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POWER  
FOR PRINTERS'  
MACHINERY

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# POWER FOR OPERATING MACHINERY IN PRINTING HOUSES

A TREATISE ON THE METHODS OF  
APPLYING POWER TO PRINTING PRESSES  
AND ALLIED MACHINERY, WITH  
PARTICULAR REFERENCE TO  
ELECTRIC DRIVE

BY

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COMMERCIAL ENGINEER  
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OF GENERAL ELECTRIC COMPANY



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## PREFACE

**M**ODERN printing and almost all processes connected therewith require power, and power today means electricity. For such applications electric power is so extensively employed that we may look to the time when every machine used by the printer has an electric motor attached.

It is not necessary for the printer to be an electrical engineer or to give much study to the fundamental theory of electricity, but it is essential that he be familiar with the broad principles which are in universal application and with the what and why of the electrical machines that keep his productive machinery in operation.



## CONTENTS

	PAGE
INTRODUCTION . . . . .	1
ELECTRIC DRIVE vs. SHAFT DRIVE . . . . .	2
DRIVE BY SHAFTING AND BELTS . . . . .	6
ELECTRIC MOTORS FOR PRINTING PLANTS . . . . .	11
ALTERNATING CURRENT . . . . .	13
MOTOR CHARACTERISTICS . . . . .	18
DIRECT CURRENT MOTORS . . . . .	18
CONTROLLERS . . . . .	22
DIRECT CURRENT—CONSTANT SPEED MOTORS . . . . .	22
DIRECT CURRENT—VARIABLE SPEED MOTORS . . . . .	23
ALTERNATING CURRENT CONTROL . . . . .	26
SELECTION AND CARE OF APPARATUS . . . . .	28
REVIEW QUESTIONS . . . . .	31
GLOSSARY OF TERMS . . . . .	34



## POWER-OPERATED MACHINERY IN PRINTING HOUSES

**T**HE art of Printing, and all the allied processes which lead up to and follow it, are so dependent upon power operated machinery that it is necessary for any one closely concerned with the actual working of the art to be acquainted with the principles and practices of the power employed.

The practical printer, electrotyper, engraver, or any of his brothers, should not only be familiar with the tools and machines used in his trade, but with the methods of driving those machines which are not operated by hand, as the successful operation of the machine often depends as much on a proper driving equipment as on the machine itself.

In considering the application of power we may divide the various power-driven machines used in the printing and allied trades into two general groups: those driven at one speed only, which we may call constant speed machines, such as paper-cutters, wire-stitchers, and many other machines used in bookbinding, electrotyping and stereotyping machinery, etc., and those which are operated at a number of different speeds, such as printing presses, folding machines, etc. These two classes of machines require different treatment from the standpoint of the driving equipment.

The sources of power are as follows: 1: A general system of overhead shafting and belts, driven from a main shaft operated by a steam engine, gas engine, electric motor, or sometimes by a water wheel. 2: A number of smaller sets of shafts and belts serving a small group of related machines, each group driven by a single constant speed motor; and, 3: An individual electric motor on each machine, driving it by belt, gear, chain, or direct coupling.

### *Electric Drive vs. Shaft Drive*

It is not within the scope of this booklet to enter into a detailed discussion of the relative merits of shaft drive and electric drive for printing houses. Indeed, the question is now very seldom argued, as the advantages of electric drive are so generally recognized that practically no new printing houses are established without individual electric drive, and existing plants now equipped with overhead shafting and belts are everywhere changing over to the more modern method of drive.

It is important, however, to bear in mind the various advantages of individual electric drive, so that the proper care in the selection and installation of motors may be taken to insure these advantages being realized.

The advantages of electric drive with individual motors are as follows:

1. Any desired speed on the machine may be obtained. This advantage applies of course to variable speed machinery only. The possibility of speed variation means that the machine can always be run at a speed best suited to the product at hand, so that the maximum product can be realized at the same time that the best quality of product is maintained. The number of speeds obtainable with overhead shafting and cone pulleys is limited, and in a great many existing plants the pulleys are so laid out that all of the speed steps cannot be used.

2. Individual drive adds greatly to the convenience of the installation. It means the elimination of overhead shafts, belts, and countershafts, giving more light and air. It means that the machine can be set in any position with respect to other machines, or with reference to its place in the line of production, and without any reference to the location of overhead shafts. One machine can easily be moved to another location. Each machine has more space around it. The chances of oil and waste dropping on the stock are eliminated and the bothersome element of floating dust largely avoided. The very appearance of the plant is

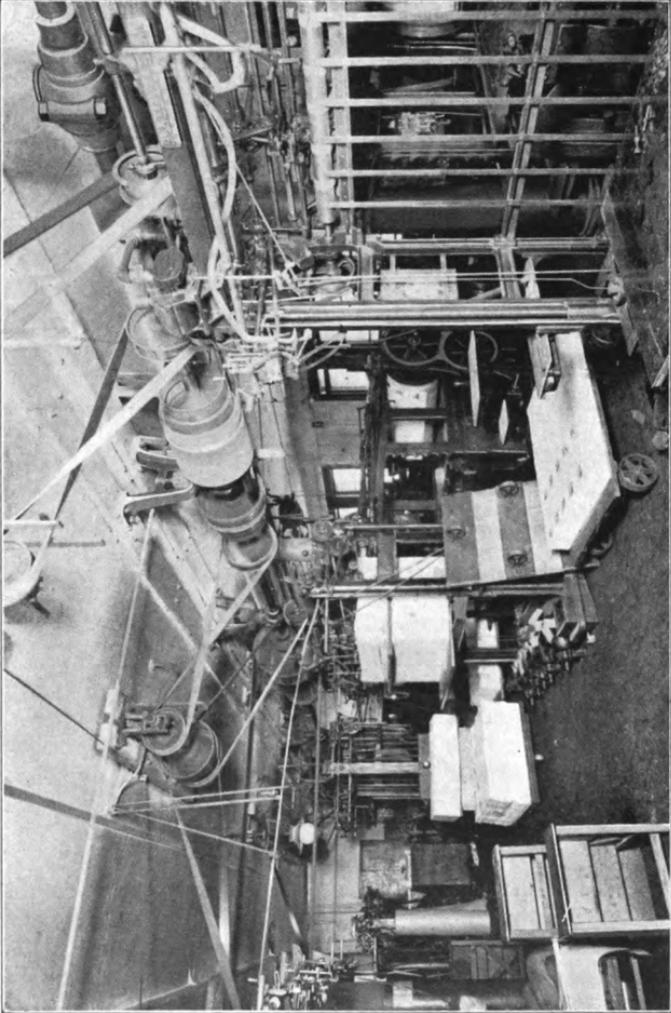
conducive to better workmanship and the working conditions are better.

3. Individual drive of variable speed machinery, such as printing presses and folders, gives much better control of the operation of the machine. By means of the modern systems of automatic electric control the machine may be "inched," started smoothly, brought up to speed quickly and automatically, run at different speeds, and instantly stopped when required, by means of push-buttons. This complete control means the fewest motions required on the part of the operator, no loss of time in making ready, or in changing speeds, no loss of time in stopping, rapid production, and the insurance that the machine is run at the proper speed.

