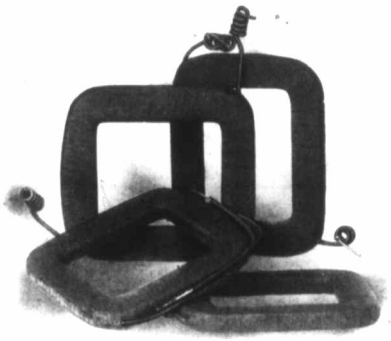
Field Coils. The field coils are wound on insulated shells. Only one size of shell is used for each frame, so that for any given frame and a given class of service all field coils are interchangeable. The coils are wound of insulated copper wire; after being wound they are first taped and then impregnated with insulating compound by the vacuum process briefly described as follows:

Vacuum Insulating Process. The coils are placed in a tank in which the temperature is raised to a high degree and the air then exhausted, thus removing every particle of moisture and practically all the air from the coils. At this stage an insulating compound, liquid at high temperature, is run into the tank until the coils are immersed; air is then readmitted and pressure is applied, thus forcing the compound into every minute crevice in the coils.



Shunt Field Coils

The compound has a melting point higher than any temperature that the coils will ever reach in operation, so that under normal conditions the coils are practically solid masses that are absolutely waterproof. The compound also conducts heat from the interior of the coil to the outside where it can be dissipated to the surrounding atmosphere, thus assisting to maintain a low operating temperature. After the coils are thoroughly cooled, they are coated with a hard finish waterproof paint, giving a good wearing surface that is easily cleaned.



Series Field Coils

Armature. The armature is of the slotted drum type. The core is built up of soft annealed sheet steel punchings that are insulated from each other by a uniform coating of japan. With the exceptions of armatures for the two smallest frames, the core punchings are assembled and keyed on cast iron spiders and are clamped between heavy end plates. For frames Nos. 1 and 2 the punchings are assembled and keyed directly on the shaft and held between end plates set up by nuts on the shafts.

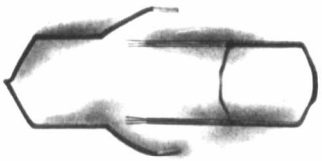
Armature Windings. The armature coils are form wound and for machines of similar characteristics, are interchangeable. While being wound the coils are varnished with insulating compound and when completed are taped and dipped in moisture-proof insulating material. The coils are then placed in the slots, and on small armatures (for frames Nos. 1 to 5 inclusive), as well as on large 600-volt machines, are held in place by bands over the core and ends. On the larger frames, except as above indicated, bands are used only on the ends, and fibre wedges are driven into grooves in the ends of the teeth. When bands are used over the core they are sunk below the surface.

The ends of the wire or strap of which the coils are formed constitute the leads, which are brought out and soldered into slots in the necks of the

Type S Armature Complete

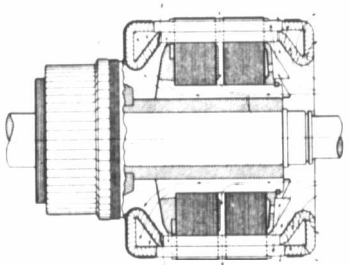
commutator bars. In order to guard against grounds and short circuits, careful tests are made on each coil before connecting it to the commutator, and also on the completed armature.

Balance. Each armature is carefully balanced after the windings are in place, thus insuring minimum vibration and removing a frequent cause of poor commutation.



Armature Coils

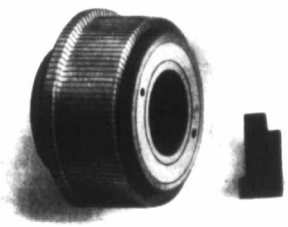
Ventilation. Good ventilation is provided by means of radial ducts that connect with openings in the spider. The rotation of the armature causes air to pass in through the spider openings and out through the air ducts and through the overhanging ends of the armature coils, as indicated by the arrows in the accompanying figure. From the armature the air is blown outward against the pole faces and around the field coils, thus keeping all the active parts of the electric and magnetic circuits cool.



Showing Method of Ventilating Armature

Commutator. The commutator is constructed of hard-drawn copper bars separated by mica segments. The insulating segments and the insulating cones covering the clamping rings are made of the best grade of selected mica. The commutator is heated while being clamped and when completed every bar is so firmly held in place that it cannot work loose in service. The materials in the commutators bars and insulating segments are so chosen that they will wear evenly.

For frames Nos. 1 and 2 the commutator spiders are pressed on to the armature shafts and keyed, but for each larger size the commutator spider is pressed on to a machined seat on the armature spider



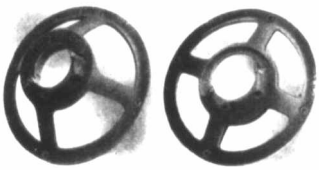
Commutator

and is keyed in place, making the armature and commutator a self-contained unit.

The commutator bars have necks with slots into which the leads from the armature coils are soldered. The use of necks on the commutator bars permits the connection of the leads with less bending, and consequently less stress on the insulation, than is necessary when the leads are soldered into slots in the ends of the bars.

Shaft

Shaft. The armature shaft is turned from tough axle steel and is designed with a liberal factor of safety. Special oil thrower rings turned on the shaft effectually prevent oil from working along the shaft to the commutator and armature. Except the two smallest sizes, the shafts can be forced out of the armature spiders and different shafts substituted without dismantling the armatures or commutators. Shafts with special extensions for pulleys or gears can be supplied.



Type S Bearing Brackets

Bearing Brackets. The bearing brackets are of the skeleton type with an outer ring machined to fit the seat on the frame, and with radial arms shaped to form rigid supports for the bearings. The brackets of frames Nos. 1 and 2 have two arms each, while those of the larger frames have four arms each. The brackets are bolted to the frames, the bolts being so placed that the brackets can be readily shifted to suit floor, wall, or ceiling mounting.

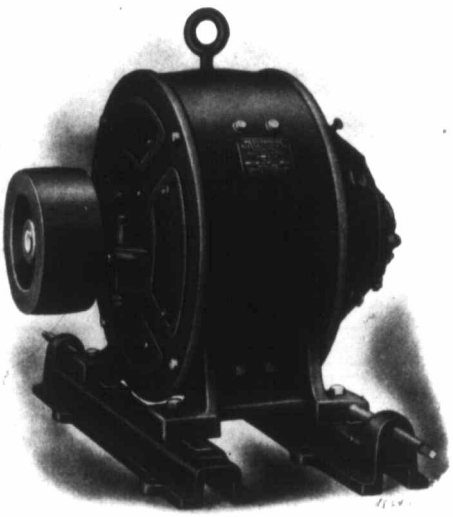
Covers For Enclosed Motors

Enclosed Motors. Perforated covers can be fitted over the openings between the bracket arms for semi-enclosed motors, or solid covers for entirely enclosed motors. These covers are held in place by simple latches, and are readily removed or interchanged.

Bearings. The bearings are cast solid with the bearing housings,

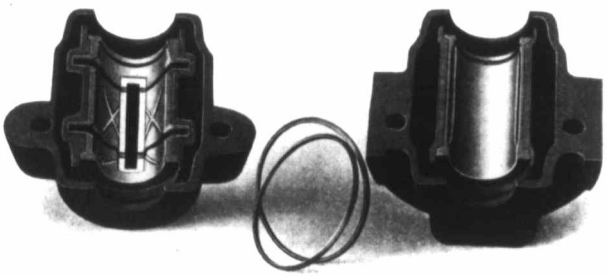
making extremely rigid bearings that have given excellent satisfaction in machine-tool work and in other service where the requirements are severe. For all except the two smallest frames, babbitt-lined split bearings are used, the housing being cast separate from the bearing-bracket and bolted to a suitable cradle on the bracket. These bearings are easily removed without disturbing the pulley or pinion.

All bearings are unusually large and have ample wearing surface, thus insuring cool operation and long life. The front and rear bearing of each motor are alike and interchangeable, and, if desired, a pinion or brake wheel can be used on the commutator end of the shaft.



Type S Motor—Entirely Enclosed

For the two smallest frames the bearing housings are cast solid with the brackets, and bronze bearing bushings are pressed into the housings and held by dowel pins.



PARTS OF MOTOR BEARING

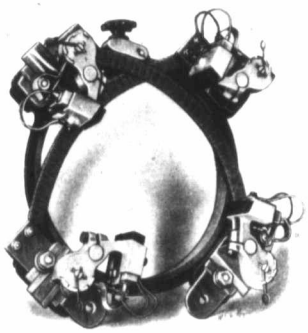
Lubrication. The bearings of horizontal machines are provided with oil reservoirs, oil rings, and distributing grooves. The rings dip into the oil and carry it to the top of the journal whence it is distributed through the grooves in the bearing lining, thus flooding the whole surface of the bearing with oil as long as the machine is in operation. A wiper groove near the inner end of each bearing lining catches the oil that might otherwise creep out at the end of the bearing, and returns it through drain holes to the reservoir.

Type S Motor With Vertical Shaft

An opening in the top of each bearing housing serves for inspecting the bearing and for flooding it with oil when necessary. A suitable cover closes the opening when not in use. An oil overflow on the side of each housing prevents the oil in the reservoir from rising high enough to flow out at the shaft opening in the end. A drain plug under each bearing serves for draining the reservoir.

Vertical Shaft Motors. The armature of the vertical shaft (Type SV) motor is suspended from a ball thrust bearing running in an oil bath. The upper guide bearing just below the thrust bearing, is supplied with oil from a sight feed cup. From the lower end of the upper guide bearing the oil passes through suitable channels to the lower guide bearing at the bottom and the drip from the lower bearing is caught in a pan. This pan is provided with a drain pipe.

