Oil and grease must not be allowed to get on the rolls, for although it will not damage them, it might lead to stains on the cloth, which it is next to impossible to eradicate.

Some of the 2-roll calenders are built with both rolls being hollow metal rolls, both arranged for permitting heating by steam (either one or both or none) and which in turn are more particularly used only as pressure calenders on heavy fabrics.

Fig. 34 shows in its perspection view the 2-roll pressure calender as built by the Curtis & Marble Machine Co., and which is chiefly designed for use on medium and the heavier grades of cotton duck, for flattening down knots and bunches on the surface, so as to give as smooth a finish as possible. This machine has two heavy iron rolls about 12¾″ diameter with means for giving increased pressure. On narrow machines, levers with weights, as shown in the illustration, are commonly used, while on wide machines, screws are provided at each end of the rolls. These rolls may be made to run either hot or cold; again a steaming apparatus (steam-box) may be used in front if desired, to slightly moisten the cloth before entering the rolls.

The machine is usually run in connection with brushing and calender rolling machines, when the fabric passes first through the brushing machine, where it is cleaned of chits, specks, and other dirt, then through the pressure calender for pressing down the lumps and knots, and then through the calender rolling machine, where it is still further smoothed or ironed, and rolled in firm, hard rolls. This combination of three machines arranged to run in connection with each other, with expansion pulleys to regulate the speed of the cloth, is a most complete and satisfactory arrangement for finishing the heavier grades of duck. The machines are built in widths for handling goods from 30 to 120″ wide.

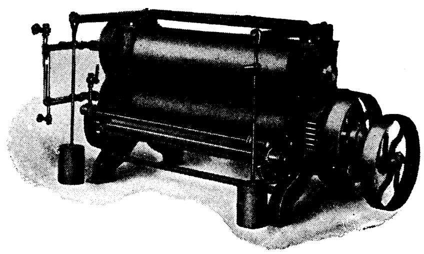


Fig. 34.

Fig. 35 shows in its perspection view the calender Rolling Machine with Measuring Roll, Steamer and Revolving Stretch Roll, as built by the Curtis & Marble Machine Co. The iron rolls may be made to run either cold or hot, and the process of smoothing out the goods and rolling them up in hard, even rolls, free from wrinkles and puckers, is the same as in the similar machine (Fig. 33) described in connection with the "Cotton Brushing Machine."

The adjustable measuring attachment consists of a measuring roll made one yard in circumference, with an expansion pulley on the end, and attached to the side of the machine is the measuring dial, made to register up to 2600 or 5100 yards, as desired; the expansion pulley may be varied in diameter, and as some goods are more elastic than others, and consequently stretch more in running, the size of the pulley may be so adjusted as to give an accurate measurement of any kind of goods as they are rolled up. The steam vapor cylinder is for slightly moistening the goods before being rolled up, to aid in smoothing them out and giving them a softer and brighter finish than otherwise obtained.

The revolving stretch roll is made with wooden slats on the outside and brass trucks and slides on the inside, so as to turn easily; as the cloth passes around this roll it causes it to revolve, and the slats are drawn outward from the centre toward each end, and thus draw out wrinkles in the goods and avoid creases being made when the goods are rolled up. It is especially desirable for extra wide goods, also for all widths of goods where wrinkles must be carefully guarded against, as, for example, where the goods are rolled up and shipped in large rolls, as required for the rubber, enamel cloth and other trades, in which the goods are coated afterwards. The machines are built in varying widths for goods from 27 to 120 inches wide.

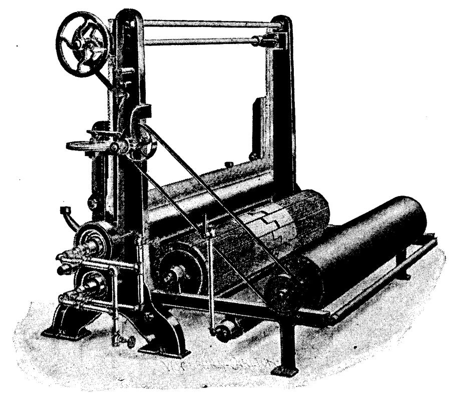


Fig. 35.

Combination Rolls.—Some nine or ten years ago The Textile-Finishing Machinery Co. introduced on the market a patented fibre roll for use in connection with Mangles and Calenders known since then as a "Combination" roll made from cotton and corn husk combined by a special process in such a manner as to obtain a roll with the smooth surface of a cotton roll and still retain the great elasticity and wearing qualities of the husk roll then in common use for water mangles and for calenders used for many classes of finishing.

This roll (shown in Fig. 36 in its perspection view) has proved of the utmost value for general use in water mangles and calenders,but is especially adopted for all water mangles and calenders used to finish goods requiring a soft finish. For water mangles it has come into almost universal use in the United States on account of its splendid wearing qualities and the uniform work which can be done when it is used, and has almost entirely replaced the husk roll for this work. It has, with excellent results, replaced wood rolls in starch mangles for white goods and is also largely used for starching yarn dyed goods. This roll has proved especially valuable for almost all kinds of roller calenders as it combines for this work all the best qualities of the cotton and husk roll without having the objectionable features of

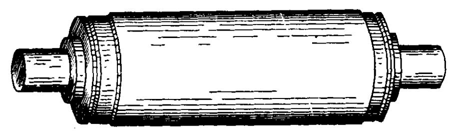


Fig. 36.

either. When cotton rolls are used in a calender it is usually necessary to join the different pieces of goods together by overlapping and pasting their ends, which not only involves considerable labor and trouble but spoils from 10 to 14 inches of goods at each union. With the combination roll, on account of its great elasticity, it is possible and the universal practice to run the goods with the ends of the pieces sewed together, thus saving much labor and injuring but a very small strip of goods.

Cotton rolls very soon lose much of the elasticity or spring which they have when new and are apt to become dead and hard after a few years' wear, while the combination roll can be used with the best results for years. While the husk roll possesses some of the good qualities which a cotton roll lacks, it is impossible to obtain a nice, smooth surface on it and for this and other reasons it is unsuited for calender use in finishing the majority of cotton goods. The Combination roll will outwear the husk roll. For calender work it has proved its superiority over all other rolls for finishing many classes of white and piece dyed cotton goods such as sheeting, shirtings, cambrics, lawns, print goods, window shade goods, sateens, twills and many others and also for almost all classes of yarn dyed goods such as ginghams, madrasses, shirtings, fancy dress goods, tickings, awning goods, denims, etc. Upwards of 1500 of these rolls are in use at the present time in the United States and England.

Calender Roll Grinder.—When calender rolls, as used in the finishing department of cotton mills got out of true, i.e. got bunchy, then the usual way was to take such rolls out of their housings and send them to the shop where they were made, to be reground. Since these rolls are exceptionally heavy, they naturally make this removal from the frame very costly, again the machine will be idle, possibly for weeks, while the rolls are being ground. This disadvantage to mills created a demand for a portable grinder, one which would grind calender rolls true, in their own bearings, i.e. without the necessity of removal from their housings.

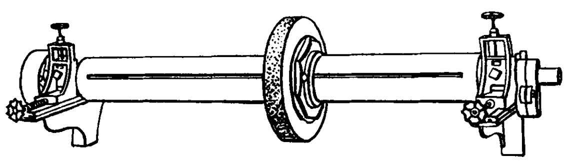


Fig. 37.

The traverse grinder, as shown in its perspective view in Fig. 37, and as built by B. S. Roy & Son, accomplishes this. The same is fitted with a solid emery wheel, and since its installation in any number of cotton finishing plants, has proven a complete success. Not only are the rolls ground without removal from the housings, but at the same time they are ground perfectly true as they are ground in their own bearings. Suitable brackets are fastened to the housings on which are set the adjustable stands and boxes in which the grinder is run. By means of these adjustable stands the grinder can be adjusted horizontally and perpendicularly, while running, to suit. The traverse grinder is fitted with a solid emery wheel, of the proper diameter to reach the rolls from outside the housings, with 2″ face as a rule, and with a special slow, positive, differential motion for slowly traversing the emery wheel, while revolving, until the high places are ground down. The emery wheel should be set very lightly on the roll, just so it can be heard striking the high places. It is not advisable to use a wider emery wheel than 2″. For this work the traverse grinder must be made with an extra strong steel shell, not less than 5″ diameter.

NAPPING.

Regarding this process the reader is referred to pages 326 to 331 explaining the napping of woolens, and which is identical with that for such cotton goods as require this process; the same machines as then explained being used also for the napping of these cotton goods.

CLOTH FOLDING MACHINE.

Fig. 38 shows in perspective view what is known as the cloth folding machine with low back frame and curved apron for feeding-in the cloth to the machine, in order to distinguish it from another style of a similar machine known as the cloth folding ma-

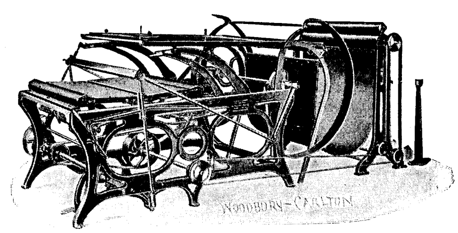


Fig. 38.

chine with high front frame to feed-in the cloth to the machine over the head of the operator, the latter doing away with the low back frame and curved apron, characteristic to the style of machine illustrated; the feeding-in of the cloth to the machine thus being the chief difference between both styles of machines. The machine shown is used both for ordinary gray goods as well as for finished cotton goods; both kinds of machines mentioned being built by the Curtis & Marble Machine Co.

In the machine illustrated, as well as in the other style only referred to, the leaves of the table upon which the cloth is folded have a positive opening movement by means of cams and levers in advance of the folding blades, so that the cloth is carried under the jaws without friction on the cloth already folded, and without pulling the cloth from the opposite jaw, or dragging the fold back when the blades are withdrawn from between the table and the jaws. The feeding-in of the cloth and the tension are easily regulated, and accurate measurement may be obtained, whether running at fast or slow speed. The swivel rod for tipping the folding blades is pivoted at the top so that the upper end does not swing upward. This swivel rod works in a hardened steel bushing in the end of the folding blades, and is fitted with an oiling device to keep the rod lubricated and prevent its running dry. Guides are also provided to prevent any motion of the blades sidewise as they move back and forth, and double spiral springs are used on each of the rocker shafts for controlling the bite of the jaws.

For folding extra long cuts, or for heavy or fluffy goods, an automatic drop centre attachment is provided, which lowers the centre of the table in a positive manner, by means of a pawl and ratchet mechanism, as the folds of cloth are laid under the jaws; thus preventing the cloth from rounding up in the middle and lengthening the folds near the last end of the cut. As soon as the piece has been folded and taken out, the whole table is readily raised into position again by the foot lever, the same as on the plain centre machines. The machine is generally made with 4-inch ratchets and jaws, though for goods which require a very large amount of room on the table, longer ratchets and higher jaws can be applied, and which in turn give a greater capacity to the machine.

Referring now to the style of machine illustrated, we find the back frame and zinc apron arranged a few inches above the floor, back of the machine, so as to prevent the operator from stepping in it, giving at the same time the cloth a long run between the apron and the folding blades, so that it has opportunity to be well straightened out when it reaches the table. The small belt which drives the nip rolls runs over carrier pulleys on the back frame, and is generally placed on the opposite side of the machine from that shown on the illustration, so as to be out of the way of the operator in threading in the cloth.

In some cases, where the goods are taken from a high pile on a truck, a high back frame and apron can be supplied in place of the low back frame and apron shown, so as to give a greater lift off from the truck than with the low frame.

These machines, if so desired, can be supplied with dials or indicators to indicate the number of yards folded, the most common style being a dial attached to the right hand side of the machine, at the top of the arch over the table. The dial is then operated by means of a cam on the crank shaft with connecting levers and actuating pawl, and registers each yard. It is provided with a spring and retaining pawl, so that as soon as released, at the end of the piece, it turns back to zero. There is also a rod, with a series of fingers attached, extending across the top of the machine, and turning freely in its bearings. The fingers are held up by the cloth as it is passing into the machine, and as soon as the end of the piece has passed in, the fingers drop, and throw the actuating pawl out of engagement with the dial. The dial therefore can register only when the cloth is passing into the machine, even though the machine is left running. For registering the aggregate number of yards folded per day or week, a counting register may be attached to the machine to register up to 100,000 or 1,000,000 yards.

These machines are also built for different widths of goods, the most common widths being for 40, 44, 50, 54, or 60 inch goods, though either narrower or wider machines than this can be furnished, if required.

Machines are also constructed which can be adjusted in a few moments from one length of fold to another, and where mills have to fold goods in different lengths of folds, and do not have sufficient work for a machine for each length, such a shifting machine can be conveniently used. The most common style of shifting machine built is to fold either 1 yard or 1¼ yard folds, another is to fold either ¾ yard or 1 yard folds, and sometimes such machines are built with as wide a range as 1 yard to 1½ yard folds.

Machines for 1 yard folds only, when running 250 turns, will fold 75 yards of cloth per minute; machines for 1¼ yard folds, when running 200 turns, will fold 75 yards per minute.

For folding pile fabrics like plushes, velveteens, corduroys, etc., which are usually folded in comparatively short folds, ranging from 12 to 24 inches long, a special folder, of a different style from the one explained is built, and which will fold the goods in short folds, and is capable of folding a pile of cloth 18 inches high on the table. An adjustable measuring attachment is commonly put onto folders of this type, to give an accurate measurement of the goods, in whatever length of folds they may be folded.

DOUBLE-DOUBLING.

This process is used in connection with wide sheetings and similar goods to fold the selvages together twice, making them thus a four-ply fold.

Fig. 39 shows in its perspective view the double-doubling machine as built by the Curtis & Marble Machine Co., the operation of which is thus: The roll of goods as it comes to the machine, is placed in adjustable brackets, with lever handle attached, by

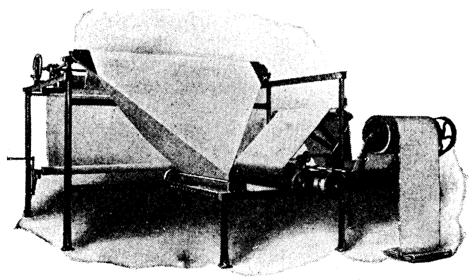


Fig. 39.

which the operator can shift the roll from side to side so as to guide the cloth into the machine as straight and even as possible. After passing over tension and guide bars at the top, the goods pass down the first triangle, where they are folded to one-half their original width, making them two-ply. They next pass through draft rolls and over the second triangle, which folds them to one-quarter their original width, making them thus four-ply. The goods then in this condition pass through a second pair of draft rolls and over a large drum to the floor ready to be folded for the market, either by hand or with a machine. The position of the triangles is easily adjusted by means of hand wheels to suit different widths and varieties of goods, so as to bring the selvages even with each other. The machine is built in different widths to suit the style of goods made in a mill.

WINDING AND MEASURING.

The machine for doing this work, and of which a perspective view is given in Fig. 40 is designed for winding goods on boards for the market, and is largely used by mills, bleacheries, printeries, dyeing and finishing establishments, etc., for almost all classes of goods; the same being built by the Curtis & Marble Machine Co.

The machine is provided with tension rods, by which any desired amount of tension may be obtained to wind the goods hard or soft; there being also guide collars to aid in guiding the cloth in straight and even, so as to make a neat looking roll with square ends. The machine is readily stopped and started by the foot of the operator on the treadle bar at the bottom, and the boards on which the goods are wound are quickly clamped and unclamped in the sockets by a hand lever, held in position by a weight, so that any slight variation in the length of the boards is immediately taken up. The cloth is quickly threaded into the machine, and the work of rolling the goods may be done very rapidly.

The machine is built either with or without measuring attachment. In the first instance the measuring roll is one yard in circumference, with nickel plated dial on the end to register up to 60 yards. On top of the measuring roll is a nip roll, so that the cloth must turn the measuring roll as it passes around it, giving an accurate measurement, without danger of slipping. Jaws of any width, from 4 to

9 inches, to suit the width of board used are provided, or if the goods are to be wound on square bars or flat plates, which are drawn out after the goods are rolled up, suitable jaws can be provided. The machines may also be arranged to roll the goods on flat cardboards, paper tubes, wooden sticks, or other devices. These machines are generally built either 3/4 wide for goods up to 28″ wide, or 4/4 wide for goods up to 37″; since however, a 4/4 machine will wind either 3/4 or 4/4 goods, this is the width most commonly used; however wider and heavier machines for 40″, 45″, 50″, 60″ or 72″ wide goods are also built.

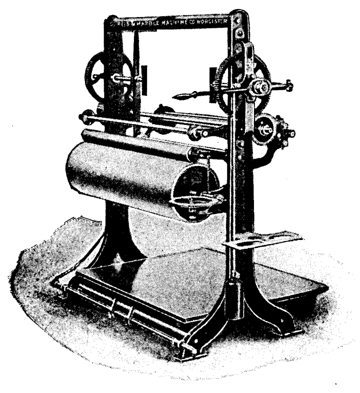


Fig. 40.

Where the cloth comes to the machine in large rolls, an Unrolling Frame is sometimes used in connection with the winding machine, to unwind the cloth from the large roll and deliver it in loose folds into an apron, from which it is taken by the winding machine. The usual speed of these machines is from 175 to 250 turns, according to the style of goods, width of boards, etc.

HOW TO TEST THE VARIOUS FINISHES OF COTTON GOODS.

When required to ascertain how a fabric, of which a sample has been submitted, had been originally finished, examine its external or physical properties, since a practical eye can detect at once if the fabric in question has been only calendered, or if starched on the back only or through the structure, etc.

Examining the fabric against the light it will show whether it has been starched or not. A heavily weighted cloth will lose much of its stiffness by rubbing it between the fingers. If, in tearing the sample, a lot of dust flies off, this indicates a weighted finish; (the more dust the heavier the weighting), and by the aid of the microscope we then may be able to detect whether the starching has been done only superficially or whether it has penetrated into the body of the structure, also if the same contains weighting substances.

The next point of value is to ascertain the amount of moisture in the sample, and which is done by carefully weighing a sample of a known size on a pair of fine scales and after recording this weight then drying the sample in a stove for some time, until there can be no further loss of weight, and when the sample is weighed again, and this weight subtracted from the first weight, the difference then indicating the amount of moisture in sample before it was tested, and from which answer it then will be easy to ascertain by means of proportion the percentage of moisture.

For example:

First weighing to be	6	grains.
Second weighing to be	5½	grains.
Loss:	½	grain.

and $6 : 5\frac{1}{2} :: 100 : x$; $\frac{5\frac{1}{2} \times 100}{6} = 91\frac{2}{3}$

and $100 - 91\frac{2}{3} = 8\frac{1}{3} = 8\frac{1}{3}\%$ amount of moisture in sample. Although this test and calculation will not show us the kind of finish, yet it is better to make it, since cellulose by itself is less hygrometric than starches, thus if there is a great percentage of moisture present it is a sure sign of the cloth being heavily starched. To ascertain exactly how much foreign matter a fabric contains, treat as large a sample of the fabric under discussion, as can be conveniently handled, after first weighing it with distilled water, containing malt; let it diaggregate, then wash, dry and weigh it. With this experiment the difference in the two weighings indicates the quantity of foreign substances deposited on the fabric; however there may be certain insoluble soaps (softeners) still in the fabric, and for which reason the sample must then be boiled in a weak acid solution in order to remove any fatty substances still adhering to the structure. After this boil, dry sample, weigh again and subtract this weight from the first weighing, the difference between both weighings being the amount of dry finishing matter in the sample and from which, by following calculation given before, it will be easy to ascertain the percentage. However we must also remember that when testing printed or dyed goods, that all colors are more or less attacked by acids.

The next procedure will be to ascertain the constituents used for starching, weighting or finishing and for which treat with boiling water for a few hours, which will remove the feculæ, starches, thickenings, gums, soluble salts, alum, sulphates, chlorides, etc., as well as all mineral or earthy matters, after which, by means of filtering, separate the soluble from the insoluble substances. In order to ascertain the nature of those soluble substances, evaporate part of the liquid, treat a few drops with tincture of iodine, which will reveal starchy substances by turning blue. If no starch present, concentrate the whole solution adding two or three times its volume of alcohol and when glue, dextrine and gum are precipitated. A tannin solution in turn will reveal the presence of gelatin by precipitating the same.

