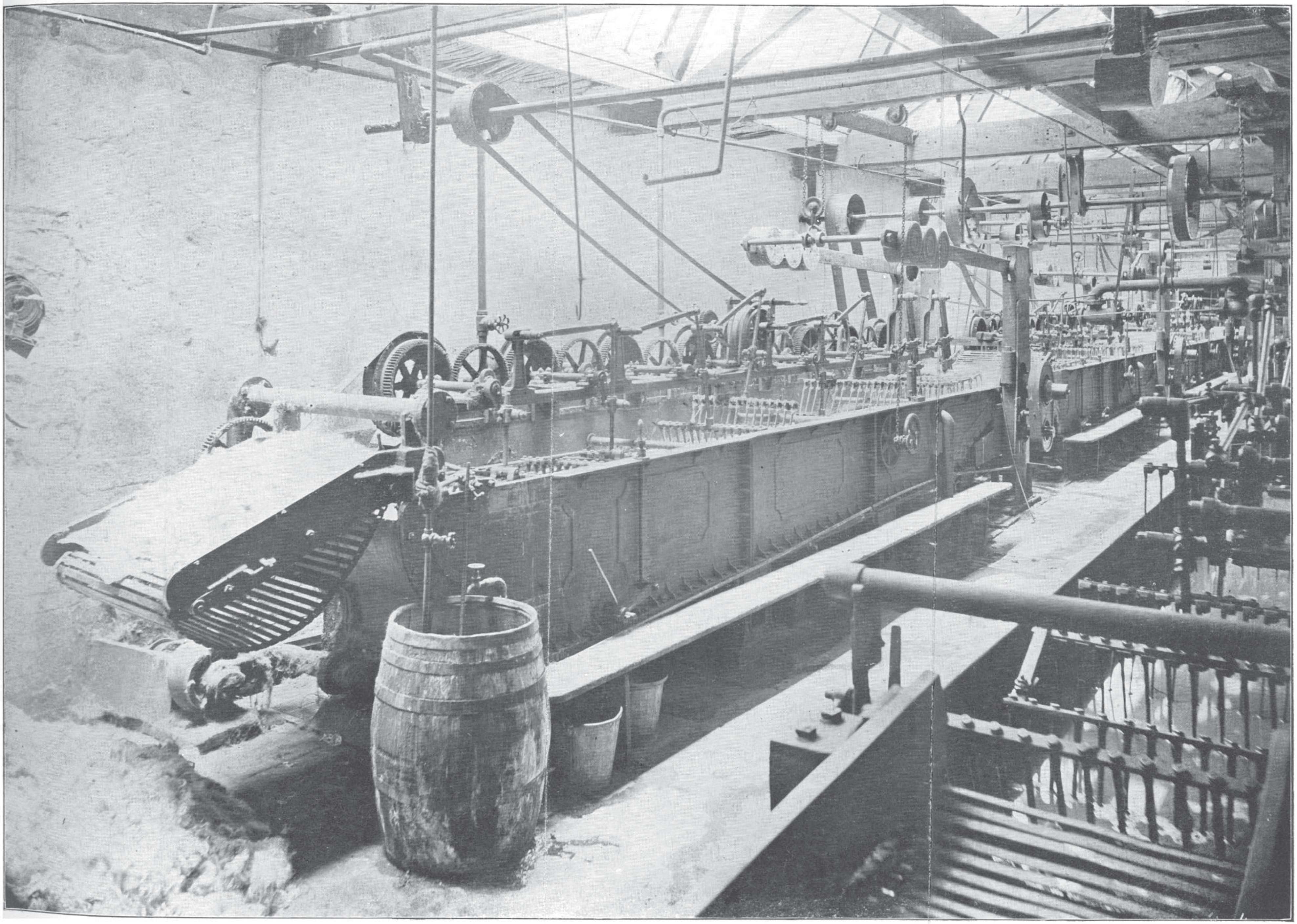
as this alkali has a corrosive and energetic action on animal fibres, it should seldom, if ever, be used for this purpose. As a detergent, it destroys the natural mellowness of the hair, and, instead of acting as a bleaching agent, imparts a yellow tinge to the wool. Potash, on the contrary, being present in the fibres of the raw material, is the alkali naturally most suitable for whitening and purifying wool, to which it gives a diffusive character and soft feel. Silicate of soda is said to be used largely on the Continent, with good results. When this detergent is employed, precautions should always be taken to thoroughly squeeze the scouring liquor out of the material before rinsing with cold water—if this is done, it is held that the wool will be white, clean, open, and soft, and also dye freely. Ammonia is milder in its action than either soda or potash. Formerly it was extensively used for wool-scouring purposes, for which it is well adapted, removing the dirty, greasy matter from the wool without injuring the staple. Soaps are now generally the scouring agents selected. The practice is to use a neutral soap and to add the requisite quantity of alkali to produce saponification—average $1\frac{1}{2}$ to 2 lb. per 100 gals. of scour—but in some wools, such as greasy Cape, up to 8 lb. of alkali may be necessary.