Brush Holder Rigging. The brush holders are attached to a ring that is clamped against the machined surface of an inwardly projecting flange on the bearing bracket. On No. 3 frame and larger the ring is open at one side and the clamping device is such as to reduce the opening, thus drawing the ring tight against its circular seat. On loosening the clamping screw the ring

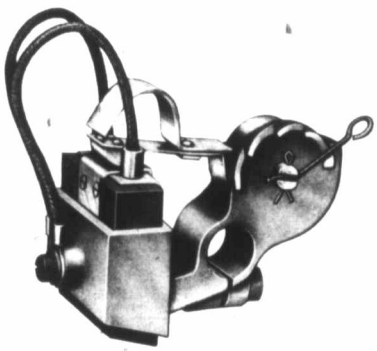


Rocker Ring and Brush Holders

is easily shifted so as to bring the brushes to the neutral position on the commutator, and can be clamped at any point without causing poor contact between the brushes and the commutator. This method of clamping is much superior to set screws, since the latter, when tightened, are very likely to throw the brushes out of position or to tilt them so as to cause poor contact.

Brush Holders. The brush holders are of the radial box guide type and are provided with means for individual adjustment. Close contact of the brushes with the commutator is maintained by long flat spiral springs. These springs are adjustable and are so arranged that the brush pressure is constant until the brushes are worn out. A heavy flexible copper shunt in positive contact with the brush and with the brush holder affords a low resistance path from one to the other.

Brushes. The brushes are a special grade of carbon selected for high conductivity and smooth texture. To the top of each brush is soldered or bolted a metal clamp with which the flexible shunt is connected and which also forms a seat for the tip of the tension spring. When desired, the brushes can be raised and held away from the commutator.



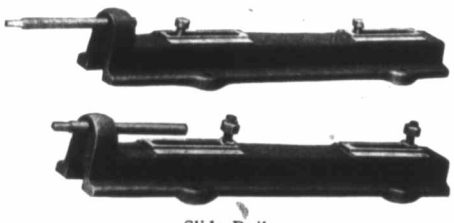
Brush Holder

Terminals and Connections. The terminals are brought out through insulating bushings in the side of frames smaller than No. 7 and through cored ducts in the base of frames No. 7 and larger. The leads of the smaller motors are supplied with standard Westinghouse terminal connectors, which afford a very convenient and thoroughly reliable method of making and breaking connections without tools of any kind. Each lead of the larger motors is supplied with a terminal lug clamped on the end of the lead and with a drilled hole for soldering the terminal on the end of the line wire.

Slide Rails. All horizontal shaft machines intended for belted connection are provided with slide rails having screws for adjusting the belt tension. For wall or ceiling mounting, special rails are supplied.

Pulleys. Paper pulleys are supplied with all belted type S motors.

Idler pulleys with adjustable tension springs can be supplied with any frame smaller than No. 6. These devices can be easily attached to the motor frames, a wrench being the only tool necessary. The idler pulley can be set to suit the lead of the belt.

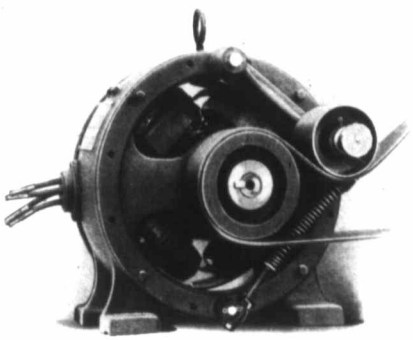


Slide Rails

An idler pulley, by increasing the belt surface in contact with the driving pulley, permits the use of a smaller motor pulley, and of a shorter distance between the driving and the driven pulley centers than would otherwise be possible. Increased speed reduction with decreased belt slippage and wear are thereby obtained.

Back Geared Motors. Standard type SG motors are equipped with countershafts, gears, and pinions. By means of this equipment very slow driving speeds can be obtained, while the armatures operate at higher and more efficient speeds. The standard position of the countershaft is on the left-hand side of the motor when viewed from the commutator end, as shown in the illustration. The location can, however, be shifted 90 degrees or 180 degrees as may be necessary for special connections.

On the smaller motors the countershaft bearings are carried on rings bolted on the outside of the bearing brackets; these rings can be shifted to locate the countershaft above, below, or at either side of the motor. On the larger motors these bearing housings are bolted to pads cast on the frames. Standard practice is to furnish cast iron cut gears, and steel pinions, except that rawhide pinions are supplied for pitch line speeds exceeding 1200 feet per minute. Either or both ends of the countershaft can be extended for a pulley or gear.



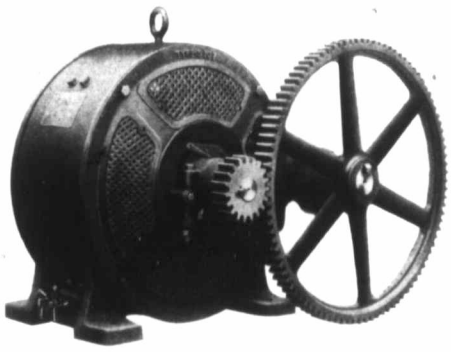
Type S Motor With Belt Tightening Pulley

Leaflets giving dimensions and gear ratios will be supplied on request.

Interchangeability of Parts. The parts of type S motors are made in large quantities, and by means of special tools, jigs, and templates, all are made of exact size. This feature is of considerable importance, since new parts can be easily and quickly substituted when necessary.

Finish. The general appearance is neat and attractive, and the finish is indicative of the general good workmanship throughout. The machine work is accurately done, each surface being made true to gauge. The machines are covered with a brush filler, thoroughly rubbed, and then painted with a preparation that leaves them with a smooth, dull, gray-black finish that has been found most suitable for general requirements and that affords an excellent foundation for any desired color coat.

Inspection and Tests. Each of the many parts entering into the construction of a type S machine passes a very rigid inspection. No piece can be used unless it complies fully with specifications that are drawn with a view to obtaining thorough reliability in the completed machine. Repeated inspections and tests are also made both during construction and after completion to make sure that the machines comply fully with their specifications and guarantees.



Type S Semi-Enclosed Motor With Back Gears

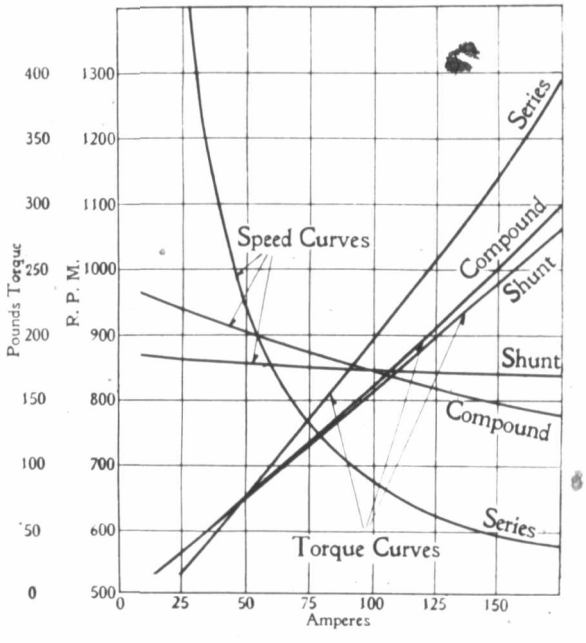
Operating Characteristics

Ratings. The maximum safe output of all direct current motors is limited either by heating or by sparking at the commutator or by both. Westinghouse type S motors are so designed and rated that their full load rating is considerably below the maximum possible safe output; that is, these machines have large overload capacity.

The ratings of the motors depend on the kind of service, whether continuous or intermittent, and on the conditions under which the motors operate, whether open, semi-enclosed, or entirely enclosed.

Commutation. Type S motors are practically sparkless at all loads within their guaranteed limits without adjustment of the brushes. Wide variations of load may occur, or wide changes in the speed of the motors, within their ratings, may be made by field control with no perceptible effect on the commutation.

Characteristics of Field Windings. A shunt wound motor runs at practically a constant speed at all loads and develops a torque that increases about in direct proportion to the current through the armature. The chief characteristics of a series wound motor are greatly



decreased speed at increased load, while the torque increases much faster than in direct proportion to the current through the armature. A compound wound motor has characteristics partaking of the nature of both the others and resembling more closely the one to which the winding most nearly approximates. For example, if the field winding is nearly all shunt, the characteristics will resemble those of a shunt motor; while if nearly all series, the predominating effect of the series winding will show in the characteristics.

Curves. Characteristic curves herewith show the general relation of load and speed for shunt, compound, and series motors. In the standard compound winding about 20 per cent of the excitation is given by the series winding. In each case the speed is greatest at no load, that of a series motor being theoretically unlimited. For this reason a series motor must never be used where it may ever be left to operate without load; under such a condition the motor would race and would almost certainly be ruined by throwing off the armature windings or bursting the commutator.

Selection of Field Winding. From the foregoing explanation the following general rules are easily deduced for the selection of field windings for use on constant voltage circuits.

Shunt Motors should be used where constant speed with varying load is desired. Shunt motors are self regulating and may be left to operate without constant attention.

Compound Motors should be used where constant speed is not essential and where at starting or during some parts of the cycle of operations the torque is considerable. Examples of such service are operating bending rolls, printing presses, plunger pumps, slotters, planers, shears, punches, etc. Unless constant speed is required, compound motors are especially adapted for handling fluctuating loads; the shunt winding keeps the speed within reasonable limits and prevents the motor from racing at no load; the series winding strengthens the field so as to give powerful torque without taking excessive current from the line at maximum load. If the voltage and the load are constant a compound motor will run at constant speed; and since such a motor will start a given load with less current than is required by a shunt motor, compound motors could be used to advantage in many places for constant loads, for example, in operating fans, centrifugal pumps, etc.

If the voltage fluctuates, compound motors will hold the load more steadily and give better general results than shunt motors. For example, in operating stationary motors on street railway circuits the voltage sometimes fluctuates so widely that compound motors give much better satisfaction than shunt motors.

