LUBRICATION OF TEXTILE MILLS

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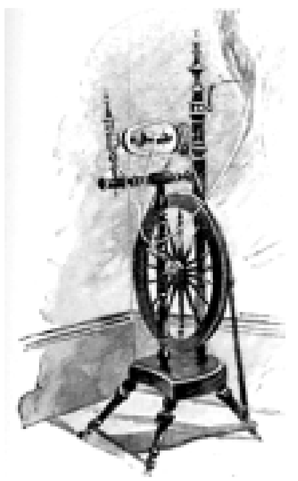
The facts outlined in the following paper, originally presented at a recent meeting of the New England Cotton Manufacturers' Association, and specially revised by the author for republication here, were obtained from a large number of comparative tests made under a new system of testing. They add a good deal of valuable practical information to the available data on the subject in question.—THE EDITOR.



DURING the last ten years much has been written upon the subject of lubrication from a theoretical standpoint, and many tables have been prepared showing coefficients of friction determined by using various lubricating materials upon various friction testing machines. All of this matter has a value in showing the range of work which lubricants can be made to cover, and for the scientifically inclined it presents an interesting field for study.

Lubricants can be selected that will give a range of readings from the very lowest coefficients to the highest that it is possible to observe upon the testing machines in use. These machines are primarily intended as laboratory instruments, and in this field have a decided value in proving to the technical student that one set of lubricants will give different results from another under duplicate conditions of pressure and speed. While these friction testing machines are valuable in their special field, their readings are of little value when used to determine what lubricants should be applied for practical work.

A striking example of the limitations of testing machines is afforded by the following:—Lubricants offered to a foreign corporation were continually rejected, and upon investigation it was found that this was because the coefficients were high as compared with certain required book standards. As the oils were to be used for lubricating car journals, the following questions were asked in regard to the testing machine:—

Was the pressure over the entire bearing surface uneven?

Was the atmosphere surrounding the instrument bearing alternately cooled and heated; was it wet at one time and dry at another; was it dusty?

Was the speed variable?

Was the bearing treated with neglect?

These conditions the rejected lubricants were intended to cover.

As a matter of fact, the bearings of the machine were nicely ground; the pressure was evenly distributed by a clever arrangement of levers; the atmospheric condition was constant; the speed varied throughout a uniform range; and the oil was carefully measured out and the bearing flooded in a clear bath. All these conditions would be exactly the reverse in actual work.

There are instances where oils have been adopted for mill work from the results of tests upon friction machines. These oils, afterwards, have been replaced by other lubricants and considerable power has been saved as a result. Another instance is recorded where the best possible lubricant for the required purpose was rejected on account of its high coefficient as compared with that of a combination of light spindle and kerosene oil, an impossible practicable lubricant.

Many difficulties arise from selecting

oils for actual work by depending upon the comparative oil chemist. His reports are based upon characteristics of the given oils, and a selection made from such reports is made with an idea that greater or less reading of characteristics, such as temperature, gravity, or viscosity, proves the superiority of one lubricant over another for any given work. Gravity, viscosity, or temperature tests do not indicate the lubricating value of an oil; they show simply some of its physical properties.

The value of the oil chemist is in checking the various stages in the process of manufacturing the oil, and in this field his services are indispensable, as he protects both the manufacturer and purchaser from too wide a variation from the fixed standard. Should all oils be examined by the purchaser, through the chemist, it would be found that in consecutive shipments of certain classes of oils one consignment would vary more from the standard than another. Every characteristic of a certain oil has its standard reading, a variation of so many points each way being allowed by the manufacturer. The oil manufacturer who produces only lubricating oils will allow but little variation from his standard, while oils not primarily intended for lubricating purposes will vary so much from their standard readings that they might almost be classed differently.

Oils are classified as fixed and volatile. The fixed oils include the animal and vegetable oils and are not capable of distillation; volatile oils include the essential oils and petroleum.

