The Use of Leather Belting in the Transmission of Power, III

The Third and Last Article, in Which the Authors Discuss Short Center Driving With Flat Belts, Pivoted Motor Drives, and Belts for High-Torque Motors.

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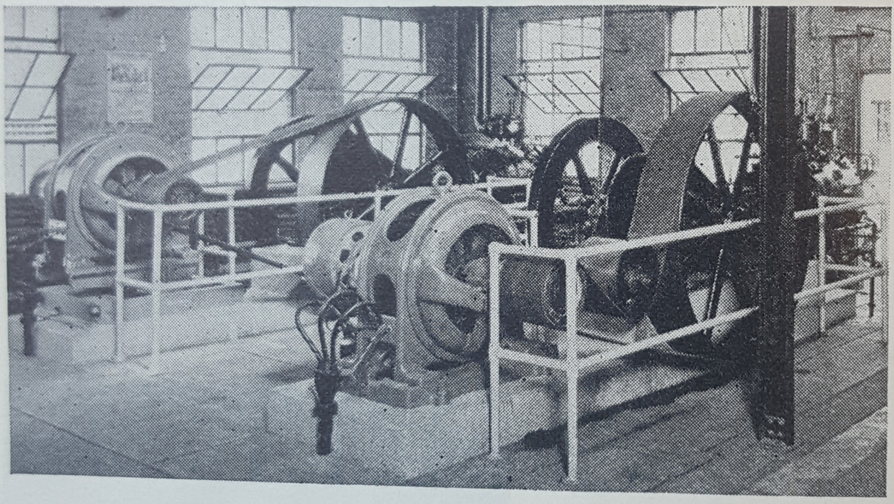
IN the two preceding articles of this series, the authors have attempted to show the desirable features of motorized group drive. The present discussion covers particular individual applications in a group-driven shop, where the drive is in each case confined to the driving of one machine. The drives under discussion are usually referred to as "short center drives." These drives are of two types.



Westinghouse synchronous motors driving 110 h.p. air compressors. The compressor in the foreground is equipped with an idler drive, but the idler is unbalanced and the tension, therefore, is increased instead of decreased. The drive on the compressor next to the window is a Rockwood drive with automatic tension control.

Swinging Binder Drives—The type of drive with which a binder pulley is used is of older origin and in many cases has been so badly engineered that the belt has given trouble and, of course, has carried all the blame. Consequently most belting manufacturers have looked with disfavor upon this type of drive. In any case, the drive places many hardships upon the belt. The worst features of the binder type can, however, be minimized by proper engineering.

Short Center Drives—The best belting practice has always called for the use of the "long center drive," in which the driving pulley is relatively far from the machine to be driven, and a correspondingly long belt is required. Such a drive has one great advantage: the weight of the belt in the slack side prevents the tension in that side from becoming too small when the load is applied. This results

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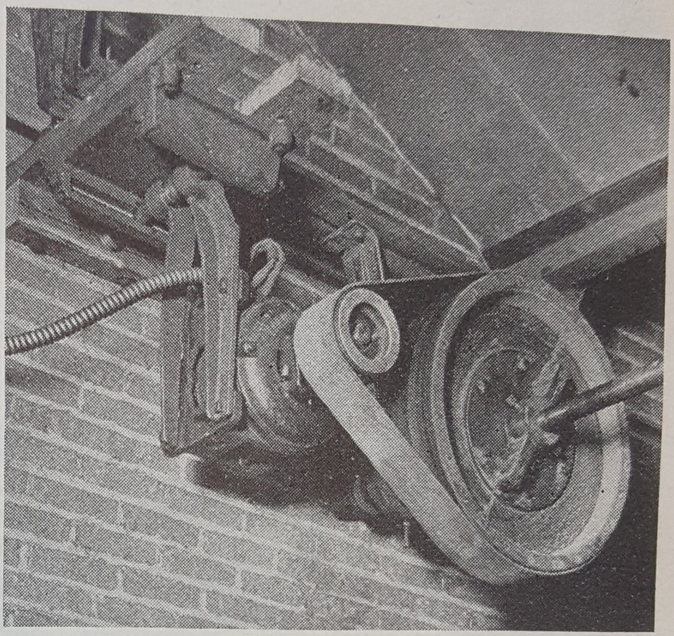
in a considerable increase in the power that can be transmitted without undue slip. When the slack side is above, there is the further advantage of a somewhat larger arc of contact.