The quantity of water in soaps may be ascertained by reducing a sample to parings and placing in a heated oven, in which it should be allowed to remain until it ceases to become lighter, when the difference between its original and dried weight will indicate the percentage of water evaporated. Other adulterations may be detected by immersing the soap in a strong solution of alcohol and applying heat, which dissolves the soap, but leaves the impurities insoluble.

Wool may be injuriously acted upon by a scouring solution of too high a temperature, and from being treated with strong alkalis. No rigid rule as to temperature can be furnished, this being a feature of scouring which varies according to the nature of the wool in hand. However,

PLATE VI



[Per Mr. Henry S. Clough, Keighley.

FACTORY VIEW OF LONG-WOOL (WORSTED) SCOURING PLANT.

Foldout reduced 1/3rd and rotated 90° to fit on page the liquor should never be at a higher temperature than is absolutely necessary to cleanse the material. For wools, open, broad, and free in staple, from 32° C. to 54° C. is a good average, but for fine wools the temperature may range from 48° C. to 55° C. To avoid unsatisfactory consequences, the temperature and alkalinity of the liquor should always be tested before a batch of wool is placed in the scour bath. A few samples of wool might now be dipped, and the alkalinity of the solution varied, until the material readily parts with the dirt and grease it contains, and possesses a soft handle. The hardness or softness of the water used is a question of importance. Soft water dissolves the soap the best, and is, in consequence, the most preferable for cleansing wool. Water varies in hardness according to the proportion of salts, lime, chalk, and other mineral substances it may contain. To use such water for wool-washing, without previously softening it, is a very uneconomical course, as a considerable proportion of the soap is thereby taken up by the lime, etc., before any of it is available in purifying the wool. When water is not softened, the lime forms with the detergents an insoluble lime soap—a compound useless as a scouring agent. It is also difficult to remove when fixed on the wool. A general mode of softening water for wool-scouring consists in collecting it in tanks, when from two to six pounds of refined carbonate of potash per 1,000 gallons is added, which in a short time precipitates the lime and leaves the water ready for use. By the Archbutt-Deely process, the water to be softened is treated in tanks with the proper amount of carbonate of soda and lime, and the mixture blown with air for a short period. The precipitate is allowed to settle and the clear water drawn off. This process will reduce the hardness of water from 16° to 17° to 3° rapidly.

23. *Wool Dusting Machine.*—For East India and other dry, dusty wools used in the blanket trade, a dusting machine is employed prior to scouring. It is simple in construction, consisting of a travelling lattice, feed rollers,

and of a cylinder or beater inclosed in a framework, and making some 600 revolutions per minute. The wool carried forward on the endless lattice is taken up by a pair of fluted rollers, the nip of which is variable by spring arrangement. These rollers are adjustable as to distance from the beater—a four-winged cylinder—28″ in diameter. The dust removed is blown by a rapidly revolving fan into a suitable receptacle. The machine may be in connection with the scourer, and arranged to deliver the treated wool on to the feed of that machine.

The Garnett wool cleaner, or duster, is designed for treating East Indian, lime, and other wools, mohair, cow hair, cashmere, card strippings, rags, and other materials. It is a machine with two cylinders in separate enclosed compartments. They work independently and may be run at different speeds. Under and over each cylinder is a hood or cover. A suction fan is employed for drawing off the dust and dirt. The cylinders are mounted with round teeth, and lash the material against a grid with metal bars. As in the teazer, the feed sheet is operated intermittently to allow of successive quantities of material being dusted or treated. The machine has two pairs of feed rollers, the first pair being toothed and the second pair fluted. After the material has been operated upon in the first compartment by cylinder No. 1, the intervening door is opened, and it passes forward to the second compartment to be similarly dusted or cleaned by cylinder No. 2.