Petroleum oils may be divided into two general classes,—the residual and distillate oils. The residual oils are products remaining after the light properties have been distilled off. There are almost unlimited variations in the character of residual oils, governed first, by the grade of the crude oil itself, and secondly, by the manner of distillation and subsequent treatment, which may vary from the most complete fractional distillation used in the manufacture of lubricating oils to that destructive distillation employed in the manufacture of burning oils, giving petroleum tar as the residual product.*

Distillate oils are of two classes; the paraffine oils made from distillation of the tar previously referred to, and afterwards deodorised and decolourised by chemical treatment; and the neutral oils which are made from an intermediate distillate produced in fractional distillation.

It is possible to duplicate an oil to within the variation allowed from the standard readings for that oil, duplication being in colour, weight, and all the known physical tests; yet upon actual work, where the requirements are exacting, the duplicate will break down completely, while the original will stand up to its work.

The most practical method of making a selection of lubricating oils is by an actual trial upon the machines to be lubricated. Sometimes these trials are very crude. Out of a large number of oils offered, one is selected that will stay on a bearing the longest; no observation is made except as to its lasting quality. While it is selected upon a comparative basis, a determination as to lasting quality does not necessarily signify that the oil is the best to use. Some selections are made after drying known quantities of the samples submitted, the purpose being to secure a non-gumming lubricant. Perhaps the method most widely used is to place the samples in the hands of the machine operators with instructions to watch the oils carefully. The difficulties in selecting lubricants in this way are that no ordinary operator is capable of judging the different stages of lubrication. Oil is reported upon as "all right," "no difference," or "it will not work." There might be ten oils that were all right, yet one would be much better than the others. In some mills where a practice is made of accepting all samples offered, the operators lose interest and send to the office the same report upon all.

For instance, one mill had for an agent a man who was constantly look-

* "About Lubrication, from the standpoint of a manufacturer of Petroleum Lubricants."—C. M. EVEREST; John Wiley & Sons, 1893.

ing for something better for lubricating purposes than he already had; but he took a wrong method of determining the comparative value of the material offered. On cylinder oils where the trial was based upon the amount of oil used for a specific work, the report given by the operators on nineteen samples was that they could see no difference in the feed,—for the very good reason, unknown to the agent, that they had always set the lubricators to feed so many drops per minute. The twentieth oil failed completely; they had to feed twice as much. They discovered the particularly bad oil, but they made no distinction between the other oils, which must have run from almost bad to very good; consequently no value was received by the agent from the trials.

Sometimes in changing oils and depending upon operators for a decision as to their comparative value, a wrong impression is made by the action of the new lubricant upon the deposits left by the old oil. This deposit in working out is very often charged up as belonging entirely to the latest lubricant, and a report is made to that effect.

Another very peculiar circumstance has been actually met with a number of times in mills where the method of lubrication has been an established factor for some years. A change of one set of oils having been made and an adverse report having been sent to the office by the operators, an investigation developed the fact that the hot bearings charged up to the new oil were not included in the test and had never had anything but the old oil upon them. They had been left undisturbed until the attention of the operator was called to the lubrication problem.

Some general system must be established by which the effect of lubricants can be determined in a practical manner. It must be along well-defined lines, and must be free from the personal factor item, from prejudice, from lack of interest, and from a too great amount of theoretical practice. Lubricants should be selected upon a basis of what they will do upon actual work towards reducing the frictional item to its lowest point. They should also be selected with an additional end in view,—that the frictional item should remain practically a constant, *i. e.*, the lubricants should not vary in quality, nor deteriorate during use, nor leave any deposit. The method of using them should conform to the class of work and to the results desired.

In treating the subject of lubrication from an engineering standpoint, using oils as a means of reducing the frictional horse-power of a textile mill, and making the different adaptations with a view of securing the lowest loss of power possible under running conditions of the mill, it is necessary that different classes of machinery be lubricated with oils of different characters.

