The Use of Leather Belting in the Transmission of Power, I.

The first of a series of three articles on this subject. In this article the authors discuss the question of individual or group drive.

By PHILIP C. BROWN, GEORGE B. HAVEN, AND GEORGE W. SWETT *

THE application of power to machine tools as motorized groups presupposes the use of leather belting as a transmission medium. The individual drive may totally eliminate any further power transmission requirements, and, in any case, will make negligible any one item in such equipment. It is necessary, consequently, to determine the type of drive to be used before considering problems connected with the use of belting.

Careful analysis will disclose many advantages for group drive in economy of installation, operation, and maintenance in the majority of cases. This article attempts to bring out the economic and engineering features thus involved. In subsequent articles, the use, maintenance and special applications (short center drives) of leather belting will be discussed.

An analysis of the relative values between motorized group and individual drive requires technical engineering of a high order. This question has been thoroughly debated in the engineering magazines. We believe that the best and most thorough articles on the subject are those written by Robert W. Drake, Electrical Engineer, McCormick Works, International Harvester Company, Chicago, Ill., and published in 1923. A recent article published by Professor Haven of Massachusetts Institute of Technology reaches about the same conclusions. Fortunately, the subject can usually be divided into installations distinctly favorable to either group or individual drive.

In general, it may be said that in most cases individual drive is favored where convenience and appearance are paramount and group drive where costs play the leading part. This subject is concisely covered by Professors Haven and Swett in their "Treatise On Leather Belting," from which a large part of the material used in this series of articles has been abstracted.

While large and important subdivisions of power may economically be carried out electrically, the final distribution to the machine is generally best accomplished by motors of substantial capacity operating belted group drives. In a large percentage of cases the latter system offers unequalled advantages, the character of which may readily be appreciated by careful consideration.

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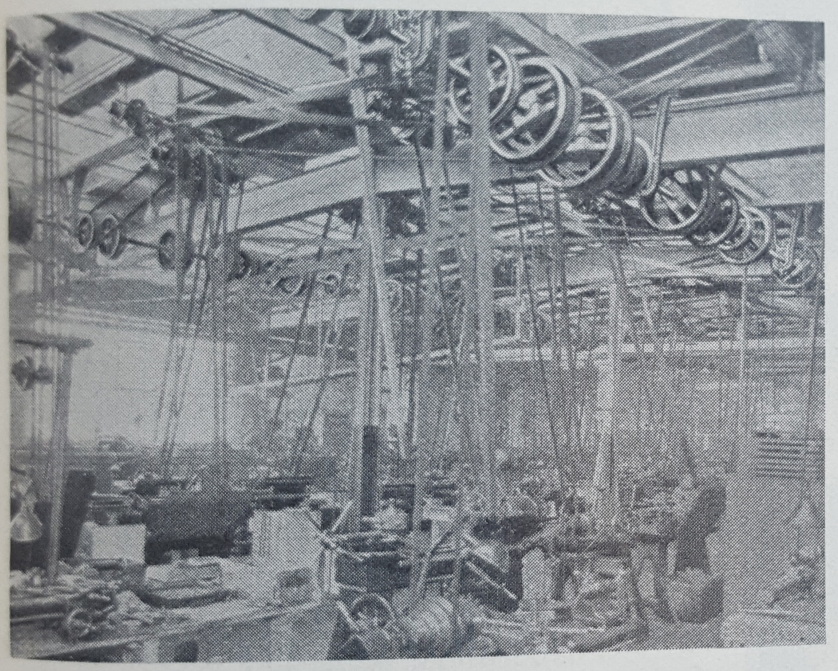
Relative Value of Group and Individual Drive

Power distribution in modern engineering is usually accomplished electrically. The ultimate application to the machine is through either group or individual drive.

The installed capacity of motors necessary for individual driving is usually from two to three times that necessary for group driving. This means that if a group of ten machines were to be driven directly, each one being equipped with a 1 h.p. motor individually applied, the total motor capacity would be 10 h.p. If these machines were arranged in a group, driven by means of narrow high speed belts from a system of countershafts with one good-sized motor supplying power to the whole, the total capacity of such a drive need only be from 3 to 4 h.p.



Modern group drive in a well-lighted plant. A relatively small number of motors is required to drive all the machines in this room. The motors are mounted near the ceiling, away from the dirt and scrap on the floor.

