[From Journal of the Franklin Institute.]

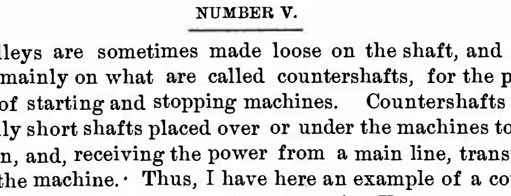
TRANSMISSION OF MOTION.

A Lecture delivered by Coleman Sellers, at the Stevens Institute of Technology, Hoboken, N. J., February 19th, 1872.

NUMBER V.

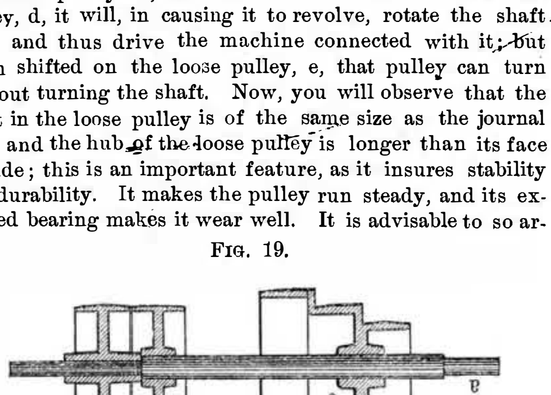
Pulleys are sometimes made loose on the shaft, and are used mainly on what are called countershafts, for the purpose of starting and stopping machines. Countershafts are usually short shafts placed over or under the machines to be driven, and, receiving the power from a main line, transmit it to the machine. Thus, I have here an example of a counter shaft for driving a lathe (see Fig. 19). You will observe that this shaft is necked down at its ends (a and b), to a smaller size; these smaller ends are the journals. It has upon it a cone pulley, c, corresponding with the cone pulley on the lathe head to be driven, the various sizes giving different belt speeds, and it has also a pair of fast and loose pulleys, d, e. Now this may be taken as an example of a countershaft; but all countershafts are not made in this manner. The term countershaft is applied to all shafts driven from the main line when placed at or near the machines to be driven, and sometimes in cotton and woolen factories some really long lines, driven from the main line in the same room, are called counters or counter lines. Such lines, differing in no respect from main lines except in name, need not be especially considered. Countershafts such as I here show you, Fig. 14, are peculiar in themselves, and must be considered by themselves. In this example there are fast and loose pulleys d, e. When the belt is on to the fast pulley, d, it will, in causing it to revolve, rotate the shaft also, and thus drive the machine connected with it; but when shifted on the loose pulley, e, that pulley can turn without turning the shaft. Now, you will observe that the shaft in the loose pulley is of the same size as the journal part, and the hub of the loose pulley is longer than its face is wide; this is an important feature, as it insures stability and durability. It makes the pulley run steady, and its extended bearing makes it wear well. It is advisable to so arrange countershafts of this character as to admit of the loose pulley being near the hanger, so as to admit of the shaft being turned down to the journal size where the loose pulley is. Thus, for a double purpose, the box of the hanger holds the pulley in place between it and the shoulder of the shaft, and the lubrication of the bearing helps to oil the loose pulley, as much of the oil will find its way along the shaft.

FIG. 19.



The hangers for that counter need not be made with a vertical adjustment. They should be provided with the swivelling principle in the box, and as the boxes can be slid on from the end, they may with advantage be made solid, not in halves, as are the boxes of line hangers. I have here two examples of hangers to countershafts, called counter hangers. One of these (Fig. 15) is for use on a countershaft where there are fast and loose pulleys; the arm is to carry a belt shifting rod, which slides in the adjustable guide, and by suitable belt forks is used to push the belt from one pulley to the other. As many counters are made without fast and loose pulleys, there are hangers made without the shifter arm, and this form of hanger is extensively used in factories for the counters of machines having the fast and loose pulley on the machine itself, as is the case with the looms.

FIG. 20.



I have already mentioned that there is a distinctive difference between the shafting system of this and other countries; let me explain this more fully, taking for example the practice that holds in England at the present day. Theoretically, motion can be transmitted more economically by means of gear wheels than by means of belt. Gear wheels transmit motion without loss by slipping, as might be the case with belts. Gear wheels are used in England to transmit the power of the engine to what is usually called the jack shaft; from this shaft, by means of bevel wheels and upright shafts, the power is conveyed to the various stories and thence by bevel wheels to the line shafts. This system insures the transmission without slip to the lines, but it is costly and very cumbersome, inasmuch as very high speeds are not possible with gearing. With a very rapid motion the teeth are broken by the back lash. Sometimes wooden teeth or cogs are inserted in the driving wheels, and the driven wheels are made of iron with the teeth carefully planed to proper shape. Wood and iron teethed wheels can run rather faster than iron on iron, but still not up to the speed now common in this country. Let us suppose, for instance, that it is found expedient to use no higher velocity to the geared shafts than 100 revolutions per minute, and the machine driven necessitates the use of pulleys 3 feet in diameter to drive them. The first cost of the line would certainly be less if the line could be run at 200 revolutions, and pulleys only 18 inches in diameter used to drive the machines. Well, the practice here is to obtain a speed of say 400 revolutions for lines in spinning rooms, and to use pulleys not more than 9 inches in diameter. These high speeds are not attainable with gearing, so belts from the engine to the line have come to take the place of gearing in all well constructed American mills, and this with a manifest gain in diminished first cost, in economical use and in steadiness and smoothness of motion.