It is impossible to more than generalise in regard to what special lubricants should be used for a textile mill, as the mechanical condition of each plant is a factor which will make it impracticable to treat all mills exactly alike. The machinery may be grouped, and the classifications of lubricants should generally be as follows:—

High-pressure cylinder oil.
Low-pressure cylinder oil.
Engine oil.
Dynamo or motor oil.
General lubricant for heavy machinery.
General lubricant for light machinery.
Shafting oil.
Loom oil.
Bath or closed spindle oil.
Oil for heavy open spindles.
Oil for light open spindles.
Top roll oil.

CYLINDER OILS

The following general conditions must be considered in making a selection of cylinder lubricants:—Location, size, and type of unit; general condition of cylinder and valves; pressure of steam; condition of steam; use of exhaust; method of oil feed.

The determination of the efficiency of cylinder lubricants is made by the manner in which the valves and piston operate during the run and by an inspection of lubricated surfaces after the run. The lubricant should possess body and spreading qualities, and be able to remain upon the walls of the cylinder and upon the faces of the valves under the temperature and conditions of entering steam. It should not volatilise under working conditions, and it should not leave a resinous or tarry deposit upon the valves or in the cylinder clearance. The oil may be slightly compounded or not, as the condition of the plant may require. Compounding with the proper amount and kind of fixed oil adds to the lubricating value of a cylinder oil; but when the exhaust is returned to the boilers through a surface condenser and closed heater, as in all marine practice, a fixed oil in any amount or condition is detrimental to the efficiency of the boiler, and a cylinder oil composed of straight mineral stock should be used.

Oils must be adapted to the pressure and the condition of the steam used. High-pressure cylinders of multiple-cylinder units require an oil that will work with the temperature of the entering steam. Oil for the intermediate or low-pressure cylinders should be of an entirely different character, one more suited to the low pressure of steam and one that will work in harmony with the oil carried over in the exhaust from the high-pressure cylinder.

The amount of feed depends upon the condition of the engine and the steam, the character and the adaptability of the oil for the work, the style of the lubricator, and upon the engineer in charge.

A badly worn engine using wet steam will necessarily consume more oil for a given condition than an engine in good order using dry steam.

A light oil for high pressures will require a greater amount of oil to furnish the same amount of lubrication as a viscous oil. Overfeeding a viscous oil will usually produce an effect the opposite from that desired. Underfeeding a light oil will add to the abrasive friction of the engine. The feed of cylinder oil should be regular.

ENGINE LUBRICATION

Engines may be classed as high, medium, and slow-speed, and the oiling system as automatic and hand. An oiling system may be considered automatic where the oil is sent to the surfaces to be lubricated, caught after use, cleaned by filteration, and returned to the lubricated surfaces by force or by gravity. Sight-drop oil cups and open cups or bearings constitute the hand-oiling class.

High-speed engines are, as a rule, of the crank-case type, or are made practically enclosed by the use of oil guards or covers. Lubrication upon these engines approaches very nearly the oil bath. They should be fitted with a diaphragm or a double stuffing box so that the oil will not throw against the cylinder head, as the oil, in order to meet the lubrication condition of these engines, will not be sufficiently heavy to withstand the heat of the cylinder. Provisions are made on all the modern types of this class of engine to keep oil in circulation. In some types after the oil has run through the bearings, it is passed through a small filter and pumped back to the crank-case. The lubricant that is adapted to these engines should be a quick-acting, pure mineral oil, and should show clear after use. Water should separate freely from it, and it must not develop any decided tendency to thicken. An oil that is properly made for this work will last indefinitely, as far as wearing qualities are concerned.

Medium-speed engines require a little heavier lubricant, if oiling is done by hand, *i. e.*, through sight-drop oil cups. If the engine is fitted up to catch the oil after it has been used, a high-grade, indestructible oil should be adopted. This should be caught, filtered to remove dirt, etc., and reused. It should be an oil that will not break down through continued service, and should retain its colour, thicken but slightly, and contain no fixed oil., *i. e.*, animal and vegetable oil.

An oil for the heavier types of engine should be greasy, rather quick-acting, and should withstand pressure. If an automatic system is in use, the oil may be quicker-acting, so as to produce a bath effect instead of a drop film.