In order to distinguish gum from dextrine use the polariscope, and when dextrine is diverted to the right, gum to the left. The mixture of the two can be sufficiently indicated by basic acetate of lead, which when cold will precipitate gum but not dextrine, whereas when warm, both. If no precipitation is obtained, but an organic substance still shown by the incineration on the platinum blade, then this indicates the presence of mosses, lichens, etc. Sugar is found by Fehling's liquor, before and after interversion; add to the tolerably concentrated aqueous liquor, a few cubic centimetres of pure hydrochloric acid, ordinary concentration, warm in water bath in an apparatus with reflux refrigerator and treat with copper solution. If desired to more closely examine the soluble mineral substances, employ the usual methods of analytical chemistry.

China clay or any other matter as was used for weighting purposes in the sample will be found in the residue insoluble in water, alabaster, gypsum and talc or French chalk, provided such should have been used, in the weighting compound, being also found in this residue.

Resin is detected by boiling the sample of cloth with carbonate of soda, which will dissolve it, its presence then being shown by the precipitate of sylvic acid as is obtained from the liquor when treated by an acid. Other fatty substances do not give any precipitate, but an oily fluid which swims on the surface of the liquor.

Glycerine, if present will be also found in the watery solution and is detected, after evaporation by treating with sulphate of potash.

To ascertain the quantity of fatty matters used in a finishing compound dissolve the latter by means of ether, and when after evaporation the weight of the residue expresses the quantity of fatty matter. By treating this residue with boiling water we then can ascertain if any soluble substances are in the water.

It certainly will be next to impossible to ascertain the exact proportions of the various substances as have been used in finishing a certain fabric submitted for analysis, however having obtained the nature of the substances used, and obtained a fair idea of about the proportions of each used, it then will be an easy matter for the practical finisher to judge on what substances to use on his part and the proper proportions of each, in order to duplicate said finish.

SILK FINISHING MACHINERY FOR YARNS AND FABRICS.

SILK LUSTRING.

The silk, during boiling off or dyeing, as the case may be, has a tendency to contract, which action causes it to lose its smoothness and lustre. In order to give back to the silk these lost properties, the operation of lustring is made use of, and which consists in stretching the silk, in the shape of skeins, while damp, either to its original length, or slightly longer, maintaining said skeins in a stretched condition from one to three minutes and causing them to be rotated or turned gradually while so stretched; together with the action of steam under pressure upon it during the operation, which in turn aids in making the lustre permanent, *i. e.*, setting it. By this process the silk is prevented from shrinking while drying, every portion of the skein of silk during the revolution of the skein being acted upon and a uniformity in the lustre produced throughout the whole skein. Lustring is of special advantage when applied to black dyed silk, and in all instances dry steam should be used.

Fig. 1 shows the silk lustring machine as built by the Webendorfer Machine Company, in its perspective view, showing also the arrangement of its interior. Referring to the illustration, A indicates the hooks on which the skeins to be lustred are hung, said hooks being made of forged steel and covered with brass, the lower hook being secured to a piston of a small engine at the bottom, the pull of which stretches the skein to effect the lustring. The piston is capable of exerting a pull of 19,000 pounds, but as the length of the stroke of the piston is under control of the operator, through the lever F, the tension on the silk can be exactly regulated to suit the requirements.

The hooks work in slides, the upper hook being made adjustable, through a hand wheel E at the top of the machine, so that the same can be set to operate on skeins of different lengths up to 54 inches; or by special construction, 60 inch skeins can be treated in the machine. The chamber B is made of cast iron, and has a double back and sides, the spaces between these inner and outer walls forming a steam chamber. The object of this arrangement is to keep the interior chamber continually hot while the process is in operation, which does away with the necessity of suspending operations from time to time to heat up the interior, as must be done in some of the older types of machines.

An inlet arrangement at C, into the box, is provided, so that the skeins can be moistened by steam, when required, *i.e.* when taken to the machine in a dry condition.

When in operation, the door of the machine is closed, being equipped with a powerful locking device D, operated by a single movement, said door

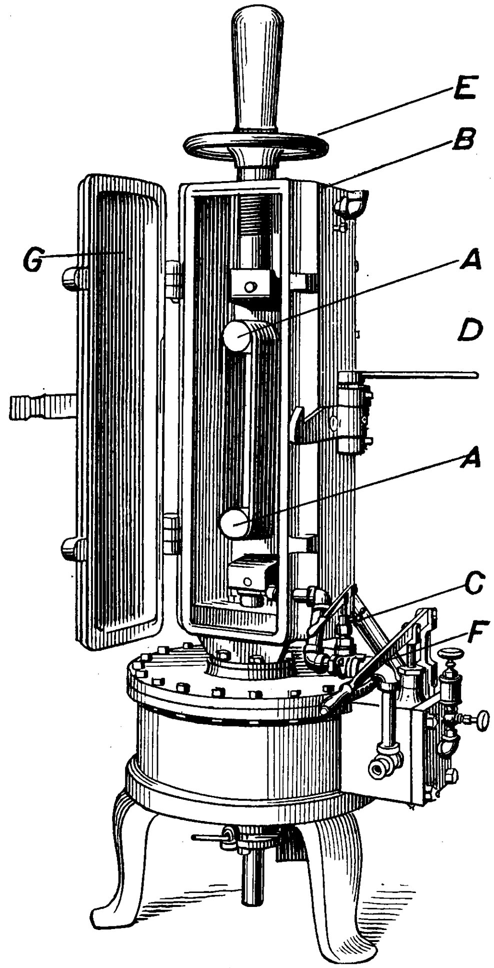


Fig. 1.

being packed around the edges with rubber gaskets, so that it is practically steam tight when closed. A safety valve in the door at G obviates all danger from accident, should the steam pressure in the chamber exceed the set limit for the safety of the compartment. Care should be taken not to overstretch the material in the operation.

The process of lustring takes from one to three minutes, and one person can lustre, with this machine, upwards of 500 pounds of silk in ten hours.

Fig. 2 is a sectional view, partly in perspective, of another make of silk lustring machine; clearly showing the method of stretching the skeins of damp silk spread out on and around a pair of hollow metallic nickel plated rollers 1 and 2 adapted to turn in their respective bearings, the silk while being maintained in said stretched condition and rotated, being at the same time subjected to a dry air temperature of about 120°F.

The upper roller 2 is mounted in bearings 3 and 4, which are secured to the upper part of the I-shaped beams 5 and 6, while the lower roller 1 is mounted in bearings or journals 7 and 8 in the downwardly projecting portions of the inverted U-shaped bridge 9, which is adapted to slide vertically between the legs 10. The bearings 7 and 8 of the lower roller 1 are raised or lowered by means of the screw 14, which passes through a worm gear wheel 13. The screw 14 has a head 15 secured by means of screw 16a to the bridge 9, and when the worm gear wheel 13 is rotated

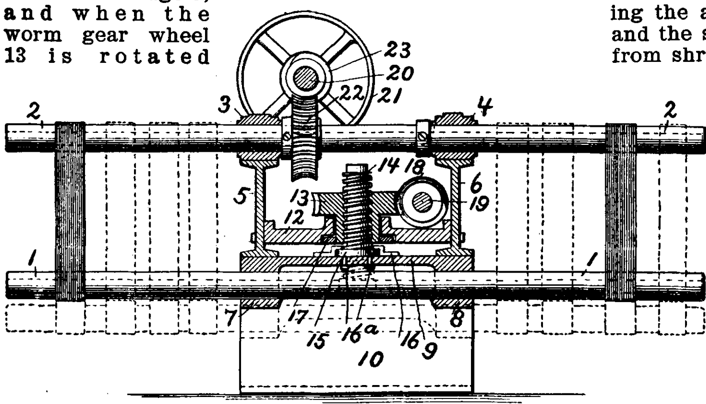


Fig. 2.

by means of the worm 18 on the driving shaft 19 the screw 14 is raised or lowered, and with it the bridge 9 and the bearings 7 and 8, according to the direction in which the worm gear wheel 13 is turned. The worm gear wheel 13 is provided at its lower end with a lock nut 17, which prevents it from rising, but permits it to turn in the support 12, which is secured to the beams 5 and 6. In addition to the head 15 on the lower end of the screw 14 being secured by the screw 16a, it is secured also by means of clamps 16 on the upper part of the bridge 9.

When the skeins of silk have been placed around and spread out on the upper and lower rollers, and the stretching mechanism has been put into operation, forcing the lower roller down until the skeins are stretched to the desired extent (shown in dotted lines), they are left in that position, thereby being prevented from shrinking, and the upper roller 2 is caused to rotate. Power being communicated to the driving shaft 20 by pulley 21, a rotary motion is communicated through the worm 23 to the worm gear wheel 22, thereby causing the roller 2 to turn in its bearings. Owing to the stretched condition of the silk around the two rollers, both are caused to turn in the same direction, thereby giving the skeins of silk a continued revolution around both rollers, so that during the successive revolutions of the silk every portion of the skein is brought in contact with the smooth heated surface of the rollers.

Fig. 3 shows another make of silk lustring machine, the same being a frame, erected in drying room and upon which frame the damp silk skeins are stretched for three or four hours, being at the same time subjected to a drying heat of about 120° F., thus preventing contraction or shrinkage of the fibre while being dried. The heated air of the drying room gradually dries the moist fibre, and owing to their inability to shrink, on account of the stretching machine, they are given an intensified lustre.

The illustration is a side view of the frame, showing the arrangement of the wet skeins of silk fibre and the stretching mechanism which prevents the fibre from shrinking while being dried or after it is dried.

Said frame comprises uprights A, braces *a*, cross beams B, long beams C, and receiving strips *c*. On each side, and near the bottom of the uprights A, a metallic side plate D is secured by screws *d* and which in turn is reinforced by an inner plate, which rests on shoulders cut in the uprights to receive it. A series of shafts I (shown in dotted lines) are journaled in bearings in the side pieces D, one end of each of said shafts having a reduced portion, forming a shoulder which rests in one of the side pieces D, while the other end *i* of each of said shafts I is squared to fit a crank lever O or a ratchet lever O1. On the operating end of each of said shafts I is secured a ratchet wheel G, and a pawl H is secured to the outer side plate D, one for each of said ratchet wheels G. The top receiving strips *c* are provided with segmental notches *c'*, adapted to receive and hold the uppermost rods E, each of which is capable of holding a number of skeins of silk. Each of the said rods is provided with circumferential grooves, one near each end thereof and one midway between the ends thereof, to prevent the displacement of the links *e* and the S-shaped links *e'*, which connect the upper and lower rods in vertical series, (three of which are shown, but more or less can be used) when

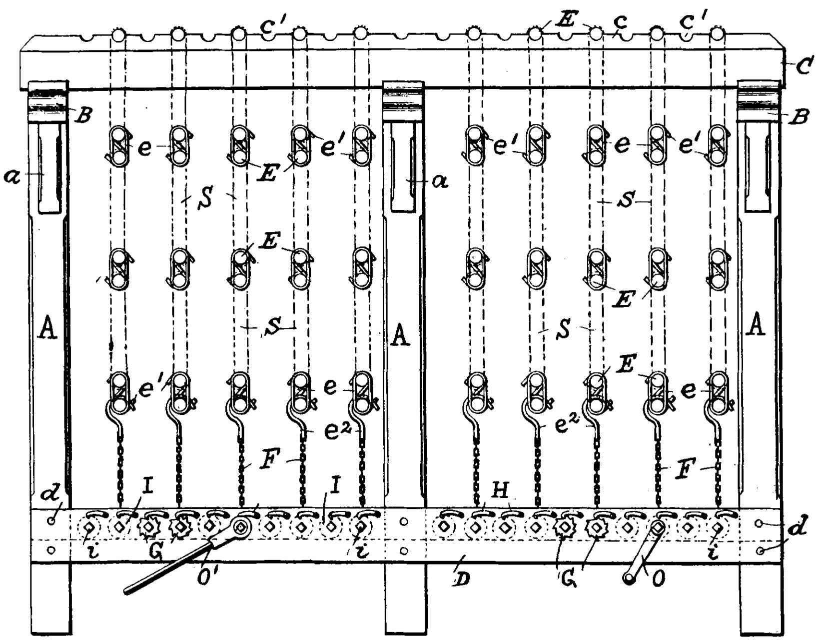


Fig. 3.

they are filled with skeins of silk S. A chain F is secured to each of the shafts I by a hook, and is provided at its other end with a double S-shaped hook e^2, which engages the lowermost of the vertical series of horizontal rods E.

After the damp silk is taken from the hydro-extractor the skeins are placed on the rods E, as many skeins as the rods will hold, and are then stretched by the manipulation of the crank and ratchet levers, the temperature of the room being kept of from 90° up to about 120° F., and the skeins left there for three or four hours in that stretched condition.

TENTERING AND DRYING MACHINE FOR SILK FABRICS.

This machine as built by D. R. Kenyon & Son, sizes, dries and tenters silk or silk mixed goods all in one process, and is so constructed that it can be easily and quickly changed to take in different widths of goods to be operated upon. The principle of construction of this machine is the same as the celebrated French machines of this character, although the improvements added to this machine have greatly increased its working qualities.

The roll of goods to be treated, is first placed on slotted pieces attached to rods, directly in front of machine, and which are adjustable for different widths of goods to be treated. The goods, thus placed, then pass over a wood roll, around a lower brass roll and between upper and lower brass rolls, the lower one of which runs in the sizing liquid contained in a copper tank, which tank can be raised and lowered and thus bring the sizing liquid up around the lower roll, and take it away when required. The liquid can be heated by means of a coil of copper piping in the bottom of the tank.

After passing between these two brass rolls, the goods pass over a table, covered with oil cloth, and a brass knife edge scrapes off the surplus size from the goods, which then pass under a small wood roll, and over a roll which is movable up and down in slots of two upright frames, placed opposite to each other on the two sides of the machine.

From this tension roll, the cloth passes under another wood roll to the point where it is fed onto the clamp chain by the operator. Weights are connected to this roll by means of a wire rope, on each side and thus tension can be given to the goods at this point by the tendency of the roll to move upwardly due to the pull by the weights. The tension of course can be varied by varying the amount of weights used.

The goods are thus held by the clamp chain, which tenters them, and at the same time passes them over a charcoal or gas fire which dries them. If charcoal is used to generate the heat, it is done by igniting the same in a large iron pan which travels in and out on a track under the machine. The amount of fire exposed to the goods can be regulated by means of a lid which slides over the pan in the direction of the motion of the goods, thus exposing as little or as much of the fire as is wanted. If the cloth or machine stops, there is a mechanism by means of which the pan can be quickly thrown out of the machine, thus preventing the burning of the goods. It is claimed that charcoal fire gives a lustre and finish to silk goods that cannot be equalled by steam, gas or any other known process of producing heat. A hood is provided over the fire, with an exhaust fan to carry off any fumes.

After being dried by the charcoal, the goods pass around a steam drum which dries the edges as were held by the clamps. After leaving the steam drum, the goods pass under another wood roll and then to the winding attachment which rolls them up.

SINGEING.

This process of cleaning silk fabrics from any loose fibres on the face and back of the structure is identical with this process as practised with cotton and worsted fabrics as previously explained, the same machines being used for this process, and for which reason the reader is referred to page 346 with reference to a description and illustration of the gas singeing machine as built by the H. W. Butterworth & Sons Co. and to pages 366-367 with reference to this machine as built by the Curtis & Marble Machine Co.

FINISHING MACHINE FOR SILK FABRICS.

This machine, shown in its side elevation in Fig. 4, refers to that class of silk finishing machinery which does the ironing and lustring of the fabric as previously impregnated with size, the object being to provide means whereby the size is "set" in the fabric previous to the ironing of the latter.

The frame of this machine consists of two side standards 1, connected together by cross girths (not to be seen in the illustration). On each standard is mounted an upright 2, to which is bolted on the front of the machine a support 3, provided with a brace 4. The uprights 2 are also provided with slots adapted to receive a series of bolts 5, carrying blocks 6, which constitute bearing brackets for a corresponding series of hollow cylindrical rollers 7. Each roller 7 is provided with a pinion 8, the pinion of the lower one only being shown for sake of clearness of illustration, said pinions intermeshing with each other, and all receiving motion through the pinion of the lower roller meshing with a gear 9, which is driven from a gear wheel 10, secured on the main drum 11 of the machine.

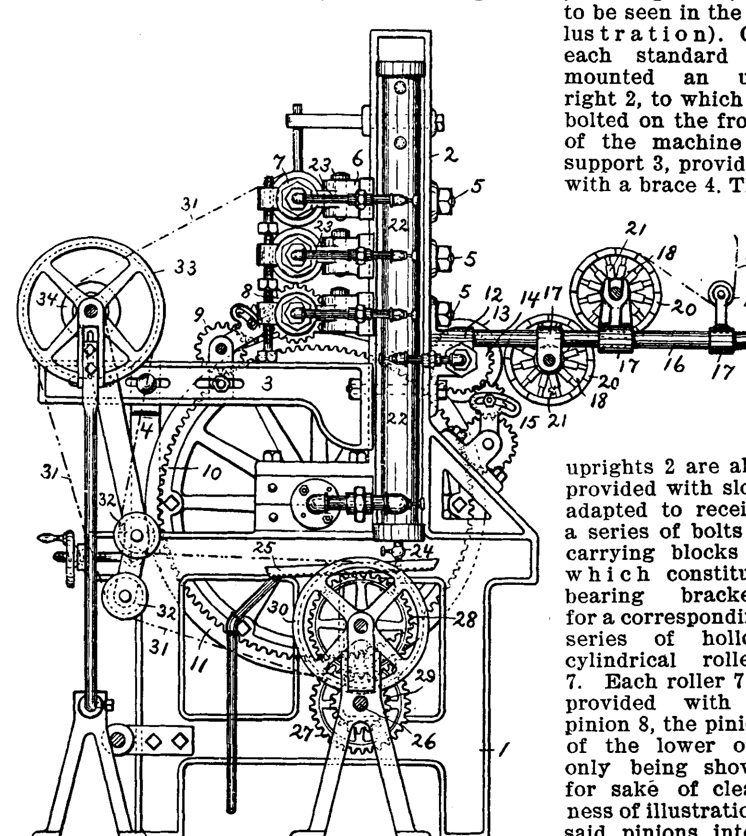


Fig. 4.

From the rear faces of the uprights 2 project brackets 12, which provide bearings for a roller 13, provided with the pinion 14, which is driven from the gear wheel 10 through the intermediate gear 15. A pair of arms 16 project from the brackets 12, and carry supports 17 for the rollers 18 and 19. Each roller 18 consists of a series of sections 20, carried by spring actuated spokes 21, which serve to exert a tension on the fabric as it passes over them, the roller 19 being simply a guide roller.

In each upright 2 is secured a steam cylinder 22, being connected with the series of hollow rollers 7 and roller 13 through a series of pipes 23. For the purpose of drawing off any condensed steam as contained in the cylinders 22, they are provided at their lower end with a pet-cock 24, beneath which is placed a drip pan 25.

The machine is driven by friction devices fastened to one end of shaft 26 (the end not shown in the illustration), the other end of said shaft carrying a gear wheel 27, which drives the drum 11, at the same time also driving the gear wheel 28 through pinion 29. The gear wheel 28 carries a pulley 30, over which is passed a belt 31, said belt running over two small pulleys 32, mounted on one of the side frames of the machine previous to its passing around pulley 33, for driving winding roll 34.

The fabric to be finished is first impregnated with its sizing compound, and then guided under the roll 19, over and under tension rollers 18, to the roller 13, which in turn evenly distributes the sizing compound all over the fabric. On account of said roller being heated, the fabric leaves it with the sizing "set" evenly on the fabric, and this in a partially dried state, with most of said size pressed through the body of the fabric onto its face, whereupon, as the fabric passes around the drum 11, its face being brought into contact with a band of absorbent material placed on said drum 11. This absorbent material completely dries the size in the fabric, at the same time evenly distributing said size all over the face, back and body of the fabric under operation.

The fabric being now thoroughly dry and impregnated with size, next passes to and between the series of heated ironing rollers 7, which, besides calendering the fabric, also, through their ironing action, impart to the fabric the desired lustre. This completes the finishing process, and the finished fabric passes to the roll 34, upon which it is wound, and from which it is subsequently removed.

CRINKLED EFFECTS ON SILK.

Silk filaments, whether in the form of threads, hanks, or fabrics, when subjected to the action of acids under certain conditions, become shortened, the effect depending upon the degree of concentration of the acid employed, the temperature of the bath, and the duration of the immersion or impregnation. It is by suitably regulating these several factors—viz., concentration, temperature, and time—that the desired result, *i. e.* crinkled effect on silk, is attained.

According to a French process, the silk threads or fabrics, in any condition, whether raw, ungummed, or boiled-off, are immersed in an acid bath until the desired shortening effect is obtained, and then washed. The density of the acid, the temperature of the bath, and the time of immersion, are determined according to the magnitude of the effect it is desired to produce, these conditions varying according to the nature of the acid employed.