Series Motors are best adapted for loads that are subject to extreme fluctuations, provided that at no time will the motors be left to operate without load, and provided also that extreme speed fluctuations are not objectionable. Examples are electric hoists, winches, cars, locomotives, etc. Unlike shunt and compound motors, series motors lack the auto-

matic speed regulating characteristic and must have constant attention unless the load remains constant or nearly so.

Temperatures and Overloads. The following temperature rises and overloads apply to type S motors that are rated for continuous service but not to those rated for intermittent service, such as bending roll motors and elevator motors. The temperature rises are in degrees Centigrade taken by thermometer.

	Open Type		Semi-Enclosed Type	
Load Condition	Windings	Comm.	Windings	Comm.
Full load continuously	40	45	50	55
25 per cent overload one hour	50	55	55	60

The overload may be applied immediately after the full load run. All type S motors will carry without injury 50 per cent overload for one hour and 100 per cent overload for short periods.

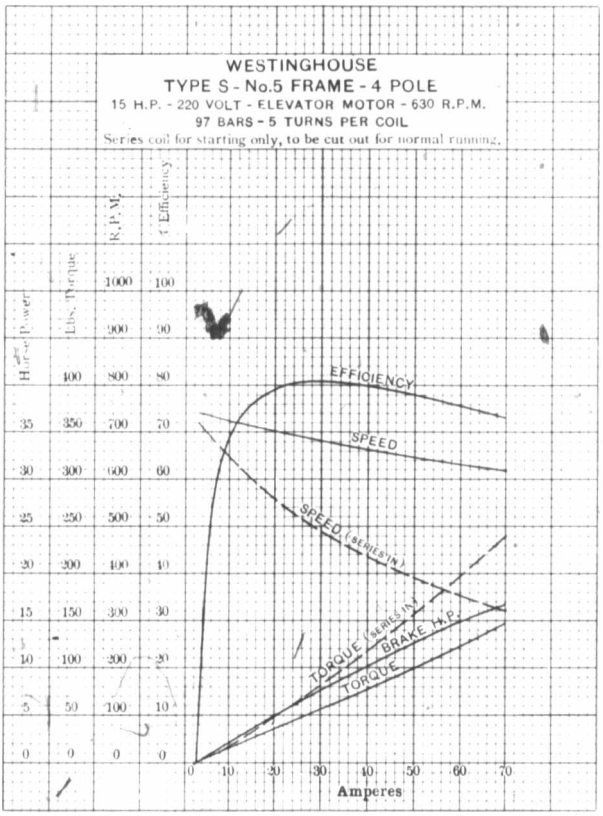
Applications

Motor Generators. A type S motor direct connected to a suitable generator forms a very compact and efficient motor-generator set. Such a set is useful for balancing a three-wire circuit, or for converting from one voltage to another for charging storage batteries, or for boosting a line voltage. By using an alternating current generator, the set will convert from direct current to alternating current.

Elevator Motors. The characteristics of an elevator motor are somewhat peculiar. The motor is used for starting, for normal running, and in many cases for braking and stopping the elevator—three distinct and separate kinds of duty. Starting and stopping require heavy torque for which a series field winding is most suitable, while normal running at constant speed with widely varying loads requires a shunt wound motor. In the type S elevator motor both a series and a shunt field winding is provided, and these are so proportioned that heavy torque is obtained by using both windings, while with the shunt winding alone, practically a constant speed results. The accompanying curves showing characteristics of a type S elevator motor are typical of all sizes. A large number of these motors are in successful use with the various makes of elevator hoisting machinery, to any of which the motors can be readily fitted.

Bending Roll Motors. Type S bending roll motors are also compound wound, the shunt winding being only sufficient to prevent racing at light loads. The heavy series winding enables the motors to start with powerful torque and to withstand successfully the severe shocks

incident to such service. Typical characteristic curves are shown for one size bending roll motor. High starting torque, together with low inertia or flywheel effect, make these motors particularly desirable where frequent reversals are necessary.

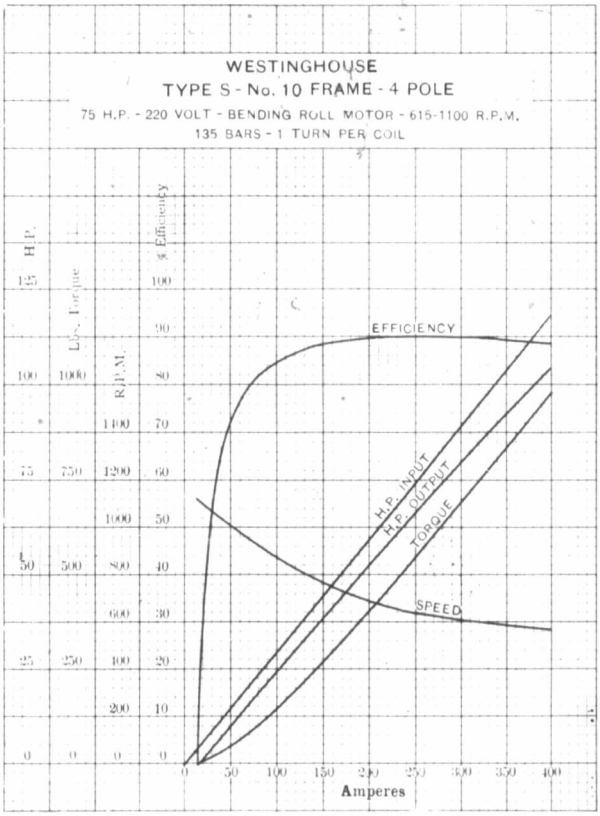


CURVES OF ELEVATOR MOTOR

Pump Motors. Standard type S motors are adapted for direct connection or for gearing to pumps of all kinds. Special high speed type S motors can be supplied for direct connection to centrifugal pumps. These centrifugal pump motors are special only in the windings necessary to secure the high speeds.

Type SA Motors

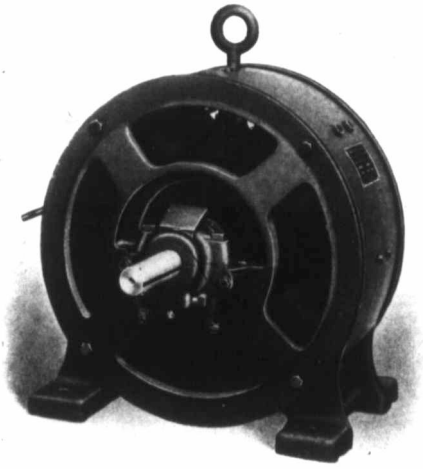
Westinghouse type SA shunt motors with auxiliary commutating poles afford an ideal source of power for all operations where increased economy can be effected by frequently changing the driving speed. The speed of these motors can be adjusted between wide limits simply by



CURVES OF BENDING ROLL MOTOR

moving a controller handle; and the speed, once adjusted, remains practically constant at all loads until further adjustment is made. The number of different speeds obtainable between the minimum and the maximum is limited only by the number of notches on the controller.

Machine Tool Motors. In order to operate a machine tool with the greatest economy the speed must be adjusted, in each case, for the work in hand. By comparing the quick, easy, and accurate speed adjustment of a type SA motor with the slow, difficult, and cumbersome methods employing belts, cone pulleys, and gears, the superiority of the motor drive is readily seen. The controller can be mounted convenient to the operator, and the desired speed can be obtained without stopping the work. The saving of the operator's time results in decreased cost of the product, and the accuracy with which the speed can be adjusted results in improved quality of the work. In one large American manufacturing establishment, where type SA motors were substituted for an older form of power, careful tests made before and after installing the motors showed a saving in favor of the motors of over 30 per cent in cost, as well as considerable improvement in the quality of the product.



Type SA Motor

Type SA Elevator Motors. For operating an elevator, a motor must be capable of developing strong torque for starting and stopping, and at the same time, the speed must be under perfect control regardless of the load.

Type SA shunt wound adjustable speed elevator motors not only meet all the requirements as to torque, but also at all loads run at approximately constant speed for each controller notch. For starting and stopping, the motor is operated at full field strength, and the torque is practically identical with that of the best compound wound elevator motors. The starting torque is approximately double the running torque. The speed of the elevator is increased by cutting a controlling resistance in series with the motor field, thus weakening the field, and is again decreased by strengthening the field. The perfect control of the speed enables the operator to bring the elevator to an easy stop, level with the landing.

TYPE SA MOTOR WITH REAR BEARING BRACKET AND ARMATURE REMOVED

These characteristics make type SA motors especially adapted for high speed elevator work. Their high torque with full field causes rapid acceleration and quick and accurate stops, while the wide range of speed adjustment permits rapid travel. The motors are thoroughly reliable and operate equally well in either direction of rotation.

Construction. Type SA motors have the same general design and construction both mechanically and electrically, as the type S motors described in the preceding pages, and in addition have auxiliary commutating poles midway between adjacent main field poles, as shown in the illustrations. The main field poles are shunt wound, and their strength depends on the adjustment of the controller; the auxiliary poles are series wound.

In all type SA motors the coils on the auxiliary poles are in series with the armature circuit, so that the strength of these poles depends on the load of the motor and is always proportional to the armature reaction. This is true no matter which way the armature is rotating. The result is that under the brushes is a fixed magnetic field of exactly

the right strength to cause sparkless commutation at all loads and at all speeds within the limits of the motor rating, and in either direction of rotation. Moreover, heavy overloads can be carried for short periods. These results are obtained without shifting the motor brushes, which are set and fastened in the proper position before the motor leaves the works.

Auxiliary Poles. The auxiliary commutating poles are cast steel of relatively small cross section and are securely bolted to the frame.

Auxiliary Field Coils. The coils for the commutating poles are form wound and are thoroughly insulated. They are supported by the pole tips and a coil support close to the armature surface where their full strength is utilized to overcome the armature reaction.