Wherever possible, and where the

greatest efficiency is desired, the drip for condensation and cylinder oil under the stuffing box should be separated from the drip from the guides. It is an easy matter in designing frames to allow for a short rib just behind the lower guide which will be the separating point for cylinder oil and engine oil. Should an engine not be arranged to catch all the oil, a lower grade can be used; but, as a rule, the lower grades of engine oils will not stand continued service, although they will do well enough if used only once. The practice of using an engine oil, catching it and using it again upon shafting and machinery in the mill, is not good economy.

Oils containing fixed materials leave a varnish-like film upon all bright work, and produce a pronounced deposit in the pipes and oil cups. Engines fitted with a gravity-feed system and using an oil of strong gumming tendencies, have to be given extra care, owing to the danger of the oil-feed stopping. Very frequently the piping has to be removed and scraped to secure a free flow of oil. Changing oil where this has been the case requires some care; the new oil, unless it contains the same amount of fixed product as the old, will act as a cleanser, loosening up the deposits in the system which will settle into the regulating gauge of the cup, and cause a stoppage of the feed. The piping should always be removed and cleansed thoroughly before changing from a gumming oil to one of different character.

Animal oils, or oils prepared by the use of acids, will attack brass and stain the bright work of engines.

DYNAMO OIL

Dynamo and motor oil may be lighter, quicker-acting oil than that used for engines. All modern electrical machines are fitted with ring-oiling bearings, and are very economical in their use of oil, which should be one that will not drop in efficiency through continued use. Thickening of the oil in a bearing of this design will result in the ring being retarded and the flow of oil over the shaft being lessened.

GENERAL LUBRICATION OF HEAVY MACHINERY

Openers, pickers, and cards are the heaviest and most important machines used in the ordinary manufacture of cotton or woolen goods. The best of care is used in setting up these machines, that they may be in perfect alignment, and all bearings true and to centre. To keep the bearings in this condition attention to lubrication is absolutely necessary. Fires in picker rooms are also frequently caused by lack of attention to lubrication. Oils should be fed by cups or bottles to all bearings that are taking all the work of the machine, and should be heavy and somewhat quick in action. They should show clear in colour after use.

Drawing frames should be treated with heavy lubricants. The top rolls require an especially heavy, greasy lubricant that will preserve a good wearing film for a considerable period. A compounded oil, an animal oil, or fat should not be used for top rolls, owing to the general tendency of these oils to oxidise and gum, thereby retarding the free movement of the roll, producing an uneven output.

GENERAL LUBRICATION OF LIGHT MACHINERY

Under this head should be classed all intermediate machinery, general lubrication of spinning frames, loose pulleys, and the light finishing machinery. This oil may be of such a character that it can be used upon the spindles of speeder and intermediate frames. It should be an oil of low fluid friction, non-gumming, and one that will stay in place.

If every ounce is required of the engine, and the mill is to be worked to its highest efficiency, in connection with the oil for spindles of intermediate frames and speeders, one of lighter body may be used for the steps. Spindles are usually oiled once a day, steps once a week, or at a longer interval, so that two oils can be used with but little trouble.

Spoolers, winders, beamers, and slashers may be treated under the head of general lubrication of light machinery, and the same oils used upon everything in this class, excepting the artificially heated bearings of slasher rolls; on these the top roll oil should be used.

SHAFTING

Shafting should be fitted with the best lubricant for the condition under which it operates. A certain horse-power will be required to operate it under that condition. This horse-power should be as low as good lubrication can make it, and it should be kept a constant by the use of new, uniform oil; any admixture of filtered oils from engines or machines, or any use of grease will increase the power necessary to drive that shafting. Compounded oils, used upon shafting, offer great resistance to the free operation of that item, and make the power a variable factor, which gradually increases as the deposits in the boxes become more pronounced, until the additional cost for power to operate the shafting beyond its normal point exceeds the extra cost of lubrication of this item with the most expensive oil to be had. Bearings of whatever description require ordinary attention to oiling, otherwise the oil will overflow. In textile mills tin guards or drip cans are usually provided, as a precautionary measure, to prevent oil from getting upon the goods in transit or process of manufacture.