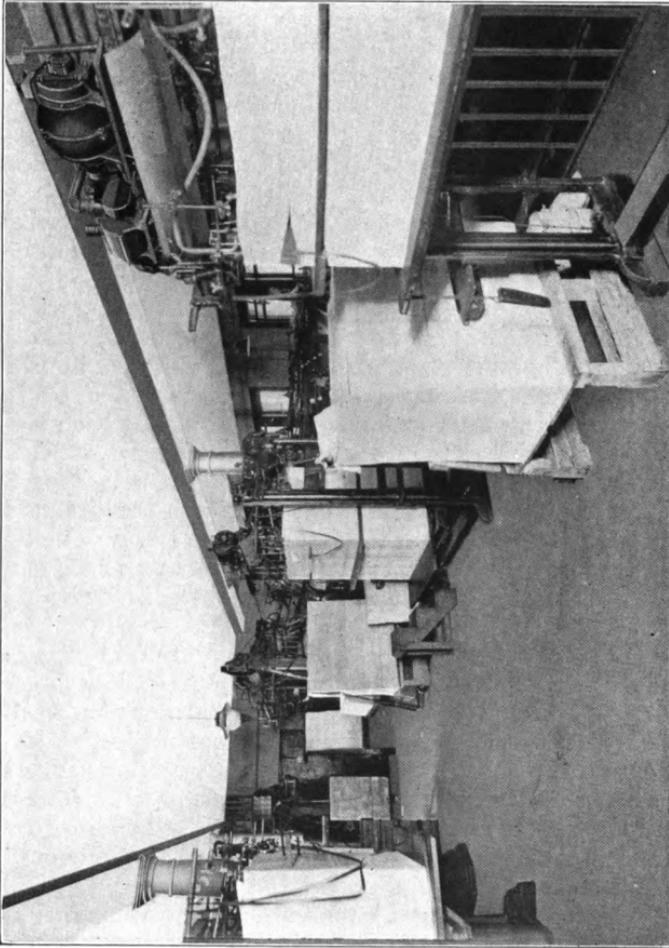
4. Individual electric drive insures the maximum of *safety* to operator and proper protection to the machine. The compact motor, usually set well out of the way under the machine, with guarded belt, and equipped with proper automatic and push-button stop features incorporated in the control, greatly reduces the liability to accident as compared with the shaft drive. It is of great importance, however, that the best authorities be consulted to insure a successful equipment.

5. Individual drive will almost always decrease the cost of power by elimination of the losses in the shafting and belts, which amount in many plants to a very large percentage of the total power input to the plant. This is especially marked where one or two machines are operated overtime in a belt-driven shop. In such cases the intermediate shafting often consumes more power than the machine itself.

6. Individual drive with electric motors is, if properly installed and cared for, subject to very low maintenance expense. Furthermore, accident to the motor on one machine does not tie up the whole plant, as is the case when accident happens to the engine or motor driving an entire shop. If the motor and control apparatus is properly selected with a view to the service requirements and given reasonable care the possibilities of breakdown are reduced to a minimum. It is not often appreciated how much maintenance



*A Press Room before the Installation of Motor Drive.*



The same room after individual motors had been installed.

is required for the ordinary shafting and belts. Electrical machinery, all things considered, is the most reliable of any.

*Drive by Shafting and Belts*

Many existing plants employing belt drive are subject to improvement in the application of the drives, and require additions from time to time, so that it is well for the practical printer to be acquainted with the principles of belt drive as applied to a print shop.

The most important step in the beginning is the general lay out. Where all the machines going into one room or bay are known beforehand they can generally be laid out to facilitate the handling of the stock and with a view to their accessibility for the progress of the work, as in a printing and binding plant. The shafting can then be laid out to secure the fewest countershafts and superfluous belts. Many plants give the appearance of never having been laid out, but of having grown by additions, with the result that not only is power lost through shaft friction and belt slippage but, what is worse, the speed of machines at a point remote from the source of power is reduced to too low a value by this slippage. This means a loss of production which can only be overcome by tightening up the belts or changing pulley diameters.

Main and countershafts are generally run at speeds between 100 and 200 revolutions per minute. The lower value was common in older shops, but it is now coming to be recognized that shafts can be run at higher speeds without danger of wearing out too rapidly. Ball-bearing hangers have been extensively introduced to eliminate friction losses, and with these bearings shafts are operated at much higher speeds. The higher the speed the greater is the amount of power a shaft of a given diameter will transmit.

Before the general introduction of electric motors manufacturers of printing presses arranged the gearing of their machines so that the driving pulleys ran at speeds around 100 to 150 revolutions per minute (rpm). This corresponded with the speed of the overhead shafting, so that pulleys of nearly equal diameter could be used on the

countershafting and on the press. This is an important point to remember when it comes to equipping old presses with individual motors, as for such machines, with slow speed driving pulleys, slow speed motors must be used, otherwise the motor pulley will be so small that it will not hold the belt or transmit the power.

With shaft drive each machine requiring variable speed must have a countershaft with cone pulleys, driven from a corresponding cone pulley on the main shaft. There are usually three or four steps on the cones, giving as many different speeds. The driving pulley on the countershaft has a wide flat face, so that the belt can be shifted from the tight to the loose pulley on the press for starting and stopping the machine. Some machines are provided with clutch-pulleys, the pulley and belt running continuously while the shafting is running and the machine proper being started by throwing in the clutch.

One of the most important things to know about belt drives of any sort, whether motor drives or drives from overhead shafting, is how to determine the proper sizes of pulleys to give the desired speeds.

The rule is as follows:—

Diameter of driving pulley=

$$\frac{\text{Diameter of driven pulley} \times \text{RPM of driven pulley}}{\text{RPM of driving pulley}}$$

*Example:*

To illustrate this principle, consider a typical group of machines as shown in the accompanying figure opposite.

The group is driven by a gas engine which runs at 400 rpm and is fitted with an 18" diam. pulley. It is desired to run the main shaft at 200 rpm, so applying the formula:—

$\frac{18 \times 400}{200} = 36$ . A 36" main pulley would be fitted to the main shaft. The auxiliary shaft in the center of the room is to run at the same speed, so we will put the same size pulley on each shaft for the belt by which one is to drive the other.

The cylinder presses are to have a minimum speed equal to one-half maximum, so the cone pulley will be selected

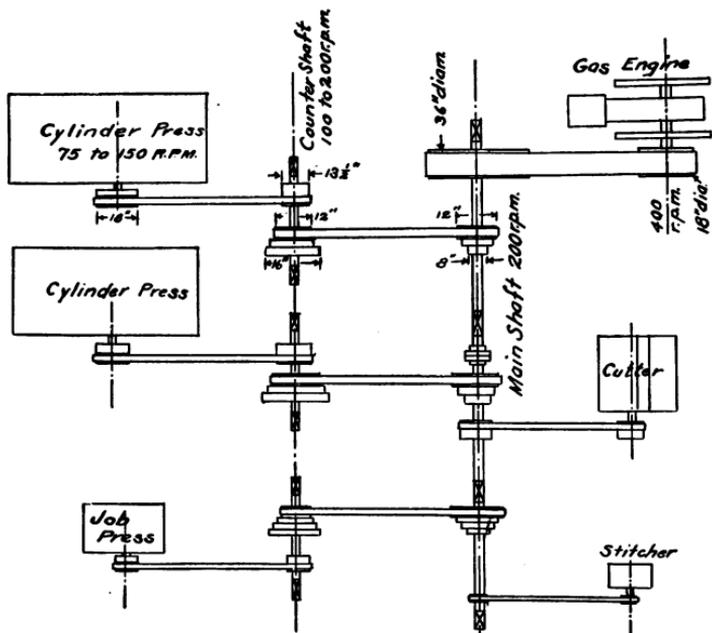


Fig 5  
 Group Drive with Gas Engine.

so that the countershaft will run twice as fast in one position as in the other. Assume that the cone on the main shaft has steps 8", 10", and 12" in diameter. If the cone on the countershaft has corresponding steps 16", 14", 12", the speed of the countershaft will be 200 rpm with the belt on the large step of the first cone, and 100 rpm, or half the high speed, with the belt on the small step on the first cone.

