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

In this, the second article of the series, the authors tell how to use and maintain belt-driven equipment.

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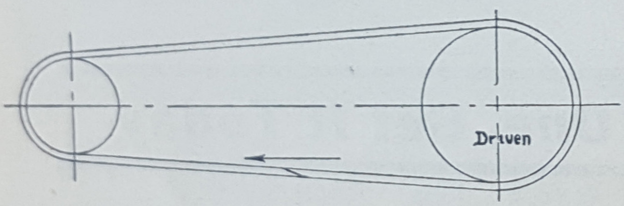
IN THE preceding article we have determined for the purpose of this discussion that a motorized group drive equipment has been decided upon as the logical economic and engineering installation. The next question is how to use and maintain it. In the first case, when trouble develops, the belt should be blamed last and not first. The engineering requirements in the successful use of leather belt are just as rigid and necessary as in any branch of science.



Pair of pulleys connected by open single belt, showing proper direction of over-lap in joint.

The Belt. Flat flexible bands, or belts, running on pulleys have long served as one of the simplest means of power transmission. Under modern industrial conditions, belting still holds a very important place in this field. Among the advantages claimed for this system are:

(1) Simplicity of the elements involved.

(2) Economy of installation and maintenance.

(3) Reliability.

(4) Ability to carry sharp peak loads.

(5) A safety device in cases of heavy overloads. Of the materials used in such belts, leather holds a leading position due to the fact that it has numerous qualities which make it admirably suited for this purpose. When care is taken to select a leather belt suitable for the conditions imposed in any specific drive, efficiency, economy and long life with a minimum of attention will result.

When practicable, belts should be made endless by lapping and cementing. Such belts will run truer and last longer with fewer stops for repairs. Particularly is this true of wide belts, belts running at high speed where any type of fastener is objectionable, and belts running over small pulleys. Using belt clamps, a good grade of cement, and belts with adequate laps and squared ends, the joint should be no weaker than other portions of the belt. If some type of belt fastener is to be used it should be flexible, not too heavy, and should not unduly weaken the belt at the point where it is attached. Stiff metal fasteners are not desirable. Hinged metal fastenings or rawhide lacing

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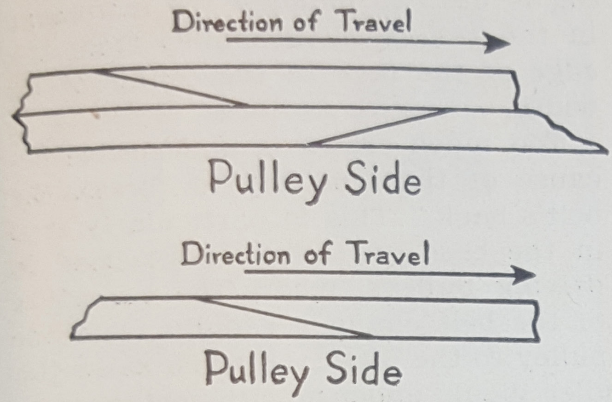
with strands on the pulley side running parallel with the belt edge make satisfactory connections for belts of moderate speeds and powers.



Sections of double and single belts showing position of over-laps in the plies.

In selecting a belt, care should be taken not to select one which is much too heavy for the power it is to transmit, as such belts will weave to and fro and will not run in a satisfactory manner.

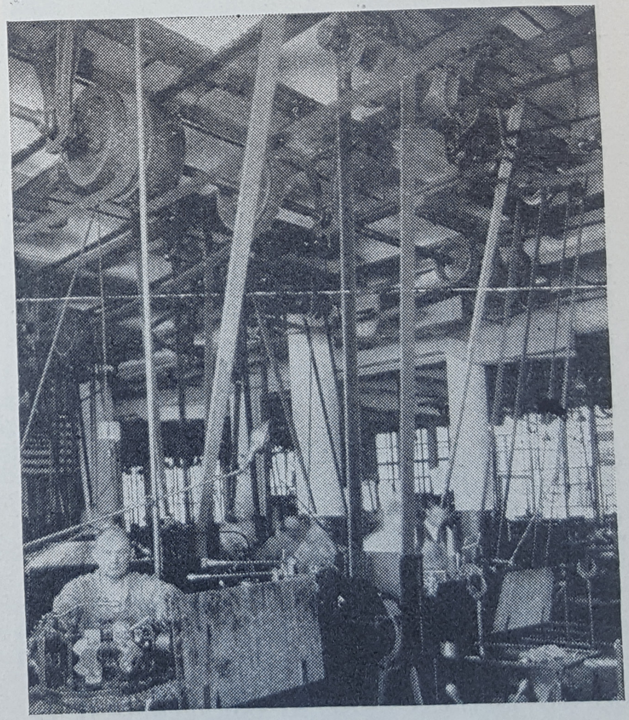
The Pulley—The proper selection and design of the pulleys with shafting and hangers has much to do with a satisfactory power distribution system. Pulleys are usually made of cast iron, fabricated steel, paper, or various kinds of wood. Pulleys may be solid or split and in either case the hub may be split for clamping to the shaft. Double belts require heavier pulleys than do single belts. For rim speeds in excess of 4,000 ft. per min., special care is necessary in securing a correct running balance. Such pulleys are necessarily subject to extra cost.