Shafting hangers may be grouped as "open" and "ring oiling," and may be treated in three ways. Open boxes, if they are new, can be lubricated with a quick-acting oil. In general character it should be adhesive, greasy, and as fluid as the condition will allow. Open shafting is sometimes fitted with bottles having spindles, which, during the operation of the shafting, cause the oil to flow slowly. If these bottles are carefully adjusted and an evenly constructed oil is used, an even condition is produced; but it is necessary to keep a uniform grade of oil supplied to the bottles after once adjusting them, and the oil should not contain a fixed material or leave any deposit; otherwise the bottles, instead of being of service, will be quite the reverse.

Open shafting hangers that are badly worn and receive but little attention require a heavier oil, one that will act as a cushion, stay where it is put, and prevent the hammering frequent in a worn box, and consequent loss of power by abrasion.

Ring-oiling hangers should be oiled with a light-bodied oil,—one that will stand wear. The general characteristics for open work should also govern; that is, the oil should be greasy and should not leave a deposit, but the main point is that its initial efficiency must last. Where an open hanger is oiled at least every other day, a ring-oiling hanger runs from one to six months. It is, therefore, necessary to have an oil that will retain its original character so that the power to drive the shafting may be a constant throughout the period between the oilings.

LOOMS

Outside of the spinning frame, no other class of machinery claims so much attention from the lubrication standpoint as looms. It is not power-saving, but "stainless," quality that is required of a loom oil. It is a generally acknowledged fact that no oil is stainless in the exact meaning of the word. In attempting to secure a stainless oil, the power question is entirely lost sight of. The proper treatment of the subject should result in not only saving power, and in doing away with those effects which a stainless oil is intended to overcome, but should also save the wear of the loom, as well as the amount of oil used.

It must be borne in mind that all oils are dark-coloured to start with. A "stainless oil," or an oil that is white or nearly so, is manufactured by a bleaching or filtering process that takes out certain hydrocarbon qualities that are essential. This bleaching process leaves the oil rather characterless; it has nothing much to recommend it except its good appearance before using. It will turn black after use, carrying with it iron in solution, and iron in particles, evidences of lost power through abrasion; and it will damage any goods with which it comes in contact, the oil itself not causing so much trouble as the iron carried with it.

Compounding the bleached oil with an animal or fixed oil, while holding up the body, brings another element into the problem, that of gumming, and deposit-leaving, which acts against the power by presenting a poor lubricating surface to the lubricant. Straight animal oils should not be used, owing to their tendency to oxidise.

In treating this subject, the natural condition of the present loom must be considered. An ordinary cotton loom cannot be compared at all on a mechanical basis with any other machine in a mill. It is always badly out of line, the boxes are always loose, the shafting is rough, the cranks are roughly turned out of a forged bar, and the whole machine during operation pounds and shakes. However, it meets the conditions for which it is built, can be built cheaply, and can be renewed at little cost when worn out or when improvements of parts make its operation unprofitable. Upon this machine, instead of a light-coloured, light-bodied oil that shows black after use (a good indication that its lubricating power is very low), a greasy, heavy oil should be used, one having the essential characteristic of staying where it is put; not necessarily a stocky oil, but one of body. The colour should not be considered. An oil of this character will stay in place, keep lubricated surfaces apart, prevent wear and the effect of wear. It will not drop or throw on to the goods, can be used in small quantities, and should reduce the power required to operate the loom by preventing actual metallic contact of the surfaces.

SPINDLES

Spindle lubrication is probably the most important item in the mill, and much has been written on this one subject from a practical standpoint. It was stated some years ago with the advent of the Rabbeth or bath type of spindle, that a so-called light gravity oil was the best to use for economising power. After the subject had been widely discussed, there seems to have been no concerted action on the part of users of these spindles to arrive at a standard. Some go further than the light-oil theory, and use an oil too light, working entirely from a gravity standpoint, thinking that the lighter the oil, the easier the spindle will operate. Black, worn spindles, and large renewal bills with a constant expenditure for power consumed by abrasion, are the usual results of such practice.