At present, however, there is a decided trend toward the "short center drive." This is due in part to economy of floor space, together with the increasing use of the electric motor as a prime mover, and in part to the tendency of machine designers to incorporate the motor as an integral part of the machine to be driven. This drive has advantages, although it often involves unnecessarily high initial and operating costs.

Use of Gravity Idlers—The high speed at which induction motors run generally makes necessary a considerable speed reduction, which is often secured by using a large pulley on the driven shaft and a relatively small one on the motor. The combination of high pulley ratio and short center distance gives an arc of contact often much less than 180 degrees. This circumstance, together with the low tension on the slack side of the belt due to lack of sufficient belt weight, renders this drive both inefficient and unreliable unless excessive belt tension is applied and carefully maintained.

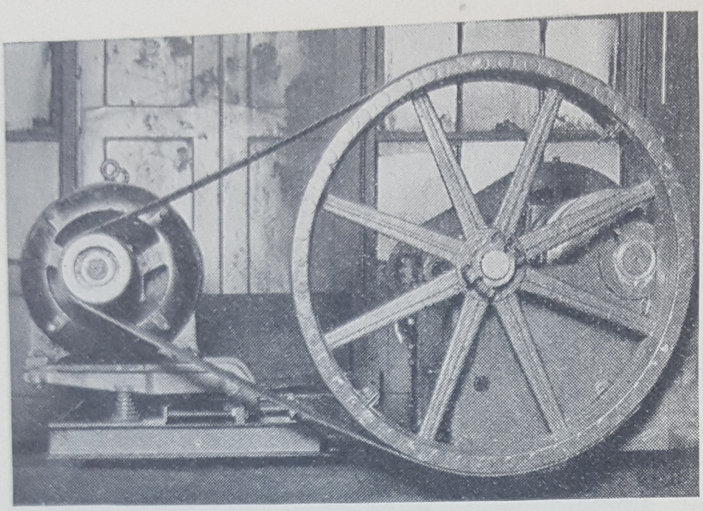
These disadvantages of the short center drive may be largely avoided by the use of a "gravity idler," or loose pulley mounted on a pivoted arm and held against the slack side of the belt by a weight. The belt is usually installed rather slack, and the idler placed near the smaller pulley, in order to wrap the belt around the latter as far as practicable. It should not be placed too near, however, for reasons given later. The idler pulley should be uncrowned. It should be mounted in ball bearings, and provided with suitable adjustments for accurate lining up. The swinging arm should be equipped with such weights or counterpoises as may be needed to secure the proper pressure against the belt. Gravity idlers may be designed to work equally well for drives which are horizontal, or at any slope.



Rockwood drive as applied to a lineshaft. As the tendency toward increased lineshaft speeds increases, the size of the driven pulley will be reduced. Note the very short center distance—just enough to allow for clearance of the two pulleys.

To sum up: the chief advantages of a gravity idler are that it adjusts itself to the length of the belt and to its varying tension, taking up slack and maintaining a suitable tension in the slack side of the belt, thus postponing the time when the belt must be shortened, and increasing the arc of contact on the pulleys. Over against these benefits there are some disadvantages.

There is a slight loss of power in the idler bearings, although with ball bearings this will be small. The belt suffers a reverse bend around the



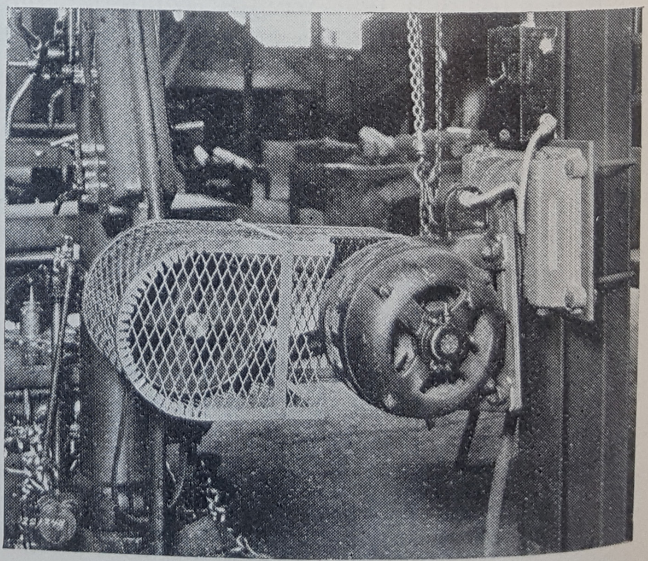
The Rockwood drive base lifts the motor off the floor from 5 in. to 10 in. and keeps it away from floor dirt and grit. The importance of perfect control of belt tension is apparent when it is considered that on an air compressor such as this one, the annual power bill equals the first cost of the compressor.