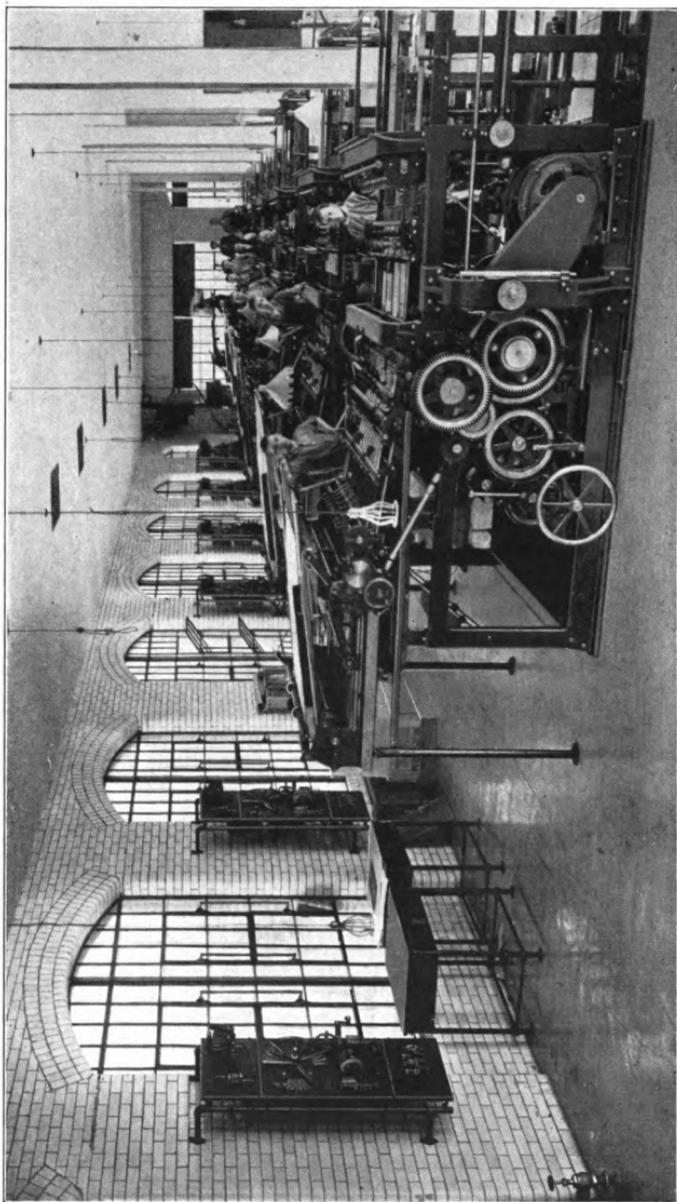
The pulley on the press is to run 150 rpm maximum and 75 rpm minimum. The tight and loose pulleys are 18" in diameter. Therefore a 13½ diam. flat face pulley will be used on the countershaft.

The other pulley diameters are worked out in the same way. The known quantities are the diameter and speed of the machine pulleys and the speed of the shafting.

The pulleys used are of solid iron, split steel, or wood. Solid iron pulleys are best, but split pulleys are satisfactory in many cases and very easy to install on existing shafting. Wood pulleys can be used for light duty and are often employed for small diameters and wide faces for shifting belts. Paper and cork-insert pulleys have adhesive qualities superior to plain iron or steel pulleys, but are not extensively used in ordinary shaft drives. They are very useful, however, for motor drives, especially where conditions are severe.

Much trouble with shaft drives is due to improper attention and care of the belts. Until recently very little scientific study has been given to the subject of belts and in consequence many unsatisfactory installations have been made.

The most common mistakes in the installation of belts are: Belts too narrow to transmit the power required; use of single ply belts where double belts should be used, with resultant inability to transmit power required; use of belts with too much tendency to stretch, resulting in belt becoming loose and slipping; belt joints laced instead of made endless; belts not treated with suitable adhesive and preservative compound; belts treated with too much compound or compound of unsuitable nature; belts soaked in oil, causing them to slip.



Row of Sheet-Feed Rotary Presses equipped with alternating current motors and "full automatic" push-button operated control. The motors have magnetic brakes for quick stopping.

It is recommended that belting experts be consulted in connection with installations of any size, so that belts of the proper grade and size may be selected. Belts should be selected which are of the best quality and preferably "processed" to prevent damage by moisture and oil. A type which reaches a permanent set without excessive stretching should be selected because belt-tightening devices are seldom available in shaft driven plants.

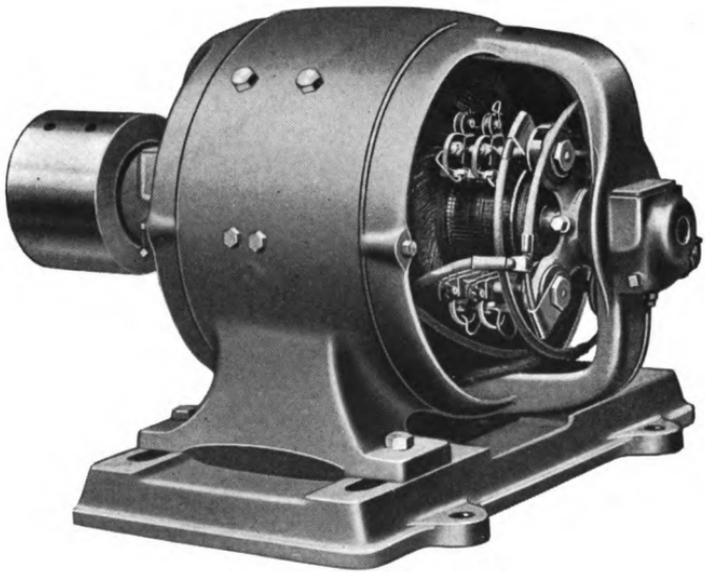
Belts differ greatly according to the care taken in selecting the hides and the tanning process employed. Their transmitting power varies with the distance between pulley centres, ratio between pulley diameters, character of pulley surface, condition of belt surface, degree of tension, and character of load.

Belts must be kept free from oil and at proper tension. They should be endless rather than laced.

### *Electric Motors for Printing Plants*

*Alternating and Direct Current Circuits:* Electric Motors may be divided into two general classes—direct current and alternating current. Direct current is found in the central districts of most large cities, while alternating current is found in the outlying districts and in most medium and small cities and towns. The reason for this is that alternating current can be more economically transmitted over long distances. The alternating current circuits are increasing in number. Many cities are changing as rapidly as possible their direct current lines to alternating current lines, especially where the former is 500 volts, because the lighting and power companies can give better and cheaper service in alternating current than direct current.

Direct current is supplied over two wires for power and over three wires for lights. With a "three-wire system" the voltage is usually 230 between the two outer wires, and these two are used for motors, and 115 volts between either outside wire and the middle wire or "neutral." The lamps are connected on the 115 volt arrangement.



