The various possible systems are in part as follows:

Steam engine driving shafting by gearing, spur or bevel.

Steam engine driving shafting by belts or ropes.

Steam engine driving electric generator transmitting power over a plant with but few, if any, belts or gear drives.

Steam engine driving compressor of air and transmitting power in pipes over a plant to many forms of tools and lifts.

Gas engines transmitting power by belt or otherwise.

Central gas generating plant distributing gas over a a plant in pipes to many engines of small units.

Every engineer or factory manager has his own ideas about these methods, and I dare say every one is much in the right as to his own particular case, in regard to which he is necessarily well informed. No one of the methods is best for all cases. Each particular one must be studied carefully. Conditions are also changing rapidly, what may be best one decade may not be best the next. How rapid this change is is well illustrated by the following quotation from a most eminent engineer, made s recently as 1867, William Fairbairn. In discuss , transmission, he said, in part referring to belt drive, at that time new and mostly used in America, while the gear drive was almost universal in Europe, "the advantages of straps (belts) are the smoothness and noiselessness of the motion, their disadvantages are cumbrousness, the expense of their renewal and necessity of frequent repairs. They are inapplicable where the motion must be in a constant ratio, because, as the straps wear slack, they tend to slip over the pulleys and thus lose time."

How little these things seem to bother us now, and how few gears there are as compared with belts, notwithstanding the faults of the belts, as expressed by Mr. Fairbairn. It is almost useless, it seems to me, to talk on such subjects as these, inasmuch as what one says becomes obsolete so soon. All one can do is to act quickly in establishing a plant; take that which is most applicable at the time, and charge off each year enough from the machine account to buy all new in ten years at the longest. Above all things, in laying out a plant, no matter how small, do not proceed by rule of thumb, but think the entire arrangement out and plan it to scale on paper, determining the speed and position of every shaft and pulley; providing for everything beforehand. By other methods much work is repeated, and never as well done as it it might be.

The most lively discussion has always followed when the question of electric transmission has come up for consideration in all our engineering societies. Its exclusive use is advocated by some. By others it is absolutely condemned. The intermediate course will be the final one adopted. For certain work it is incomparable. For example, the large printing presses of to-day may be better manipulated by separate motor than by belt drive from main shaft. Entire independence of speed, reverse, repeated trials of the print, stopping and starting, and finally the cleanliness, make the motor drive directly connected, almost essential. The government printing office at Washington has materially reduced the expense and increased the product by the adoption of the motor drive throughout the place.

All machines served by overhead cranes should be motor driven so that the crane shall not meet the interference of belts. The printing press is one of these. All shops where groups of machines are run independently of other groups should be equipped with motors for each group. As a rule it is well to equip all heavy machine tools with independent motors, inasmuch as such tools stand idle much of the time. The plants in cotton and woollen mills need not be equipped with motors, unless perhaps, certain floors and departments are often run alone or are frequently shut down when the remainder of the mill is in operation. Anything that will do away with heavy and long belts will prove a commercial advantage. One case that came to my knowledge was a long belt that drove machinery in another building and around a corner. Some thirty horse-power was consumed in driving the other department. A separate motor was installed for a trial. A ten horse-power motor did the work and consumed only about six horse-power doing it. The trial became a permanent fixture.

How far to carry the idea is hard to determine. The first cost may be heavy, and yet such savings result that this cost is wiped out in a year. Convenience in a shop, rather than the cost of the motor or the power to run it, is most often the determining factor. Assuming that by introducing electric motors generally throughout a shop, the cost of all things considered were the same, it is quite possible to imagine such conditions that increased convenience would save 50% of the cost of the product. First cost and power might be disregarded under these conditions. Every case should be carefully considered by one familiar with all the conditions. If in doubt, a few motors should be tried, but nothing under five horse-power units should be used except in rare cases. The smaller units are expensive and not efficient, and machines should be grouped to get the five horse-power. Below two horse-power the electric motor is not efficient.