As the changing from one compartment to the other is being automatically effected the feed sheet delivers a second quantity of material to the first cylinder. A series of change wheels is supplied for varying the speeds controlling the supply of the material, the time at which it is acted upon by the respective cylinders, and also the speeds of the same.

24. *Wool Steeping.*—Greasy wools have been prepared for scouring by subjecting them to a process of steeping, the object being to drive off the acid which the fibres contain and dissolve the hard, dirty substances, without removing any of the yolk in the wool. The apparatus

shown in Fig. 15 consists of three steepers, A, B, and C, similar to each other both in size and construction. Each steeper has two bottoms, the upper one being perforated as indicated by the dotted lines. The water is kept in tanks, T, T, the pipe connections with which are so arranged as to admit of the steepers being worked separately or together. The steam enters the vessel containing the material at the bottom, and is forced upwards, passing through the hard and entangled masses of wool; thus the whole is opened and softened, and a large amount of extraneous matter removed. As there are no chemical

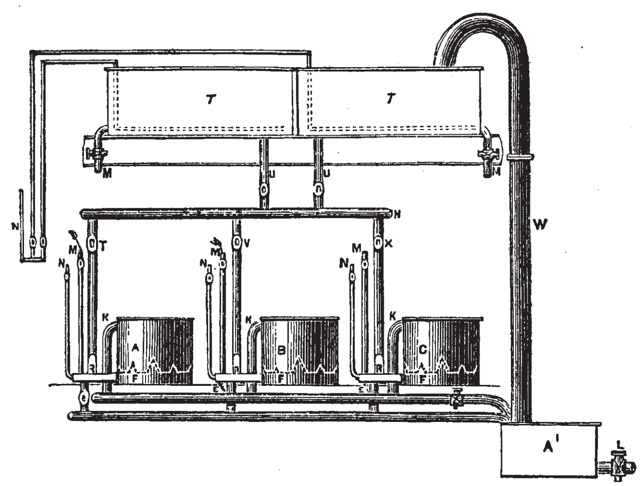


FIG. 15. Wool Steeping Apparatus.

agents used in the process, the natural pliability, lustre, and colour of the fibre are preserved.