**Direct Current Commutating Pole Type Printing Press Motor.**

Direct current for printing plants, when purchased, is usually 230, except in a few towns that still supply 500 volts. There are a number of private plants in large printing establishments, however, that supply 115 volts.

The standard "low" voltage d. c. (direct current) motors are 115 and 230 volts, and these can usually be safely operated on 110-120, or 220-240 volts respectively. The speed will vary almost in proportion to the voltage.

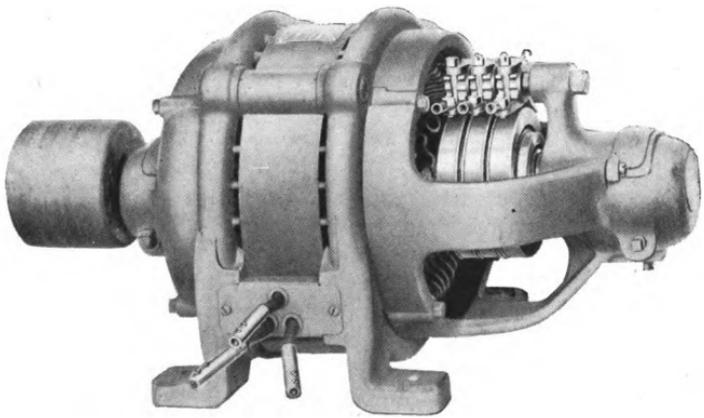
230 volt apparatus is preferable to 500 volt because the higher voltage is more dangerous and more apt to give trouble. The 500 volt apparatus is for this reason more expensive. 230 volt apparatus is preferable to 115 volt because it involves half the current for the same power and hence needs much smaller supply wires and the controller parts can be made lighter and less expensive.

### *Alternating Current*

The growth of alternating current circuits in this country was not accompanied by a great deal of standardization in its early stages and there are accordingly a wide variety of different kinds of circuits which require different motors to operate on them.

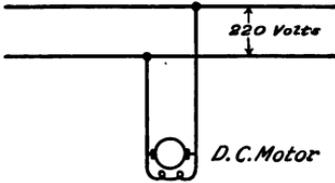
Alternating current circuits have three aspects or characteristics, each of which has to be known when motors are being ordered—the *phase*, the cycles or *frequency*, and the *voltage*.

Most alternating current systems are *three phase*, requiring three wires. Any two of these lines, considered by themselves, constitute a *single phase* system. Thus, by tapping off a two-wire feeder from the three phase system we get a single phase line. For example, a three phase system in a large town may have a number of single phase lines running out into the suburbs. Single phase is of course all that is needed for lights, but motors to operate on single phase lines are more expensive and not so simple as three phase motors except in sizes below one horse power. Three phase (or two phase, see page 16) should accordingly be secured by a printing plant wherever possible.

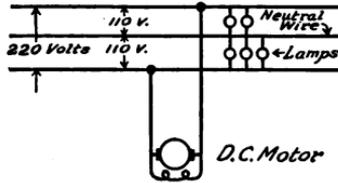


**Three Phase Alternating Current Printing Press Motor,  
variable speed.**

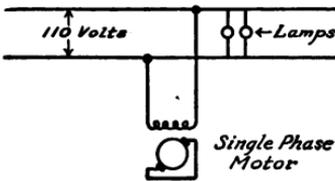
**DIRECT CURRENT  
2-WIRE 220 VOLTS**



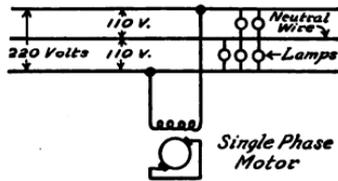
**DIRECT CURRENT  
3-WIRE 110-220 VOLTS**



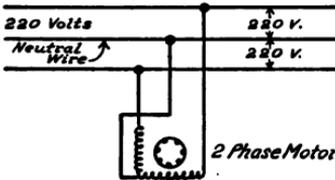
**SINGLE PHASE  
2-WIRE 110 VOLTS**



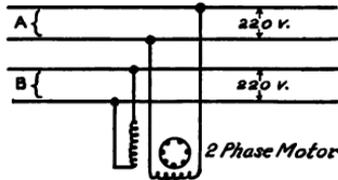
**SINGLE PHASE  
3-WIRE 110-220 VOLTS**



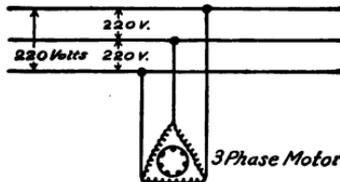
**TWO PHASE  
3-WIRE 220 VOLTS**



**TWO PHASE  
4-WIRE 220 VOLTS**



**THREE PHASE  
220 VOLTS**



*Diagrammatic Representation of  
Different Electric Circuits.*

Many large districts have *two phase* instead of three phase circuits, for example the United Electric Light and Power Company circuits in upper Manhattan and the Bronx, and the North Jersey circuits of the Public Service Corporation of New Jersey.

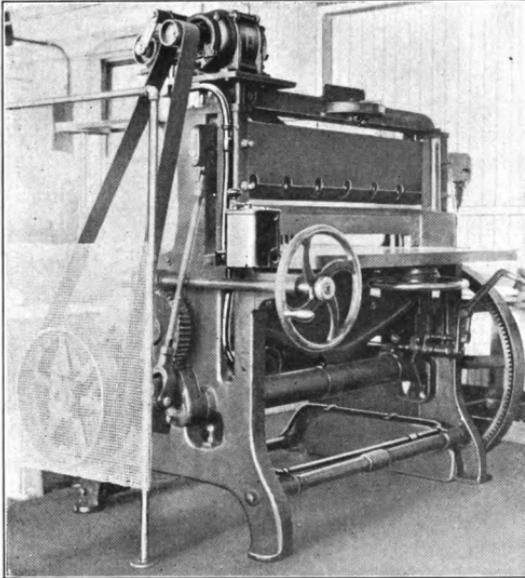
A *two phase* system has four wires, or sometimes three, the middle one being a sort of neutral in this case. The use of two phase in the districts where it is employed arose from the fact that the lighting load can be balanced a little more easily than on three phase. Most new systems, however, are three phase.

Two phase and three phase motors are alike in their operating characters, and are of the same size and cost for the same output, but *three phase motors cannot be run successfully on a two phase circuit or vice versa.*

Single phase motors can be run on any two wires of a two or three phase circuit. Many power companies require the use of single phase motors in sizes under three or five horse power in certain districts, but from the standpoint of the printer the two or three phase is preferable except in the smaller sizes.

Alternating current "alternates," or changes its direction, a great many times a second. The number of changes or cycles per second is the frequency. The usual frequency in this country is sixty cycles, and most alternating current power for industrial purposes is *distributed* at this frequency, although a great deal of power is still *generated* at 25 cycles, because this used to work better in the rotary converters which change over a. c. (alternating current) to d. c. for railroads, and other purposes. Much of the power in New York City, for example, is generated at 25 cycles a. c. and converted to 230 volts d. c. Many 25 cycle individual circuits, on which printing plants exist, are in use, for example Buffalo and Niagara Falls. There are a few 40 cycle circuits, such as Albany and Troy, and a few 50 cycles, as Los Angeles.

The early a. c. circuits were single phase, before poly-phase systems were developed, and were operated at 125 or 133 cycles. There are only a very few of these left, however, in small and remote towns in the East.