Competent and careful investigators have repeatedly found the losses of transmission due to driving or transmission devices to vary from 5 per cent. to 90 per cent. of the total power consumed. Here, then, in these days of small margins and close competition is the chance to save an annuity that will amount to a fair profit in most cases. The question of using copper or aluminum for transmisssion purposes is one worthy of consideration. In the case of a 9 mile transmission plant in my state, aluminum has been used. At the time of installation copper was selling at 17 cents per pound, and aluminum at 41 cents, yet the reduced weight of the latter made it the cheaper of the two. The average loss of transmission for the cotton mill and flax mill is 60 per cent., and for the woollen mill 40 per cent. In heavy iron working plants the loss is about 15 per cent. In any small mill or workshop the matter of friction is of the greatest importance, and, if I am not greatly mistaken, it is in the small mill that one generally finds the greatest neglect in such matters. In the large organizations such things are in the hands of some particular person, whereas in the small mill it is no one's business, and is neglected. Friction in mills is subject to great variations. Probably half the friction in the small mill is caused by lubricated surfaces. A change in temperature with improper lubricants, such as heavy animal oils, may increase or diminish friction to a considerable extent. Prof. Thurston estimates the friction of shafting in general, including the total belts and bearings, and varying with the size and load, at from 33 horse power to 1.5 horse-power per 100 feet. Prof. Benjamin, by careful investigation in many shops and with every precaution for practical and at the same time accurate results, found that in six machine shops, where heavy machine work was done, an average of 62.3 per cent. of the power produced was used in driving the shafting alone. In one case it was 80 per cent. This was explained by the fact that the shafting had to be built large enough for tools that are often idle, and necessarily the shafting must be kept running. In this item the tension of belts is a serious matter. A belt should be just tight enough to do its maximum work. Many belts, if not most of them, are much tighter than is necessary. No easy means is at hand to ascertain how tight a belt may be, and the belt mechanic sets it firm and tight to make sure that it shall not slip. Then when a wet day comes, a shop full of moderately tight belts makes a heavy drain on the coal pile. In this same investigation it was determined that the busiest of tools was only in operation 80 per cent. of the time, and the average tool about 33 per cent. of the time.

The argument has been made by those opposed constitutionally to nice work toward economy of any kind that the power amounts to little or nothing in the cost of a product. As a matter of fact the cost in percentage is small in machine shops, being from 1½% to 2%. This seems small indeed when stated this way; but looked at as an annuity it takes on another aspect. Supposing for example the product costs a million per year, one per cent. means ten thousand dollars.

Another class of losses occurs in the bearings of the machines themselves. It has been found by test with motors, for the driving power, that printing presses, and other heavy machine tools, consume twice the power running idle that they should. Investigation disclosed the fact that the loss was in the bearings, and that they were very tightly adjusted. There is no means of telling how tight a bearing is when it is one of many in a train; and had the machines in the cases mentioned been belt driven from a shaft, the friction would have continued until heating occurred or until the bearings wore loose. Again, to offset the argument that power saving is in any case only a small factor, we must consider that where there is friction there is wear, and that cost of repairs is increased by friction. This is a serious matter in the case of line shafting and counters. It means a mechanic at the works many Sundays in the year, to overhaul bearings and loose pulleys. The following general principles have been laid down by Prof. Benjamin to save friction losses in manufacturing establishments. There are none better and I quote:

1. Use pulleys of large diameter on counter shafts and narrow fast running belts.

2. Use the best oil for the purpose, and enough of it, catching the drip and purifying it for repeated use.

3. Have everything oiled regularly, and do not depend too much on even the best of oiling devices.

4. Inspect line shafts to see if in line and will turn easily.

Neglected shafting, both in respect to alignment and lubrication, is the cause of tremendous friction. Anything that will do away with both of these evils at once deserves earnest consideration. A good so-called "frictionless" bearing will do this, as lubrication is practically unnecessary, and heavy pressures produced by lack of alignment count but little. More of this later. Samuel Webber sub-divides the friction in a mill as follows: To run loose pulleys and their belts, 10 per cent.; to run main shafting, 20 per cent.—the engine itself takes but 6 per cent. He puts overtight belting and consequent bending of shafting with resulting heavy journal friction as the chief cause of transmission losses. I think the average manager does not look at it in this light. Even this source of friction may be avoided. If managers of factories would only take the pains to measure their idle load once in a while, they would find the information gained both instructive and surprising. Compar- atively few do it.