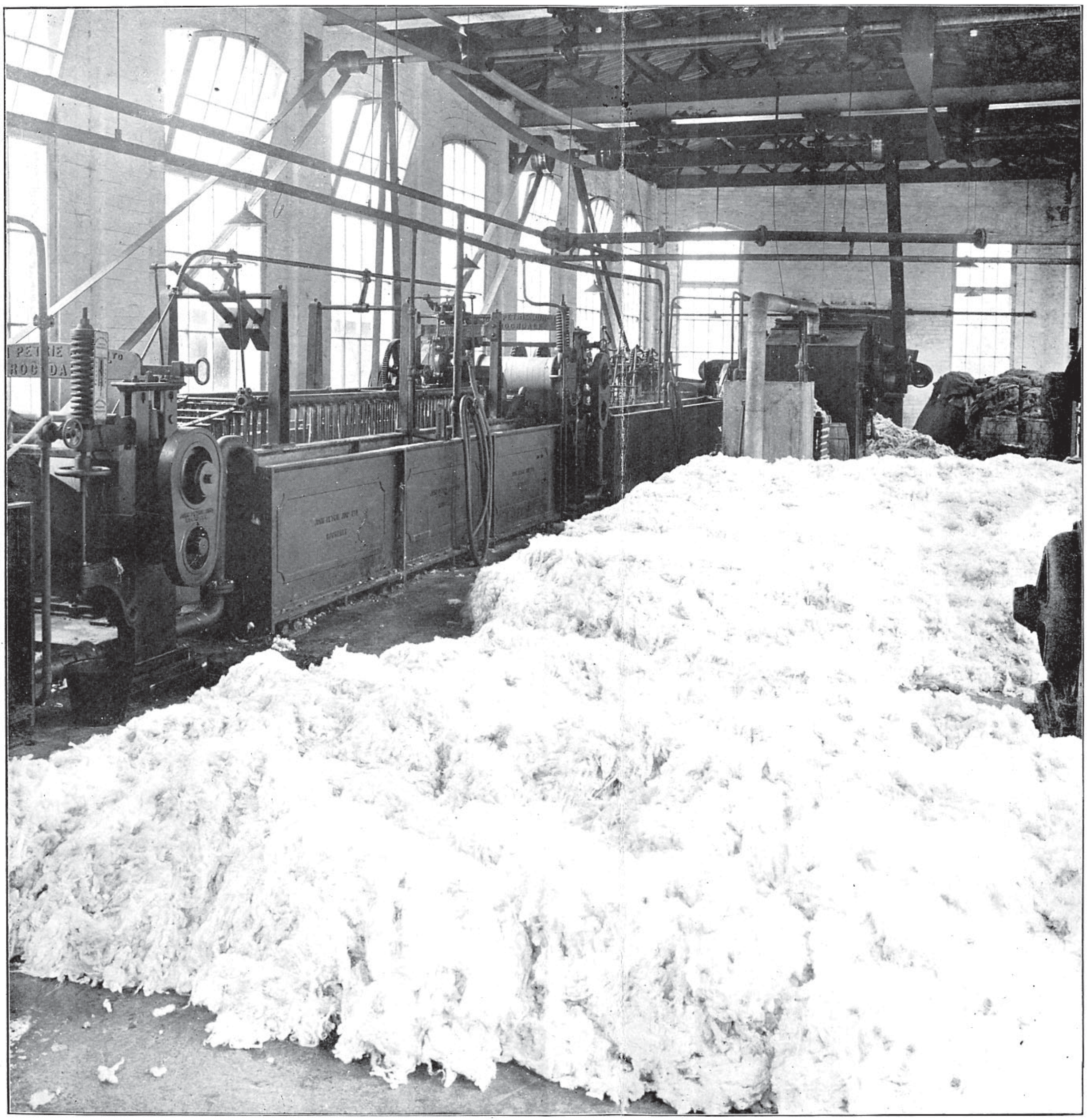
The main advantage arising from steeping greasy wools, previous to washing, is the considerable saving effected in soap. The cost of steeping, once the apparatus has been obtained, is not to be compared with the difference in the quantity of detergents used when the wools are submitted to the scouring process without having the hard limy matter in the staple softened or dissolved, as is the case of wools that have passed through this operation. After steeping, the material readily parts with the dirty substances it contains, the fibres being in a more open state, and the impurities more readily acted upon, so that the time required in scouring, and the quantity of soap used, are considerably decreased, while cleansing is accomplished with less injury to the properties of the wool.

The improved efficiency of scouring machines and the increased length of the first bowl has proved an efficient substitute for this method of preparation for scouring. In some systems of scouring, the first bowl is defined as the "steeper."

25. *Hand Method of Scouring.*—Wool may be scoured both by hand and by machinery, but the former method is entirely out of date, having been superseded by machine washing, and hence need only be briefly described. The wool, in such a case, was placed in a large vat or tub which possessed a false perforated bottom that rested on small supports about six inches from the bottom proper; it was freely agitated for some time in the solution contained in this vat, then lifted on to a large scray to allow some of the liquid to drain off. Rinsing followed, being performed in the "rinse" box, a long, narrow trough also having a perforated bottom to admit of any hard, dirty particles, that had not been removed in scouring, to escape. The material was next placed in perforated cages, and immersed in a stream of fresh water, which thoroughly cleansed it of the "scour" it contained on being removed off the scray. One workman on this system of scouring would cleanse from 500 to 1,000 lb. of greasy wool per day.

26. *Scouring by Volatile Solvents.*—Scouring may be effected by means of volatile solvents—naptha, benzine, bi-sulphate of carbon, ether, and like fat solvents. The system invented by Maartens consists of a plant capable of treating 20,000 lb. of wool per day. The apparatus comprises a series of four large digestors or retorts in which the wool is inclosed, and may be treated by drawing warm air through the digestors to ensure vaporization of the moisture. A pump is applied for producing a vacuum. When this is stopped, and the material

PLATE VII



[*Per Mr. Alex. Weir, Convoy Woollen Co., Ltd., Convoy, Co. Donegal.*

FACTORY VIEW OF WOOL-SCOURING PLANT FOR WOOLLEN YARN.

has been acted upon by the heated air, the first digestor is connected at the top with a reservoir containing the solvent partially saturated with wool fat. "Communication is next established between the *bottom* of the first digestor and the *top* of the second, and by the influence of the vacuum existing in the second digestor and of the