The reason for this lies in the fact that the individual needs of the machines regarding starting torque, accelerations, idle intervals, and maximum and minimum loads would overlap in such a manner as to economize greatly in the total power required. This condition is sometimes expressed as the "diversity factor." Normally, the greater the number of machines driven in a group, the greater will be the "diversity factor." This means that the maximum demand upon a group-drive motor will usually become less and less with relation to the aggregate peak horse power required by individual units, the greater the number of machines. Obviously, in comparing these two types of drives, many other items must be considered, such as the cost of installation, maintenance and upkeep, repair, cleaning, and lubrication.

Variations In Electric Motor Efficiency

For constant-speed alternating current motors, the loss in efficiency of numerous small individual motors in comparison with that of one large motor for the same task ranges from 5 per cent to 7 per cent. This figure in general offsets the friction losses incidental to the countershaft and belts of the group drive. Thus as a matter of overall efficiency with alternating current motors there is but little choice between an application of numerous small motors and one sizeable motor including its necessary shafting.

The efficiencies of direct current motors at fractional loads are much lower than those of alternating current motors operating at the same horse power. Thus constant-speed

direct current individual drives will show much greater losses than either alternating or direct current group drives.

Relative Cost of Individual and Group Driving

The cost per horse power of motors, with accessories, for group driving is roughly from twelve to fifteen dollars per horse power. This includes moderate installation costs and is a fair figure for the average age group-driving system. The corresponding figures for small individual drives of the same aggregate horse power vary from fifteen to fifty dollars per horse power. Considering the greater installed capacity required for the individual drive, as mentioned above, the ratio of cost, including only the item of motors and accessories, would be roughly fifteen dollars per horse power for the group motor in comparison with sixty to seventy-five dollars for the individual drive.

The cost of maintenance and inspection for each small motor amounts to almost as much as for one large one. While the cost of repairs increases somewhat with the size of the motor, this item is by no means proportional to the size of the unit.

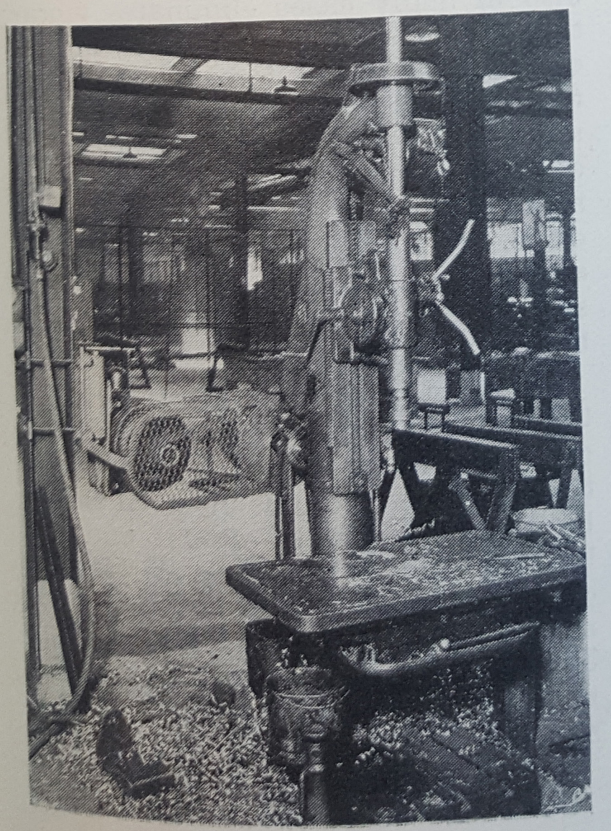
The cost of installation of individual drives when carried to an extreme will often reach from two to three times that of a well-designed group drive. An individual motor installation generally demands a method of speed reduction. This is accomplished at considerable expense by various systems such as chains, cut gears, and mechanical speed changers. In some cases the cost of such an installation may reach as high as five times that of an equivalent group drive. In addition to this, the operating expenses of numerous individual drives will generally exceed by 50 per cent that necessary for a well-planned distribution with one large motor.

Lastly, the cost of the motors alone is interesting as a comparison of the expense of these two types of driving.