The degree of concentration of the acid proper to produce the required effect upon the silk must be carefully determined for each acid, as it is only susceptible of variation within very narrow limits. Thus, for example, an active acid will not produce a useful effect if of too low a density, whatever may be the temperature and period of immersion. On the other hand, an acid of too high a density would either burn the silk or fail to produce any useful effect, according as the temperature is too high or too low.

As examples of the extreme limits of deviation allowable in the case of sulphuric, hydrochloric, nitric, and ortho-phosphoric acids, the following directions are given:

SULPHURIC ACID.

Density at 15°=1375 to 1400.
Temperature of the bath=60 to 100° F.
Period of immersion=5 to 15 minutes.

HYDROCHLORIC ACID.

Density at 15°=1130 to 1145.
Temperature of the bath=40 to 95° F.
Period of immersion=1 to 15 minutes.

NITRIC ACID.

Density at 15°=1270 to 1330.
Temperature of the bath=40 to 110° F.
Period of immersion=½ to 15 minutes.

ORTHO-PHOSPHORIC ACID.

Density at 15°=1450 to 1500.
Temperature of the bath=75 to 110° F.
Period of immersion=2 to 15 minutes.

The process may, as before mentioned, be applied to silk whether in the form of threads or fabrics. In the first case, the crinkled thread which results from the action of the acids may be used in the manufacture of fabrics either alone or mixed with other textile fibres. In the case of fabrics the contraction of the silk threads interwoven enables varied effects to be obtained, according to the mode of combination of the silk and other threads in the warp and filling, whilst in the case of fabrics made wholly of silk the effect produced on the fabric, and consequently its final aspect, may be varied by the application of reserves upon the fabric either by printing or otherwise. For fabrics of mixed silk and other threads, the effect varies according to their relative disposition in the fabric, but in any case it is the silk threads only which are shortened by the process herein described, the other threads (such as cotton, wool, etc.) preserving their original length and forming a crinkled surface.

Instead of steeping or immersing the fibres or fabrics in an acid bath, the acid may be applied by printing the pattern upon the fibre, thread, or fabric, with an acid mixed with suitable thickening material, the impression being applied upon those parts which are to be contracted. The printed fibres or fabrics are thereupon immediately subjected to the action of heat until the desired contraction is obtained, after which they are washed and dried. The temperature and period of heating, as well as the strength of the acid employed in the mixture, is to be varied according to the nature and the quantity of the thickener employed and the strength and composition of the fabric. To the printing mixture may be added metallic salts or coloring matters, for example, in the following proportions:—A printing mixture containing 5 per cent. of gum tragacanth and 45 per cent. of real ortho-phosphoric acid printed on silk tulle and afterwards subjected to a temperature of 100°F., for from three to seven minutes, gives good results. With the same composition a good effect may be obtained on foulards, when exposed to a temperature of 110°F., for from five to twelve minutes. With a composition containing 30 per cent. of gommelin, 60 per cent. of real ortho-phosphoric acid, silk tulle should be subjected for from five to ten minutes to a temperature of 105°F., and foulard for from seven to twelve minutes to a temperature of 110°F.

HEAT, POWER, TRANSMISSION AND ACCESSORIES TO MILL CONSTRUCTION.

Heat requires for its production mechanical energy in the proportion of 772 foot lbs. for each unit of heat, which is the amount of heat required to raise the temperature of 1 lb. of water, at or near its temperature of greatest density (39.1°F.) through 1° F.

The ratio of the quantity of heat required to raise the temperature of a given weight of any liquid substance through 1° F., is known as its specific heat, and as compared to the quantity of heat required to raise the temperature of an equal weight of water, at 39.1° F., *i.e.* its temperature of greatest density, through 1° F.

POINTS REGARDING HEAT, BOILERS AND POWER.

Heat of common fire	1140°	F.
Heat of blood	98	"
Water boils at	212	"
Lead melts at	594	"
Brass melts at	2233	"
Iron melts at	3479	"

For each nominal horse power a boiler should have: One cubic foot of water per hour (at least); One square yard of heating surface; One square foot firegrate area; One cubic yard of capacity; Twenty-eight square inches flue area.

One pint of water evaporates into 206 gallons of steam.

Mechanical Stokers will keep the steam pressure more regular, effect a considerable saving in fuel, prevent the emission of black smoke, and besides by means of them, one man will be able to do the work of two or three hand-stokers.

To ascertain proper size of Injector needed for a boiler, multiply the nominal horse power of the latter by 10, the result being the gallons of water needed per hour.

To find the number of cubic feet of exhaust steam that the cylinder emits per minute, multiply the area of the piston expressed in square feet by the speed of the piston expressed in feet per minute.

A horse power (technically expressed H.P. or h. p.) equals 33,000 lbs. lifted one foot in one minute, or its equivalent motion against resistance.

To ascertain the indicated horse power of an engine: Multiply the mean pressure, expressed in lbs. per square inch on piston, by the area of the piston in square inches, and the piston speed in feet per minute, the result being the number of lbs. the engine will raise one foot per minute. Dividing this result then by 33,000, will give the indicated horse power, from which then deduct $\frac{1}{6}$ for friction, in order to ascertain the effective horse power of the engine.

To prevent incrustation to the boiler: Every day throw into the feed water of the boiler, 1½ lbs. of Wyandotte Textile Soda to each 100 gallons of water used. For ordinary hard water this is amply sufficient. For very hard water, 2 lbs. should be used to each 100 gallons of water. Use the blow-off tap freely. The detrimental effect of boiler scales is shown by the following: A scale of ⅛ of an inch in thickness causes 16% increase in the consumption of coal, ¼ of an inch thickness of scale an increase of 50%, and a scale of ½ inch in thickness increases the consumption of fuel 150%. The lime which causes the hardness of the water is precipitated as a muddy sediment by the Wyandotte Textile Soda, which is thus easily removed, instead of forming on the plates and tubes of the boiler as a scale. Wyandotte Textile Soda is absolutely harmless, and will not rust or pit the metal parts nor injure the fittings, and readily dissolves in cold or hot water.

FUEL ECONOMIZERS.

The best known Fuel Economizer is the one built by The Green Fuel Economizer Co., the object of which is to utilize the waste heat in the gases passing off from the boiler furnace, and in the main consists of a stack of tubes arranged vertically in the flue leading from the boiler to the chimney. The

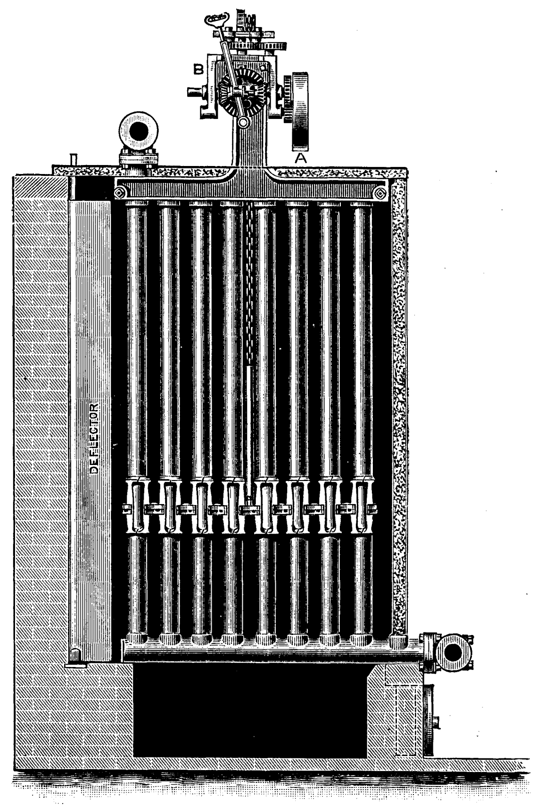


Fig. 5.

utilization of the waste heat is accomplished by heating the feed water for the boiler with the low temperature heat of the gases passing from the furnace to the chimney, said heating taking place by absorbtion of the heat by the water, which is first pumped through the economizer, before its entry to the boiler.

It is a fundamental principal of heating the feed water in a separate vessel quite apart from the boiler, and thereby utilizing the waste gases passing to the chimney, which constitutes the distinctive feature of the first invention of the fuel economizer.

It is well known to every one acquainted with the working of steam boilers that in all cases there is a large amount of surplus heat escaping up the chimney, which should not be allowed to go to waste, but be used for heating the feed water for the boilers. It is a recognized fact that the most economical boilers are those which have the most rapid circulation, and to obtain this circulation the temperature of the escaping gases must leave the boiler considerably above the temperature of the steam. What this ratio should be to obtain the highest economical results, is a subject on which engineers differ very widely. With the high pressures now in use, and gradually increasing, the temperature of the escaping gases increases in proportion to the temperature of the steam generated, and thus the necessity of economizers becomes greater in order to utilize this heat, which is otherwise wasted.

The construction and operation of the economizer is best shown by means of the accompanying illustration, which is a cross sectional view through the economizer chamber.

The economizer consists of a series of sets of cast iron tubes about 4 inches in diameter and 9 feet in length, made in sections (of various widths) and connected by "top" and "bottom headers," so as to have a continuous circulation of water through the pipes, these again being coupled by "top" and "bottom branch pipes" running lengthwise, one at the top and the other at the bottom, on opposite sides and outside the brick chamber which encloses the apparatus. The waste gases are led to the Economizer, that is, to the outside of pipes, by the ordinary flue from the boilers to the chimney, and the heat is thus absorbed by the water in the pipes.

The feed water is forced into the Economizer by the boiler pump or injector, at the lower branch pipe nearest the point of exit of gases, and emerges from the economizer at the upper branch pipe nearest the point where the gases enter between the pipes.

The tubes are made from a mixture of the best American pig, cast vertically in dry sand moulds, and are of equal thickness and free from blow holes throughout. The tubes are tested up to a pressure of 500 pounds on the square inch before being sent out. The joints of the tubes and headers are all conical, turned and bored metal to metal, and forced together by powerful hydraulic pressing machinery expressly designed for the purpose. The lids to each tube are turned conical with a taper joint, made metal to metal. The internal lid to use for high pressures has the large diameter inside the header, so that the pressure of water is all the time tending to tighten it. The external lid as used for low pressures, is held in place by a bolt and cross bar.

Each tube is provided with a geared scraper shown near the bottom of the tubes, and which travels continuously up and down the tubes at a slow rate of speed, the object being to keep the external surface of the tubes clean and free from soot which is a nonconductor of heat, and thus otherwise prevents the proper absorbtion of heat by the feed water in the tubes. The mechanism for working the scrapers is placed on the top of the economizer, outside the chamber, as shown, and the motive power is supplied either by a belt from some convenient shaft or small independent engine or motor.

The gearing for operating and reversing the scrapers is fitted with an improved clutch box and reversing lever with rolling weight which never fails to reverse at the right moment, and change the direction of travel of the scrapers on the tubes. The power required for operating the gearing is very small. The apparatus is fitted with blow-off and safety valves, and a space is provided at the bottom of the chamber for the collection of the soot, which is removed by the scrapers.

The illustration also shows a sheet iron sectional covering for the front side of the economizer, where it is desired to use it in place of usual brick walls. Although this covering is more expensive than brick walls, it is lighter, air tight, and facilitates the cleaning and examination of the economizers. It consists of a wrought iron or steel casing, lined with asbestos or any good non-conducting material.

Under conditions where a forced circulation of the feed water may be an advantage over natural circulation, an improved circulating blow off manifold is provided. By means of these manifolds any portion, or the whole of the economizer, can be made to circulate the water, and at the same time every section can be thoroughly blown off. As the economizer should be blown off for a few moments at least once a day, the valves are connected together by a long lever, which makes the operation very simple and takes the least possible time to operate. The arrangement consists of a series of wing valves placed in the manifold, worked by short levers connected by means of a long bar of iron. The valves having equal pressure on both sides, there is practically only the friction of the packing to overcome in opening. It will thus be seen that the arrangement is very simple and can not get out of order.

Where impure water is used for the boiler, the tubes require internal cleaning. An improved method of flushing the economizer by means of a patent access pipe obviates the necessity of taking off the branch pipe, and so simplifies the operation of cleansing the tubes and bottom boxes that an economizer may be thoroughly washed out and be again made ready for work in a few hours without skilled labor.

By means of an economizer, the temperature of the escaping gases is reduced on an average from 550° F. on the boiler end of the economizer to 300° F. on the chimney end, while the temperature of the feed water is increased on an average about 150° F. This rise of temperature on the part of the feed water represents so much pure gain, since it is effected by heat which would otherwise be wasted. The percentage of gain resulting from the increase of temperature of the feed water in any particular case can be easily calculated by the following formula:

$$\text{Gain Per Cent} = \frac{100\ (T-t)}{H-t}$$

where H = Total heat of steam at boiler pressure reckoned from 0°F.

T = Temperature of feed water after heating.

t = Temperature of feed water before heating.

Among the advantages claimed for the economizer are a saving of from 10 to 20 per cent. in fuel; heating the feed water economically to high temperatures, considerably above what can be obtained by other means; a great volume of water always in reserve at the evaporative point, ready for immediate delivery to the boilers; utilizing in a practical way heat from the escaping gases which otherwise goes to waste; prolonging the life of boilers by having the high temperature of feed water, thus preventing the usual expansion and contraction, due to feeding cold water; considerable sediment in the feed water being deposited in the economizer (where it can be easily blown off) by reason of slow circulation and the high temperature obtained; and increasing the boiler efficiency by adding to its heating surface.

THE CONSTRUCTION OF CHIMNEYS FOR POWER PLANTS.

The sizes and proportions of chimneys vary considerably according to different requirements. Every chimney should be large enough in cross section to carry off the gases from the furnace, and high enough to produce sufficient draft to cause a rapid combustion of the fuel in the furnace. The object of a chimney being to carry off the waste gases, it naturally determines the amount of fuel that can be burnt per hour, and it is advisable to have always a good draft, as it can then always be regulated by a damper.

Draft pressure is caused by the difference in weight between a column of hot gases in the chimney and a column of air of equal height and area outside the chimney.

The formula for finding the force of draft in inches of water of any given chimney is as follows:

$$F = H\left(\frac{7.64}{T_2} - \frac{7.95}{T_1}\right)$$

Where F = Force of draft in inches of water.
H = Height of chimney in feet.
T_1 = Absolute temperature of chimney gases ($t+460$).
T_2 = Absolute temperature of the external air (t_1+460).
t = Temperature of chimney gases.
t_1 = Temperature of external air.

Formula for finding the height of a chimney in feet for a given force of draft:

$$H = \frac{F}{\left(\frac{7.64}{T_2} - \frac{7.95}{T_1}\right)}$$

To find the maximum force of draft for any given chimney, the external air being 60° F., and the heated column of gas being 600° F., multiply the height of the chimney above the grate, in feet, by .0073, and the product is the force of draft expressed in inches of water.

The draft power of a chimney varies as the square root of its height.

The retarding of the ascending gases by friction may be considered as equivalent to a diminution of the area of the chimney, or to a lining of the chimney by a layer of gas which has no velocity. The thickness of this lining is assumed to be 2 inches for all chimneys, or the diminution of area equal to the perimeter × 2 inches (neglecting the overlapping of the corners of the lining). Let D=diameter in feet, A= area, and E= effective area in square feet.

For square chimneys, $E = D^2 - \frac{8D}{12} = A - \frac{2}{3}\sqrt{A}$.

For round chimneys, $E = \frac{\pi}{4}\left(D^2 - \frac{8D}{12}\right) = A - 0.591\sqrt{A}$.

For simplifying these calculations, the coefficient of $\sqrt{A}$ may be taken as 0.6 for both square and round chimneys, and the formulæ become:

$$E = A - 0.6\sqrt{A}.$$

The power varies directly as this effective area E.

A chimney should be proportioned so as to be capable of giving sufficient draft to cause the boiler to develop much more than its rated power, in case of emergencies, or to cause the combustion of 5 lbs. of fuel per rated horse-power of boiler per hour.

The power of the chimney varying directly as the effective area E, and as the square root of the height H, the formula for horse power of a boiler for a given size of chimney will take the form:

$$H.P. = C\,E\,\sqrt{H},$$

in which C is a constant, the average value of which, obtained by putting the results obtained from numerous examples in practice is 3.33.

The formula for horse-power then is

$H.P. = 3.33\,E\sqrt{H}$, or substituting the value of E

$$H.P. = 3.33\,(A - .6\sqrt{A})\sqrt{H}.$$

If the horse-power of boiler is given, to find the size of chimney, the height being assumed,

$$E = \frac{0.3\ H.P.}{\sqrt{H}};\ = A - 0.6\sqrt{A}.$$

Then for round chimneys, diameter of chimney= diam. of E+4″.

For square chimneys, side of chimney= $\sqrt{E}+4''$.

If the effective area E is taken in square feet, the diameter of the chimney in inches is $d = 13.54\sqrt{E} + 4''$, and the side of a square chimney in inches is $s = 12\sqrt{E} + 4''$.

If horse power is given, and area assumed, the height $H = \left(\frac{0.3\ H.P.}{E}\right)^2$

In proportioning chimneys, the height is generally first assumed, with due consideration to the heights of surrounding buildings or hills near to the proposed chimney, the length of horizontal flues, the character of coal to be used, etc., and then the diameter required for the assumed height and horse power is calculated by the formula or taken from the table.

TRANSMISSION OF POWER.

There are three systems by which power may be conveyed from its source, whether steam or water power, to the shafting of the mill, viz, wheel, rope and belt driving.

Wheel Driving or Gearing, is the oldest of these three systems, but is what we might call out-of-date, for the fact that it is an expensive system on account of the necessary massive foundations of engine, etc., bed and thick gearing walls which support the shaftings and this in complicated wall boxes and fixings. As a rule it consists of a large spur segment wheel on crank shaft, driving a pinion on a second motion shaft, which in turn communicates this motion by means of bevel wheels to a vertical shaft in the gearing room, driving in turn also the shafting in the various rooms of the mill by similar wheels.

When calculating by wheel gearing, take the pitch diameter as the effective diameter, the pitch circles touching or rolling upon each other when wheels are properly geared.

Rule for calculating the horse power transmitted by cast iron wheel gearing: $(\text{Pitch})^2 \times$ breadth of tooth × speed in feet per minute ÷ 1,000 = H.P. safely transmitted.

Example.—Consider a cast iron spur wheel 7′ in diameter, having 66 cogs of 4″ pitch and 10″ broad. The shaft on which the wheel is keyed to run 110 revolutions per minute. Ascertain H.P. which by means of this gearing can be transmitted safely:

Circumference of pitch circle=($3\frac{1}{7}$×7)=22 feet.

Speed of pitch circle in feet per minute=(22×110) =2420 feet, speed per minute, and

$$\frac{4 \times 4 \times 10 \times 2420}{1000} = 387\ \text{H.P. Ans.}$$

If applying this rule to bevel wheels consider the average pitch. Never run cast iron wheels over 2,500 feet per minute, whereas steel wheels can be run about 3,500 feet per minute.

The only advantage of this system of transmission of power is that slipping when the wheel teeth are in gear cannot take place. When wheels work with little noise and a minimum of friction, it is then a sign that the teeth are correctly formed and geared; however this is only seldom met with as a rule, a great amount of noise and vibration being the experience with gearing in motion.

Wheel gearing as a drive for a mill is also frequently the cause of breakdowns caused by the back lash in many wheel teeth, which is set up when a load is suddenly thrown off the machinery, which causes the driven wheels to run back upon the drivers, and when this pounding action will frequently be the cause of mutilating or breaking out teeth.

When the axes of driving and driven shaft are parallel, spur gearing is used, whereas when the axes of driving shaft and driven shaft are at right angles, bevel gearing is employed. When a shaft is at any angle with the one from which it is driven, angle wheels are used.

Mitre wheels are bevel wheels of exactly the same number of teeth of an angle of 45 degrees.

Mortice wheels are such as have teeth of hard wood inserted into spaces cored in the rim, and are rather noiseless and consequently can be run at a higher speed.

How to Compute the Velocities, etc., of toothed gears. The relative velocities of gears is as the number of their teeth.

Where idle or intermediate gears intervene they are not reckoned.

The Pitch of a Gear is the distance apart of the teeth from each other, and gears of unequal pitch cannot run together.

The Pitch Line of a gear is a circle struck from the centre, and passing through the middle of the teeth. It defines the diameter of a gear, which is not, as many suppose, the whole distance across from point to point of teeth, but half way from bottom to top of teeth.