**Cutter driven by Alternating Current Motor. The motor is mounted on a special bracket on the machine, and is well off the floor. The motor is started and stopped by an enclosed drum type switch at the operator's left.**

Alternating current is supplied to printing plants at 110, 220, 440, or 550 volts in this country. 220 volts is the most common. The 440 and 550 volt circuits are less objectionable on a.c. than 500 volts on d.c., and are in fact quite advantageous on account of the small current required and hence the smaller supply wires needed.

### *Motor Characteristics*

It is of importance to be thoroughly familiar with the main characteristics of alternating and direct current motors, as affecting their operation on printing machinery, in order to select them with intelligence and profit.

### *Direct Current Motors*

Direct current motors are classed according to their windings; as shunt, series, and compound wound.

Shunt wound motors have a speed at no-load 5 to 10% higher than at full load. That is, the speed is practically independent of the load. The shunt motor is used on machines which do not require heavy starting torque, or are not subjected to sudden heavy loads; for example, small job presses, folders, stitchers, saws, blowers, line shaft drive, belted motors on rotary newspaper presses with separate mechanical slow motion.

Series wound motors have a speed which depends on the load, decreasing as the load increases. Series motors are used on street railways and locomotives and cranes, but have little application in printing houses except for the lifting or receiving tables of some sheet delivering web presses, hoists for paper rolls, and kindred applications.

Compound wound motors have a combination of series and shunt windings. The series winding helps to produce a heavy starting torque, and give the motor a speed variation between no-load and full load of between 10 and 30% depending on the design. They are especially suited to flat-bed presses, embossing presses, cutting machines, and, in general, machines requiring heavy starting torque, or having a reciprocating motion, or having heavy fly wheels. When

applied to flat-bed presses, for example, a compound wound motor should start up the press under compression if necessary, and will slow down a little on reversal, thus cushioning itself, and allowing the fly wheel to do some of the work it is intended to do.

The speed of direct current motors is varied by means of inserting a resistance in series with the armature (armature control) or in series with the field (field control). The former method is the cheapest, but the speed reduction obtained is dependent on the load and the current consumed is nearly as much at low speeds (and consequently low power on the press) as at high speeds and high power, so that it is very wasteful of current.

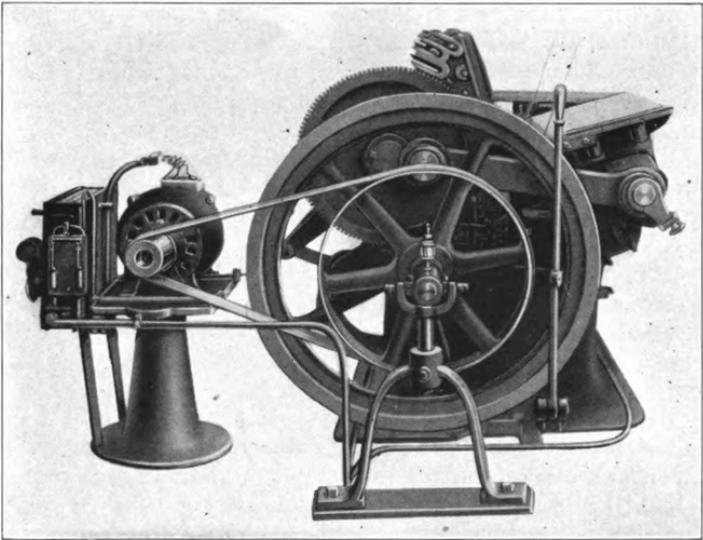
The *normal* speed of a motor is the speed at *full rated load*, hot (with the windings heated up), without resistance in armature or field circuit. Armature control can only *reduce* this speed, usually fifty per cent. If the motor is a 5 HP, for example, the standard resistance reduces the speed 50 or 60%, when the load is 5 HP at *normal* speed. If the load is only 3 HP, the speed reduction will be only about 25% with the same resistance. This point must be remembered.

By inserting resistance in the field circuit the speed is raised, the percentage of increase depending on the characteristics of the motor, the motor speed, and the maximum which the speed of the driven machine will allow. The current consumption throughout the range of field control is in *proportion to the load*, hence is less at low speeds than at high. Therefore field control should be used on direct current motors of any considerable size where it is desired to conduct actual operations on machines at a number of different speeds.

The following example will illustrate the selection and characteristics of a direct current motor.

### *Example*

A motor is desired to operate a No. 3-E Whitlock Press. It is known that three horse power is required.



**Job Press driven by direct current motor mounted on pedestal. An automatic controller is mounted beside the motor. The controller is actuated by a switch linked to the brake lever. The press is started and stopped by releasing and applying the brake lever.**

We cannot now at once select a "standard" speed motor, or the least expensive three horse power motor available. Reference to data on this press shows that its maximum speed is about 2100 impressions per hour, that the maximum diam. of press pulley is 26", and that this pulley makes 5 turns for one impression. 2100 I. P. H. is 35 sheets a minute, and this times 5 gives 175 rpm of the press pulley. Now the press shaft speed in rpm must bear a certain relation to the speed of the motor. In general the motor speed should not be more than 6 times as fast as the press-speed, except in small sizes, since the ratio between the pulley diameters is the inverse of the ratio between the speeds, and to use too high a speed motor may result in a motor pulley so small in diameter that a belt heavy enough to transmit the power cannot bend around it and grip it close enough to prevent excessive slipping, because of the small arc of contact.

In the case in point, 26" divided by 6 gives  $4\frac{1}{2}$ ", which is a large enough diam. for the motor pulley in this instance. 175 rpm multiplied by 6 gives 1050 rpm, which must be the maximum motor speed.

Now as we have direct current in our typical installation we can use some "field control," and get part of our range of speed variation without sacrifice of economy. Let us therefore select a motor running at 825 rpm, *normal*—this being a standard slow speed.

The motor should be compound wound for this class of service.

The controller to be selected will provide for increasing the speed by field control from 825 rpm to 1050 rpm, and decreasing it from 825 to about 450 rpm by armature control.

The above example has been cited because the press has a low ratio, that is, a small number of turns of the fly wheel per impression. There are many such presses, indeed most of the old types were so designed, and the example shows that care must be taken to get the correct data on a press before selecting a motor to drive it.

Presses having high ratios, for example, a New Miehle 4 Roller (12:1), a 10-K Cottrell (9.6:1) Whitlock Premier

GY (13 4/16:1) or a New Babcock No. 11, Optimus (10:1), can utilize to advantage the "standard" speed motors, running at 1000 to 1300 rpm *normal*.

If in our example above the current had been alternating we would have selected a motor rated 900 rpm (60 cycles). In this case the speed variation is all a reduction *below normal*, hence the high speed of press corresponds to normal or full load speed of motor. The pulley would have been 5" in diam. instead of 4½", as the maximum speed is 900 instead of 1050 in the d.c. motor.

### *Controllers*

Quite as important as the selection of the proper motor is the selection of the proper controller. Equipments which would otherwise be successful often fail because of improperly chosen control.

The best results are secured by the purchase of both motor and control apparatus from a thoroughly reliable firm which manufactures both, brings them into harmonious relation, and assumes the responsibility for their combined successful operation.

Automatic control, in which the variable elements of the human equation are very largely eliminated, has now reached so high a state of perfection, and at so reasonable a price, that there is no reason why it should not be installed everywhere.