In the selection of pulleys, consideration should be given to rim speeds. The motor manufacturers equip their motors with standard pulley sizes designed to give belt speeds between 3,500 to 4,500 ft. per min. This figure represents the best of engineering practice. The balance of the shop installation can well follow this example where possible.

The reasons are simple and elemental.

Power is a product of force and a rate of speed. The faster a belt travels, the less effective are the tensions required to transmit a given horse power. The limit of this argument is determined by centrifugal force at a speed of about 4,500 feet per minute.

Since high speeds mean lower tensions, they also mean lighter or narrower belts and less bearing pressures. These factors may make a tremendous difference in the life and efficiency of the equipment. Unfortunately, in the past many machine manufacturers have equipped their apparatus with pulleys that were too small. They had two reasons—reduction of cost of manufacture and an appearance of low power requirements. The latter factor has often been a

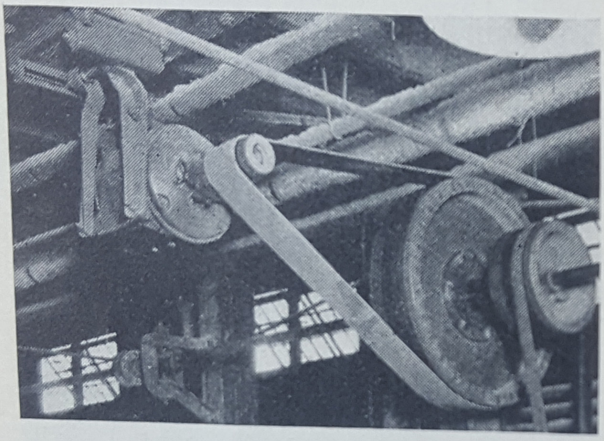


Well-arranged group drive with modern hangers, ball and roller bearings, and so on.

snare and a delusion very costly to the user. In general, then, larger diameter pulleys are preferable where their use is feasible.

Pulley face widths are nominally the same as the width of the belt they are to carry. Actually, however, the pulley face should be approximately one inch more than the belt width for belts under 12 in. wide, two inches for belts from 12 to 24 in. wide, and three inches for belts over 24 in. in width.

Belts may be made to center themselves on their pulleys by the use of crowned pulleys. Flanges on the sides



Rockwood short center drive, ceiling mounting. 10 h.p., 1800 r.p.m. motor drives lineshaft through 5-in. belt on 5-in. driving and 34-in. driven pulleys. Shaft centers, 42 in.

of the pulleys are in general very undesirable and unnecessary, since the belt tends to crawl against them. Belts running on such pulleys may have their edges injured or may ride the flange, if the belt is loose and the flange poorly designed. In general, if the pulleys are properly crowned, they will retain their belts in correct central position without other means.

Crowned pulleys may have a rim section either with a convex curve, or a very flat V-form. While the straight crown is the easier to construct, it is somewhat more liable to injure the belt, especially if excessive. Also straight crowning tends to load and strain the belt at the center while the other portions may not secure, with stiff belts, a very good degree of contact. A usual figure for the amount of crowning is ⅛ in. per ft. of pulley width, which is equivalent to the usual rule that the crowning should be 1-96 of the pulley width. The term crowning is used to indicate the increment in the radius of the pulley from the edge of the face to the center of its width.

Too much crown is undesirable because of the tendency to "break the belt's back." This is particularly true in the case of riding idlers close to driving pulleys, where the curvature of the belt changes rapidly from one pulley to the other. In such cases the idler should under no circumstances be crowned and the adjacent pulley should have very little crown. Pulleys carrying shifting belts are not crowned. Tight and loose pulleys may be of the same size, or the loose pulley may be made somewhat smaller in diameter to relieve the belt tension when running idle. In this case the idle pulley should be slightly wider with an extra rising tapered edge leading the belt from the loose to the tight pulley when the shifter is thrown for that purpose.

In the interest of belt economy, when possible, shafts running at slow speeds should carry reasonably large pulleys to give a high belt speed. Pulleys of small diameter with consequent severe belt flexure as well as heavy belts at very low speed are undesirable items in industrial equipment.

For the successful distribution of power by belts, it is essential that the shafting, bearings and hangers shall be correctly designed and carefully erected. Shafts which deflect unduly, bearings that are too small, and hangers that are out of line are the sources of great power losses.