idler, so that the fibers on the "pulley side" of the belt are stretched, as well as those on the outside. This tends to shorten the life of the belt, especially when too small an idler is used. Good practice demands an idler as large as the small pulley in the drive, but for economic reasons this demand is not always met.

The portion of belt between the crowned motor pulley and the flat-faced idler is always subjected to a "crinkling" strain, frequently resulting in breakage near the center line. This is especially likely to occur when the crowning is excessive, and when there is too short a length of free belt between the idler and motor pulleys. It is a good rule that the distance between these pulleys shall not be less than the width of the belt. Any crown on the idler would, of course, make matters worse.

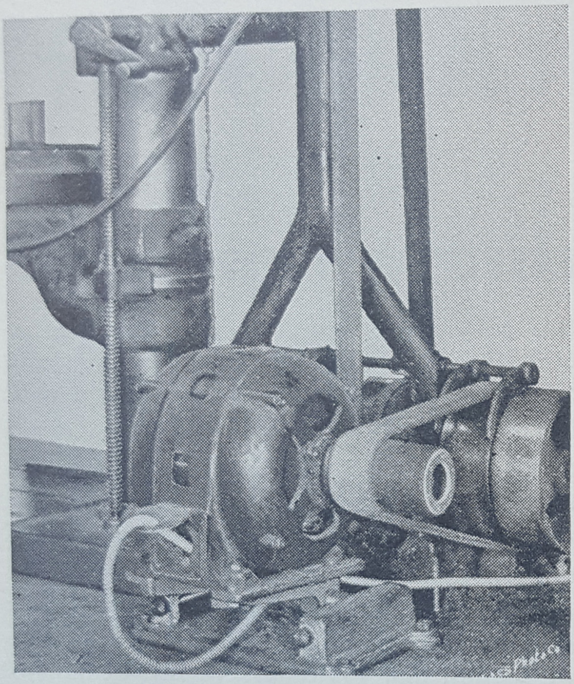
This center break is particularly troublesome in wide belts with the backbone in the center of each ply. The backbone section is composed of the shortest and most compact fibers with the least stretch availability; consequently breaks across the backbone are very common on ill-designed drives. In this connection, it seems advisable to specify again some of the points which the best engineering knowledge in the trade consider necessary to the proper designing of these idler units:

1. Idler pulleys must be flat faced and have such bearings as to keep them in perfect alignment; anti-friction and self-oiling bearings preferred.
2. All other pulleys on such a drive must have a minimum crown. The increased diameter of the pulley at the crown over the diameter at the edge should not be over one-eighth inch per foot of pulley width, preferably less.



Standard Rockwood short center drive applied to a 5 h.p. 1200 r.p.m. motor driving a drill press. Pulley diameters, 3 in. and 12 in. Center distance, 19 in. Note the method of clamping the drive base to the steel pillar in a vertical position.

3. The diameter of the idler pulley must be at least as great as that of the motor pulley or other small pulley in the installation.
4. All pulleys in the installation must be in careful alignment.
5. Motor pulleys of diameter smaller than standard shall not be used.
6. The idler pulley shall be so located that the length of belt from the point where it leaves the motor pulley to the point where it passes onto the idler pulley shall never be less, but preferably more, than the width of the belt.



Rockwood short center drive applied to a drill press, using a floor mounting that permits the shifting of belts. The center distance is 18 inches.

7. In installations of pulsating load, or where sudden overloads may be met momentarily, the idler pulley should be controlled with some device to prevent jumping. Such a device is similar to a shock absorber, and may be accomplished by the use of some sort of dash-pot arrangement.