To Measure the Diameter of a Gear it is only necessary to take the distance from the bottom of the teeth on one side to the top of the teeth on the opposite side of the gear.

To Ascertain the Pitch of a Gear.—Find the diameter as above, then count the teeth, and divide their number by the diameter.

Example.—If a gear of 21 teeth measures 3 inches diameter on the pitch line, then the gear is 7 pitch.

How to Distinguish the Driver from the Driven Gear.—If the gearing is in motion a glance will usually suffice to show this, since if a wheel is bright or worn on the front of the tooth, *i. e.*, on the side in the direction of which the wheel is moving, it is the driver; whereas the driven wheel is worn on the side of the tooth further from the direction of motion. With reference to bands or straps, one side of the band or strap is always tighter than the other since the driver is doing the pulling.

Worm Wheels.—As drivers only are usually single threaded and are equal to one tooth as a multiplier of speed, worm wheels are used to rapidly diminish speed.

Example.—A worm wheel revolving 750 times per minute, drives a 150-tooth wheel. What is the speed of the latter?

Answer.—$750 \times 1 \div 150 = 5$ revolutions per minute.

If the worm wheel had been double-threaded it would have taken two teeth at one revolution, and the result would have been 10, obtained thus:

$$750 \times 2 \div 150 = 10.$$

A Mangle Wheel is a driven wheel only, and is used to reverse its own direction of motion. The speed for it is calculated as for an ordinary wheel, but since the tooth at each end is used only once in a double revolution (all the others being used twice) its size is taken as one tooth less than it actually is.

Example.—A 12 pinion revolving 350 times in a minute drives a mangle wheel of 140 teeth. How many times will the mangle revolve in a minute?

$350 \times 12 \div 140 = 30$ revolutions (equalling 15 in each direction). Ans.

How to Ascertain the Number of Revolutions of the Last Wheel at the End of a Train of Spur Wheels, all of which are in a line and mesh into one another: Multiply the revolutions of the first wheel by its number of teeth, and divide the product by the number of teeth of the last wheel; the result is its number of revolutions.

How to Ascertain the Number of Teeth in Each Wheel for a Train of Spur-Wheels; each to have a given velocity: Multiply the number of revolutions of the driving wheel by its number of teeth, and divide the product by the number of revolutions each wheel is to make, to ascertain the number of teeth required for each.

How to Find the Number of Revolutions of the Last Wheel of a Train of Wheels, and pinions, spurs, or bevels, when the revolutions of the first, or driver, and the diameter, or the number of teeth, or circumference of all the drivers and pinions, are given: Multiply the diameter, the circumference, or the number of the teeth of all the driving wheels together, and this continued product by the number of revolutions of the first wheel, and divide this product by the continued product of the diameter, the circumference, or the number of teeth of all the pinions, and the quotient will be the number of revolutions of the last wheel.

Rope Driving was introduced on a large scale not until 1860, and in its principle consists in a fly rope pulley, being made up in segments, is keyed on the crank shaft of the engine, driving in turn the other pulleys on the various line shaftings in the mill by means of ropes working in grooves turned in the outer rim of the pulleys.

The angle of groove varies from 40° to 45°, and the ropes (as are made either of hemp or cotton) do not rest at the bottom of groove, but are wedged in on the sides, so that slipping is reduced to a minimum.

The average life of a rope is about ten years, and the limit of speed for maximum efficiency about 5,000 feet a minute. Beyond this speed there is loss of driving power, caused by the resistance of the air and the centrifugal force, which tends to throw the rope out of the groove and decrease the grip of the rope in the groove. Place the slack side of the rope on the top, and the tight, or driving side on the bottom, so that as great an arc of contact as possible is obtained. The diameter of a rope pulley is always measured to centre of rope, and should not be less than 30 times the diameter of rope itself in order to equalize as much as possible to permit the alternate bending and straightening action the rope is subjected to during its travel.

Belt Driving. To obtain the full power and longest service from belting, care must be taken in laying out shafting and pulleys.

All shafting should be made to run perfectly true at the first, for a slight negligence in this matter at the outset becomes constantly more serious the longer it is allowed to go uncorrected, causing loss of power and the rapid destruction of belts and machinery. The pulleys should be perfectly balanced and centered, and the circumference of both outer edges of the same pulley must be exactly alike. The highest part or crown of the pulley face being exactly in the centre, the crown of the pulley face should not exceed ⅛ of an inch in length above that at the edges, to every 12 inches in width, and experience has demonstrated that these are about the best proportionate dimensions to secure the best running and the greatest endurance of the belts; with the crown of the pulley face higher than this, the belt is liable to be strained in the middle and lift off on its two edges, especially with light belts. Pulleys for shafting belts should not be higher in the middle, but have a straight face, and pulleys and belting alike should be ample size for the work to be done. Always try and use pulleys as large as circumstances will permit, and the diameter of the pulleys should be increased as the thickness of the belt is increased, for the reason that in order to bend around one-half of the pulley, the outside of the belt must stretch and the inside compress, and the larger the pulley the less the stretch or compression for a foot of belt, and consequently the less the wear to the belt.

Increasing the diameter of the pulley, the number of revolutions remaining the same, will increase the power, for which reason a light belt on a large pulley is more economical than a thick belt on a small pulley. When more power is wantéd, and the diameter of the pulley cannot be increased, increase the face of the pulley and the width of the belt.

Single belts may be used, with economy, as wide as 12 inches, but where greater width is required they should be of double thickness. All belts, 8 inches wide and more, are cut on the hide lengthwise of the back. This is necessary to insure their running straight. A wide belt made of leather cut from the side, cannot, with the greatest care, be made to run evenly, on account of the differences in the tensile strength of the different portions of the hide; but a wide belt, made from the centre of the back, has the same thickness and quality of leather on each side and must necessarily run evenly, the lightest and weakest parts of the leather being in the middle, and the strongest and heaviest on the sides, the difference in thickness amounting, in some cases, to as much as one-fourth of an inch; for this reason, when a wide, single belt is placed under a heavy strain, the thick heavy edge crowds up toward the centre, or lighter part, running on the crown of the pulley, and this prevents the even, uniform hug, so essential where the best results are desired.

Double belts are stiffer and better able to resist the tendency to cup in the middle, to crowd up from the edges, as they generally hug the pulley closely along the whole width. There are those who hold that the single belt, being more flexible, adheres better to the pulley, but this is correct only in cases where they are subjected to but a moderate strain. Where an inch single belt has to do extra heavy work, it will be almost certain to stretch, lift up from the pulley in the middle, or the fastenings give way, therefore, where a single belt must be used, it should be of ample width for the labor to be performed, and not run too tight on the pulleys, so that the fastenings need not be strained. When the fastenings frequently give out, it is a sure sign that too much work is being done by the belt, and either a wider single belt or a double belt should be substituted. For machinery which is run at a high rate of speed, and where fine work is done, light even belts with joints only cemented should be used. Such joints will pass over the pulleys smoothly, causing no jar or vibration to either pulleys or shafting.

Double belting should always be used when a slow motion, great strain and hard labor are required; also when a belt is to be run at one-quarter turn, so as to give the proper angular motion, the principal strain in these cases being on the sides. Belts which have to be constantly shifted, or those which are run on upright shafts with flanged pulleys, should also be double. Where wide belts are made double, they may be subjected to severe strain without injury, for there must always be one strong solid part to the leather to cover every point of possible weakness or where the ends are lapped in breaking joints. It should not be forgotten in ordering belts, that one wide belt is better than two narrow ones, even if the two narrow belts would, together, cover more surface than the one wide one.

Double belts transmit about 50 per cent more power than single belts.

Vertical belts require special tension to obtain sufficient friction on the lower pulley.

Excessive tension on a belt is injurious.

Horizontal belts and belts running at an angle of 45° or less should have the lower side, the tight or pulling side of the belt wherever possible.

Avoid quarter turn belts wherever possible, and if run in this way, they should be turned end for end often until the stretch is entirely taken out.

It is reckoned that leather belts, grain or hair side to the pulley, will drive 34 per cent. more than with flesh side to the pulley; 48 per cent more than rubber; 121 per cent. more than gutta percha; and 180 per cent. more than canvas.

The slack side on top, with large pulleys at high speed, is undoubtedly the true philosophy of transmitting power by belts.

Not speed alone, but adhesive force must be gained to do work without destructive tightness or slippage of the belt, therefore, there should be a proper proportion of pulley diameter and belt contact.

Long belts are preferred to short ones, but care must be taken that the length be not too great.

To Find the Length of a Belt: Add the diameters of the two pulleys and multiply sum by 1.57, and to this add double the distance between the centres and the two shafts; then, (when dealing with pulleys of different diameters, in order to compensate for oblique direction of running belt) subtract separately the diameter of the smaller pulley from the diameter of the larger and multiply the remainder by itself, divide product by four times the distance between centres of the two shafts, and add this result (which naturally would be 0 if pulleys of equal diameter) to that of the first part of the calculation, the answer being the exact length of belting required (less tension). It will be readily understood that in connection with the calculation, all dimensions must be expressed in either feet or inches.

Example: Pulleys to be 6 feet and 3 feet, and distance between centres of shafts 30 feet.

$6+3=9\times1.57=14.13+60=74.13$
and $6\text{-}3=3\times3=\ 9\div120=\ 0.133$

$\overline{\ 74.263\ }$

Answer. $74.263'=74', 3\frac{156}{1000}''$, practically $74'\ 3\frac{1}{6}''$.

To Measure Belts in Coil. In order to calculate the length of a belt in coil, we may consider the coil as composed of a series of concentric circles, and then calculate the sum of their circumferences for the total length of the coil; but this would be tedious, and a simple method should be devised.

To obtain this, first, find the mean diameter of the extreme coil diameters by taking half the sum of the diameters of the outer and inner coils, multiply this number by 3.1416, and then by the number of coils, this will give the total length of the coil in inches if the diameters of the coils were taken in inches.

A formula expressing this rule will be:

$$L=3.1416\ n\left(\frac{D+d}{2}\right)$$

and may be simplified thus:

$$L=1.5708\ n\ (D+d).$$

In both of which L D and d must represent like units of measurement.

To simplify calculations still further by getting the length L in feet, and the diameters D and d in inches, the rule may be put into this form, which is probably the best for use:

$$L=.1309\ n\ (D+d).$$

Method of Calculating Horse Power of Belting. A single belt 1″ wide running at 1,000 feet surface speed a minute, will safely transmit 1.7 H.P., and a double belt 1½ times the amount. Hence the rule:

$$\frac{\text{Breadth of belt} \times \text{speed of belt in ft. per minute} \times 1.7}{1000}$$

Example.—Find the H.P. which may be transmitted by a pulley 3′ diameter, 4″ broad, when running 300 revolutions per minute.

3′ diameter=(3.1416×3)=9.4248 feet circumference, 9.4248×300=2827.4 feet=speed per minute, and

$$\frac{2827.4 \times 1.7 \times 4}{1000} = 19.2 \text{ H.P. Ans.}$$

Miscellaneous Calculations, Etc.

How to Find the Circumference of a Circle, or of a Pulley: Multiply the diameter by 3.1416; or as 7 is to 22 so is the diameter to the circumference.

How to Compute the Diameter of a Circle, or of a Pulley: Divide the circumference by 3.1416; or multiply the circumference by .3183; or as 22 is to 7 so is the circumference to the diameter.

How to Compute the Area of a Circle: Multiply the circumference by one-quarter of the diameter; or multiply the square of the diameter by .7854; or multiply the square of the circumference by .07958; or multiply half the circumference by half the diameter; or multiply the square of half the diameter by 3.1416.

How to Ascertain the Circumferential Velocity of a Wheel, Driver or Cylinder: Multiply the circumference in feet by the number of revolutions per minute.

Example.—A roller has a circumference of 4 feet and makes 12 revolutions per minute. Ascertain its circumferential velocity:

4×12=48 feet. Ans.

How to Find the Speed of Last Shaft where several shafts and pulleys or wheels intervene: Multiply all the drivers into each other and the product by the speed of the first shaft, divide this product by the product of all the driven pulleys or wheels, multiplied into each other. In connection with pulleys consider circumference, in connection with wheels consider the number of teeth.

Example.—A line shaft in a weave room revolves 120 times per minute, and carries pulley 12 inches in diameter. The looms driven by them carry pulleys 10 inches in diameter. Find the speed of the looms.

$$\frac{120 \times 12}{10} = 144 \text{ revolutions. Ans.}$$

Driving-Driven: The manner of describing the driving wheel must also be applied to the driven. If the diameter of the driving wheel be taken, we must also use the diameter for the driven wheel, and neither the radius or circumference.

Example 1.—An engine has a driving wheel 20 feet in diameter, revolving 40 times per minute, which drives, by means of ropes, a pulley on the second motion shaft 2 feet in radius (semi-diameter). Ascertain speed of the second motion shaft:

Two feet radius=4 feet diameter, thus 40×20 feet ÷4=200=revolutions speed of the second motion shaft per minute. Ans.

Example 2.—Speed of under shaft of a loom 80, the same carries a 10-teeth bevel, which gears with a 10 on an upright shaft, at the top of which a 32-teeth wheel on a block of tappet wheels, is driven by an 8. Find the speed at which they revolve:

80 × first driver 10, × second driver 8÷ first driven 10 and second driven 32.

80×10=800×8=6400÷10=640÷32 = 20 revolutions per minute. Ans.

How to Find the Speed of the Driving Wheel, when the speed of the last driven wheel and the size of the gearing are known: Multiply the speed of the last driven wheel by the size of the driven wheels and divide by the size of the drivers.

Example.—A spindle revolving 1,500 times per minute, is driven from a line shaft by a 30 inch drum to a 10 inch pulley, which is fixed to a 10 inch tin roller driving the 1¼ inch wharve of the spindle. Ascertain speed at which the line shaft will revolve:

The drivers being 30 and 10, and the driven 10 and 1¼.

1500×10×1¼=18750.

18750 ÷ 30 = 625 ÷ 10 = 62.5=62½ revolutions per minute speed of line shaft. Ans.

How to Obtain the Size of the Driving Wheel the speed of the driven and driving shaft and the size of the driven wheel or pulley being given: Multiply the speed of the driven shaft by the teeth in the wheel or the size of the driven pulley, and divide by the speed of the driver.

Example.—A shaft having a speed of 125 r. p. m., drives another shaft at 100 r. p. m., on which is a 40-tooth bevel wheel. Ascertain the size (teeth) of bevel wheel on the driving shaft:

100×40=4000÷125=32 teeth. Ans.

How to Obtain the Size of the Driven Wheel if the speeds of the driver and driven wheel or wheels are given and also the size of the driver: Multiply the size of the drivers by the speed of the first driver, and divide by the speed of the driven, and by the driven pulleys given, if any.

Example.—A shaft making 17 revolutions per minute, carries a 15-tooth wheel, which drives a second shaft by means of a wheel, the number of teeth in which it is desired to find. On this shaft is a 120-tooth wheel driving one of 64-teeth, which latter revolves at $15\frac{15}{16}$ revolutions per minute. Required the size of the first driven wheel:

Drivers 15 and 120. Driven 64 and $15\frac{15}{16}$.

$17 \times 15 \times 120 \div 64 \div 15\frac{15}{16} = 30$ teeth required in wheel. Ans.

How to Change the Speed of a Driven Pulley, Shaft or Wheel: Increase the size of the driver or decrease the size of the driven pulley in exact proportion to the increase of speed required; or vice versa if a decrease is required.

How to Cool a Hot Shaft: Make a belt of something of a loose, water-absorbing nature, and hang it over the shaft as near the hot journal as possible, allowing it to hang down and run loose on the shaft. A pail of water may now be fixed so the lower part of the belt will run in it, and in this simple way the shaft may be cooled while running.

Another method consists in the use of black antimony and best castor oil; you may, if you like, add a little black lead. Work it up nicely together and lay it on the shaft, first thick, and then taper down to nothing but the oil.

Cooling Compound for Hot Bearings: Mercurial Ointment mixed with black cylinder oil and applied every quarter of an hour, or as often as expedient. The following is also recommended as a good cooling compound for heavy bearings: Tallow 2 pounds, plumbago 6 ounces, sugar of lead 4 ounces. Melt the tallow with a gentle heat, and add the other ingredients, stirring until cold. For lubricating gearing, wooden cogs, etc., nothing better need be used than a thin mixture of soft soap and black lead.

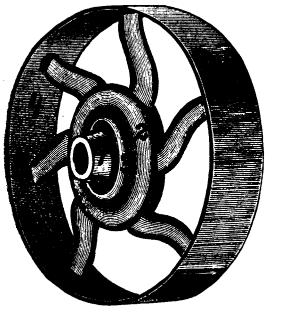
Steel and Iron: To distinguish steel from iron pour on the object to be tested a drop of nitric acid; let it act for one minute, then rinse with water. On iron the acid will cause a greyish-white, on steel a black stain.

In case of wire, heat in the gas and dip in water; if hard and brittle it is steel.

McCAFFREY'S SELF OILING LOOSE PULLEY.

The advantages of this pulley are: (1) that it will run for weeks with a single oiling, (2) that oil can be applied in quantity to the pulley while the machine is running at high speed, and this without a waste of oil, (3) that by oiling these pulleys while running the danger of a machine suddenly starting up while oiling and maiming the oiler is avoided, (4) that the throwing off of any surplus oil onto the machine, the yarn, the fabric, etc., when starting up, is avoided.

With reference to the accompanying illustration, which is a perspective view of this pulley, the oil is applied to the surface of the cone shaped journal 1; the surplus oil travels up the cone and disappears in the interior 2 of the pulley, in turn feeding (oiling) the shaft surface from within the pulley. The surplus oil then travels between the shaft and the bearing of the pulley to the outer end of the cone 1, and from where it is again drawn up on the outer surface of the latter and the procedure as before explained repeated.



When the pulley is idle, the oil drops below the level of the shaft, and any oil on the cone surface will then run down the lower side of the cone to the interior of pulley 2, and from where in turn it is also re-used. A flange 3 protects the oil when on the cone surface 1 from dropping onto the inside 4 of the pulley belt surface.

Sticking of this pulley, caused by lack of oil, is prevented, for the fact that no oil is wasted, the latter being continually conducted into the inside of the pulley, and re-used, thus accomplishing a saving in time, lost otherwise by having to stop the machine to loosen the pulley provided the latter has run dry, in turn preventing any possible injury thus caused to the shaft and journal surfaces, prolonging also the life of the belt.

Directions to oil the pulley: Fill the chamber until the oil can be seen in the ring, turn the pulley around a few times, then put on the belt. To oil the pulley while running, place the oil-can on the hub, just inside the ring and the hub will carry the oil to the chamber. To keep the oil clean in the chamber, wipe off the hub occasionally and put in fresh oil. (John McCaffrey, Lawrence, Mass.)

THE AMERICAN PIONEER PRESSED STEEL SHAFT HANGER.

As a substitute for the common cast iron hanger a new form of pressed steel has recently been produced. Cast iron, from the nature of its structure, is a poor material to use where bending or torsional strains are present. Steel and wrought iron have higher tensile strengths and greater elasticity, making a lighter construction possible to withstand a given strain. In a cast iron member it is necessary to allow a greater factor of safety on account of possible blow holes or imperfections, while with steel and wrought iron the close grained, uniform structure makes this unnecessary, which means a still greater saving in weight.

The accompanying illustration Fig. 1 gives a perspective view of this hanger assembled, and which is made of rolled open hearth steel, a material very much stronger than the very best cast iron, more homogeneous, and one that may be worked in dies and pressed to shape. The pattern shown is known as the American Pioneer four-way adjustment hanger, and consists of two pressed steel legs each strongly ribbed and flanged to give rigidity and lightness. At the upper ends these are shaped into broad feet to form a solid base, where the hanger bolts to the footing piece, while the lower ends are narrowed down to fit the lower cross piece or clamp.

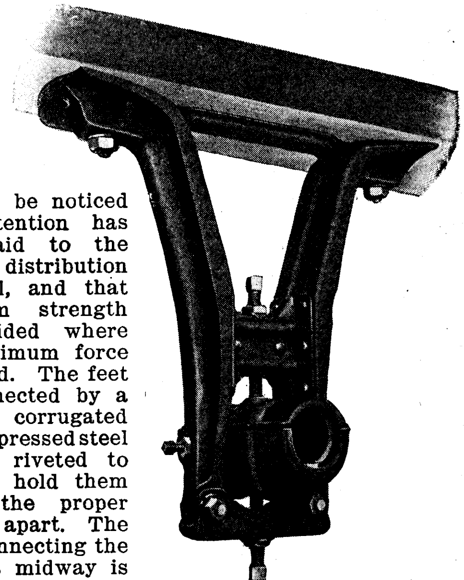


Fig. 1.