Enclosing Covers. All type SA motors may be semi-enclosed or entirely enclosed by the simple addition of gratings or enclosing covers to the openings between the arms of the bearing brackets. The use of gratings does not change the motor capacities, although the operating temperatures are slightly increased. When closed covers are used the ratings will be decreased.

Modifications. Type SA motors can be equipped with vertical shafts, back gears, idler pulleys, etc., in exactly the same way as type S motors.

Ratings and Speed Ratios. Standard type SA motors are built in capacities of from one-half to 23 horse-power for speed ratios of one to four and in capacities of from one-half to 50 horse-power for speed ratios one to three.

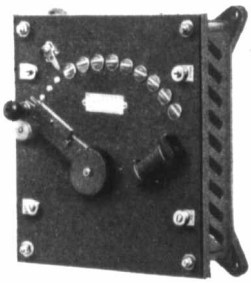
Type SA elevator motors are made in capacities of from 10 to 50 horse-power and for speed ratios of from one to two.

Leaflets giving ratings, dimensions and instructions for ordering will be sent on request.

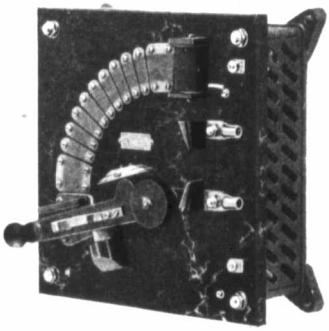
Temperature and Overloads. Two standard methods of rating have been adopted; viz., twelve hour and two hour ratings. The open type SA motor will carry its full rated load at any rated speed for twelve hours or two hours, according to its rated time of operation, with a temperature rise not exceeding 40°C. measured by thermometer. It will carry an overload of 25 per cent for one hour or of 50 per cent momentarily without injurious heating or sparking.

The semi-enclosed type SA motor will carry its full rated load as above with a temperature rise not exceeding 50°C. by thermometer.

The two hour ratings are satisfactory for intermittent machine tool service and will give excellent results when applied to such service.



Starting Rheostat With Low-Voltage Release and Arcing Tip

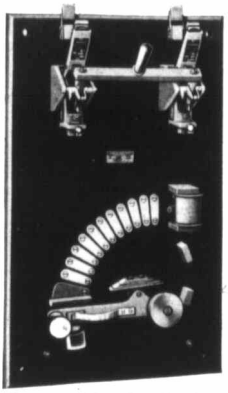


Starting Rheostat With Low-Voltage Release and Blow-Out Magnet

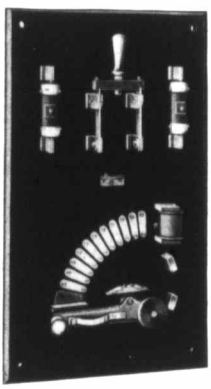
On account of the peculiar and variable nature of elevator service, no temperature ratings are given for elevator motors.

Motor Controlling Devices

The Westinghouse Electric & Manufacturing Company has developed and is prepared to furnish motor starters and controlling devices for many classes of work. Special lines of controllers are made for machine tool motors, for rolling mill motors, for elevator motors, for automatic control of pump motors, as well as controllers for causing motors to perform automatically predetermined series of operations.

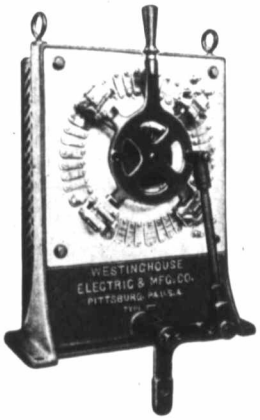


Starting Panel—Circuit-Breaker Type

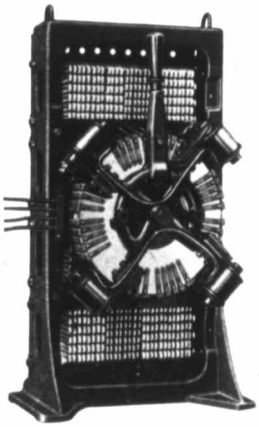


Starting Panel—Fused Switch Type

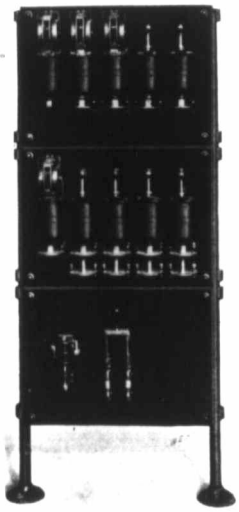
Machine Tool Controller



Controller for Bending Roll Motors
1-10 H.P., 110, 220 and 500 Volts



Controller for Bending Roll Motors
10-30 H.P. 110 Volts
10-50 H.P. 220 Volts
10-75 H.P. 500 Volts



Reversing Controller for Elevator Service
Type A Magnet Switches

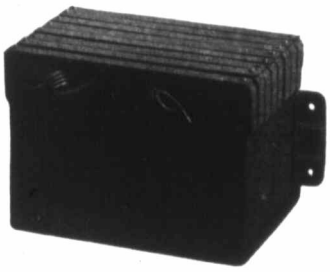
The illustrations of a few of the controlling devices shown herewith will suggest some of their desirable features.

The starters are equipped with automatic low voltage release devices, arcing tips, and blow-out magnets, and are thoroughly reliable under all conditions of service. By substituting a panel for the face plate, room is made for mounting a fused switch or a circuit-breaker, thus making a compact unit containing all the devices necessary for starting and protecting a motor.

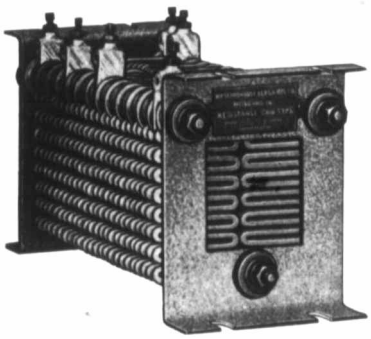
The machine tool controllers are drum type and are operated by means of a crank handle and ratchet wheel, which holds the handle squarely on each operating notch until moved by the operator. Continuous movement of the handle from the off position first cuts out starting resistance and brings the motor up to speed and then cuts in field control resistance until the desired speed is obtained. Special provision has been made for mounting the handle and ratchet wheel separate from the controller when desirable to do so; for example, on the carriage of a lathe so that the controller handle will travel with the cutting tool.

The excellent design of these machine tool controllers, together with the high quality of material and labor employed in their construction, make them thoroughly reliable in service. All necessary safety devices, such as blow-out magnets, arc deflectors, and automatic stops, are used to protect the controllers, as well as the motors, from injury.

The controllers for bending roll motors operate by varying the resistance in series with the motor armature. They have thick copper contact segments mounted on heavy soapstone discs and also moving con-



Bar Type Resistance



Grid Type Resistance

RESISTANCES USED WITH WESTINGHOUSE MOTOR CONTROL DEVICES

tacts of ample size. Powerful blow-out magnets prevent injurious arcing. All contacts are easily and cheaply renewed.

For controlling elevator motors, type A magnet switch controllers are used. Each controller consists of a group of electro-magnetic unit switches mounted on a panel and operated from the elevator cage mechanically by means of a rope, wheel, or lever, or electrically by means of a small master controller. The operation of the unit switches is entirely automatic and they can be adjusted so that the motor speed will accelerate at any predetermined rate.

Full description of any type of controller mentioned or illustrated will be sent on request.

Selection of Electric Motor Equipment

The electric motor has extremely flexible characteristics; it can be built in any size and horse-power capacity, for any speed, and in any mechanical form desired, thus making it applicable to every kind of mechanical effort and to practically every known industry.

When considering the question of a power distribution system, comparisons between driving by electric motors and by some other means are no longer in order; no other form of power drive for distributed machines can be compared with electric motors. The important questions now are, whether to use motors with constant or intermittent ratings; whether to use constant speed or adjustable speed motors; whether to drive each machine by an individual motor or to drive several machines in a group by one larger motor; what form or type of motor to use, etc.

In laying out a motor application the following points should be considered:

(1) The time factor, or the ratio of the length of time the motor is operating with load to the time it operates without load, or is at rest.

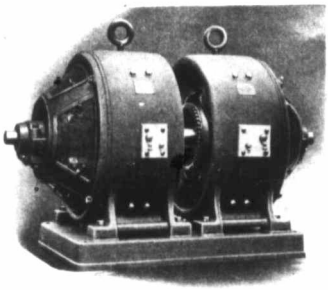
(2) The load factor, i.e., the ratio of the average load to the maximum load, each considered with reference to the time factor.

(3) The location of the machine with reference to other machines and to the source of power supply.

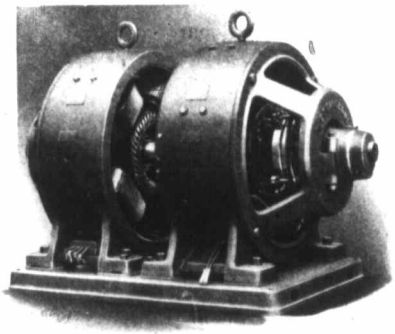
(4) The operating requirements, i.e., the necessity for controlling the power supply and the motor speed, and for locating all controlling devices where the operator need not leave his work.

(5) The advantages of an unfailing power supply and a speed that is under perfect control.

(6) The floor space available for the machine and the motor, for storage, for passage ways, etc.