Not very long ago, an enterprising firm imported from England some peculiar spinning machines, and some, to us, novel machines for preparing the wool with the intention of making fine yarns. They also brought out a boss spinner to put up the machines and organize the factory. They consulted me in relation to the shafting to drive the new machinery, and I asked for speeds of machines, etc., to enable me to arrange the proper speed of shafts, power, etc. They referred the matter to this spinner, who said that he did not know what speed the machines were to run, but if I would make the shafts 3 inches in diameter and run them at 100 revolutions per minute, the pulleys should be 36 inches in diameter. This was, of course, information enough to guide me, but, instead of making all the shafts 3 inches diameter, I made some only 2¼ inches and giving a speed of two hundred and forty. I could use pulleys only 15 inches in diameter. When the plan was shown to the spinner, he condemned it *in toto*. These machines could not be driven from any less pulleys than 36 inches; that he knew, and no argument could convince him that the same speed was being obtained at a less cost. The mill owner, a good business man, but not much of a mechanic, was in doubt as to what to do, but was convinced when he saw the estimate of the two systems, one at so much less cost than the other, and when he was shown that the pulleys on the machine were only 12 inches in diameter, hence would require no larger pulley on the line, so far as power was concerned. I could relate many other examples of converts to the American system of mill shafting, whose conversion was brought about through their pockets, but who are now enthusiastic in praise of the entire principle of light shafts, small pulleys and transmission by means of belts in place of gearing.

It is in America only that the production of all that pertains to mill gearing and shafting has been reduced to a systematic manufacture. To make a machine is one thing; to manufacture machines is quite another thing. Thus one sewing machine may be made by itself at a cost more or less in proportion to the labor expended upon it. But the same machine, by means of organized labor, can be produced in quantities for a tenth of the cost of one machine. Hence systematized manufacture is needed to insure cheap productions. The hanger which Mr. Bancroft showed to the New England machinists would indeed have been an expensive luxury if simply made one at a time, with no special tools fitted to its production; but with most special tools, thorough organization of the labor employed, and the production of immense numbers of them, with all parts made to gages and interchangeable, the cost is less now than what the commonest, rigid bearing hangers were made for formerly, and their adoption is now universal. Apart from systematized labor, an important item in first cost is weight of material. Not very many years ago all shafting, and all pulleys, and everything relating to the machine for transmitting motion, were made and sold by the pound. Purchasers were attracted to the makers who charged the least per pound, and no very great care was taken to see that too many pounds did not go into the various parts of the machine. Shafts of a given size could not be made to weigh more or less by different makers; but much needless weight might be put into hangers, into couplings, and into pulleys, so that the price per pound really came to have no meaning so far as total cost was concerned. Some dozen years or so ago, the house of William Sellers & Co., feeling that this system of selling hangers, pulleys, couplings, etc., by the pound was not the proper way to dispose of such things, determined on a radical change. They instituted an extensive series of experiments to demonstrate just how strong and consequently how heavy each article comprised under this head should be. They found that pulleys might be reduced in weight, and, by the employment of suitable machinery, be more perfectly made. So of hangers, and all that pertains to shafting, except the shafts. They then published a price list, offering to sell each item at some certain fixed price, dependent upon its own cost. This price list enabled the purchaser to know beforehand just how much money would be required to obtain what he wanted, and for strength and durability he took the guarantee of the makers. There was great opposition to this system from those who were still anxious to sell by the pound; but in time the manifest advantages of the plan caused its adoption by other makers.

Various establishments have been fitted up at great cost for the production of "shafting," and the same attention is now paid to its construction as is given to any other branch of the machine business. All conceivable wants of the trade are met by specially contrived devices, which can be made in quantities and kept in stock ready for sale. Hangers varying in size and "drop" (that is, in distance from center of shaft to the foot), are made from carefully designed patterns. Pulleys fitted for double or single belts, for wide or narrow belts, and made high or straight on the face, are all from patterns nicely adapted to the work each has to do. Last, but not least, all these things are made to standard gages, so as to have their parts interchangeable. A nomenclature, too, has come into use, and all the technical terms used are in a degree uniform through the trade. In regard to the sizes mentioned, in speaking of shafts, they are called always from the size of the bar iron from which they are made, and the term "shafting size" has come to have a significant meaning. All turned shafts are made from merchantable sizes of round bar iron, and in turning, one sixteenth is taken off in diameter, so that what is called a two inch shaft is really only one and fifteen sixteenths in diameter, and so of other sizes; they are all one sixteenth less than their names imply; and the couplings, hangers, etc., are made to conform to these sizes.