It will be noticed that attention has been paid to the proper distribution of metal, and that maximum strength is provided where the maximum force is applied. The feet are connected by a flanged corrugated plate of pressed steel securely riveted to them to hold them rigidly the proper distance apart. The brace connecting the two legs midway is also pressed steel, strongly ribbed, and being riveted to each leg by six rivets is practically one piece with them. Besides acting as a transverse or lateral brace, this part also takes the thrust transmitted through the upper vertical adjusting screw. The arched clamp connecting the ends under the bearings is of U section so as to resist the bending moment due to the thrust on the other vertical adjusting screw. It fits outside the narrow ends of the legs, and is secured to them by two fitted bolts, so that it ties the narrow ends of the legs together, strengthening the whole construction. By removing one of the bolts which secure the cap, the latter, as shown in connection with Fig. 2, can be swung upon the other bolt as a hinge when removing or inserting the bearing blocks—a convenient feature which is not found in the ordinary cast iron hanger. The bearing consists of three parts, all cast iron; an upper and lower half bearing, and an oil pan. The top of the upper half

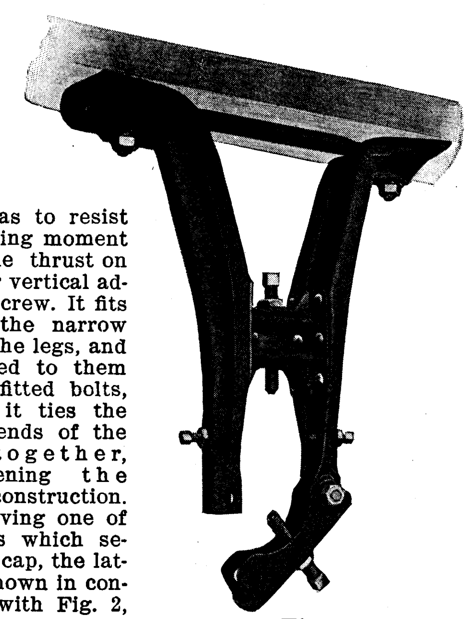


Fig. 2.

bearing and the bottom of the lower one are formed to fit sockets having their common center in the axis of the bearing. The lower socket is cast in the oil pan, which is made large enough to accommodate the lower half bearing, with space between to hold lubricating oil. The bottom adjusting screw engages a recess located centrally on the under side of the oil pan. When the bearing is assembled and the vertical and lateral screws adjusted the half bearings rest on each other their full length and are supported in the socket of the oil pan. While the pan is stationary, being firmly held by the set screws, the bearings are free to adjust themselves to fit the shaft. The bearings are provided for ring oiling, as shown in the sectional view in Fig. 3, and to prevent dripping of oil, are fitted with automatic wipers.

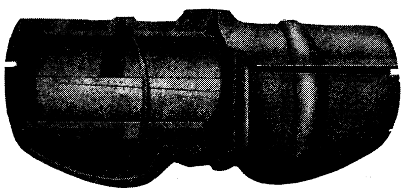


Fig. 3.

The pressed hanger complete with cast iron boxes is claimed to weigh but one-half of an all cast iron hanger designed for the same work. Being lighter, the hanger is much easier to install, especially in locations difficult of access, and may be shipped in quantities at a considerable saving of freight charges. (Standard Pressed Steel Co., Philadelphia, Pa.)

MINERAL TANNED LEATHER BELTING.

The old saying, "there is nothing like leather" as far as belting is concerned, at least, still holds true. Rubber, Canvas, and other kinds of belting are being used mainly for the reason that a belt is required that will stand steam or moisture. But this class of belting is short lived, as a rule, and cannot be run successfully as cross belts or when subjected to constant shipping; oil or grease tends to rot rubber. Again this class of belting practically cannot be repaired.

The Barnes Mineral Tanned Leather Belting has solved the problem of a leather belt that will run successfully in wet and steamy places. Not only is the cement used in this belt, proof against steam or water, but the leather as well; it can even be boiled in hot water without any apparent effect. This belting is now used in a large number of bleacheries, dye houses, etc., and will also run in places where exposed to intense heat or gases, remaining at the same time pliable under such conditions. There is practically no stretch to this belt. (Henry K. Barnes, Boston, Mass.)

THE JACKSON BELT LACING MACHINE.

The object of lacing belts by this machine is to overcome the disadvantages characteristic to hand lacing, producing a smoother connection, doing the work quicker and at the same time more economically, both with reference to material used for the lacing as well as saving in length of belting needed.

The smooth connection is the direct result of the ingenious construction and operation of the machine, and is equal in every respect to a joint in an endless belt made by skiving and gluing. Necessarily as the joint is a perfect hinge, it passes over the pulleys noiselessly, without slippage and without friction, thus reducing to the lowest possible percentage the vibrations and the wear upon the bearings and shafting, a feature impossible for a handlaced belt, whether lacing-leather or studs, clamps or hooks are used, and which cannot help but produce an uneven surface in that portion of the belt; whereas in belts laced by means of the Jackson machine, the lace is the same on both sides of the belt and is even with the surface in every instance. This certainly is the most important item to be considered by the management of any mill, since in the transmission of power, it is important that the ends of the belt be joined in such manner as to secure the greatest strength, combined with a flexible joint and an even surface on its face, a feature the Jackson machine does to perfection.

With reference to cost, lacing by this machine is in the first instance only about one-quarter that of the old methods employed, and at the same time will last about three times as long. Computing these two claims for the Jackson machine vice versa old methods will give us ($4\times3=$) 12 points in favor of the machine, by which we mean that besides the belt running smoother, and its consequent advantages to transmission and machinery in a mill, the actual lacing of the belt by the machine will be only about $\frac{1}{12}$ the cost of that by the old methods, in turn readily explaining such claims as: One cent laces a 5-inch belt, two cents a 10-inch belt, or three minutes required to lace a 6-inch belt, four minutes an 8-inch belt, etc., indicating that the lacing is an indispensable adjunct to every factory in which belting is used, the Jackson Belt Lacing Machine having solved, through the wire coil clasp lacing, a vexing problem. The saving to the manufacturer of time and money in these days of keen competition, when slight advantages are so often attended by the most important results, occupies the best thought of business men the world over, and when consequently any textile manufacturer must pay the closest attention to belting, no doubt one of the most important items with reference to Supplies in every mill. If then he is still using the primitive method of lacing belts by hand in his mill, the great utility of the Jackson Belt Lacing Machine will readily be seen in a brief investigation of its capabilities.

First and foremost, the Jackson Lacer will not only save money in the cost of lacing 12 : 1 as previously referred to, and besides this better work, but it will at the same time reduce to the minimum loss in production (=$) caused by the stoppage of machinery for the sake of relacing belting.

The Jackson Belt Lacing Machine, and of which a perspective view is given in Fig. 1, is most simple in construction, and is made of the very best material. The rolls and gears are of hard tool steel, and furthermore, all the parts of the machine are interchangeable and can be easily replaced, should necessity require, without the return of the machine to the factory. They are built in four sizes, known respectively as 6-12-18 and 24 inch machines, the numerals quoted indicating the maximum width of a belt, one or the other machine is capable of lacing. Although as a rule the machines are operated by hand, yet if required, the #18 and #24 machine can be equipped for power. It certainly might be useless to mention that the machines will lace belts made of any material, up to 24 inches wide and ⅝ of an inch thick. The simplicity, construction and operation of the machine will certainly alone recommend it, but in this connection the factor of strength and durability of the lacing is also an additional (and certainly most important) factor in favor of this machine, tests of two and a half inch belting having shown that the wire coil as was used in connection with a #6 machine, has stood a tensile strain of 1900 pounds without breaking or pulling apart.

The operation of lacing consists first in squaring the end of the belt by means of the cutter bar seen on top of the machine (see Fig. 1) and a specially constructed knife furnished with the machine. The end of the belt being square, the belt is clamped firmly between the jaws by means of the levers and the end punctured by a spiral needle. The needle is driven ahead by three grooved rollers which are revolved by means of the crank. Following the needle the coiled wire is inserted and enters the holes punctured in the belt by the needle. The lacing being in the belt, it is removed and the surplus wire cut off with pliers. The wire is then flattened between the jaws of the machine until it is flush with the surface of the belt (see *a* in Fig. 2). The other end of the belt being laced in a similar manner, the two ends being brought together (see b in Fig. 2), they are held by means of twine, lace leather, rawhide or metallic pins inserted between the wire meshes of both ends of the belt (see c in Fig. 2). The joints thus made are fully twice as strong as those made by lace leather (hand lacing) to a similar belt, since considerable less of the cross section of the belt has to be removed for the insertion of the wire, at the same time a larger number of loops per inch are made than with hand lacing, and consequently each loop in proportion exerts less strain upon the belt, when the latter is under tension. For belts subject to steam or acid fumes, brass lace wire is used. The size of the wire used varies with the width and thickness of the belt, as will be readily understood.

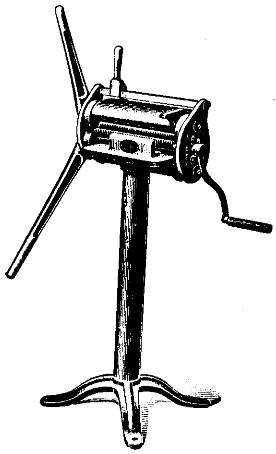


Fig. 1.

Another advantage that should not be lost sight of in connection with this modern system of belt lacing, is that by simply pulling out the pin c, the belt can

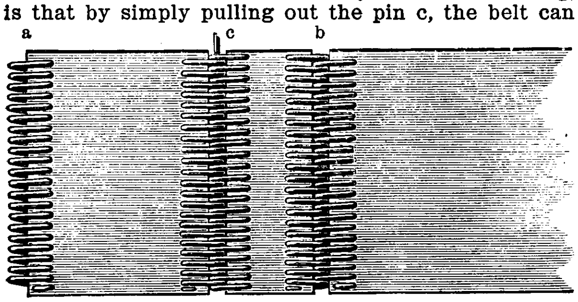


Fig. 2.

be disconnected in a moment, a feature which is a great convenience in mills where belts of varying length are required or where it is desirable to have a reserve belt in readiness for a machine when required.

Rule for ascertaining the length of a new double belt: Draw a tape line around the two pulleys in the manner the belt would be when working; then deduct from this length obtained ⅛ inch per foot to give the required tension to the belt to start with. This now would give you the length of belting required if dealing with hand lacing. However, if dealing with the Jackson Machine, deduct an additional ¼ inch per foot to allow for the final elongation of the belt which will in time permit the ends to come together, and which latter item (¼ inch for each foot of belting ever used in your mill) is a clear saving in your pocket, since with hand lacing when in time tightening the belt, this means waste of belting, thrown away, but which is not the case with machine lacing, a feature readily explained by a practical test.

Example: Instead of cutting a belt the right length to reach around pulleys, and allowing for proper initial tension, a new two-ply belt, say, 20 feet long by 4 inches wide, is cut 7½ inches shorter and an extra (a spare piece and of which different lengths are kept on hand) piece 5 inches long is inserted to make up the deficiency minus (2½″ see rule =⅛″ per ′ as given before) tension. The 5 inches belting are a clear saving to you on this belt and similarly on another. The person in charge of the belting in the mill, as indicated before has several sets of pieces of 4-inch belt in lengths of 1, 2, 3, 4 and 5 inches, with wire lacing in their ends ready for use. After the new belt has been run a few hours and requires tightening, he then takes the two rawhide pins (see c Fig. 2) out, removes the 5-inch piece and inserts a 4-inch piece, repeating the operation at intervals when occasion demands; using in turn the 3-, 2- and 1-inch spare pieces of belting until the two ends of the initial belt come together. We then have a belt that has been taken up five times and has been laced only once. It will be readily understood that these spare pieces of belting are carefully saved for future use in connection with any other 4 inch wide belt. In the same manner the spare pieces for other widths of belting are saved for ready use when required. In the small mills and where it would not pay to regularly employ a man to look after the belts, the several sets of different width belting can be placed in the tool room and the operator of the machine can at any time exchange a long piece for a shorter one, and thus save the time of re-lacing. Besides technical points quoted thus far in favor of the machine, there is one more point which came to our notice, but which more correctly speaking, does not belong here, the same being the fact that six thousand inches of coil lacing (or enough for 500 belts 6″ wide) belong to the outfit with each machine, and since this quantity of lacing will serve for as much belting as $35.00 worth of lace leather, a #6 or #12 machine will practically half repay itself at once by means of this single item.

The advantages of this belt fastener are as follows: The belt remains of the same thickness all through, even at the place of joint. This is a great advantage, especially in electric light installations. The fastener is very elastic and strong, and is quickly and cheaply made (the heaviest and widest belts can be joined inside of half an hour). Further there is no waste of belt material. It is easy to take a joint apart when the belt has to be shortened. It can be made at any place, and can be used immediately. With the exception of one case, the belts can be placed on the pulleys without the use of belt clamps. Only when both pulleys have flanges, is a belt clamp necessary. This belt fastener can be used in connection with tight and loose pulleys. The belt does not suffer on account of the lateral strain when shifting. The joint further has sufficient elasticity crosswise to allow of its being used on crown pulleys. (Diamond Drill & Machine Co., Birdsboro, Pa.)

CLING-SURFACE AND ITS NEW METHOD OF BELT TRANSMISSION.

In taking up the consideration of improved methods of belt management, it may not be inadvisable to rehearse the general form of procedure followed in the past and in many plants at the present.

The keystone of this whole method of transmission of power by belts or rope has been the necessary ruling that "you must have a belt more or less tight in order to transmit any power." Initial tension (the tightening strain put on the belt before it begins to work) has been the great necessary element which has made such method of transmission possible, and which has also been the seat of all attending trouble and operative waste.

What does a tight belt mean? The usual rule is to run single belts under about 50 pounds initial tension per inch of width, and double belts under about 65 pounds per inch of width. The actual conditions are apt to be over than under this. On a 6-inch single belt, then, we have 300 pounds tension, and for, say a 20-inch double, we have 1300 pounds tension on belt, bearings and shafting *before any working load is put on at all.* This strain is actually extra friction added to the necessary friction from the working load, and the whole sum of this portion of the friction load, of course, is that of the tightening strains on every belt in the plant. It foots up to an enormous amount and it must be dragged along all day by the transmission machinery (belts, bearing and shafting), while it all concentrates at the engine. The engine and coal pile have to meet this enormous extra friction load every hour of the working day, in addition to its legitimate manufacturing work.

It produces high friction in bearings, as frequent hot boxes testify, and excessive lubrication is necessary. It is a continual strain on the shafting.

The belts being merely animal or vegetable fibre, show it excessively. Imagine such a belt to be a 20-inch double belt on say 2,000 feet speed. Its estimated output would be 100 H.P. But to get this output it would have to drag along 1300 pounds of initial tension. This is on day and night. In the day it is under this plus the 100 H.P.; at night it is still kept tight by the 1300 pounds. Its fibres are always on the stretch, they can never regain their natural position, and as the belt stretches and loosens it is again taken up and the stretching is renewed until all its elasticity is destroyed and it becomes "dead"—like an old rubber band about a package. There is waste every minute, waste in coal, in wear on engine, shafting and bearings, in oil for engine and bearings, in the belt itself, in men's time who work over this belt, in the time of other operatives.

All this results from the necessity of keeping the belt tight in order to stop slipping.

F. W. Taylor, in his paper, "Notes on Belts", read before the A. S. M. E. at Germantown, 1893, related that one of his mills was belted, half on a basis of 65 pounds tension per inch of width for double belts at 5000 to 6000 feet per minute: the other half on a basis of 30 pounds at 4000 to 4500 feet per minute. And then says:

"It is safe to say that the belting of the first half of this mill gave 100 times as much trouble as that of the second half. In fact, the belting proved to be the chief source of trouble and expense in running the first half of the mill, owing to frequent interruption of manufacture caused by it; while that of the second half ran from the start with hardly any trouble."

If half-tight belts make "hardly any trouble" how much will slack and easy ones make?

In an extract from a book published by Jones & Laughlin, Ltd., an eminent cotton-mill engineer is quoted as saying that the power necessary to drive shafting alone in eight of the best textile mills in New England was as follows:

Mill.	Whole Load in H. P.	Shafting alone in H. P.	Per cent. of whole.
No. 1.	199	51	25.6
No. 2.	472	111.5	23.6
No. 3.	486	134	27.5
No. 4.	677	190	28.1
No. 5.	759	172.6	22.7
No. 6.	235	84.8	36.1
No. 7.	670	262.9	39.2
No. 8.	677	182	26.8

Z

He also says "Taking the cost of a horse power at 35 pounds coal per day and allowing 15% of the whole as a reasonable loss from friction, one can see that the cost of running tight belts is no inconsiderable one—to say nothing from shortened life of the entire equipment."

A mill having, say 100 looms, might easily on certain grades of cloth turn out 50 cuts per day. The cut averages 35 yds. and sells for say $1.25 per yard. This totals $2,187.50 daily and $682,500.00 yearly. Put belt slippage at 5% which is common enough (2% is minimum average in all plants) and it means a loss of $34,125.00 worth of product per year. And the fact that the slip is never constant injures the general average of quality. This loss is from slippage only, and the profit on it above would more than pay for all the Cling-Surface needed.

Tight belts have long been recognized as an evil, but there has been no satisfactory mode of cure previous to 1897.

Belt dressings have been sold for relief of the slipping, but with little satisfaction, for they were either rosin preparations which operated by adhering the belt to the pulley, and forcing it to be ripped off at much expense of power and belt, while the preparation itself was harmful, or else simply preservative oils like neatsfoot, which kept the belt pliable and helped a little, but belts still had to be run tight.

In 1897, after a long series of experiments, Cling-Surface was perfected. It was designed to be, first, a real and perfect preservative for all fibre, leather, cotton and hemp, and, second, to eliminate slipping without causing any adhesion or sticking of belt to pulley. It was made in solid form like a grease, rather than liquid, to keep the belt pliable yet not soft and flabby. For a year it was placed in the hands of one-hundred manufacturers of all kinds, for trial, and proved to be even better than expected.

Cling-Surface is applied hot (liquid) in small quantities and gradually penetrates into the belt, surrounding every fibre with a preservative lubricant. This keeps them pliable, elastic and water-proof. It becomes simply impossible to make a belt so filled, hard or dry. We thus have a belt not only preserved, but pliable, and obtaining the best possible grip on the pulleys. But in addition, Cling-Surface has the property (as it penetrates) of leaving the surface clinging. This is very different from adhesion. There is no stickiness, but only a smooth, clean, velvety condition that grips the pulley with a slipless grip and then releases it with perfect freedom. In theory it acts as a moist hand grips a tool handle better than a dry one—there is no necessity of adhesion, simply a cling, and the belt leaves the pulley as readily as it meets it.

This eliminates slipping. As a result we have removed the foundation of the whole tight-belt method and rendered a tight belt unnecessary. And the rule of cause and effect has carried it further: it will be granted that providing there is no slip, there is no necessity of running a belt tight, but it can be run easy. Then if a belt will run one inch easy, it will as readily run 12 inches slack, run slack until the top touches the bottom. This is exactly what practice has proved and as a result we not only have an entire removal of that part of a plant's friction load due to tight belts, but we find that as the belts run slacker they gain a larger and larger arc of contact on pulleys and the slacker they run the more power they transmit.

Mr. H. E. Collins of New York City an expert engineer, was called to a silk mill, where power was short. He decided tight belts was the cause. He bought Cling-Surface and in 47 days decreased the friction load over 18% by running slack and easy belts, giving an ample margin of power from the old equipment.

Professor R. C. Carpenter of Sibley College, Cornell, has made a series of tests of Cling-Surface, from which the following diagram was used.

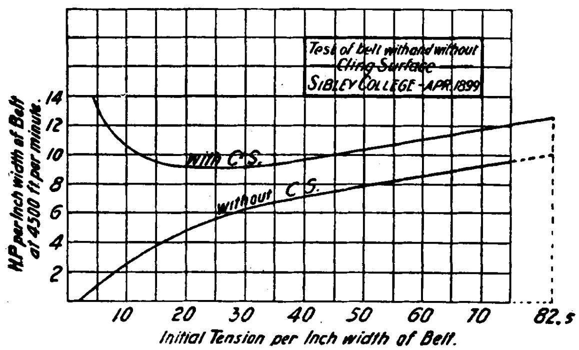


Fig. 1.