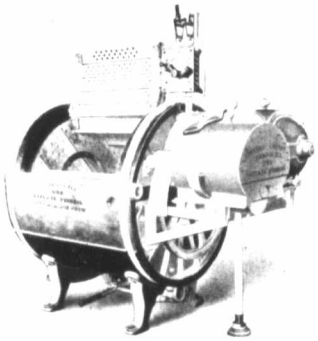


D.C.-D.C. Motor Generator
Type S Motor Driving Type S Generator

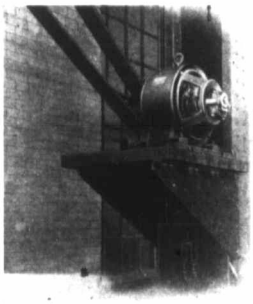


D.C.-A.C Motor Generator
Type S Motor Driving A.C. Generator

Many unavoidable delays, due to renewing or readjusting the work, occur with a large percentage of all manufacturing machinery, thus keeping the machines idle the greater part of the time. This is especially true in metal working establishments, where, unless automatic machinery is used, the average time that each machine is actually working is probably not over 20 or 30 per cent of the total time. In a cement mill or a textile mill, on the other hand, the average time of operation



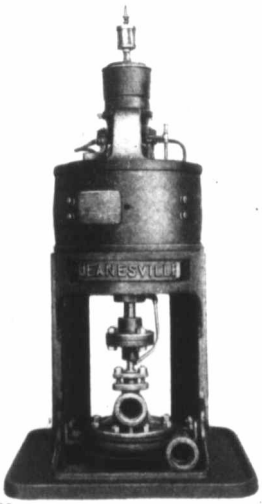
Type S Motor Geared to Conkling Washer



Type S Motor Belted to Line Shaft For Group of Small Machines

of each machine may be 85 or 90 per cent of the total time. These two cases are probably the extremes.

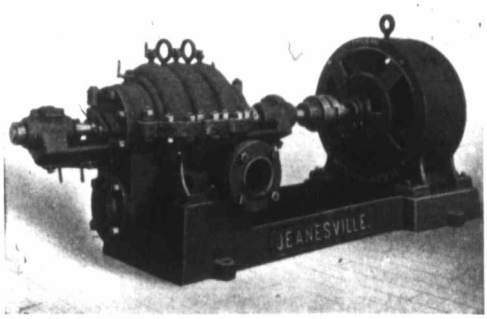
It is very apparent that in metal working establishments operated by line shafts and belts, much power is lost in friction; for much of the driving mechanism must run continuously so long as any machines are operating, even though most of them are idle. With motor drive, this waste does not occur; each machine is available for duty at any instant and all losses in connection with a machine stop when the motor stops.



Type SV Motor Driving Jeansville Centrifugal Pump

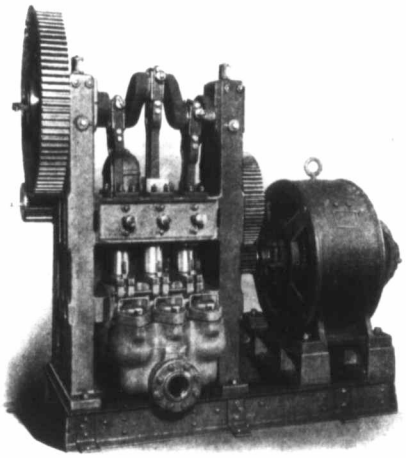
Experience has shown that the power lost in friction of belts and line shafts in machine shops so driven is considerably greater than that actually used for production. The direct saving by operating each machine or group of machines by an electric motor can be readily calculated or determined by suitable tests.

The indirect saving owing to the perfect control of the speed of each machine is frequently the most important consideration in favor of electric motors. The ability to obtain instantly on each machine the exact speed required for each operation increases the quantity and improves the quality of the product. The indirect saving thereby affected is not so quickly apparent as the direct saving in friction losses, but has been found to be very often the larger item.

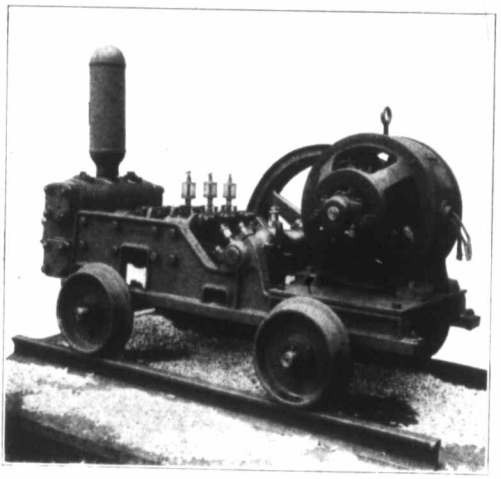


Type S Motor Driving Jeansville Centrifugal Pump

On account of the great advantage derived from close speed control, much depends on the proper selection of the controller. It

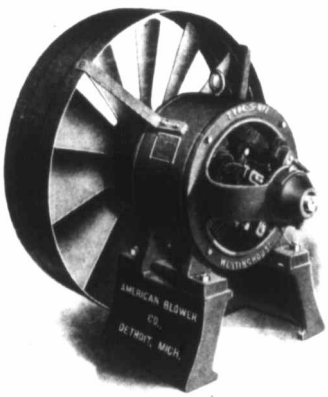


Type S Motor
Driving Gould's Triplex
Pump



Type S Motor
Driving Portable Aldrich
Triplex Mine Pump

must be adapted to the service required and to the motor to be controlled. The machine, the motor, and the controller must be so chosen that they will work together as an efficient and reliable unit.



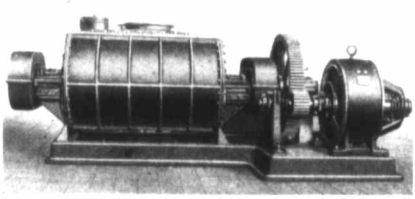
Type S Motor Driving ABC Ventilating Fan

As examples showing the diversity of types of machines used in metal working establishments may be mentioned lathes, planers, shapers, boring mills, drills, etc., each of which when working under proper conditions has a time factor seldom over 30 per cent. Such tools should be driven by either constant speed or adjustable speed individual motors, rated in accordance with the time factor of operation.

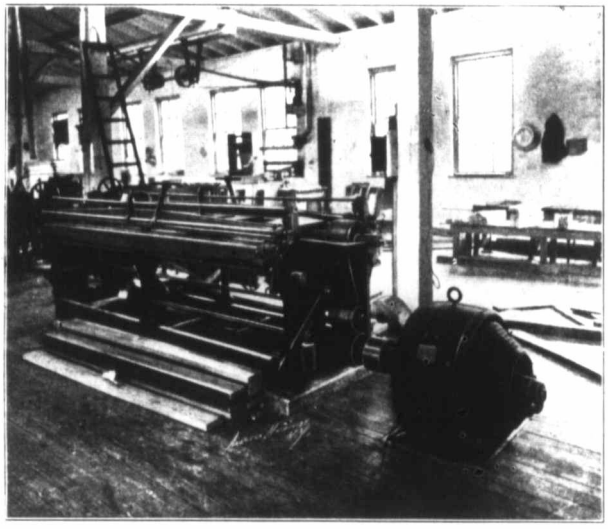
Examples of machines working still more intermittently than those just mentioned are punches, shears, bending rolls, elevators, etc., for which special types of individual motors are desirable.

The choice between individual motor drive and group drive depends so much on the conditions governing the installation that no specific rules can be given. If several machines operate intermittently and have irregular periods of load and of rest, or if the periods of rest are comparatively long, it will nearly always be economical to drive each machine by an individual motor. This is true of all sizes from the large machine tools already mentioned to a sewing machine.

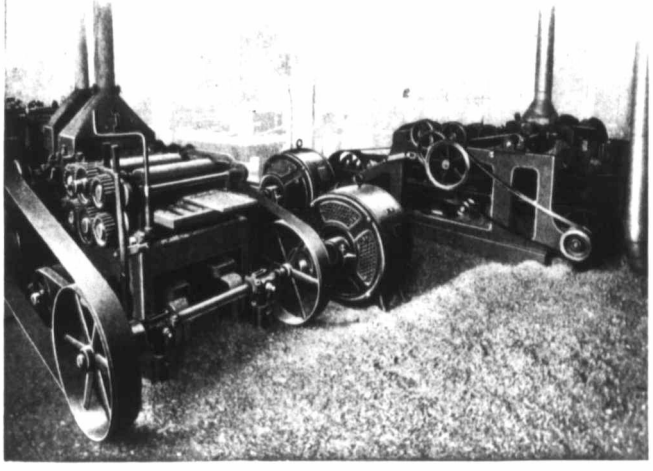
If the machines have regularly recurring periods of load and rest, each of which is comparatively short, such as series of small punching or stamping machines or factory sewing machines, several of them can be driven profitably by one motor operating a short line shaft. The same is true of a number of automatic machines, such as screw machines, on which the load is fairly constant. The Westinghouse Electric & Manufacturing Company has had many years experience in equipping industrial plants with electric motors



Type S Motor Driving Roots' Foundry Blower



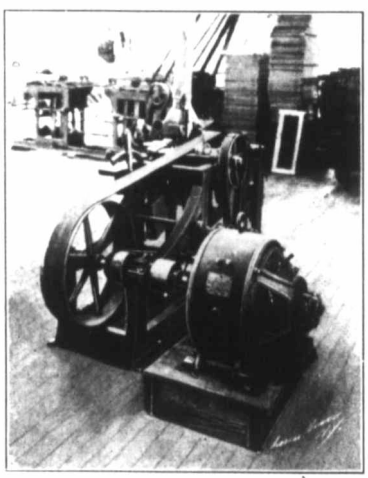
TYPE S MOTOR DRIVING SPINDLE BORER IN WOOD WORKING SHOP



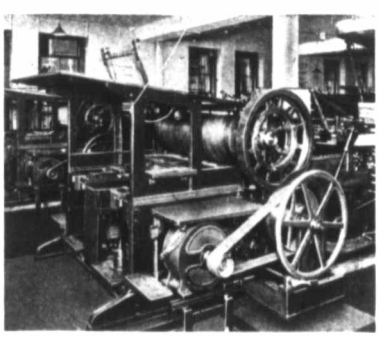
TYPE S MOTORS DRIVING MOULDER AND PANEL RAISER IN WOOD WORKING SHOP

and has in its employ a corps of men who have for years made a specialty of this kind of work. These men have been trained to give careful consideration in each case to the performance of the complete outfit consisting of the machine, the motor, and the controller, and their advice can be had on any proposed installation.