Comparative Cost Per H.P. of Different Sized Motors For Given Total Capacity

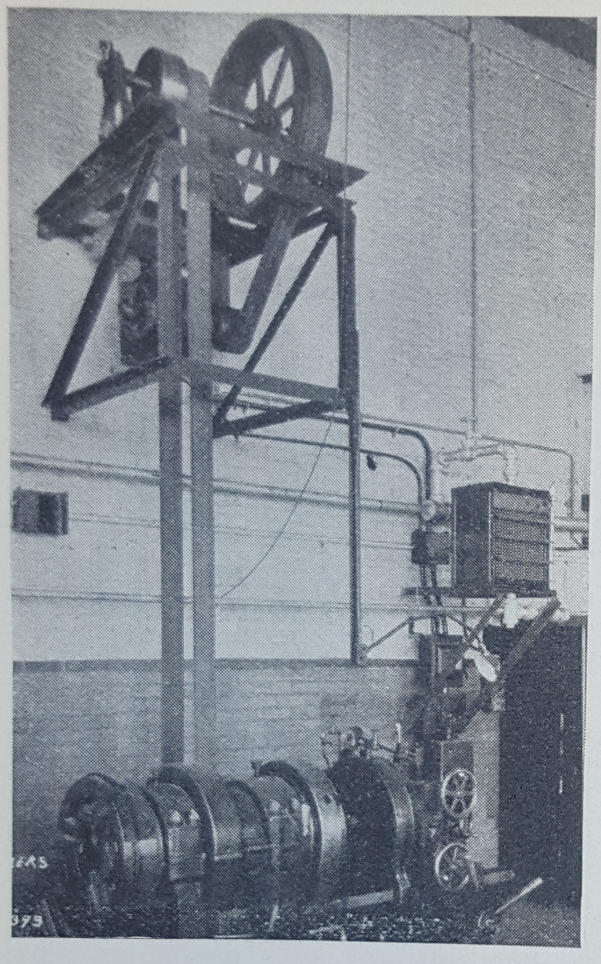
A-C Motors, 60 Cycle, 3-Phase, 550 Volts, with Starters, 1,800 R.P.M.

Motor Rating	Motor Cost	Cost per H.P.
One 50 H.P. motor.....	$ 440	$ 8.80
Five 10 H.P. motors.....	$ 570	$11.40
Ten 5 H.P. motors.....	$ 780	$15.60
Fifty 1 H.P. motors.....	$2,600	$52.00



Drill press being driven by motor mounted on a pillar, thus keeping it clear of chips and dirt. Rockwood drive is used, with pulleys 3 in. to 12 in. diameter on a 9-in. center distance. Belt is 4-in. single leather, endless.

In the light of the above table, one of the most difficult conditions to be overcome in the individual drive is the tremendous amount of capital



Interesting arrangement of a Rockwood drive, involving the use of a wall mounting with jack shaft. A pipe machine is being driven by a 10 h.p., 900 r.p.m. reversing motor through pulleys of 8 in. to 36 in. diameter.

necessary in the original outlay for so many small motors.

It is sometimes claimed that the machine driven by an individual motor gives greater production than the same machine in a group drive by one motor. If true, this is the fault of the group drive design and equipment, and not that of the system. With proper installation there is no reason why a group drive may not be as efficient as the individual. Of course, there are cases where large or isolated machines or those used only occasionally, should be individually driven.

In spite of the cost advantage of group drive, there are (particularly in a machine shop) many machines and situations that reverse this cost advantage. Such situations are those where overhead crane service interferes with shafting or belts; or where large machines with even and uniform loads occur, or machines not in constant use; and lastly, machines that may be moved from time to time or that may be desired set up at odd angles and places. The list of such loads favorable to individual drive looks impressive, yet in the great majority of cases, costs of installation, maintenance and operation determine group drive as the logical equipment.

The group drive with leather belt has other advantages than lower cost. It provides a flexible medium between the driver and the driven which will absorb shocks. This may be absolutely essential to the life of the driven machine. Leather belt drive also in many cases eliminates vibration (often known as chatter) in machine tools. Some lathe work of the finest precision is impossible with direct drive. These advantages are, of course, negligible compared to the shock absorbing feature of a flexible drive. If a machine jams or reaches a load beyond its capacity, a belt will slip or run off before the machine is broken and destroyed.