He used two 4-inch belts, run under exactly similar conditions, one treated and one untreated. He started them both at 82.5 pounds initial tension and gradually reduced this tension to zero. At 82.5 pounds the Cling-Surface belt transmitted 13 H.P., while the untreated transmitted only 10 H.P. As they were slackened, both did less, in the same proportion, the untreated belt doing less and less until at 5 pounds it would not deliver 1 H.P. The Cling-Surface belt however, decreased to the 25-pound mark and then, as it began to wrap the pulleys, did more, until at 5 pounds initial tension—the slackest, it was doing 14 H.P.—4 H.P more than the untreated *and about two H.P. more than it did itself at its tightest.* Professor Carpenter said in his report, "The general effect of Cling-Surface appears to enable the full capacity of the belt to be obtained for transmitting power when the belt is so loose that the sides nearly touch."

In Fig. 2 there is shown four 12-inch belts in the Homestead Works, of the Carnegie Steel Company.

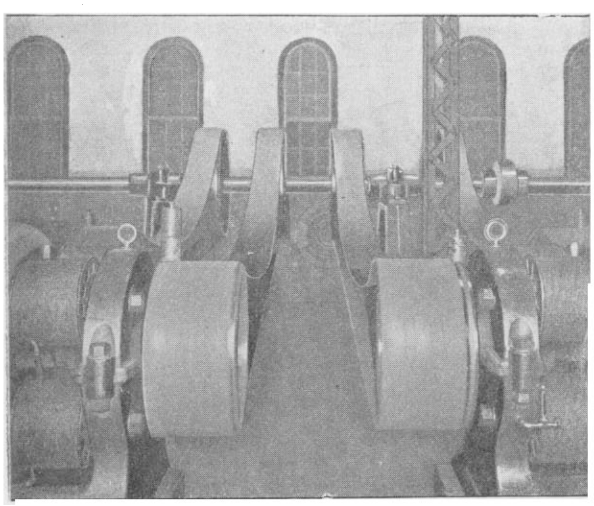


Fig. 2.

In 1900 they were as tight as it was possible to pull them. They probably added a ton and a half to the friction load of the plant and yet gave trouble. Cling-Surface stopped the slipping. The dynamos were set at the other end of the slide and ever since they got more power than before, with no troubles.

The belt at 45 degrees angle, shown in Fig. 3 was

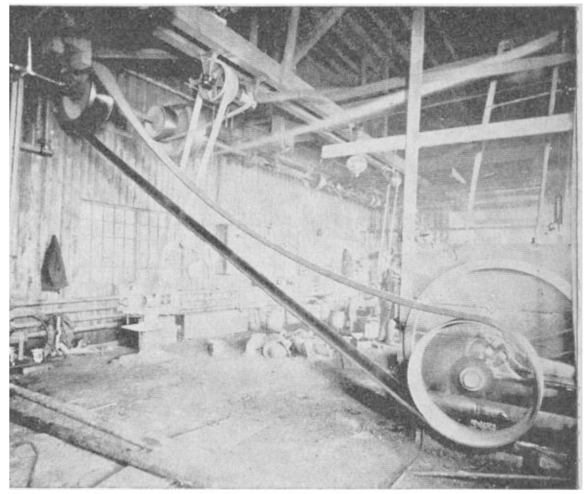


Fig. 3.

twelve years old, was tight and delivering power to a line of machines—short power at that. It was treated with Cling-Surface. A further piece (18 inches long) was put in the belt and it was run slack and two more machines were added to the row—the gain in power to all the machines being 24 per cent.

The main belts of the Broadhead Mills at Jamestown, N. Y. (Fig. 4) are 40-inches face, on 45 and 34

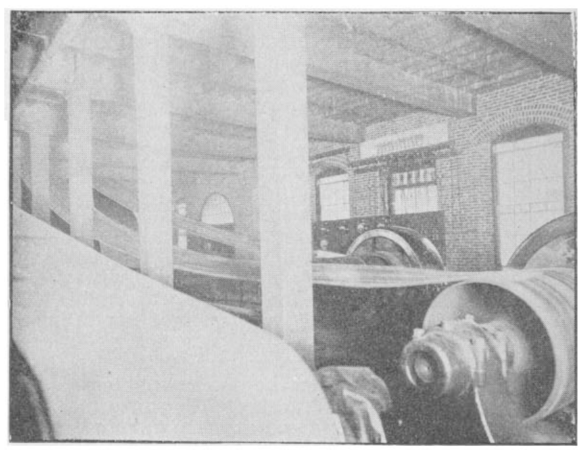


Fig. 4.

feet centers, doing 500 H.P. easily when photographed, and running 4-feet and 22-inches slack respectively, in perfect condition, after five years use of Cling-Surface.

The vertical belt (Fig. 5) is a 12-inch belt, 9 feet centers and has done 55 H.P. in this way for nearly four years. It shows the possibilities of the slack belt.

Vertical belts cannot usually run slack—simply easy. Over-drives the same. If a belt can run slack, every inch is a direct gain. If it cannot, still tightening strain is removed and full power is obtained with low friction load. The slacker the better, as conditions permit.

Equally good results are obtained with rope drives —preservation of the rope, no fraying from internal friction, pliable, water and weatherproof rope, lasting

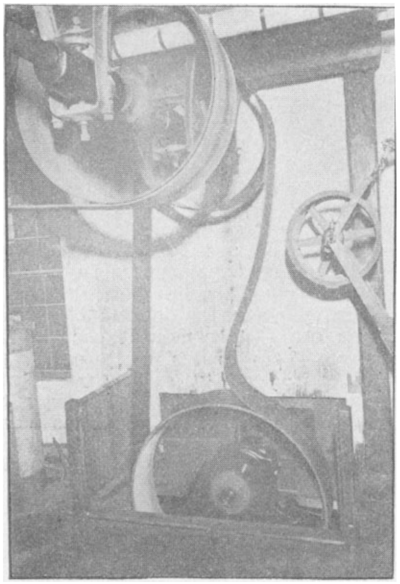


Fig. 5.

much longer than under ordinary conditions, and doing more work.

There is no part of a plant where economy can be more easily put in operation and where direct returns are so quickly obtained. (Cling-Surface Co. Buffalo, N. Y.)

THE BARNEY COMPOUND FAN.

The same is an apparatus for moving large volumes of air with whatever floats therein, and is used for the removal of

Steam from Dye-Houses, Bleacheries, Slasher Rooms, Wash Rooms, Drying Plants (Barney System);

Heat from Dynamo and Boiler Rooms, Press Rooms in Woolen Mills, Spinning Rooms in Cotton Mills;

Moisture from Dry Rooms where the wet goods are constantly surrounded by a current of dry air, Wool-Dryers, etc.; as well as for ventilation of all kinds, under varying conditions, and whatever a volume fan can do.

The purpose accomplished by this fan is to increase the volume and velocity of columns of air and to deliver them freely through the fan in such a manner as to meet with a minimum of atmospheric resistance at the discharge face of the fan. The fan is so constructed, that while the rear blades suck in the air, the outer blades beat away the surrounding air and draw out that taken in on the other side of the fan. The unchangeable shape and angle of the blades (all scientifically determined) being such that the proportionate maximum of work is accomplished whatever the speed employed. Amount of air passing through the fan in a given time is then easily decided by the speed at which the fan is run, it being directly in proportion to that speed.

A Blower moves small volumes of air at great velocity, requiring large horse power on account of small air inlet, and is unequalled for blowing fires, moving materials that require a powerful and rapid current of air of small volume, whereas:

A Barney Compound Fan moves large volumes of air at low pressure, requiring small horse power on account of large inlet for air, and is unequalled for moving air, dust, smoke, steam, heat, gases. The fan is so constructed as to admit of being run either way, and will blow or exhaust an equal current of air in either direction. This feature is often a valuable one where it is desirable to sometimes exhaust and at other times force in a volume of air. Size of fan required and speed to run are best left to the decision of the fan engineer, since in most cases the consumer has little, if any, experience in that matter. Where pipes are necessary the size should equal diameter of fan revolving portion. All air inlets near the fan should be closed, but air must be allowed to take the place of that expelled, for which reason the point of air inlet should be in such relation to the fan, that the air will flow across the dusty, steamy or heated portion.

Fig. 1 shows a face view and Fig. 2 an edge view of the Barney compound fan. The blades of the fan are in two sections A and B respectively, each section consisting of a series of four blades mounted upon hubs at an angle to the axis of the hub, with the inner straight edge of each blade lying in the plane of the rear face of the section and the outer curved edges forming the front face of the section. These two sections are united upon a common shaft, with the planes of their inner faces abutting and the outer ends of each blade secured to a common peripheral central ring, the concave inner surfaces of each two alternate opposite front and rear blades forming channels for the passage of air through the fan at an angle to the axis of the fan, corresponding in degree with the angle at which the blades cross the shaft. The compound fan in its central cross section shows an elliptical outline.

Facing the fan on the pulley side, it usually revolves to the right, and when the blades marked A scoop in the surrounding air, while those on the

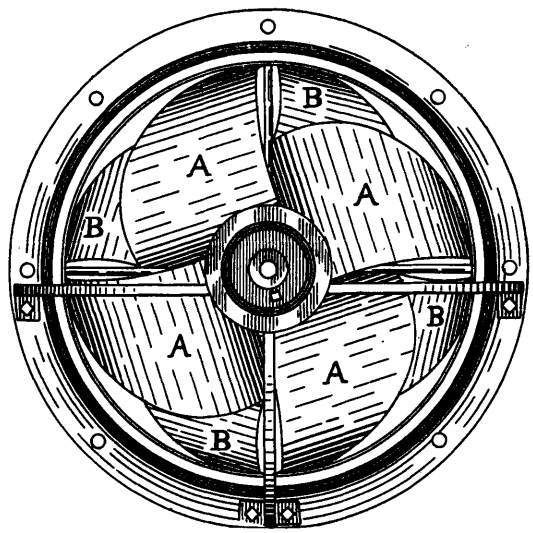


Fig. 1.

other side, marked B beat away the air outside, thus forming a vacuum in advance of the column of air which is being scooped in on the feed side, and when consequently a solid column of air is discharged. In other words, the concave inner face of the front blades, acting as suction, in unison with the convex outer face of the rear blades, acting as "plenum," produces a practical vacuum at the rear of the wheel and in advance of the discharged column of air, thereby increasing both the volume and velocity of the column of air moved through the wheel.

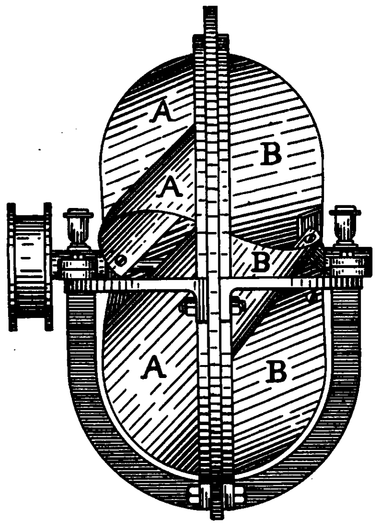


Fig. 2.

The shape of the blades, as is clearly shown in Fig. 1, *i. e.* wide near the hub and narrow at the periphery, is the correct shape, for if the blades were narrow at the hub where the circle described in revolving is small, and wide at the periphery where the circle described in revolving is large, then the air would be drawn through at the periphery with much greater velocity than at the centre, resulting in partial vacuum near the centre and a consequent back flow of the air, being forced out at the periphery, back into the fan again. This is the cause of back draft which materially cuts down efficiency of most fans.

The shape of the blades of the fan as shown, together with the action of the rear set of blades, assure an equal velocity of air through all parts of the fan, and thus make back draft impossible. (Barney Ventilating Fan Works, Boston, Mass.)

WING'S DISC FAN.

This fan is characterized chiefly by its efficiency in circulating air for ventilation, heating, drying, etc., and the ease with which it can be adjusted to circulate more or less air as may be required at different times. They are used in all kinds of textile plants, for ventilating purposes, removing heat, dust, steam, etc., and in bleacheries, print works, dye houses, etc., for removing steam, heat, vapors, and for drying purposes. They may be driven in three ways, according to the different requirements, viz: by belt and pulley, by a small steam engine attached to the fan, the engine shaft also acting as the fan shaft, or by an electric motor attached to the frame of the fan, the armature shaft carrying said fan.

A perspective view of a disc fan is given in the accompanying illustration, showing it complete in its casing. The fan consists of six blades, equally spaced from each other, as it has been found by tests that a fan with six blades will either propel or exhaust more air than one with any greater number, and that if the number of blades be increased beyond six, the amount of air propelled or exhausted is in inverse ratio to the number of blades employed. The blades are made adjustable as to the angle they are to work at, and can thus be set to suit the conditions under which the fan is to operate. Each fan is, therefore, available for efficient use under widely varying conditions, since the current of air can be reduced, increased or turned without having to replace the fan with one of another size, or change any pipe or belt used in connection with it.

Standing on the pulley side of the fan, as shown in illustration, the direction of running is similar to that of the hands of a clock, and the current of air is moved from the pulley side through the fan when the latter is running. For open ventilation the blades of the fan are set at an angle of 35°, which angle has been found to be the best for exhausting air from mill rooms, etc. For forcing air through long pipes, or a series of rooms or drying chambers for cooling or drying purposes, the blades of the fan should be set at a different angle from the one just given, and in accordance with the conditions under which the fan is to operate.

The speed of the fan is also an important item, and depends on the use to which it is put. For heating and ventilating purposes, a comparatively low speed will give excellent results, while with higher speeds, pressure is obtained for forcing air through pipes, etc. When using these higher speeds, the usual angle of the blades is altered.

Two other characteristics of this fan are that it is practically noiseless, and does not obstruct the light, when placed in a window. In all cases where these fans are to be used, two things must be attended to; viz: the proper size or sizes of fans must be ascertained, and an ample supply of air must be admitted for the fans to exhaust; or if the air is forced in, there must be plenty of avenues for the escape of the air thus driven in, as well as a sufficient supply for the fan. If this is neglected the efficiency of the fan will be reduced.

The following table of speeds, horse power used, and amount of air exhausted will assist in ascertaining fan or fans required for certain results.

Size.	Rev. Per Minute.	Horse Power Used.	Exhaust Cubic Feet of Air Per Minute.
12 in.	1,000 to 1,500	$\frac{1}{16}$ to $\frac{1}{4}$	1,500 to 2,200
18 in.	700 to 1,200	$\frac{1}{8}$ to $\frac{1}{2}$	3,000 to 5,200
24 in.	600 to 1,000	$\frac{1}{4}$ to $\frac{3}{4}$	4,500 to 7,500
30 in.	500 to 900	$\frac{1}{3}$ to 1	7,500 to 13,500
36 in.	400 to 800	$\frac{3}{4}$ to $2\frac{1}{2}$	12,500 to 24,000
42 in.	400 to 700	1 to 3	18,000 to 31,500
48 in.	400 to 500	2 to 5	24,000 to 36,000

To decide on size, or size and number of fans, needed for any room or building that is to be heated, ventilated, cleared from steam, etc., find out how much steam, dust, etc., is to be removed, or how much material to be dried. When these facts have been ascertained you must decide upon how often the air in the room or machine should be changed to keep the air in the proper condition, and when then this most important point has been determined, you then can figure what fan or fans you want.

For example, say we wish to ventilate a room that is 60 ft.$\times$200 ft.$\times$25 ft., which thus contains 300,000 cubic feet of air, and the air should be changed, say, every 20 minutes to keep it pure and healthful.

To find the proper size of fan to use, we have

$$300{,}000 \div 20 = 15{,}000 \text{ cubic feet per minute.}$$

Then from the table given, it will be found that a 36 inch fan is required, the same to run at about 480 revolutions per minute, in order to exhaust the required amount of air in the time specified. The same principle of calculating is followed for ascertaining the proper fan or fans to use for drying, heating, cooling, etc. purposes.

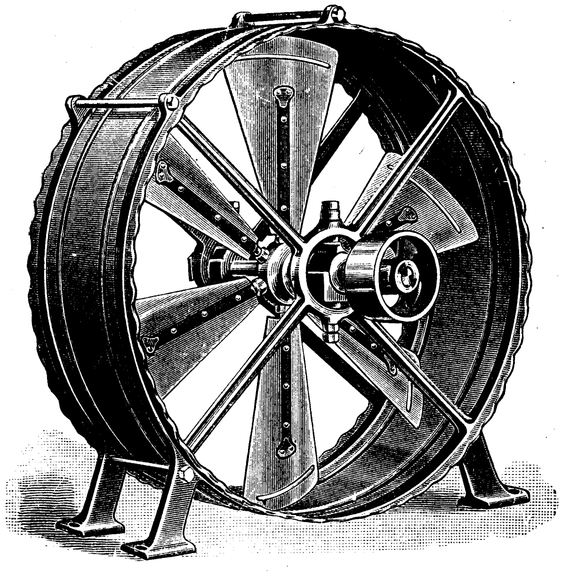
In ventilation, the air usually needs changing in from 15 to 30 minutes, while for drying, taking out vapors, dust, etc., it varies from once an hour to once a minute.

In heating and ventilating, the best results are obtained by both forcing and exhausting the air. The openings for the exhaust (when flues are used) should be distributed, having one-half of them near the floor, and the other half near the ceiling, as this assists in keeping an even temperature and makes heating more economical.

Special attention must also be given to the location of the fans and the admission of fresh air. For heating, ventilating and drying, the fan or the pipes and ducts leading to the fan must be located as nearly as possible on the opposite side of the room from inlets of fresh air.

For taking away dust, vapors, etc., the fan must be placed as nearly as possible to where the same are generated and the air admitted from the opposite side or end of the room. When this cannot be done, place the fan where convenient and run pipes or ducts to those parts of the room where the dust, etc., is made.

In dye houses, boiler rooms, etc., where the fans are placed in the walls or windows, it is absolutely necessary to keep the doors, windows and other openings near the fan closed, since the fan will draw



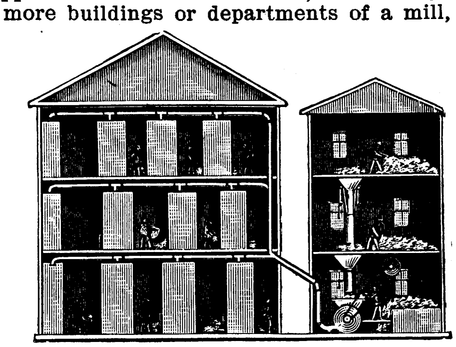
air from these nearest openings, whereas the air should come from the other side of the room to give proper results.

Where pipes, ducts or flues are used to exhaust from a number of machines or places, the sum of the area of all the pipes, etc., should not exceed the area of the fan.

The pipe or pipes on the force side of the fan must be of same area as the fan to move the largest quantity of air. Fans put in walls, windows, etc., should always have openings the full size of the fan. (L. J. Wing Mfg. Co., 251 and 253 West Broadway, New York.)

SCHNITZLER'S PNEUMATIC CONVEYOR SYSTEM.

This system consists principally of a blower, especially constructed for the rapid handling of all kinds of fibrous material, and a system of galvanized iron piping with special transfer valves, by which means all kinds of fibrous material, such as wool and cotton stock, hair, rags, jute, etc., wet or dry, can be taken from Pickers and Dryers or other machinery, or, in connection with hand feeding, from Hoppers as fitted to the blower, and conveyed to one or more buildings or departments of a mill, and, by



an arrangement of a system of bins, to any one of the latter which may be desired, either in the lower or the upper stories of the mill, or any building, as shown in the accompanying illustration, and the same can be conveyed to any particular place without any possibility of mixing or exchanging stock, as nothing is left in the pipes or against the valves.

The system is also adapted for plants where several parties are manufacturing in the same mill and when one or the other needs to use the conveyor, the signal is given, transfers made to party using, and then stock can be passed through the telescope feeder, pipes connecting from the first, second or third floor, as the case may be, to blower, and thence to the desired departments of the mill. It saves 25% in handling stock, such as wool, cotton, etc.; it opens up the material under operation and makes it light and flaky. This system of conveying will handle material at the rate of 100 to 150 pounds per minute. Another feature of the system is the economy of space required, since stock can remain in the picker room until needed, and then be immediately sent to the department where it is needed to be worked. No stock need be put up in sacks or sheets, pressed, and thus in turn made bunchy and unsuitable for perfect work at the card. The latter department thus can be kept neat and clean, a feature much desired by manufacturers.

This system is being placed in Wool, Cotton and Carpet Mills, Dyehouses, etc., with great success. (Chas. H. Schnitzler, Philadelphia, Pa.)

THE BELL SYSTEM OF HUMIDIFICATION.