No attempt will be made here to enter into the development of the modern printing press control, which is one of the most interesting chapters in electrical history, but a brief description will be given of the control devices as they exist today with a view to assisting in the selection of the proper apparatus. The discussion will treat first of direct current and then of alternating current apparatus.

### *Direct Current—Constant Speed Motors*

Small d.c. motors up to ½-HP. may be connected directly to the circuit by means of a snap switch or knife

switch, without a starter, if the motor is compound wound; very slow speed shunt motors, for example, a  $\frac{1}{4}$ -HP. 345-rpm motor for linotype machines, may be similarly started.

Larger motors require a starter to cut down the current inrush and prevent "sticking" of the armature. Hand starters are cheapest, but automatic starters are recommended. The automatic starters require only the closure of a knife or snap switch, or push-button, to start the motor, the cutting out of resistance being automatically performed by the starter. This method saves time, saves wear and tear on the starter, insures smooth acceleration, saves the machine and the motor from shocks, and lessens the possibilities of accident. The starter should be enclosed, if mounted on or near the machine, in a metal box. This is regularly done in electrotyping plants, for example, because of the dirt and black lead, but the time is coming when it will be done in all installations.

### *Direct Current—Variable Speed Motors*

Control apparatus for variable speed motors has passed through many stages, and the development of the electrical art in this particular has been an almost continuous progress towards greater simplicity and reliability, combined with perfect control over all the operations of the machine.

It is through the control that the pressman comes into personal contact with the electrical equipment—for the motor is out of sight and out of mind, usually, and is forgotten so long as it does its work. But every operation of a press, and the larger the press the more will be the number of operations—starting, stopping, slowing down and speeding up, requires some movement of the control apparatus on the part of the pressman.

The modern controller has reduced the operations necessary by eliminating the hand lever of the old controller and substituting a few push-buttons mounted in a well

protected and enclosed box or station. From this push-button station all of the operations of the press are conducted. The controller proper is mounted on the wall or on a post near the press.

For flat-bed and small rotary presses the push-buttons provide for jogging, "inching," starting and running at slow speed, running at maximum speed, (as determined by the position of a hand-set dial on the controller, which provides for a large number of speeds,) slowing down to minimum speed, and stopping.

It is significant of the great progress made in the art that these push-button operated controllers for flat-bed presses sell for little more than the old hand-operated controls, and at the same time they facilitate faster work, involve less lost time in making-ready, secure more even acceleration, require less attention and maintenance, last longer, give less trouble, and, in short, produce more product at less cost and with greater safety to the operator.

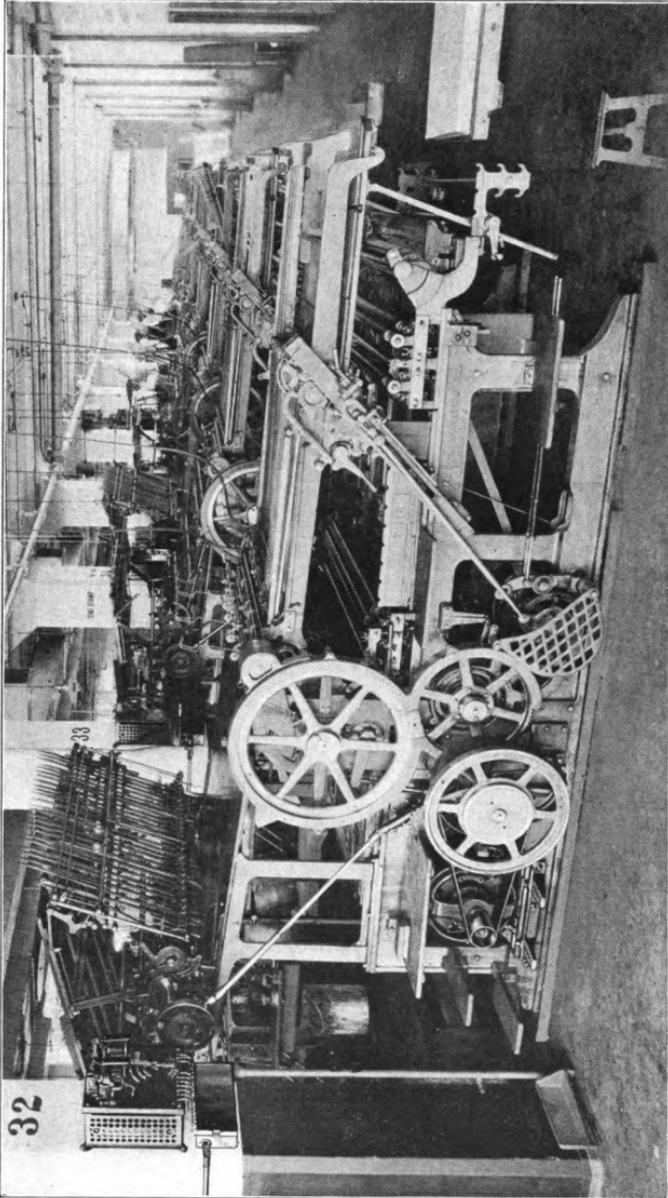
Some little care is to be observed, however, but this is nothing compared with that needed under other systems of manual control, and if the equipment is properly installed it is practically fool-proof.

To secure the best results the motor and control apparatus should be purchased from one firm making a specialty of both for this particular class of service to insure proper coordination and undivided responsibility.

Much trouble results from not properly adapting the controller to the motor or vice versa.

For newspaper web presses, in the large sizes, the control is even more automatic than described above. The machine requires control from a number of different points and special attention to safety and to smooth acceleration. To this end the push-buttons provide for complete control of any speed, high, low, and intermediate, and for a very slow and steady speed for threading in the web. The control of newspaper presses is too complicated a subject for this brief pamphlet, so only passing mention of it can be made.

For job presses, plain speed regulators of various types are used, but here as in flat-bed presses a form of automatic



Row of Flat-Bed Presses equipped with direct current motors and automatic push-button operated predetermined speed control. The controllers are mounted on the pillars at the left. Note the convenient out-of-the-way location of the motor.

control is available which tends towards increased convenience and greater production. The automatic speed regulator for job presses consists of a hand-set dial like that of the ordinary regulator combined with a self-starter. The handle of the dial is set to the position corresponding to the desired speed and the press started and stopped by means of a snap switch, push-button or knife switch. In this way the time of the operator is saved, he has less to attend to so far as the electrical part of the outfit is concerned, and the press is driven at the proper speed.