The Belt and Pulley.—The practice of running the grain side of single belts next to the pulley is almost universal in this country. In Europe the opposite practice frequently prevails. The grain side has better frictional value, however, and should therefore run in contact with the pulley. The flesh side is the stronger and not as liable to crack when the belt is old, hence it is run on the outside where the tension is greatest. Single belts should be run with the outside lap edge pointing in a direction opposite to that in which the belt is moving.

The minimum diameters of pulleys over which belts of various thicknesses will run satisfactorily varies with the care used in the manufacture of the belt. Good practice is represented in the following table:

Minimum Pulley Diameter for Various Belt Thicknesses

Type of Belt	Thickness Ins.	Min. Pulley Diameter Ins.
Light Single	1/8 to 5/32	3
Medium Single ..	5/32 to 3/16	4
Heavy Single	3/16 to 7/32	5
Light Double	1/4 to 9/32	6
Medium Double ..	5/16	10
Heavy Double ...	3/8	16
Medium Three Ply	1/2	30
Heavy Three Ply.	9/16	36

Practical Rules.—For small and relatively unimportant drives it is rarely necessary to employ the theory of belting in order to determine the necessary width of belt. Simple arithmetical rules can generally be used in such cases and will give a fairly good margin of safety in the use of the belt. Such rules generally embody simply the horse power to be transmitted and the velocity of the belt. They are called "Millwright's Rules," and may be stated as follows:

1. A single leather belt traveling 800 ft. per min. will transmit one horse power per inch of width.
2. A double leather belt traveling 500 ft. per min. will transmit one horse power per inch of width.

These rules do not take into account the centrifugal force of the belt, but merely consider a double belt 1.6 times as effective as a single belt. As has been shown heretofore, there is considerable latitude in the use of the terms "single" and "double" as applied to belting. However, the above rules are applied to the average single and double belt and give wide margins of safety in the transmissive power when the velocity of the belt is not over 4,000 feet per min. As will be shown in a subsequent chapter, at a speed of about 4,000 feet per min. the centrifugal effects due to the belt weight begin to manifest themselves in an important manner. Therefore, for heavy transmissions and high speed belts the simple rules adduced above should be checked by a competent engineer or manufacturer.

Installation, Care, and Specifications.—The success of a belt drive depends very largely upon a suitable selection of belt, and proper installation and care. For a given cross-section, narrow thick belts are to be preferred to wide thin ones; that is, a light double belt rather than a wider single is more economical if the pulleys permit its use. Single belts over eight inches wide should not be used. The narrower belts may be run on narrower pulleys—a distinct advantage in cases of overhung pulleys—and stepped pulleys. Furthermore, narrower belts, especially if light doubles, run truer, stretch less and shift easier.

Belt drives located in acid fumes where temperatures above 120 deg. F. and high humidities prevail, or those installed in air charged with dust and grit, must be carefully selected and specially treated.

Care must be taken in aligning shafting, as pulleys out of line cause an unevenness of strain across the belt, and, where flanged or stepped pulleys are used, there is danger of injury to the belt edge.

The tension with which a belt is

placed upon the pulleys is very important and for maximum service it should be neither too tight or too loose. If too tight, there is excessive belt stretch, and the bearing loads will be too heavy, with consequent power losses and heating tendency. If too loose, the belt will slip, thereby injuring the belt and reducing the power which the belt is capable of transmitting.

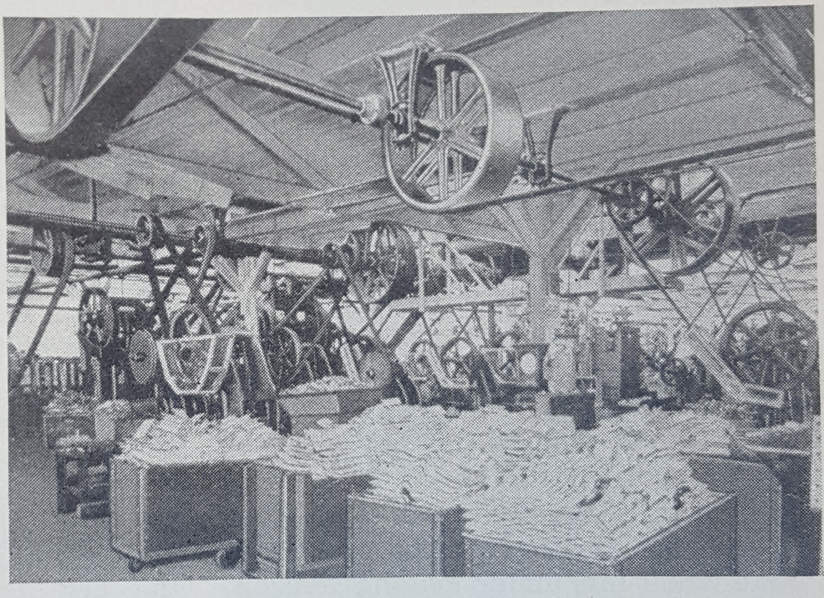
Laced belts should have their ends cut square and evenly butted together. The lacing should be drawn equally tight, to prevent an uneven strain with a tendency to cause the belt to run crooked.