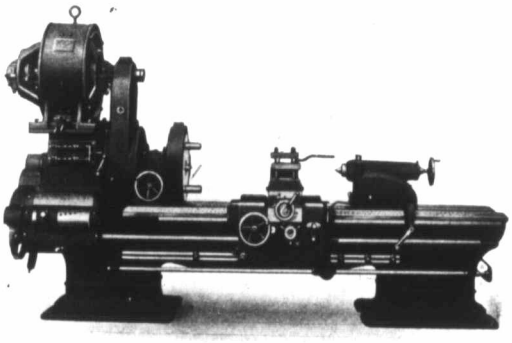
The accompanying illustrations show a number of typical applications of motors to machines. In a publication of this kind, little more can be done than to suggest the possibilities. Illustrations of other applications to machines in any line of industry will be sent on request.



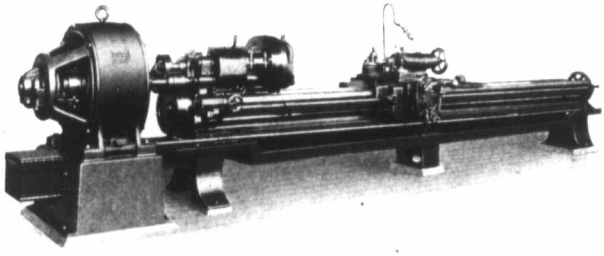
Type S Motor
Driving Sash Sticker in Wood Working Shop



Type S Motor
Driving Miehle Cylinder Press

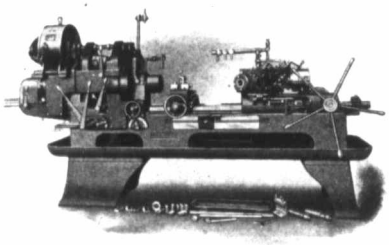


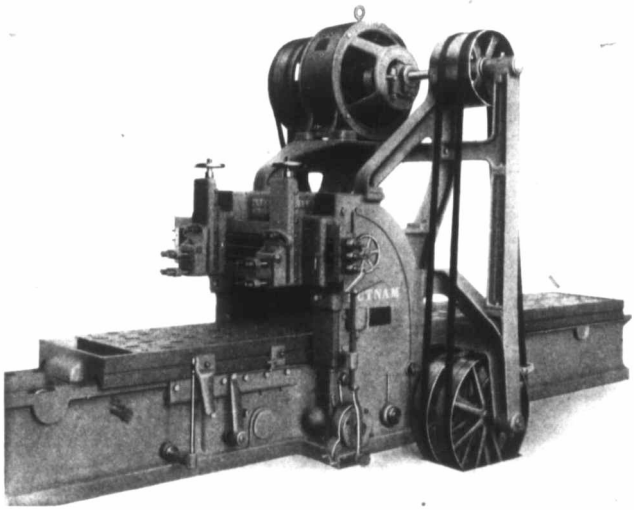
Type S Motor
Geared to LeBlond
Lathe



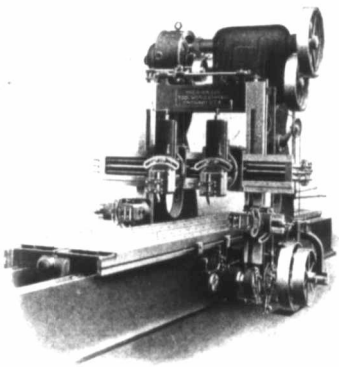
TYPE S MOTOR DRIVING PUTNAM LATHE

Type S Motor
Driving Pratt & Whitney
Turret Lathe

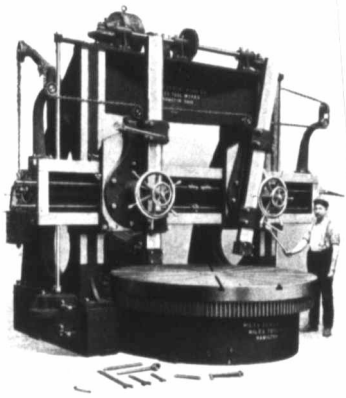




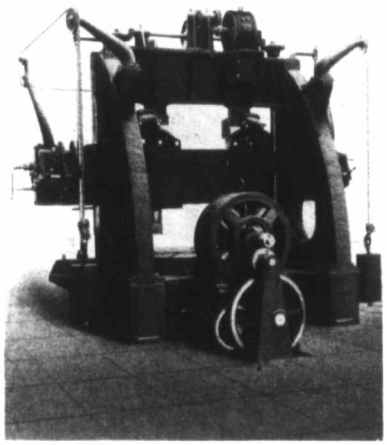
TYPE S MOTOR DRIVING PUTNAM PLANER



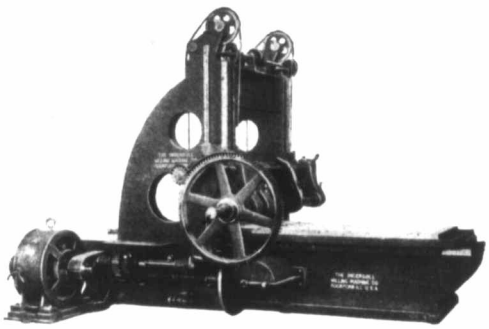
Type S Motor Driving American Tool Works Planer



Type S Motor Driving Niles Boring Mill

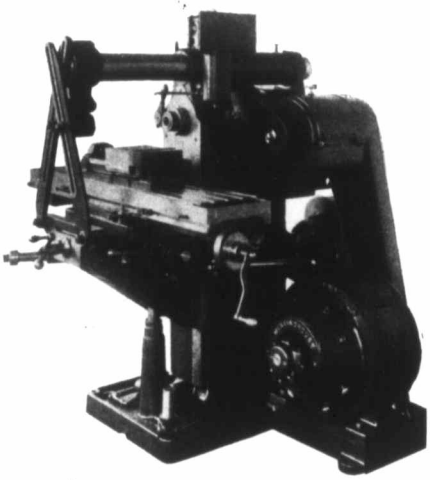


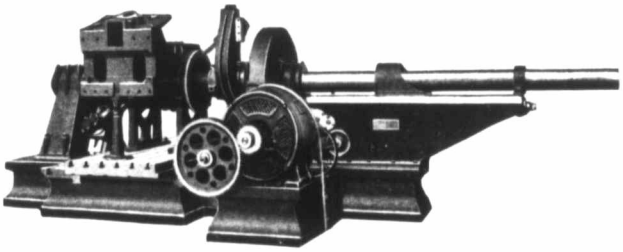
Type SA Motor
Geared to Niles Boring Mill
Also Type S Motor For
Adjusting Position
of Cross Head



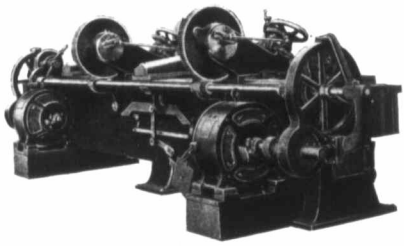
Type S Motor
Driving
Ingersoll Miller

Type S Motor
Driving
Cincinnati Miller

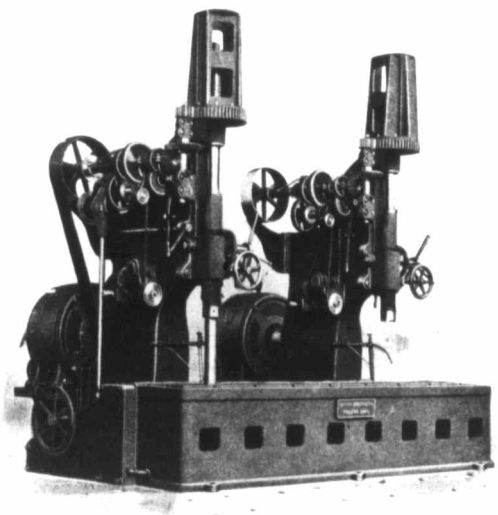




TYPE S MOTOR GEARED TO CYLINDER BORING MACHINE

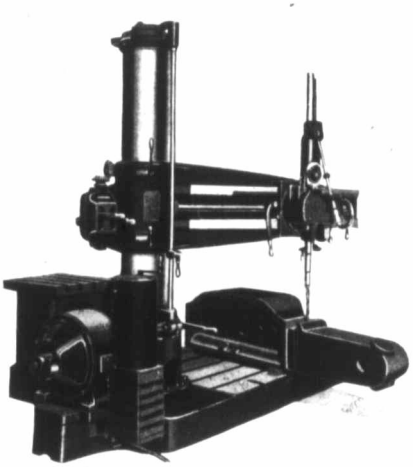


Type S Motors
Driving Double Head Transverse Cincinnati
Shaper

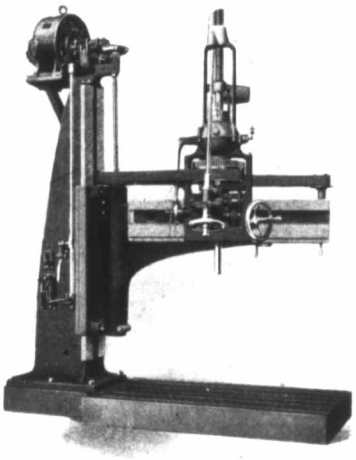


Type S Motor Driving Baker Bros. Double Spindle Rod Boring Machine

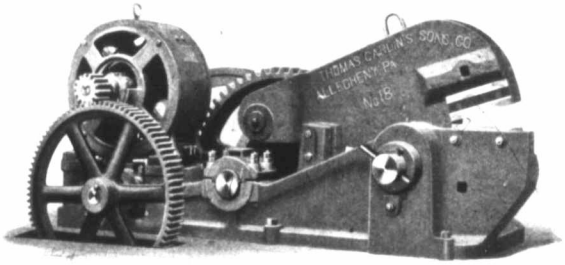
Each Head Driven by a Direct Belted Motor