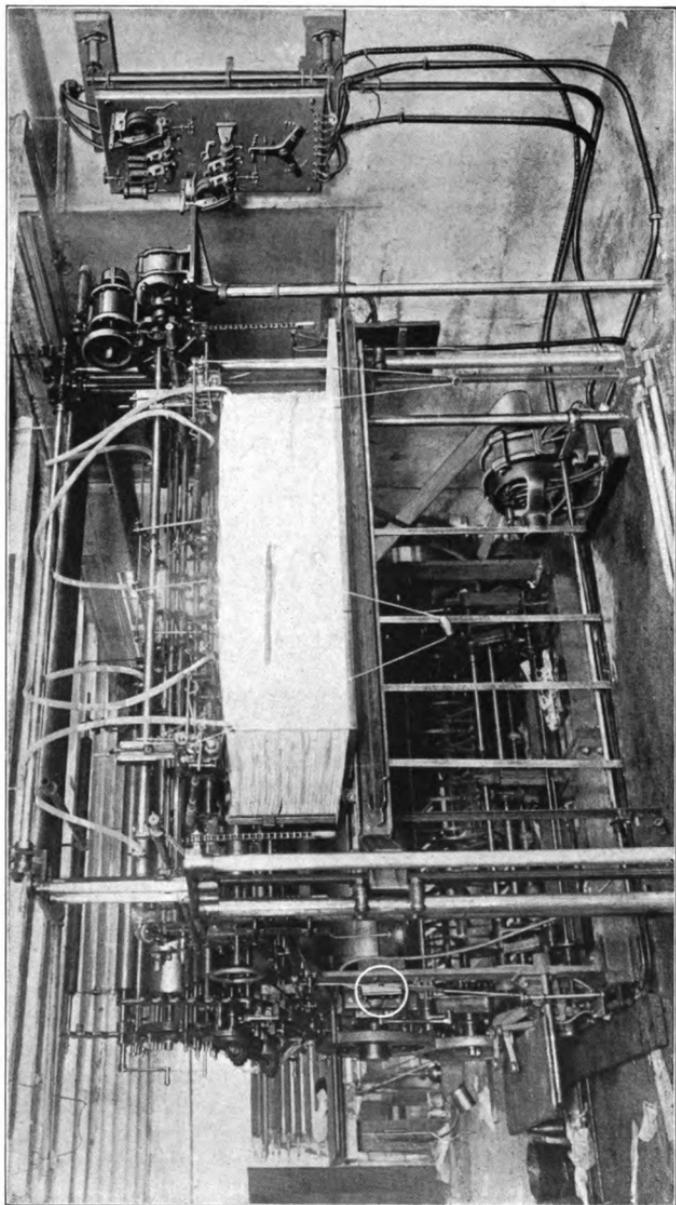
A word should here be said about self-starters for constant speed motors as used on cutters, bookbinding machinery, electrotyping machinery and the like. Self-starters are so cheap and so rugged that they should be used wherever possible, as they save time, protect the motor and machine, and require less attention than hand starters. To start the machine all that is needed is to close a knife switch or push-button.

### *Alternating Current Control*

Alternating current control has reached a point of perfection where the line of apparatus available parallels the better known d. c. control throughout. Aside from certain inherent limitations of the ordinary alternating current motor, such as the absence of field control, the a. c. installation can afford all the features of excellent speed variation, push-button operation, convenience, and substantial construction, enjoyed by the better known d. c. installation.

For the larger flat-bed presses the control is similar to the predetermined-set-speed type described under d. c. control. For the small job presses a dial type regulator is used, which can be set to any desired speed and the motor started and stopped by means of a knife switch.

For the large newspaper presses the automatic push-button control on a. c. is fully as complete and effective as the d. c. control and works in just the same way.



**Rotary Offset Press driven by alternating current motor with automatic push-button operated predetermined speed control. The button station is shown in the circle at the left.**

*Selection and Care of Apparatus*

Control apparatus for electric motors, and especially automatic control, is of course more or less complicated in structure however simple in operation. It is not within the scope of this pamphlet to enter into the theory and detail of electric control.

It is well, however, to point out here a few general points which should be borne in mind because they are matters with which the operators of electrically controlled printing machinery have directly to do.

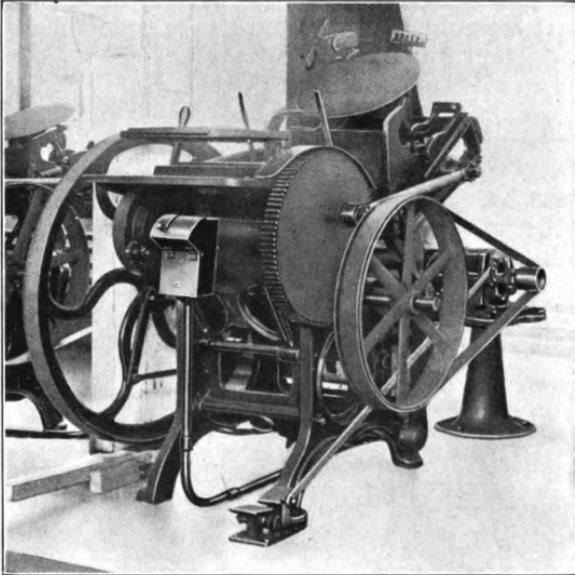
1st. Selection of apparatus. Place the matter of furnishing your control apparatus in the hands of a concern of experience and manufacturing ability and equipped with a competent construction force to install and look after it from time to time.

2nd. Specify clearly what you want to accomplish in the way of speed and output of your machine under different conditions. Do not "for safety's sake" get the equipment so large that it is inefficient or, for the sake of economy in first cost, get an equipment so small that it cannot perform its functions properly.

3rd. Remember that in most forms of control the speed of your machine will depend on the load. A press running without web, paper, form, or rollers does not run so slow with the same control as when fully loaded. This is especially true on alternating current circuits.

4th. Operate the equipment with reasonable care and respect. Don't move controller handles suddenly and nervously. Press push-buttons positively, firmly, and not so quickly and jerkily that contact is not firmly made. A little skill with the electric control is all that is needed and is as easily acquired as any of the other operations about a press.

5th. Electric apparatus requires perhaps less care than any part of the press it operates, but it won't run forever without attention. Keep the motor clean; keep the bearings properly oiled; keep excessive oil away from the motor and belt; keep the controller clean, especially all points that



**Job Press driven by single phase alternating current motor. The motor is mounted on a pedestal and the speed is controlled by a foot treadle, leaving the hands free. An enclosed starting switch is mounted under the feed board, convenient to the operator.**

## 30 SELECTION AND CARE OF APPARATUS

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make contact. Most electrical troubles arise from neglect or abuse of the apparatus. Care for it as you do for the press.

6th. Electricity is now an essential part of a print shop and is an element worthy of regard just as much as the question of oiling the press, caring for the rollers, etc. Do not think you can disregard it. Find out from your electrician or from the man who installs the equipment all you can about how it works and how to care for it. This will be your own insurance against trouble.

7th. If you are buying apparatus, buy with a broad view to your best interests. This does not mean merely getting the cheapest price. The best will always pay for itself in the end. Many a buyer has set up a bargain counter and found that after the lowest bidder had been beaten down lower and secured the contract there was nothing left for service and emergencies. Such a buyer places himself in the end at the mercy of the none-too-willing seller.

8th. When you buy, buy early. Don't wait until the last minute to place your order. Make up your mind, waste as little time as possible, and give the seller plenty of time. Many an expensive delay is thus avoided.

## QUESTIONS

1. Into what two general groups are the machines used in a printing plant divided?
2. What are the sources of the power by which the machines are driven?
3. What method of drive is now generally employed?
4. How many distinct advantages are enumerated belonging to electric drive with individual motors?
5. Name and explain each of these advantages.
6. Why should we study drive by shaft and belt?
7. What is the first thing to consider in a system of shaft drive? Why?
8. What is the general speed of shafting?
9. What made possible the increase of speed?
10. What is the advantage of higher speed?
11. What was the speed of driving pulleys before the general introduction of electric motors?
12. What did this correspond with, and what was the result?
13. What must be remembered if you change from shaft drive to motor drive?
14. What happens if you put a high speed motor on a press with a slow speed driving pulley?
15. What is the rule for determining the proper size of driving pulley to give any desired speed in belt drives?
16. Given an engine which runs at 300 rpm, fitted with a 12-in. pulley, it is desired to run the main shaft at 150 rpm: what size pulley should be fitted to the main shaft?
17. What would you do to make an auxiliary shaft run at the same speed?
18. What device is used to provide for varying the speed of the press?
19. What are the known quantities in figuring the various pulley diameters?
20. Of what materials are pulleys made, and what is the use of each?