In considering the advantages of the motorized group drive, the technical development in recent years of the transmission mediums involved should be given due credit. Roller and ball bearing shaft boxes have tremendously reduced friction losses. Instruments for aligning shafting leave no excuse for undue loads and stresses in a well engineered and modern shop. Last, but by no means least,

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Use of Leather Belting

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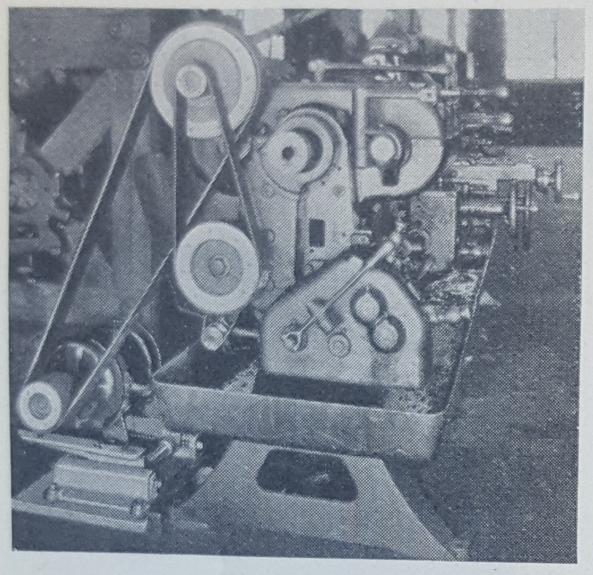
leather belt has been developed until there is a proper installation for each drive which should be determined by



Double reduction through two belts. The first belt is from motor mounted on Rockwood base, floor mounting position, well off the floor. Automatic tension control which can be adjusted to suit the load.

a careful engineering study of each case. Speeds, size of pulleys, arc of contact, loads, and so on, should all be considered.

In succeeding articles, we will assume that motorized group drive has been selected as the desired type of drive from both economic and engineering considerations.

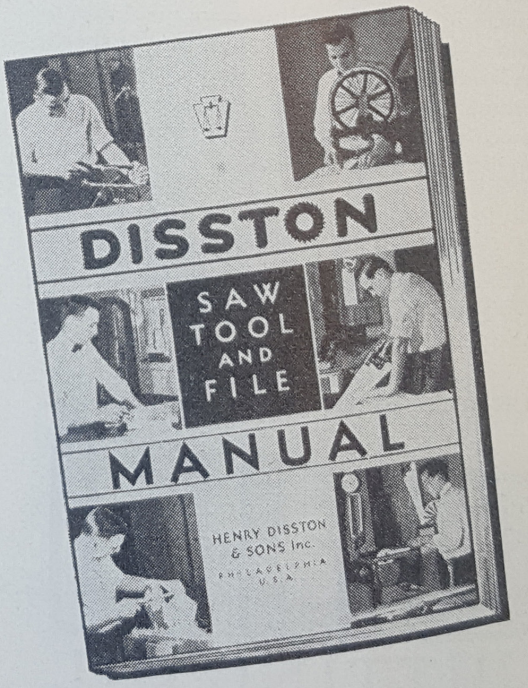
Ideal Issues Synchronous Motor Bulletin

A 16-page bulletin on synchronous motors has been issued by The Ideal Electric & Mfg. Co., Mansfield, Ohio. The bulletin includes complete descriptive matter, application data, and dimension charts covering the Ideal Flywheel Type Synchronous Motor and six other standard types of synchronous motors. A variety of Ideal motor installations are shown.

An unusual method of giving dimensions is used, making it possible for the reader to obtain approximate dimensions of any of the various types of motors for any horsepower and speed rating. Two tables are given for each type of machine, the first giving frame sizes and dimension key according to horsepower and r.p.m. rating, and the second giving the dimensions corresponding to the frame sizes and dimension key just determined. Copy sent upon request.

Disston Saw, Tool, and File Manual

A 48-page book of instructions on the use and care of saws, files, squares, and other tools has been issued by Henry Disston & Sons, Inc., Tacony Sta., Philadelphia, Penna. The book tells and shows each step necessary for the production of accurate work, 229 illustrations being included to make clear the points brought out in the text. An entire section of the book, for instance, is devoted to the hack saw, giving instructions for selecting the correct type of blade for any class of work, holding the work in the vise, and for cutting metals and other materials most efficiently with minimum breakage of blades. Another section takes up in detail the correct use of files. Every



possible use of the wood and metal saw, either for hand use or for power machine use, comes in for thorough discussion.

A brief history of the saw industry, together with a sketch of the development of the Disston works, is included. A copy of the book will be sent without charge to any mechanical executive.