Pivoted Motor Drives—A more recent development in short center driving is what is known as the pivoted motor drive. The drive has proved so satisfactory from the belt makers' point of view that the trade in general is fostering this type of installation. Very careful engineering tests run at the University of Cornell showed that the drive possessed extraordinary efficiency and large overload capacity, with reasonable loading and flexing of the belt. For short center driving, this type of installation should receive the most careful consideration.

Weight of Motor Used to Tighten Belt—In one of the most recent developments for short center driving, the motor is swung from a pivot, and a component of its weight is employed to produce tension in the belt. The usual motor base is replaced by a pair of arms, having lugs at one end through which a heavy horizontal pivot rod is passed. The motor hangs upon this pivot and is drawn to one side just far enough to secure the proper belt tension. The ends of the pivot rod are provided with adjustments for lining up the pulley and securing the desired initial tension.

This drive has all the advantages of the gravity idler drive, except increased arc of contact, without its disadvantages. It has already proven its practicability, even under severe conditions. This type of drive avoids reverse bending of the belt, the tension being automatically maintained. The slack caused by centrifugal force

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The operating tension may be considered as a force taken from the slack side and added to the operating side. As the lever arm of the forces on the slack side (tight side nearest motor pivot) is greater than the lever arm of the forces in the tight side, such a shift of forces automatically reduces the moment of forces, counterbalancing the weight of the motor. This makes the motor moment just that much more effective.

and operating tensions is taken up as it develops.

If this drive is engineered to the best advantage, the operating tension will increase the effectiveness of the motor weight (see foot note); that is, the greater the load the more tension is given the belt to develop its work. This is particularly helpful in starting and on peak loads. A final advantage of this type of drive is that the tensions just discussed are released when the motor is idle. As the motor stops and the stretch, due to centrifugal forces and operating tensions, is released, the motor rises and the belt shortens. This gives the belt periods of rest and relaxation which generally prolong its life.

This article, from its title, presumed to discuss only short center drives. There is, however, another motor application of special nature that we desire to bring to the attention of machine shop engineers. In the last few years, most motor manufacturers have offered for sale what is known as a high torque or "line-start" motor. Due to its great overload capacity, which often is 200 per cent for short periods, the belt has sometimes given trouble. This is due to a lack of foresight in not providing a pulley of sufficient size to carry a larger capacity belt.

Line-start motors are designed to start at the full current without the use of compensators or other apparatus. They come to speed very promptly and save much valuable time in accelerating production. Naturally they have a very high starting torque, since the current goes at once and at full amperage to the rotor. Such motors have come to be very widely used, and range in size from 5 h.p. to 30 h.p.

However, it is a mistake to equip a line-start motor, adapted to a starting torque of from 200 to 300 per cent of normal, with an ordinary belt. The motor itself has to be especially designed for this operation and the belt that is used with it should be adapted for extra severe usage. Belts selected for use with such motors should be from 25 to 50 per cent wider than those ordinarily provided. This practice will maintain a reasonable factor of safety in the belt and enable the user to obtain the full advantage of the line-start feature of the motor.

The points enumerated above are high spots only in the proper application and use of leather belting. Careful attention to this phase of machine operation will pay good dividends.

"Master" Data Book On Geared Head Motors

Data Book Section 210, presenting 20 pages of descriptive matter and illustrations showing the Master Geared Head Motor in service, has been issued by The Master Electric Company, 104 Davis Avenue, Dayton, Ohio. Cut-away views show the application of the motor to parallel shaft and right angle drives, as applied to machine tools, vacuum pumps, slow-speed pumps, winches, air compressors, slow-speed fans, slow-speed mixers, conveyors, polishing machines, and other mechanical units. Examples are given of the flexibility of design, and engineering data is provided with which the engineer may be guided in the selection of a motor for his particular application. General information as to lubrication, installation, and operating temperatures is included. A copy of the section may be had by addressing this firm as above.

"Industrial News"

The Square D Company, Industrial Controller Division, Milwaukee, Wis., has published a four-page newspaper called "Industrial News." The sheet is standard newspaper size, and the "news" consists largely of stories of the application of industrial controllers to all sorts of mechanical apparatus, the information being gathered from all over the world. Plant engineers and others interested in electrical control apparatus can secure copies by sending their request to this firm at the above address.