The Bell system of Humidification is based on strictly scientific principles and carries them out in a practical, economical and efficient manner, reproducing and automatically maintaining in the mill the best climatic conditions required for perfect work, thus ensuring to the mill, product through all seasons and all weather conditions, quantity as well as quality.

The Bell Humidifier takes up water by rapid evaporation, produced by the forcing of air at constant speed over large, ingeniously arranged wet surfaces, producing moisture as aqueous vapor, just as it is found in nature but always below the dew point, maintaining the air in the room at the point below saturation that is most suitable for any class of textile working. It treats all the air in the room, separating from it the static electricity, dust and impurities, and keeping down the fine fuzz.

This Humidifier is self-regulating and does not keep on moistening when further moistening is useless. When once set to produce a given humidity no further regulation is needed under ordinary variations in the external conditions. When the general humidity of the room has been brought up to the pre-determined point the Humidifier automatically ceases raising it further, thereafter merely supplying the deficit produced by absorption and condensation. If by sudden temporary changes, such as the opening of doors and windows, the humidity falls, the air receives more moisture automatically in the machine. In wet weather the humidity in the room is not affected materially unless the windows are kept open; if damp air comes in and raises the humidity temporarily the machines do less moistening until absorption has taken care of the surplus, when things settle down to an equilibrium as before. The apparatus, by keeping the air moving, tends to produce rapid absorption by the yarns, etc., which also tends to hold conditions uniform. About the only effect of changes outside is that the machines do not have to do quite so much work in wet weather as in dry; the absorption in the room is far more than enough to take care of the little moisture that may creep into the room, so that the machines are still kept busy.

The humidifying apparatus by itself requires no outside connections, being arranged for suspension it takes up no floor space, and requires only ⅛ H.P. to operate.

Details concerning the application of the Bell system can be obtained from the BELL PURE AIR AND COOLING COMPANY, New York.

POWER PRESSES FOR BALING AND FINISHING PROCESSES.

A most important adjunct to any mill is satisfactory baling presses, may it be for yarns, knit or woven goods, in order to bring them in proper shape for shipping purposes; again in some instances certain styles of these presses are needed in the finishing department of cotton and woolen mills.

Fig. 1 shows what is known as a *Yarn Baling Screw Press*, which as its name indicates, is operated upon the double screw principle, being mainly used for the baling of yarn, or knit goods, etc., and when no extra heavy pressure nor great speed is an object. The frame of this press is made of steel channel beams securely riveted together. The standard size of this press has its screws of steel, 3″ in diameter, and with a movement of 44″. The gearing is heavy and the screw nut seats self-oiling and self-adjusting. The pulleys are 24″ diameter, to be used in connection with 4″ belts. The baling box is 24″ x 36″ x 52″ deep, the sides of the upper part being arranged to lift off for convenience of filling. The lower part of the box is hung on hinges and opens downward for tying and removing the bale. The entire box can be readily removed and the press used for baling knit goods or cloth if so desired. A safety device is provided for shifting the belt at the extreme upward movement. As the press is all iron and steel except the baling box, its durability is beyond question. It will be readily understood that this press is built in any size required, as regulated by the requirements of a mill, the dimensions quoted having been simply given to illustrate the general construction of a certain standard make, of advantage to be used by the average mill. As will be readily seen from our illustration, this press bales or presses downward, and which as a rule is the system of pressing mostly preferred for the class of work these presses are designed for; however in some cases it may not be convenient to have the press in a room where power can be easily applied, and in which instance the gearing of this double screw press is then placed below the floor, raising the platen and baling box upward, a plunger being attached to the head beams of proper size to enter the box. In connection with this construction, arrangements are sometimes provided to permit the box to be put on wheels and run to any part of the room for convenient loading or unloading purposes.

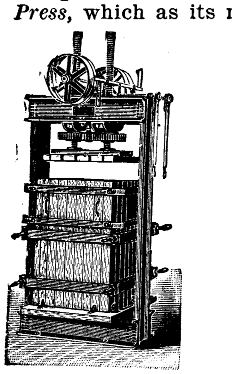


Fig. 1.

Fig. 2 shows a specimen of a *screw and lever press* designed for the finishing departments of cotton and woolen mills in connection with (pressing) ginghams, calicoes, bleached goods, woolen goods, as well as for baling cotton, woolen and worsted goods of every description. It will be readily understood by anybody only somewhat versed in mathematics, that by means of the power principle, the action of this press is based upon, *i. e.* the double lever, and screw arrangement, an immense power can be exerted by this press, which is built in various sizes—from a pressure of 60 tons to 500 tons—to suit the demands of a certain mill as to kind of work or production required. The press itself—no matter what size of press under consideration—as will be readily grasped, to withstand the immense pressure exerted by the press, is all iron and steel. An automatic shifting device is provided to the press, which stops the latter at any point desired for either upward or downward motions, an indicator showing at all times the amount of pressure being applied on the goods. This kind of a press is also, where so desired, built to have its pulleys and attachments placed on the floor beneath that in which the baling is done, and in which case the platen rises similarly as in an ordinary hydraulic press.

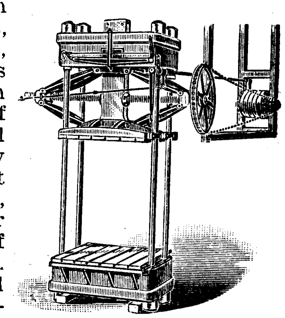


Fig. 2.

The Indicator for these presses consists of two levers arranged to accurately indicate the spring of the head beam of the press, enabling the operator to see at a glance the amount of pressure being transmitted to the material under pressure. The advantages of this are that this attachment (as is supplied to all presses) greatly reduces the possibilities of breakage and enables the operator to determine when the material under operation is sufficiently pressed, *i. e.* to put more or less pressure upon the material in the press as desired, the Indicator being for this work as accurate as a pair of steel scales.

Fig. 3 shows us a specimen of a *Hydraulic Press*, as used in connection with finishing cotton and woolen cloth as well as baling material.

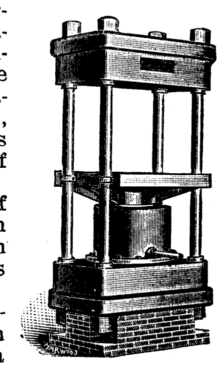


Fig. 3.

As the action of the hydraulic press does not seem to be understood by all, a short sketch, explaining the principle underlying this system of pressing, will not be amiss. Hydraulic power depends upon the principle that liquids press equally in all directions, and that if the power applied to the plunger of a force pump be multiplied by the ratio existing between the area of the pump plunger and the ram of the press, the product will be the power of the press; thus if the diameter of the pump plunger be $\frac{8}{10}$ of an inch, the area would be ½ square inch, and if the ram were 12 inches in diameter, the area being 113 square inches, the ratio between pump and ram would be as 1 to 226, or the area of the ram would be 226 times larger than the pump plunger. Now if one thousand pounds weight were laid on the pump plunger, the pressure transmitted through the water to the press ram would be $226 \times 1000 = 226{,}000$ pounds, or 113 tons and the water pressure would be 2,000 pounds per square inch of surface, both in pump, pipes, valves and cylinder. In other words the power of the press would be 226 times the pressure or weight applied to the pump plunger. Increasing the size of the ram, or decreasing the size of the plunger, would increase the ratio and hence would give increased power to the press.

In use, the foundation for this press is made of such a height as to bring the platen on a level with the floor when cars are used for loading and unloading the material to and from the press, or a little above the floor (as shown in the illustration), when goods are laid up, in the press. Wooden baling strips are attached to head and platen when the press is used for baling purposes. As will be readily understood these hydraulic presses are also built in all sizes, *i. e.* dimensions and pressures to suit the amount of work to be handled by it in the mill.

Hydraulic Pumps. In connection with a hydraulic press it is necessary to bestow care to the selection of the proper hydraulic pump and of which there are several styles of construction and which can be divided into belt and steam pumps.

The first kind again may be a common double plunger pump, or a double plunger pump of different size plungers and which gives a very great advantage in point of time over those of ordinary manufacture. Again there are triplex pumps which give a smooth and continuous flow of water and will be found very satisfactory. The plungers in this pump are all of the same size and driven by eccentrics, the diameter of the plungers depending upon the pressure and capacity required to do the work in the best manner. In many cases when the material is soft like waste, wool, etc., it is desirable to get the material condensed quickly, and for such work a pump having two larger plungers to give a quick movement and two smaller ones to give the final and heavy pressure, are used, each set of plungers being provided with safety and relief valves. For very large presses requiring extreme high water pressure, geared pumps are used, the same having machine cut gears, steel barrels, plungers, and crank shaft.

When the greatest efficiency is desired the steam hydraulic pump may be used to advantage. Its first cost is more than a first class belt pump, but it uses no steam that is not required for effective work, can be run without running the engine, and "follow up" without the loss of any power, whereas in a belt pump the surplus water must overflow through the safety valve, consuming power and wearing the valve rapidly. (Boomer & Boschert Press Co., Syracuse, N. Y.)

RIVER WATER AND ITS FILTRATION FOR TEXTILE PURPOSES.

One of the most important supplies for any Textile plant, more especially with reference to scouring, bleaching, dyeing and finishing, is a plentiful supply of good water. With reference to judging the suitability of any source of water for textile purposes we must be guided by different considerations, for the fact that some impurities which may be very injurious in one instance may be harmless in another, and in some instances even of benefit to the process. There is no doubt that the use of an absolutely pure water would be of immense advantage for textile manufacturing purposes, but it is equally well known that such a water in sufficient quantities could never be obtained, hence we must set ourselves thinking how to make the best of the supply of water at our command.

The impurities existing in water as we have to use, vary considerably, both in quantity and kind, and it is very important that the chemist or overseer of any of the various departments of a textile mill as quoted before, should know what impurities in connection with a certain water he has to deal with, since these impurities cannot help but exert an influence to the process under operation; again he must inquire how these impurities, if injurious to the process, can be removed, or at least their effect counteracted.

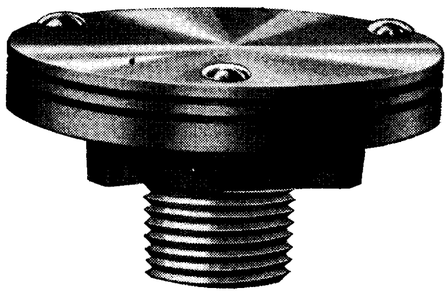
Aqueous vapor condensed forms pure water, and for which reason, rain water if collected before reaching the ground, would constitute the most pure natural form of water, since it only will contain such impurities as absorbed by it during its passage through the air; however in its usual course, rain or dew falls on the ground, in which case a portion of the water simply drains over the surface, flowing to lower levels, and in turn forming and feeding streams and rivers, whereas other portions of the rain or dew will sink in the ground, etc., etc., in turn either forming the supply of water known as spring or well water respectively. Of these three water supplies, no doubt the first mentioned one is the most important supply to textile mills, hence will be only treated by us, the other two supplies belonging more particular under the special care of the chemist of the mill.

River water has for the most part simply run over the surface of the ground, and consequently has been in contact with the latter only for a short time, thus, as a rule, does not contain so much dissolved impurities as spring or well water; however, on the other hand, it is frequently muddy by reason of solid vegetation or mineral matter held by it in suspension. As will be readily understood, river water is much more quickly and extensively polluted by heavy rains or continued drought than springs or wells.

After heavy rains, many water supplies are made practically useless for scouring, bleaching, finishing or dyeing purposes, owing to the large quantities of suspended matter, mud and sand, organic matter from the banks of the stream or the gathering ground, and solid matter turned into the river by works or towns situated higher up the stream, and which remain in suspension for a long time. The composition and amount of these is very variable, not only in different places but also at any given place at different times. The only remedy for this trouble is ample storage and subsiding reservoirs or efficient filters, since no chemical treatment will meet this case. The first plan in most cases is a rather expensive affair to mills, again in most instances the space necessary for such a plant is not available, hence filtering the water by means of a reliable filter is the most advisable adjunct to use.

The Roberts System of Filtration. The chief features of this filter are its simplicity of construction and operation, and this in connection with perfect filtering. The filter as will be readily understood is built in various sizes, in order to suit the various demands of a mill; again any number of these filters may in turn be connected to one main supply of filtered water to the mill. The filter in itself consists of a large tank of cast iron or steel shells, supplied in its interior at the bottom with special brass strainers on 6 inch centres, all over the bottom to prevent passage of sand with the filtered water from the filter.

The accompanying illustration shows one of these strainers or sand valves as they are called, in its



perspective view, the same being made of first quality brass or valve metal, being designed to permit the escape of the filtered water from the filter when filtering, and at the same time to admit the wash water when washing the gravel and sand, *i. e.* the interior of the filter. These sand valves or strainers are of a superior construction compared to other strainers used in connection with other makes of filters, and have by practical application proved not to clog or channel the sand bed, and to positively prevent the escape of sand with the filtered water. These strainers consist of two metal plates, riveted on their bottom plate of the strainer, leaving a small aperture, produced by means of small washers on the rivets between the metal plates. The bottom plate connects to the outlet or inlet as the case may be of the strainer. The two apertures between the three metal plates are about $\frac{1}{32}$ of an inch, and for the fact that they are on the side of the strainer—around its circumference—they naturally will successfully prevent this strainer from carrying off sand in connection with the filtering water; whereas, in other strainers as used in connection with other makes of filters, plugging up of the inlet holes of such strainers —then in the shape of a screen on top and around its sides—is a frequent occurrence, on account of the sand embedding itself into the holes of these strainers, these holes in most cases being in direct contact, more or less, with the sand, which in such filters generally is used without gravel.

Coming back to the Roberts Filter, we find placed on top of the strainers 8 inches of gravel. Here we must state that the right kind of gravel is used, since there are many kinds of gravel which will mix with the sand, and thus make filtering more cumbersome. On top of the gravel 3 feet of pure silicate sand, sterilized and graded is placed, in this way finishing the interior arrangements of this filter.

Another important feature of this filter is its single controlling valve, by means of which every operation of the filter is controlled. This controlling valve is so simple that the filter can be successfully operated by the most ignorant workman, it abolishing the old style complication of valves generally found in other makes of filters. The controlling valve is operated by a simple lever from the outside of the filter, said lever pointing against a dial, carrying 5 different readings, thus at once indicating the acting of the filter, viz: (1) cleaning filter; (2) filtering purpose; (3) by passes—cut out filter for passage of water, when for example no filtering is needed for a short time; (4) setting valve so that the first filtered water which naturally is dirty will run in the sewer in place of the supply pipes for the mill; (5) closed —everything closed up, filter completely placed out of use, *i. e.* temporarily not needed for some time.

By the use of an ingenious device, a solution made from commercial crystal potash alum is fed, drop by drop, into the unfiltered water before it enters the filter. The alum coagulates the impurities in the water and gathers together the exceedingly fine particles of clay and suspended matter, as well as the bacteria. The alum, with its enveloped and entangled impurities, is precipitated in the form of large gelatinous flakes. These flakes, being much larger than the voids between the sand grains, are easily arrested and retained by the filtering material, and, during the cleansing or washing of the filter, are completely eliminated from the sand bed and thrown into the drain or sewer. Absolutely no trace of the Alum remains in the filtered water.

GRAPHITE AS A LUBRICANT.

The object of all kinds of mechanism is the application of energy for the purpose of doing useful work. Owing to inherent imperfections in materials and construction of machinery, which cannot be avoided, a large part of the energy or force applied is wasted in overcoming the resistance to motion, offered by surfaces in contact with each other. This resistance is called friction, and is due to minute roughness and unevenness of the surfaces in contact. It is not possible to produce an absolutely smooth surface, and no matter how smooth the surface may appear to the naked eye, it will always prove to be rough and full of inequalities (as compared to absolute smoothness) when examined under the microscope. These minute elevations and depressions (of the two surfaces) interlock when said surfaces are in contact, and consequently resist free motion. Therefore, when force is applied, the irregularities of the different surfaces must either ride over on another, or the minute projections on the surfaces be broken off. When this occurs we have a continual abrasion and wearing, and all of the energy absorbed is converted into heat.

Lubrication has a threefold object, viz.: reducing frictional resistance, reducing wear of the parts in contact, and lessening the amount of power or energy wasted. Lubrication is accomplished by introducing, between the moving surfaces, a layer or film of some other substance which will keep the minute projections from interlocking or even touching, if the best results are to be obtained.

When the friction surfaces of a bearing are lubricated with oil, that part of the oil-layer or film nearest the box will be largely at rest, while that next to the journal will tend to move with the latter. Thus there is a constant movement of the particles of oil one upon the other, technically called "internal friction between the different particles or layers of the lubricant itself." The amount of this internal friction varies directly with the "viscosity" or "body" of the lubricant. The more viscous the lubricant, the greater the internal friction, and vice versa.

A good and efficient lubricant must possess the following characteristics:

(1). Sufficient body or viscosity to keep the friction surfaces apart, but at the same time with the greatest possible fluidity, consistent with this condition.

(2). A minimum coefficient of friction in actual service.

(3). Must not thicken or "gum" when in use, and must not contain acids or other injurious ingredients.

(4). Must not be easily thinned or vaporized by heat, or thickened by cold.

(5). Must be wholly free from all gritty or other foreign substances.

Petroleum or mineral oils have now come into almost universal use as lubricants, and in certain cases they are mixed with animal oils, especially in the case of those for cylinder lubrication of engines.

Animal oils will decompose quite readily, especially in the presence of heat, setting free their fatty acids, which in turn will cause serious corrosion of metals, although they retain their viscosity at high temperature. This makes them very suitable for adding to mineral oils for special purposes, but as a general rule, it is much better to use a "straight" mineral oil, if it will do the work, because mineral oils will never cause corrosion, and are more easily separated.

Graphite is also a lubricant. It is one of the purest forms in which carbon occurs in nature, possessing a bright lustre and a remarkable degree of smoothness and softness. It is unaffected by heat or cold, is not acted upon by acids or alkalies, and has a strong attraction for metal surfaces. When rubbed upon other substances it imparts to them a sort of greasy coating of great smoothness. Graphite occurs naturally in two forms, the crystalline or flake, and amorphous, but the latter is usually closely associated with clay and other impurities, and is therefore not at all fit for lubricating purposes. Both theory and practice clearly indicate the flake form of graphite for all purposes of lubrication.

The ideal lubricant should get at the cause of friction, that is, the minute roughness of the metal surfaces, and permanently fill up all these irregularities. Furthermore, it should have a low coefficient of friction, should be solid enough to resist being crushed out by great pressures, *and should wholly prevent cutting and abrasion.* It should be unaffected by any degree of heat attained in a cylinder or bearing, and not decomposed in any manner, to attack metals in contact with it.

The action of flake graphite is to fill up the minute depressions, roughnesses and pores in metal surfaces, bringing them much nearer to a condition of perfect smoothness, which brings about a very great reduction in the "solid friction" between those surfaces. Graphite has a strong tendency to attach itself to metallic surfaces, and imparts a veneer of great smoothness and endurance that materially reduces the necessity of a thick oil film. Its use therefore brings about a double reduction in friction. The best results for lubrication are probably obtained when flake graphite is used with oils or greases rather than with flake graphite alone and the gain in efficiency and reduction in friction is very evident.

With graphite, a thinner and probably cheaper oil may be used. Flake graphite is an accessory lubricant that makes oils more efficient, and supplies, with oils, an almost perfect system of lubrication. To reduce friction losses to their lowest, the lubricating film must be composed of an oil with the least possible internal friction. The thinner the oil that will suffice for a given bearing, the less the friction losses will be at that point. It is not enough appreciated among engineers that too viscous a lubricant can cause overheating just as surely as one that has not enough body. Very small percentages of flake graphite are sufficient to enable oils to have the best lubricating action. When first beginning to use graphite, use only enough to thoroughly coat the bearing surfaces, and after that only enough to maintain that thin layer against natural wear. The action of the graphite is to coat, with a smooth, hard coating, the metal surfaces in contact, and by so doing to relieve the liquid oil from some of the service which it would otherwise have to perform. In this manner the whole process of lubrication is made more effective, and, also the wearing qualities of the oil are preserved. In the case of very light bearings or sliding surfaces flake graphite alone is often sufficient to keep the surfaces bright, clean and smooth, and to furnish ample lubrication.

Graphite will not build up on itself to the extent of causing the moving parts to bind, because graphite is the softest of all minerals, being worn down easily by rubbing with the fingers, so that any tendency to build up is at once overcome by the wearing of the moving surfaces.