The adoption of high speeds for shafts has, as I have said, rendered it almost impossible to employ gearing for the purpose of transmission. Belts have become the recognized means of transmission, and mills formerly driven by gearing are now being altered so as to use belts only. When two shafts are placed parallel, the transmission by belts is a very simple matter; but sometimes shafts are required to be driven at right angles to the axis of the source of motion. This can be done by belts, provided the belts be carried over guide pulleys, so set in relation to the driving and receiving pulleys as will enable the band to lead properly from one to the other. Various devices have been arranged to effect this with readiness, and it is not an unusual thing to carry belts as wide as twenty inches over such guide pulleys, and in all imaginable positions. But this subject is one that would require more than the time allotted to one lecture to fully explain. I must therefore pass it by with this brief allusion to it, trusting that I may have an opportunity at some future time to explain it more fully to you.

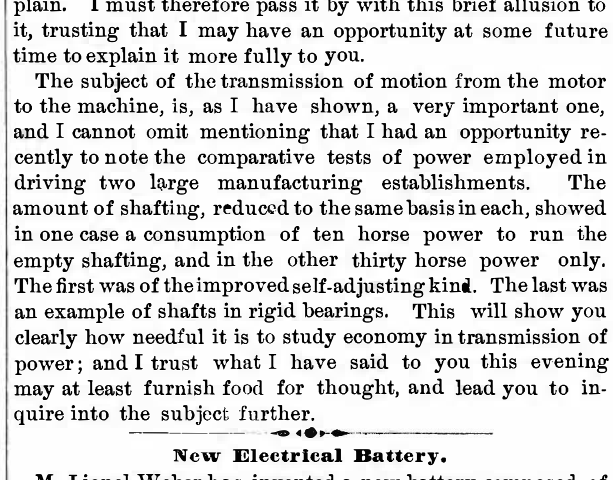
The subject of the transmission of motion from the motor to the machine, is, as I have shown, a very important one, and I cannot omit mentioning that I had an opportunity recently to note the comparative tests of power employed in driving two large manufacturing establishments. The amount of shafting, reduced to the same basis in each, showed in one case a consumption of ten horse power to run the empty shafting, and in the other thirty horse power only. The first was of the improved self-adjusting kind. The last was an example of shafts in rigid bearings. This will show you clearly how needful it is to study economy in transmission of power; and I trust what I have said to you this evening may at least furnish food for thought, and lead you to inquire into the subject further.

New Electrical Battery.

M. Lionel Weber has invented a new battery composed of a porous diaphragm filled with plumbago. This vessel is placed in a glass or porcelain vase containing a saturated solution of ammoniacal chlorhydrate. Into the plumbago is introduced a plate of charcoal which constitutes the positive pole; and into the solution which surrounds the diaphragm is plunged a plate of amalgamated zinc, forming the negative pole. This battery has been found to have great force, to be con- stant in the support of regular and continued work, to be economical and to need but little attention.

HEAD BLOCK FOR SAW MILLS.

The invention herewith illustrated is designed to facilitate the operation of setting logs to the saw in the process of sawing lumber, so that the thickness of the piece to be cut may be determined with accuracy. In Fig. 1, A is one of he head blocks of the carriage. B is the knee against whichl the log rests, and by which it is moved. C is a horizonta t



screw immovably affixed to the head block. D is a sleeve nut traversing said screw, and connected with the knee by means of the stirrup, E, as more clearly shown in the sectional view, Fig. 2. The same engraving represents how the edges of the horizontal portion of the knee, B, are grooved to slide in a slot in the upper portion of the head block.

Connected with the sleeve nut, D, is the bevel gear, F, which is actuated by the rod and hand wheel, as shown. By turning the latter, the sleeve nut on the screw, C, is caused to rotate, and consequently to move forward or back, carrying with it the stirrup, E, and also the knee. By this means the sawyer can reach the setting apparatus from the side of the log, and also set the latter with great precision. At G is shown another bevel gear which is also actuated by the hand wheel. This rotates the shaft, H, which ends in a miter wheel that forms the portion of a similar mechanical device on another head block, so that both blocks may be connected together and actuated by a single hand wheel or crank. By having three blocks, those on the ends communicating, as shown, with the one on the center of the log, it is claimed that the stiffness of the log will obviate the tension or twisting in the extension rod, a common defect in other devices.

Patented through the Scientific American Patent Agency, April 16, 1872. For further information address the inventor, Mr. H. C. McEwen, Oakdale Station, Alleghany Co., Pa.