An oil, to be a good spindle lubricant, must have other characteristics besides light gravity. It must be homogeneous in character; that is, so constructed that it will not change in lubricating value from oiling to oiling; the power to drive spindles must not increase as the oil wears until just before the renewal of the oil it is taking a great deal more power than absolutely necessary. The oil must be strictly neutral, and absolute freedom is necessary from material that will gum and attack metal. Moisture in a spindle oil produces a brown rust; acid will produce rust and attack metal; gumming will greatly add to the power to drive spindles. Spindle oils that contain any of the fixed oils will leave a varnish-like deposit over all of the running part of the spindle except the foot, and over the bolster and in the base. This film causes loss of power by means of offering extra resistance to the revolving oil. A smooth, clean spindle and bolster with a dry, clear, quick oil are necessary in order to secure the best efficiency.

The most power in spindle work is lost through the oil friction of the lubricant used. The oil should be of sufficient weight to keep the surfaces a part under the light pressure of band pull and load, and should work upon itself with the greatest ease. The construction of such an oil enters largely into the problem. One that is made by a destructive method of distillation, where the molecular parts are altered by burning, and where this charring and burning effect is partially removed by the use of acids, will not work well upon itself. Every care should be exercised in the various stages of manufacture of a spindle oil, as it must run uniform in grade and quality. One bad barrel will affect the power of an entire room, and may cause endless annoyance, besides loss of production and power.

Bath spindle oil, from an oil manufacturer's standpoint, is a very small item. It is a small item to the mill when compared to the total lubrication bill. This oil should not be overlooked, however, as there is no single class of machinery that is so quickly influenced and that responds so readily to lubrication or the lack of it as the modern spindle.

Spindles of the Sawyer or open type require a more stocky lubricant, as there is no mechanical method of retaining the lubricant upon and around spindle and bolster other than the nature of the oil itself. In extremely fine cases it is possible to use two oils, one for the bolster and another for the steps. The latter may have the same characteristics as the bath spindle oil, but it will have to be applied more often.

Mule spindles, if new, may be treated the same as the lighter Sawyer or open spindles by using two oils, one for the bolster and one for the steps; or one oil weighty enough for the bolsters may be used all around. If the spindles are worn badly, as is the case in most old machines, the extra bolster oil is almost a necessity. It should be an oil about twice as heavy as that used for Sawyer spindles. This will effect a cushion, prevent abrasion and consequent loss of power. The initial power required to operate with the heavy oil will be greater, but there will be no loss caused by the surfaces coming together, as they eventually would if a light oil were used. If a mule is noisy, and produces a sharp, dry rattle, this treatment will invariably show a decided and immediate improvement.

Twister spindles and heavier spindles of bath types should be treated the same as the regular bath spindles, if power is being considered. The only change, owing to the extra weight of the spindles, would be to oil up more frequently; where this is not done an oil heavier in nature must be used.

TOP ROLLS

Top rolls, as in drawing frames, whether solid or shell, should be oiled with a mineral, non-compounded oil, which should be the heaviest oil used in the mill, outside of cylinder work. It should be a stocky, greasy, mineral oil that will not flow readily so as to run out on the leather covering, or onto the yard. While the speed is slow and the weight light, and the power, as compared to the frame, small (probably eight per cent.), the drawing roll condition from a production standpoint is an important one, and a well lubricated condition is necessary to the smooth running of the work in the machine and during the after processes.

The cost of oil should never be considered in selecting lubricants, since a reduction of seven per cent. in the total horse-power of a mill through reduction of frictional losses will usually pay for the entire oil consumed. Three per cent. saved from the total horse-power of a mill will more than offset any increase in yearly cost, from the very cheapest oils to the most expensive adapted lubricants. In many modern mills there is no investment which can be made for new machinery, or any improvement in system of operation, or reduction in cost of production which will give the immediate financial results that attention to lubrication from an engineering standpoint will produce.