Graphite does not behave like oil, but associates itself with one or the other of the rubbing surfaces. It enters every crack and pit in the surfaces and fills them, and if the surfaces are ill-shaped or irregularly worn, the graphite fills in and overlays until a new surface of more regular outline is produced. When applied to a well-fitted journal the rubbing surfaces are coated with a layer so thin as to appear hardly more than a slight discoloration. If, on the other hand, the parts are poorly fitted, a veneering of graphite of varying thickness, which in the case of a certain experiment was found as great as $\frac{1}{16}$ inch, will result. The character of this veneering is always the same, dense in structure, capable of resisting enormous pressure, continuous in service without apparent pore or crack, and presenting a superficial finish that is wonderfully smooth and delicate to the touch.

The best percentage of graphite to use with each oil has never been scientifically and accurately determined, but from 2% to 8% by weight of flake graphite is advised, according to the work to be done and the character of the oil used.

The use of graphite in textile mills as a lubricant, both for shafting as well as machinery, is worthy of consideration. It makes possible clean systems of lubrication, thus minimizing the danger of oil stains upon goods in process of manufacture. Lubricating oil stains upon woven goods are almost impossible to remove without damage to the fabrics, and especially is this true of mineral oils. Again the consumption of power in a textile mill is not a case of a comparatively few machines, but of many thousand small spindles, great lengths of shafting, many looms, etc. The unit of friction may be small, but it occurs thousands of times, and the cost of power is a heavy fixed expense that must be reduced to the lowest possible figures.

It is also important that wear of spindles, looms, and machinery be made as low as possible, if uniformly good work is to be turned out, and all bearings be kept from overheating. More than one textile mill fire has been traced to the overheating of a bearing causing ignition of the oil which should have lubricated it. The use of pure flake graphite occasionally will glaze the small friction surfaces of each spindle, lowering their friction, keeping them cool, and preventing wear. In this instance it conspicuously aids the regular lubricating oil. The use of flake graphite almost wholly guarantees freedom from the danger of shut-downs due to hot bearings.

All bearings that are not siphon-fed may be regularly treated to a little flake graphite, with marked benefit, in the shape of lower friction, less wear, and the impossibility of abrasion and overheating. If flake graphite be used, less oil will suffice to give good results, and there will be a corresponding decrease in the likelihood of a pulley or gear to "sling oil" and stain a fabric.

From experiments with flake graphite as a lubricant, the following conclusions were obtained:

(1). The addition of graphite to oil results in a lower frictional resistance of the journal than would be obtained by the use of oil alone.

(2). When graphite is used with oil, the amount of oil required for a given service is reduced.

(3). By the use of graphite a light or an inferior quality of oil may be employed for a given service.

(4). By the use of graphite, water under favorable conditions may serve as a sufficient lubricant, as in the case of engine cylinders.

(5). A small amount of graphite only is required, since too much graphite unduly thickens the oil and correspondingly increases its internal friction due to viscosity. The supply, however, should be constant, though small, for the best results.

MENSURATION OF SURFACES, SOLIDS, ETC.

Diameter of a circle×3.1416=the circumference.
Circumference of a circle×0.31831=the diameter.
Diameter of a circle×0.8862=the side of an equal square.
Side of a square×1.128=the diameter of an equal circle.
Square of diameter×0.7854=the area of a circle.
Square root of area×1.12837=the diameter of equal circle.
Square of the diameter of a sphere×3.1416=surface area.
Cube of the diameter of a sphere×0.5236=solidity.
Diameter of a sphere=0.806=dimensions of equal cube.
Diameter of a sphere×0.6667=length of equal cylinder.
Square inches×0.00695=square feet.
Cubic inches×0.000578=cubic feet.
Cylindrical inches×0.0004546=cubic feet.
Cylindrical feet×0.0290946=cubic yards.
183.346 circular inches=1 square foot.
2200 cylindrical inches=1 cubic foot.
Area of triangle=base×half the perpendicular height.
Surface of cylinder=area of both ends+length×circumference.
Surface of cone=area of base×½ (slant height×circumference of base).
Surface of sphere=diameter squared×3.14159.
Solidity of sphere=diameter cubed×0.5236.
Solidity of cylinder=area of one end×length.

AREA OF CIRCLES IN SQUARE FEET.

Diameter in Inches.	Area in Square Feet.	Diameter in Inches.	Area in Square Feet.	Diameter in Inches.	Area in Square Feet.	Diameter in Inches.	Area in Square Feet.
5	0.136	12	0.783	25	3.408	38	7.87
5½	0.164	13	0.921	26	3.687	39	8.29
6	0.196	14	1.069	27	3.976	40	8.72
6½	0.230	15	1.227	28	4.276	41	9.16
7	0.267	16	1.396	29	4.586	42	9.62
7½	0.306	17	1.576	30	4.908	43	10.08
8	0.349	18	1.767	31	5.24	44	10.55
8½	0.394	19	1.968	32	5.58	45	11.04
9	0.441	20	2.181	33	5.93	46	11.54
9½	0.492	21	2.405	34	6.30	47	12.04
10	0.545	22	2.639	35	6.68	48	12.55
10½	0.601	23	2.885	36	7.06	49	13.09
11	0.659	24	3.141	37	7.46	50	13.63

U. S. MEASURES.

Measures of Length.

12 inches (in.) = 1 foot (ft.)
3 feet = 1 yard (yd.).
5½ yards = 1 rod (rd.).
40 rods = 1 furlong (fur.).
8 furlongs = 1 mile (mi.).
3 miles = 1 league (lea.).
1760 yards = 1 mile.
6 feet = 1 fathom.

Measure of Capacity.

60 minims = 1 fluid drachm (fl. dr.).
8 fluid drachms = 1 fluid ounce (fl. oz.).
20 fluid ounces = 1 pint (pt.).
2 pints = 1 quart (qt.).
4 quarts = 1 gallon (gall.).
8 quarts = 1 peck (pk.).
4 pecks = 1 bushel (bus.).
8 bushels = 1 quarter (qr.).
1 minim equals 0.91 grain of water.

Avoirdupois Weight.

16 drachms (dr.) = 1 ounce (oz.).
16 ounces = 1 pound (℔.).
28 pounds = 1 quarter (qr.).
4 quarters = 1 hundred weight (cwt.).
20 hundredweight = 1 ton.
1 pound Avoirdupois = 7,000 grains, Troy.
1 ounce " = 437½ " "

Troy Weight.

24 grains (gr.) = 1 pennyweight.
20 pennyweights = 1 ounce.
12 ounces = 1 pound.

Apothecaries' Weight.

20 grains = 1 scruple.
3 scruples = 1 dram.
8 drams = 1 ounce.
12 ounces = 1 pound.

Surface Measure.

144 square inches (sq.in.) = 1 square foot (sq. ft.).
9 " feet. = 1 " yard (sq. yd.).
30¼ " yards = 1 " rod (sq. rd.).
40 " rods = 1 rood (ro.).
4 roods = 1 acre (ac.).
4840 square yards = 1 acre.
640 acres = 1 square mile

Cubic Measure.

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.).
27 cubic feet = 1 cubic yard (cu. yd.).

Angle Measure.

60 seconds (″) are 1 minute (′).
60 minutes " 1 degree (°).
360 degrees " 1 circumference (C).

Counting.

12 units = 1 dozen (doz.).
12 dozen = 1 gross (gr.).
12 gross = 1 great gross (gr. grs.).
20 units = 1 score.

Paper.

24 sheets = 1 quire.
20 quires = 1 ream.
2 reams = 1 bundle.
5 bundles = 1 bale.

METRIC SYSTEM.

The Metric System, of weights and measures, is formed upon the decimal scale, and has for its base a unit called a metre.

Units.—The following are the different units with their English pronunciation:

The Metre (meter).—The unit of the Metric Measure is (very nearly) the ten millionths part of a line drawn from the pole to the equator.

The Litre (leeter).—The unit for all metric measures of capacity, dry or liquid, is a cube whose edge is the tenth of a metre (or one cubic decimetre).

The Gram (gram).—The unit of the Metric Weights, is the weight of a cubic centimetre of distilled water at 4° centigrade.

The Are (air).—is the unit for land measure. (It is a square whose sides are ten (10) metres.)

The Stere (stair).—is the unit for solid or cubic measure. (It is a cube whose edge is one (1) metre.)

Measure of Length.

Metric Denominations and Values.			Equivalent in Denominations used in the United States.		
	Meters.		Inches.		
Myriametre (Mm.)	or 10000	equals	393707.904	=	6.21 miles.
Kilometre (Km.)	" 1000	"	39370.7904	=	3,280 ft. 10 in.
Hectometre (Hm.)	" 100	"	3937.07904	=	328 ft. 1 in.
Decametre (Dm.)	" 10	"	393.707904	=	32.8 ft.
Metre (M.)	" 1	"	39.3707904	=	3.28 ft. almost 40 in.
Decimetre (dm.)	" 0.1	"	3.9370790	=	almost 4 in.
Centimetre (cm.)	" 0.01	"	0.3937079		
Millimetre (mm.)	" 0.001	"	0.0393707		

U. S. Measures.	Metric Measure.	U. S. Measures	Metric Measures.
1 Inch =	2.5399 Centimeters.	1 Foot =	3 0479 Decimetres.
1 Yard =	0.9143 Metre.	1 Mile =	1609.32 Metres.

Measure of Capacity.

Metric Denominations and Values.								Equivalent in United States Denominations.		
Myrialitre (Ml.)	=	10000	litres	=	10	cubic	meters	=	2200.9670	gallons
Kilolitre (Kl.)	=	1000	"	=	1	"	metre	=	220.0967	"
Hectolitre (Hl)	=	100	"	=	100	"	decimetres	=	22.0097	"
Decalitre (Dl.)	=	10	"	=	10	"	decimetres	=	2.2009	"
Litre (L.)	=	1	"	=	1	"	decimetre	=	1.7608	pints
Decilitre (dl.)	=	0.1	"	=	100	"	centimetres	=	6.1027	cubic inches
Centilitre (cl.)	=	0.01	"	=	10	"	centimetres	=	0.61027	" "
Millilitre (ml.)	=	0.001	"	=	1	"	centimetre	=	0.061	" "

Measure of Weight.

Metric Denominations and Values.									Equivalent in United States Denominations.
Myriagram (Mg)	=	10000	grams.	= 10	cu.	decimetres	of	water	22 046 lbs., Avoir.
Kilogram (Kg.)	=	1000	"	= 1	"	"	"	"	2.204 " "
Hectogram (Hg.)	=	100	"	= 100	"	centimetres	"	"	3.527 oz., "
Decagram (Dg.)	=	10	"	= 10	"	"	"	"	154.323 grams.
Gram (G.)	=	1	"	= 1	"	"	"	"	15 432 "
Decigram (dg.)	=	0.1	"	= 100	"	millimetres	"	"	1.543 "
Centigram (cg.)	=	0.01	"	= 10	"	"	"	"	0 154 "
Miligram (mg.)	=	0.001	"	= 1	"	"	"	"	0.015 "

CLASSIFIED BUYERS' INDEX.

FOR ALPHABETICAL LIST OF ADVERTISERS, SEE PAGES 413 AND 414.

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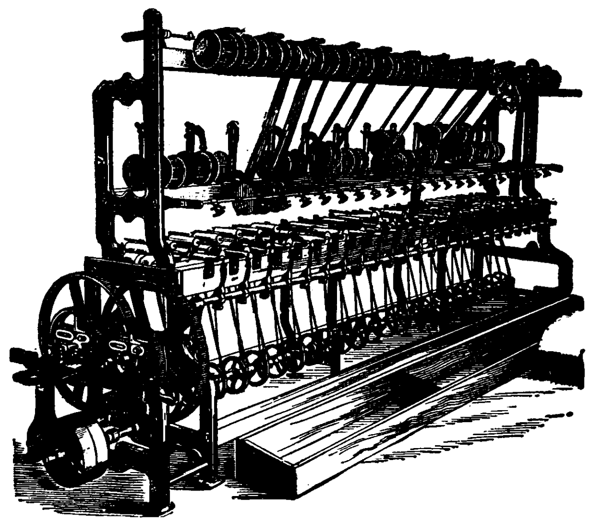
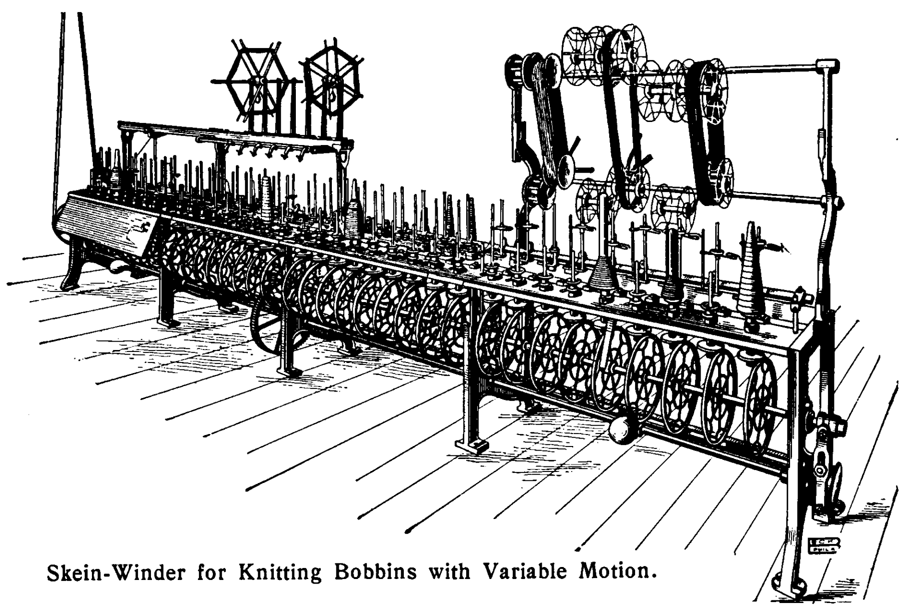
ALPHABETICAL LIST OF ADVERTISERS.





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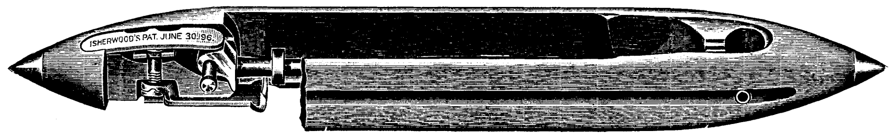

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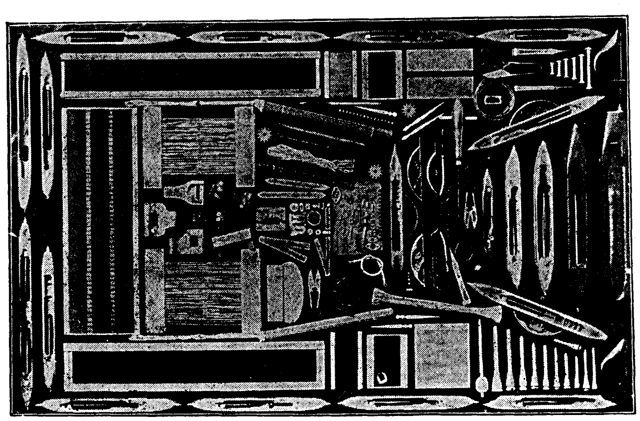

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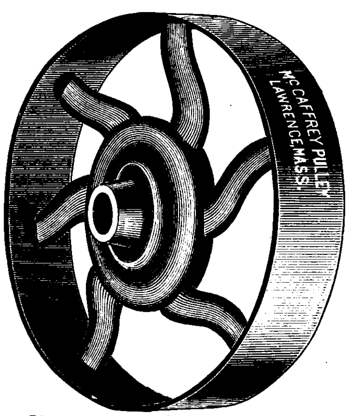

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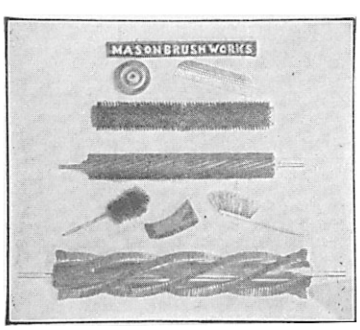

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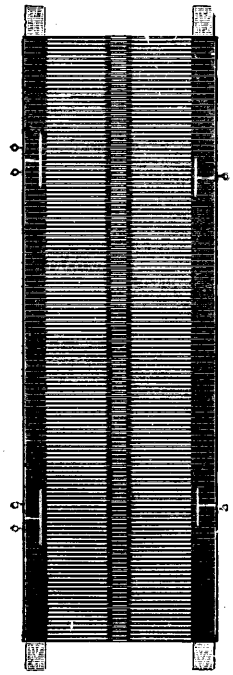

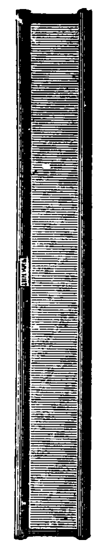

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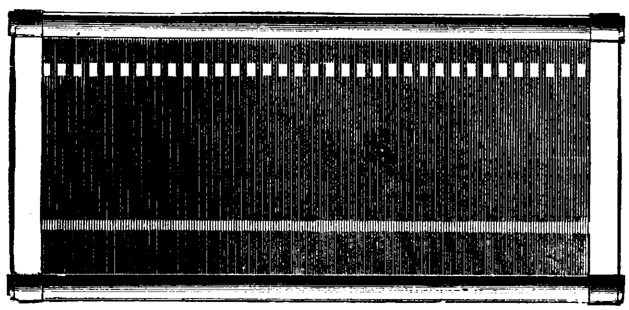

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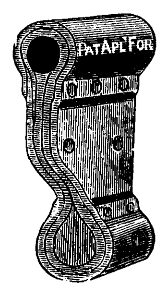

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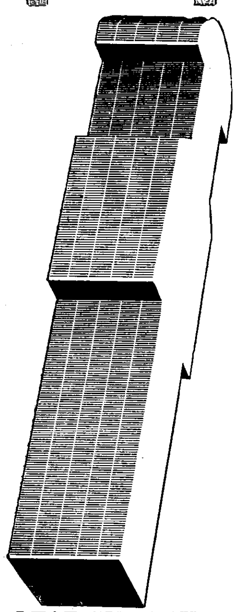

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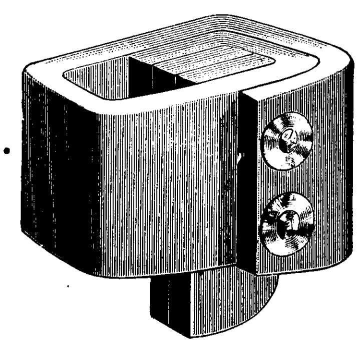

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See description of our Heddle on page 171.

See pages 167 and 168 for description of last two.

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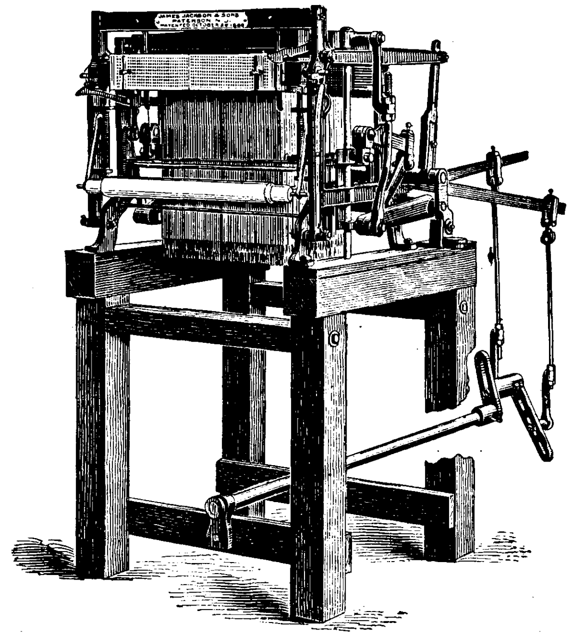

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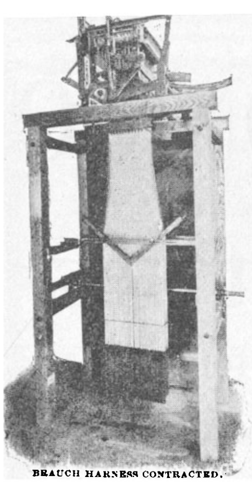
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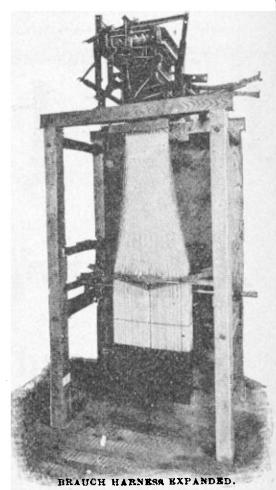
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