21. What is one of the greatest sources of trouble with shaft devices?
22. What are the most common mistakes in the installation of belting?
23. What should be done to avoid these difficulties?
24. What are some of the causes of difference in the transmitting power of belts?
25. What general principles should be observed in installing belting?
26. What are the general classes of electric motors?
27. Where is each class generally found, and why?
28. What change is being made in many cities, and why?
29. How is direct current supplied?
30. What is the usual voltage over a three-wire system?
31. How is power supplied for lamps?
32. What is the voltage usually used in printing shops?
33. What is the relation between voltage and speed?
34. What voltage is preferable, and why?
35. What are the three aspects of alternating current circuits?
36. What is an alternating current system requiring three wires called?
37. What do any two of the three wires constitute?
38. How may the two varieties be combined?
39. Which variety is used for lights?
40. Which variety is used for motors?
41. Which variety should a printing plant have?
42. What is an alternating current system with four wires called?
43. What two kinds of motors are alike in operating characteristics, use and cost?
44. What can you say of the relations between type of motor and kind of circuit?
45. What is an alternating current?
46. What is the meaning of "cycle"?
47. What is the usual cycle in this country?
48. Are generation and distribution at the same cycle rate? Why?

49. What is the usual voltage of alternating current as supplied to printing plants?
50. What comparison can you make between high voltage alternating current and high voltage direct current?
51. Name and describe the three types of direct current motors.
52. Name and describe the methods of varying the speed of direct current motors.
53. What is "normal speed"?
54. What is the effect of each of the methods of speed and control?
55. How can you best secure proper control apparatus?
56. What is the best kind of control apparatus?
57. Describe the starting mechanism of small direct motors.
58. Describe the starting mechanism of larger motors.
59. How does the pressman come into personal contact with the electrical equipment?
60. How are the operations of the press conducted?
61. What can you do with push-buttons on a flat-bed press?
62. What advantages have controllers operated by push-buttons over those operated by hand?
63. What should be done to secure the best results from the controllers, and why?
64. What can you say of the automatic control of web presses?
65. Describe an automatic speed regulator for job presses.
66. What can you say about self-starters for constant speed motors?
67. What can be done in the control of alternating current?
68. What is the control for larger flat-bed presses? for small job presses? for web presses?
69. What eight points should be observed in the selection and care of control apparatus?

NOTE—It will be observed that no questions are given on the example illustrating the selection and characteristics of a direct control motor which appears on pages 19, 20, 21 and 22. This example should be carefully explained by the instructor and its principles illustrated by reference to the machinery in the plant.

## GLOSSARY

- ALTERNATING CURRENT**—That kind of electric current which changes its direction many times a second. Has certain characteristics which make it peculiarly advantageous for some applications.
- ARMATURE**—The revolving element of an electric motor.
- ARMATURE CONTROL**—A method of varying the speed of a motor by inserting resistance in the armature circuit to reduce the speed below normal; speed variation depends on load.
- AUTOMATIC CONTROL**—A method of starting, stopping and changing the speed of a motor whereby push-buttons are used instead of a lever to be moved by hand.
- AUTOMATIC STARTER**—A starting device for electric motors which performs its functions automatically upon closure of a switch or push-button.
- BAY**—A section or division of a large open room or building.
- COMPOUND WOUND**—A type of winding of direct current electric motors which gives a high starting torque and causes them to slow down somewhat on heavy loads, as where a flat-bed press reverses.
- CONE PULLEY**—A pulley having several steps of different diameters.
- CONTROLLER**—A device for varying the speed of a motor.
- COUNTERSHAFT**—An auxiliary shaft parallel to a main shaft and belted to it.
- CURRENT**—The amount of flow of electricity in the wires, measured in units called amperes.
- CYCLES**—The changes per second in direction of flow of alternating current electricity, e.g., *60-cycles*.
- DIRECT CURRENT**—That kind of electric current which always flows in the same direction.
- FIELD**—The stationary element of an electric motor.
- FIELD CONTROL**—A method of varying the speed of an electric motor (direct current only) by inserting resistance in the "field" circuit, to increase the speed above normal. Speed variation independent of load.
- FREQUENCY**—The number of changes per second of flow of alternating current electricity. See Cycles.
- GROUP DRIVE**—A method of applying power to a number of machines in a group by belting them to a countershaft which is in turn driven by one motor.

- HAND STARTER**—A starting device for electric motors operated by hand and not by push-buttons.
- HIGH SPEED MOTOR**—A motor having a normal speed of 1800 revolutions per minute or thereabouts.
- INCHING**—Causing the moving elements of a machine to act through a very small distance.
- INDIVIDUAL DRIVE**—A method of applying power to machines by connecting a motor to each machine.
- INPUT**—The power supplied or drawn from the line by a motor driving a machine.
- KNIFE SWITCH**—An open switch for opening and closing an electric circuit.
- LOAD**—The amount of turning effort required of a motor—measured usually in units of electric current or amperes.
- NORMAL SPEED**—The rated speed of a motor as marked on the nameplate, without resistance in armature or field circuit.
- PHASE**—The characteristic of an alternating current circuit describing the number of current impulses per cycle, e. g., single phase—one impulse per cycle; three phase—three overlapping impulses per cycle.
- POLYPHASE**—More than one phase, i. e., two or three phase.
- PREDETERMINED SPEED CONTROLLER**—A push-button operated controller for electric motors which brings the motor speed up to a point determined by the position of an arm on the controller, the arm being adjustable.
- RATIO**—The number of turns of the fly wheel of a press for one impression, e. g., a press having 12 turns is said to be "high ratio."
- REGULATOR**—Same as controller, but usually applied only to hand-operated speed changing devices. Applied also to any device for regulating some part of the electric circuit.
- RESISTANCE**—A system of wires or other material which impedes the flow of electric current and reduces the electric pressure or volts.
- SELF-STARTER**—Same as automatic starter.
- SERIES WOUND**—A type of winding of direct current motors which gives a very high starting torque and causes the motor to run very slow at heavy loads and very fast at light loads.
- SHUNT WOUND**—A type of winding of direct current motors which gives a moderate starting torque and causes the motor to run at constant speed with varying load, except as varied by a controller.
- SINGLE PHASE**—A type of alternating current circuit involving a single current impulse per cycle and requiring only two wires.
- SLOW SPEED MOTOR**—A motor whose normal speed is from 400 to 800 revolutions per minute.

- SNAP SWITCH**—An enclosed switch for making and breaking electric circuits, with a snap or quick brake action.
- STEP**—A division of an electric controller, giving a change in speed, e. g., "50% speed reduction in 8 steps."
- THREE PHASE**—A type of alternating current circuit requiring three wires and involving three current impulses per cycle.
- THREE-WIRE SYSTEM**—A method of connecting wires for a direct current or single phase circuit whereby two two-wire circuits are combined and one wire omitted. Not the same as three phase.
- TORQUE**—The turning effort or pull of an electric motor.
- TWO PHASE**—A type of alternating current circuit requiring three or four wires and involving two current impulses per cycle.
- VOLTAGE**—The electric pressure under which the electric current flows. The pressure is measured in units called volts.

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