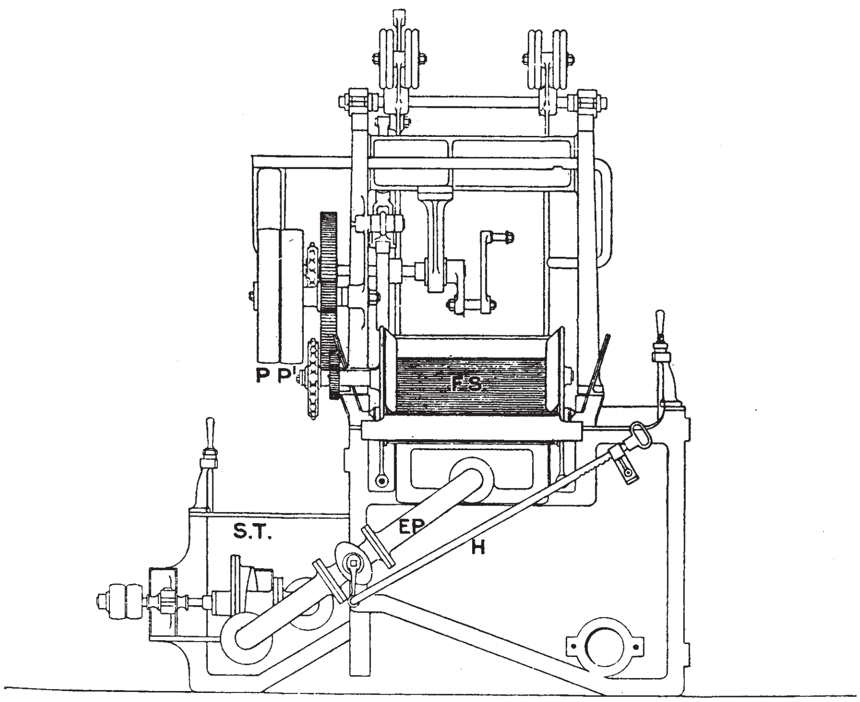


FIG. 16*b*. McNaught's Wool Scourer. Feed End.

F.S. = Feed Sheet.
P P' = Loose and Fast Pulley.
H = Connecting Bar between handle and valve of Pipe E P.
E P = Pipe connection between Scum Bowl and Settling Tank S.T.
S.T. = Settling or Side Tank.

compressed gas applied at the top of the first digestor, the solvent is driven out of the first and blown, in liquid form, from the wool which it contains, over and into the second digestor." This process is repeated through each digestor, the solvents being of the same nature but of a lesser degree of saturation, becoming finally pure solvent. The solvents are returned, after each process, to their respective storage tanks.

The wool having been treated with the pure solvent, dry steam is applied to the bottom of the last digestor, when the solvent is immediately volatilized. The action of the vacuum pump causes the distillation of residuary solvent adhering to the fibres to be effected at a rapid rate, and at a low temperature, and through the medium of a condenser it is delivered into the storage tank without any appreciable loss.

To deoderize the fibres, a current of air, and of air and steam mixed, is drawn through the wool, when it is rinsed in clean, tepid water.