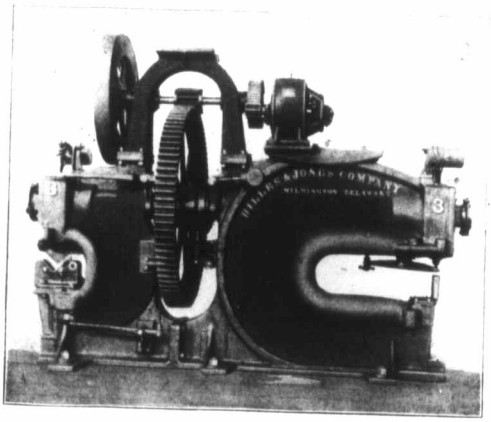
Type S Adjustable Speed Motor Driving Rickford Radial Drill



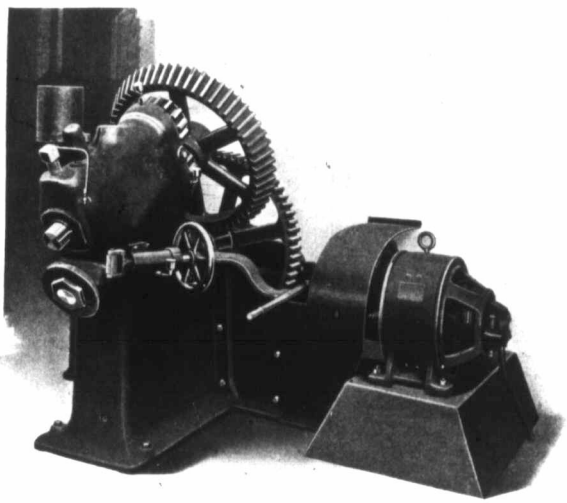
Type S Motor
Geared to Niles Radial
Drill



Type S Motor
Geared to
Carlin's Heavy
Shears

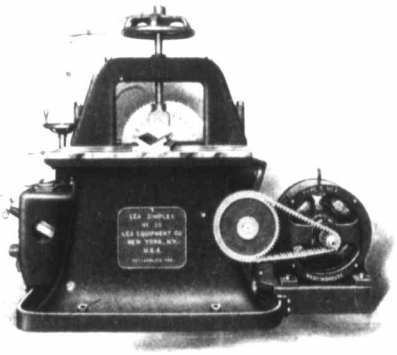


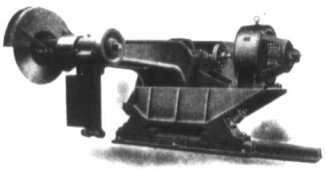
Type S Motor
Geared to
Hilles & Jones Heavy
Punch and Shears



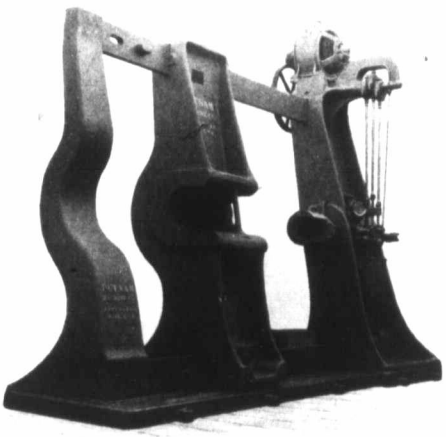
Type S Motor
Geared to
Lenox Bevel
Shears

Type S Motor
Driving Lea Cold Saw
by Means of
Morse Silent Chain

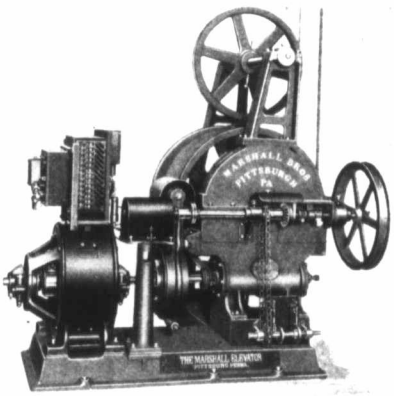




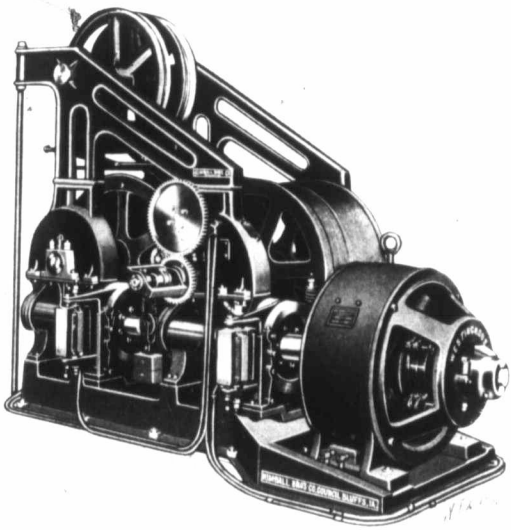
TYPE S MOTOR COUPLED TO UNITED ENGINEERING
42-IN. DROP HOT SAW



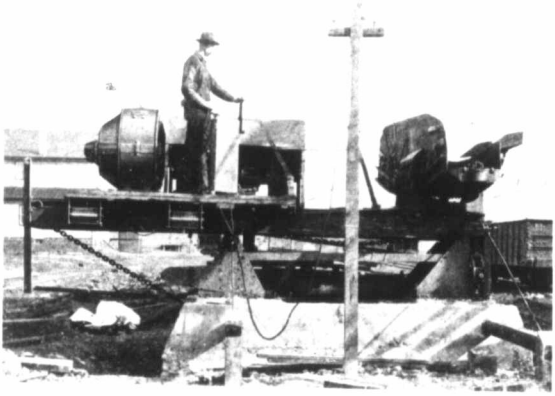
Type S Motor
Geared to Putnam
Hydrostatic Wheel Press



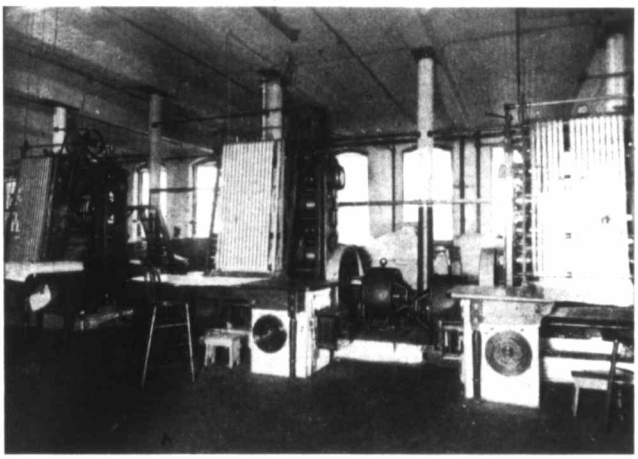
Type S Motor
Driving
Marshall Elevator
Hoist



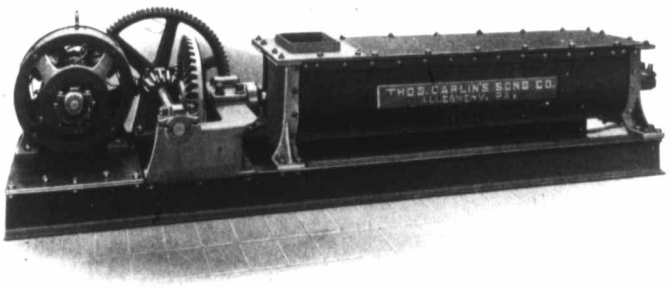
Type S Motor
Driving
Kimball Elevator
Hoist