Belts should be installed when possible with the slack side on top for all horizontal or inclined drives. Vertical drives, unless absolutely necessary, should be avoided.

Care of Belts.—Leather belts should be periodically inspected. Any accumulation of dust, dirt or grease should be removed and a clean surface restored. Mineral oil injures leather and should be prevented from penetrating the belt by removing with gasoline. If the belt becomes hard and dry, an application of neatsfoot oil, or a proper belt dressing consisting of a compound of cod liver oil and beef tallow, may be used to soften the surface. Rosin or compounds containing rosin should not be used. Commercial castor oil is dangerous as it is liable to break down and release acids. Difficulties in power transmission should be remedied by the use of a wider belt, by suitable belt tension, or by the use of an approved type of belt dressing. Belts should be inspected periodically for loosened laps, as a lap once started rapidly fails.

Estimates and Recommendations.—For the preparation of estimates and recommendations for a belt drive the following information should be supplied:

(a) Horse power to be transmitted.
(b) Fluctuations of power requirements.
(c) Sizes of both pulleys.
(d) Speed of one pulley, stating which one.
(e) Distance on centers.
(f) Belt open or crossed.
(g) Type and position of idlers, if any.
(h) Inclination of drive.
(i) Location of slack side, top or bottom.
(j) Use of flanged or stepped pulleys.
(k) Use of belt shipper, if belt is shifting.
(l) Unusual conditions, as
  (1) Acid fumes.
  (2) Grit or dust in air.
  (3) High temperature.
  (4) Dampness.
  (5) Angular drive.



Group drive in press room, with relatively few machines to a group. A saving is effected here in total connected load increase over power demand.

Ordering Belts.—When belts are to be slipped over pulleys, endless (that is, in a continuous loop), care must be taken in ordering from the manufacturer to specify "endless" or "made endless." The manufacturer will then cement the ends together, making a continuous loop, or "endless" belt. When the belt is to be threaded over the pulleys first and made endless afterwards, the ends should be prepared but not cemented together. In such case order "prepared for endless."

Measuring For the Belt.—Measure with steel tape around the pulleys (if necessary to measure over the old belt, deduct from the tape line length six (6) times the thickness of the belt); or figure the length from the diameters and center distances of the pulleys. Tape line measurement is always the safest and best.

Use plenty of belt. It is poor economy to be forced to make a belt unduly tight or smear it with sticky belt dressing to make it carry the load. These conditions waste power and shorten the life of the belt.

Allowance For Stretch. — Leather belts, being elastic, will let out somewhat when put under driving tension, hence it is necessary to make allowance for this in cutting off the belt. The general rule, and usual practice, is to cut the belt ⅛ in. per ft. short of the steel tape line measurements. For example, a belt for a drive 16 ft. long (tape line measurement) would be cut 15 ft. 10 in. long.

When ordering a belt, always give the full tape line measurement to avoid double allowance for stretch, as the manufacturers are accustomed to make allowance for this initial let-out when cutting off belts to measurements for particular drives.

In this article we have attempted to give the high spots only in the application, use and maintenance of leather belting to motorized group drive installations. The "Treatise on Leather Belting" has been abstracted freely and we also want to suggest that leather belting manufacturers are always glad to co-operate in any engineering question as to the application, use, or maintenance of leather belt.

Ferner Catalog of Portable Hardness Testing Instruments

The R. Y. Ferner Co., Investment Bldg., Washington, D. C., has issued Catalog No. H-1, describing two types of portable hardness testing instruments that have been placed on the market by this firm. One of the instruments is a pendulum type tester, called the Duroskop, which is not only adapted to the testing of metals, but also to such materials as ceramics, rubber, plastic and vulcanized products, linoleum, and so on. The second is a Dwarf Brinell Press that can be used in any part of the shop where a vise, arbor press, drilling machine, or large C-clamp is available with which to apply pressure. This outfit includes a unique magnifying glass for reading the diameters and Brinell numbers of the impressions in the pieces tested. Copy free upon request.

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Shafer Roller Bearing Bulletin No. 501

Bulletin No. 501, issued by Shafer Bearing Corporation, 619 South Kolmar Avenue, Chicago, Ill., lists all the latest sizes of Shafer Roller Bearings (both single and double row), together with complete dimensions and list prices. A speed factor table for figuring intermittent speeds is included. Copy free upon request.