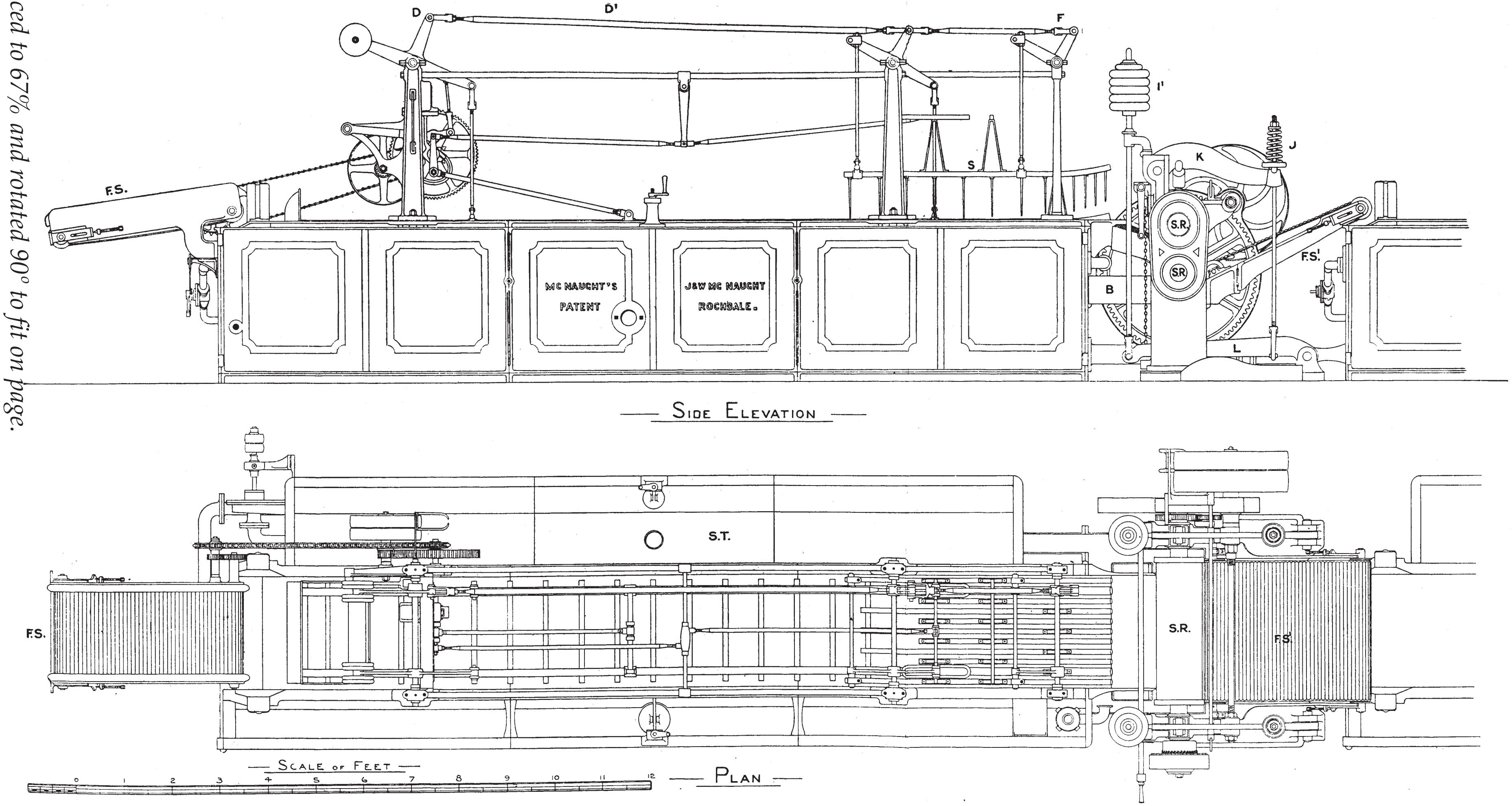
27. *Scouring Machines.*—These are of several distinct types, the principal being:

I. The Fork or Harrow Machine, in which there is a minimum of mechanical movement of the wool.
II. The Rake Machine, chiefly suitable for long wools.
III. The Rocker and Posser Machines, in which the wool is squeezed repeatedly as it passes through the tanks or bowls.
IV. The Conduit Machine (a principle of mechanism but not developed to any extent commercially) in which the wool is cleansed in tubular ducts.

Mill views of plants of scouring machinery for long wools for worsted yarns, and for short wools for woollen yarns, are given on Plates VI and VII. They show the method of arranging the bowls, driving, and conveyance of the wool from one bowl to another, and also of delivery.

I. The Fork Machine. The construction and principle of action of McNaught's Fork machine are indicated in Figs. 16, 16*a*, 17, and 18. A set of machines arranged for the washing of various classes of wools—short and medium staple—consists of four bowls, the first being 32′ 6″ long, the second 26′ 3″, the third 20′ 3″, and the fourth 14′ 3″. The greater dimensions of the first bowl are to provide for ample time for steeping or conditioning the wool for actual scouring which follows. The four bowls are connected together by intermediate "feeds" as shown.

Plate VIII



Figs. 16 and 16*a*. Side Elevation and Plan of McNaught's Fork Scouring Machine.

F.S. = Feed Sheet.
D. = Balance Lever for Fork Frame.
D[1]. = Connecter for Levers D and F.
S. = Section of Fork Frame.
K and L. = Levers for Regulating the Pressure on the Squeezing Rollers S.R.
I[1] and J. = Weights and Spring for Rod Connecter of Levers K and L.
B. = Small Collecting Trough for Waste Scour leaving the Squeezing Rollers S.R.
F.S.[1] = Lattice Conveyor.