Some noon hour, or some evening at six o'clock, turn off all work on all machin. and see wh engine indicates; it is som g any of y gineers can do if furnished an indicator am sure you will feel repaid Nine times o you will overhaul a considerab umber of thi

Is it not true that in almost shop, if the does not get heated, if it does not make a it does not stop the mill and no dy kicks, th is not much thought about it?

My experience in such matt as been th shafts may be turned by hand d in other similar dimensions a bar stuck rough a p be used for a lever in order to c at all. Sub test in these cases showed co ponding los one or two instances I have se oose pulleys shafting and waiting for Sunda pairs.

As a matter of general inte I thought I look up the origin of belts. doing so I m my mind that it was prehistoric e first belt o seems to be in connection with e fire machi original method of starting a f y friction. ment or other string was wound out a pointe and pulled as in spinning a to Then follow use of the belt in all the vari ways known It is old, but it is good, and I doubt very much shall ever drop it entirely, notwithstanding ele motors. The rope is newer as a commercial f It serves its purpose admirably a is an efficient Careful experiment has shown when well ar in each case, the efficiency of be and rope is cally the same. The rope has one practical adva and that is, that the tension may be exactly trolled by tension pulley and weight. On the hand, the rope is not good for small powers. necessary splicing and complication of manip n count against it and practically bar the use o size smaller than ¾ of an inch. A rope running too small a pulley goes to pieces very fast, an rope drive has suffered on account of this mista installing.

The following figures give an idea of the p relative size of rope and pully:

For a 1¼ inch rope, diameter of pulley must b least 3 feet.

For a 1½ inch rope, diameter of pulley must b least 4 feet.

For a 1¾ inch rope, diameter of pulley must b least 5 feet.

For a 2 inch rope diameter of pulley must be at 6 feet.

These pulleys and ropes will transmit respect per 100 revolutions per minute, 5, 8, 11, 15 horsep

An increase of 25 per cent. over these figures is sible when the bottom rope is the driver and proper conditions. The best speed is about 3,30 per minute. Cotton and manilla are equally good viding long fibre cotton is obtained, and, in any the character of the splice is all important.

The comparative efficiency of belt and rope, as termined at Lisle, France, by official investigat is as follows: Power transmitted, 162 horse-pow taking efficiency of rope at 100 (manilla) cotto 100.87 and leather belt 100.37. To all practical purp this difference is nothing.

As I have already emphasized, belt tension is important. It is estimated that the pull of a belt is, rule, at least three times that necessary to tra the power required. The velocity of belts should kept at the maximum possible point, and the most cient velocity is given at 4,000 to 5,000 feet per mi Data on belts is to be found anywhere, and I w but little, as there are branches of my subject on there has been absolutely nothing written or publi

Mr. Souther spoke at considerable length on subject of bearings and lubricants, advocating greater use of the ball bearing and mineral oils.

D. H. Campbell is building a sash and door fa at Kamloops, B. C.

Fleming & Company, of St. John, N. B., have nished three boilers for the box factory of Cush Company, at that place.

The new saw mill of Thackray & Rawlins, at P broke, Ont., made its first cut early in January, a few days ago was wrecked by a boiler explosion.

Knight & Smith, who operated a saw mill at Fourth Chute, near Eganville, Ont., have diss partnership, and the business will be continued by Knight.

J. McKercher, of Elko, B. C., has completed a s mill fourteen miles from that place, on the line of Crow's Nest Southern Railway. The mill has a ca city of 40,000 feet per day, and will be operated and night on a contract for piling, bridge timber ties for the Crow's Nest Southern Railway.

A meeting of the directors of the Manitoba Fores Association was held at Winnipeg on February 2 the president, Dr. Bryce, in the chair. A resolution passed calling the attention of the Dominion Fores Department to the desirability of reserving for forest purposes all the region lying south of the main line the Canadian Pacific Railway in the neighborhood Austin, Carberry, and Sewell, that is unsuitable homesteading purposes. It was decided to hold annual meeting of the association in Winnipeg Tuesday, March 11th.