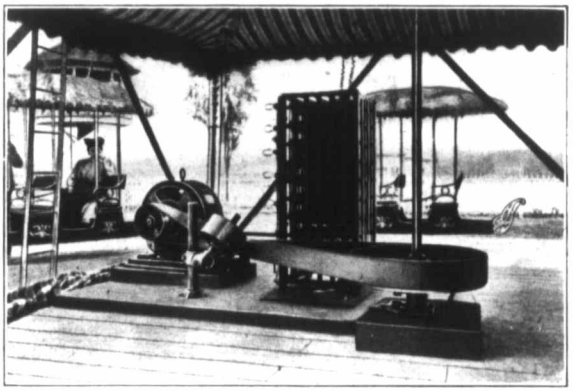
TYPE S MOTOR DRIVING OTTUMWA BOX CAR LOADER



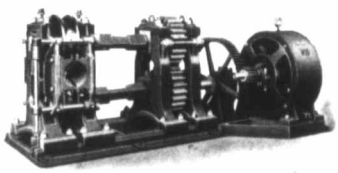
TYPE S MOTOR OPERATING PAPER CALENDER



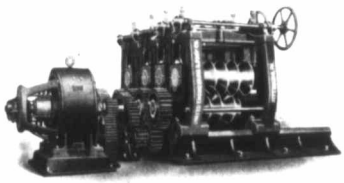
TYPE S MOTOR GEARED TO CARLIN'S CONCRETE MIXER



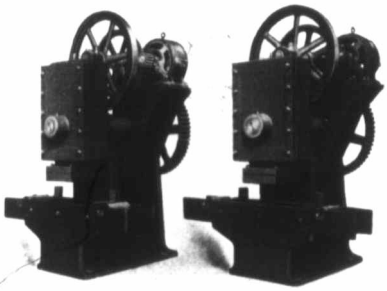
TYPE S MOTOR BELTED TO CIRCLE SWING



Type S Motor Geared to United Engineering 4 Pipe Sizing Machine

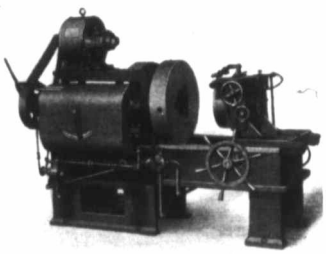


Type S Motor Geared to No. 0 Angle Straightening Machine

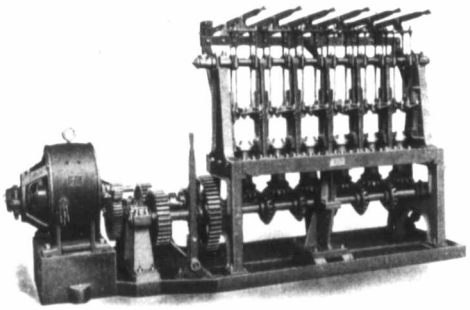


TYPE S MOTORS GEARED TO UNITED ENGINEERING RAIL STRAIGHTENING MACHINES

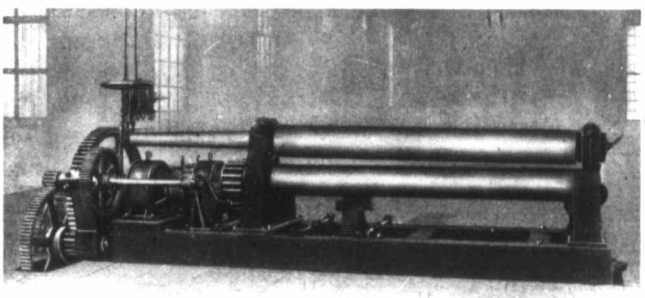
Type S Motor Geared to 54-Inch Plate Shear—United Engineering & F'ndry Co.



Type S Motor Driving Stoever Pipe Threader

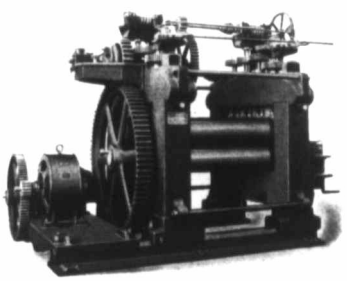


Type S Motor
Geared to Pipe Coupling
Tapper
United Engineering &
Foundry Company

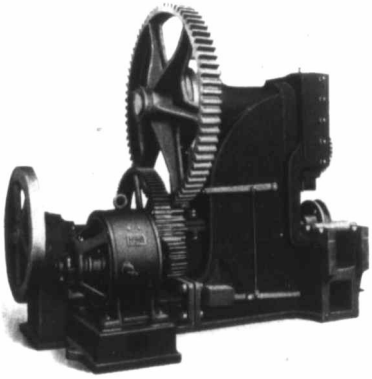


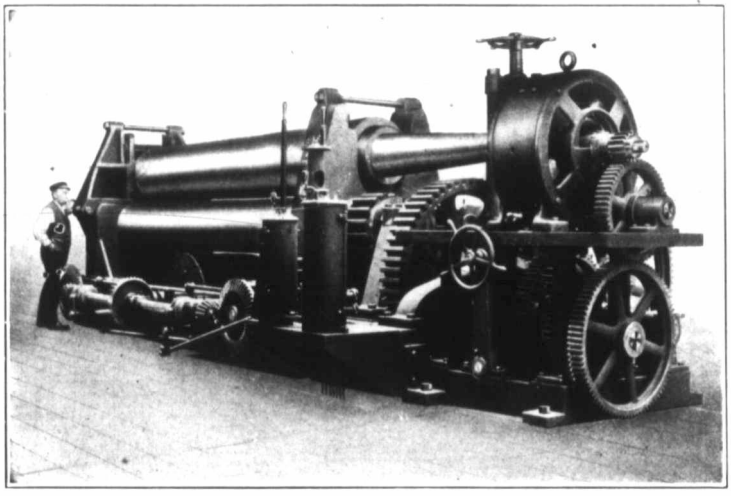
TWO TYPE S MOTORS GEARED TO PLATE ROLLS
ONE MOTOR FOR ELEVATING AND ONE FOR DRIVING

Type S Motor Geared to
United Engineering
Plate Straightening Roll



Type S Motor Geared to 6-Inch Pipe Straightening Machine United Engineering & F'ndry Co.





TYPE S MOTOR GEARED TO BENDING ROLLS

ALPHABETICAL LIST OF CIRCULARS

In Force May 15, 1908

SUBJECT		Circular No.	Date of Issue
Alternators	Revolving Field	1133	May, 1907
Ammeters	See Meters		
Arc Lamps	Multiple Alternating Current	1092	June, 1907
	Direct Current Multiple	1102	May, 1907
	Direct Current Series Multiple	1103	April, 1906
	Metallic Flame	1145	June, 1907
Arc Light System	Series Alternating	1084	May, 1907
Balance Coils		1081	July, 1907
Circuit-Breakers	Automatic, Carbon Break	1107	Sept., 1907
	See also Oil Switches, etc.		
Compensators for	Alternating Current Circuits	1026	Sept., 1904
Control	Unit Switch System of Multiple	1091	March, 1907
Controllers	Automatic, for Direct Current Motors	1136	Sept., 1906
	For Power, Mining, and Railway Service	1086	July, 1904
	Machine Tool	1142	April, 1907
	Regulating and Reversing, for D.C. Motors	1143	July, 1907
Converter	See Rotary Converters		
Electric Motor Vehicle Equipments		1050	March, 1907
Generators, A.C.	See Alternators		
Generators, D.C.	Three-Wire	1088	March, 1908
	Engine Type	1111	Jan. & May, 1907
	Self-Contained	1115	Feb., 1906
	Type S with ABC Engines	1141	May, 1907
	Type SB with Acme Engines	1140	Jan., 1907
Lightning Arrester	Electrolytic	1146	Sept., 1907
	See also Protective Apparatus		
Mercury Rectifier	Battery Charging Outfits	1148	Aug., 1907
Meters	Switchboard Indicating	1098	Feb., 1905
	Portable Testing	1104	Jan., 1908
	Electrostatic Voltmeter	1130	Sept., 1907
	Graphic	1131	Dec., 1906
	Integrating Wattmeter for A.C. and D.C. Circuits	1137	Dec., 1907
Motors, Small Power	For A.C. and D.C. Circuits	1128	June, 1907

ALPHABETICAL LIST OF CIRCULARS

In Force May 15, 1908 Continued

Canadian Westinghouse Co., Limited

GENERAL OFFICES AND WORKS: HAMILTON, ONTARIO

OFFICES

Traders' Bank Building, TORONTO

Sovereign Bank of Canada Building, MONTREAL

Walsh Block, Pender St., VANCOUVER

922-923 Union Bank Building, WINNIPEG

158 Granville St, HALIFAX

THE BRITISH WESTINGHOUSE ELECTRIC & MFG. COMPANY, LIMITED

Registered Office—LONDON, Westinghouse Building, Norfolk Street, Strand, W. C.
Head Office and Works—MANCHESTER, Trafford Park

BRANCH OFFICES

BIRMINGHAM, Central House, New Street—CARDIFF, 102 St. Mary Street—GLASGOW, Castle Chambers, 65 Renfield Street—NEW CASTLE ON TYNE, Collingwood Bldgs., Collingwood Street—MANCHESTER, Haworths Building, 5 Cross Street—SHEFFIELD, Market Place Buildings
For South Africa—JOHANNESBURG, Consolidated Bldg., Tel. Address "Converter Johannesburg"

AGENTS

For Australia, New Zealand and Tasmania—Noyes Bros.—SYDNEY, 109 Pitt Street—MELBOURNE, 153-7 William St.—DUNEDIN, 1 Crawford Street—PERTH, Commercial Bank Chambers, St. George's Terrace—BRISBANE, 45 Adelaide Street—WELLINGTON, CHRISTCHURCH & DUNEDIN, Turnbull & Jones, Ltd., Selling Agents
For India, Upper and Lower Burmah—CALCUTTA, Jessop & Co. Ltd., 93 Clive Street.
MEXICO—G. & O. Braniff & Co., City of Mexico
NEWFOUNDLAND—Reid Newfoundland Co., St. John's.
JAPAN—Takata & Co., Tokio.
CHINA—Takata & Co., Shanghai.
CUBA—Charles H. Thrall & Co., Havana.
BRAZIL—Trajano de Medeiros & Co., Rio de Janeiro.
CHILE, PERU, BOLIVIA AND ECUADOR—J. K. Robinson, Iquique, Chile.
SWEDEN—The Amalgamated Electric Co., Stockholm.
NORWAY—Elektrisk Bureau, Christiania.
EGYPT AND SOUDAN—Orenstein & Koppel, Alexandria, Cairo & Kartoum.
ARGENTINE REPUBLIC, URUGUAY AND PARAGUAY—Agar, Cross & Co., 124 Calle Defensa 128, Buenos Aires.
BULAWAYO—Sykes & Co. (for Rhodesia)
BOMBAY—Bradbury, Brady & Co.

SOCIÉTÉ ANONYME WESTINGHOUSE

2 Boulevard Sadi Carnot, LE HAVRE, FRANCE
for France, Belgium, Spain, Holland, Switzerland, Italy, Portugal, their colonies and countries under their protectorate

WESTINGHOUSE ELECTRIC COMPANY, LIMITED

4 Rue Auber, Paris France

WESTINGHOUSE ELECTRICITÄTS-ACTIENGESELLSCHAFT

51 Dorotheenstrasse, BERLIN, N. W. 7—for Germany, Hungary (including Bosnia and Herzegovina), the Balkan States, Greece, Turkey in Europe and Asia

SOCIÉTÉ ELECTRIQUE WESTINGHOUSE DE RUSSIE

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WESTINGHOUSE ELECTRIC & MFG. CO.

PITTSBURG, PA., U. S. A

for North America, South America (except British and French Possessions), Cuba, Puerto Rico, Hawaiian Islands, China (except British Possessions and Dependencies) and Japan