Fold-out reduced to 67% and rotated 90° to fit on page.

Fig. 17 is a cross section of each bowl. Part A is the wool-washing portion proper, being perforated at the bottom; B, the bowl with inclined bottom so that hard particles of matter and other impurities settle towards B^1 leaving clean scour at the top; and C is the side or overflow tank similarly shaped to the main tank, B.

When the solution has been used for a sufficient number of times in the first bowl it is run off, and the solution from the second bowl is forced by an injector into the first bowl; that from the third into the second, and from the fourth into the third.

The two distinguishing features of the machine are (1)

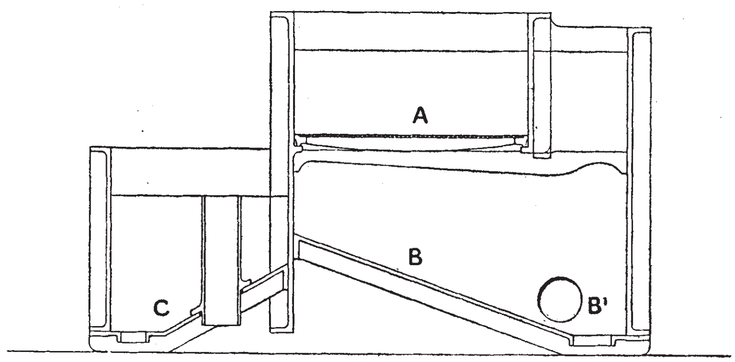


FIG. 17. Vertical Cross Section of McNaught's Wool Scouring Machine.

scouring of the wool in an interior perforated trough, and (2) the conveying of it from the feed to the delivery end of each bowl by gentle mechanical movement, facilitating scouring without felting, and leaving the wool in an open, free condition. This is effected by the combination of parts sketched in Figs. 16 and 18. The rising action of the frame, S, carrying the forks or prongs, is done by the cam A (Fig. 18), lifting lever C, connected to balance lever D, which by rod D^1, operates the lever E. Levers D and E are connected by the uprights I, to frame S, which is shown in the upper position.

The compound motion of the frame, namely, its forward and backward traverse in the bowl—the former with the prongs in the solution, and the latter with the prongs out of the solution—is as follows: The frame is lowered until the prongs are immersed in the suds, when it makes a stroke forward. At the end of the stroke it is lifted by cam, A, and levers described until the forks are clear of the suds, when the backward stroke takes place. Following a few forward strokes circulation of the "scour" towards the squeezing rollers is commenced, floating the wool gently to the end of the bowl. For greasy, heavy wools the frame may operate forward, backward, and forward a second time before rising, getting additional agitation of the solution and accelerating the cleansing.

The wool is fed on to the feed sheet F S, Figs. 16 and 16*a*, pressed by the sinker into the "scour," moved forward as described to the squeezing rollers S R, the pressure on which may be moderated by weights and springs, I^1 and J, and levers, K and L, Fig. 16. It is now lifted by forks S, Fig. 18, of diminishing lengths up an inclined plane, and then glides down to the squeezers which remove the surplus solution running into B, Fig. 16, while the wool is conveyed into the next bowl on the travelling lattice FS^1, Fig. 16*a*. The waste scour thus escaping into the side tank, S T, after settling—impurities going to the bottom—may be pumped into the bowl and reused. As the wool leaves the last pair of squeezing rollers of the final bowl it is acted upon by a revolving fan or blown or conveyed direct to the dryer.

PETRIE'S "HARROW" MACHINE. Figs. 19, 20, and 21 is a similar type though differing in mechanical details. It is also chiefly suitable for fine wools, being essentially a method of scouring by steeping and squeezing rather than by moving the wool to and fro while in the washing bowls, four in number, as sketched in Fig. 20, to which the drying machine is conveniently connected. A compound of the "rake" and "harrow" machines is arranged for different classes of wools. Taking the standard set—a four-bowl arrangement—the bowls are grouped as follows for the classes of wools named:

1. Fine merino and other wools. Bowls 1, 2, 3, and 4 Harrow type. 2. Medium stapled wools. Bowl 1 Rake type, bowls 2, 3, and 4 Harrow type.

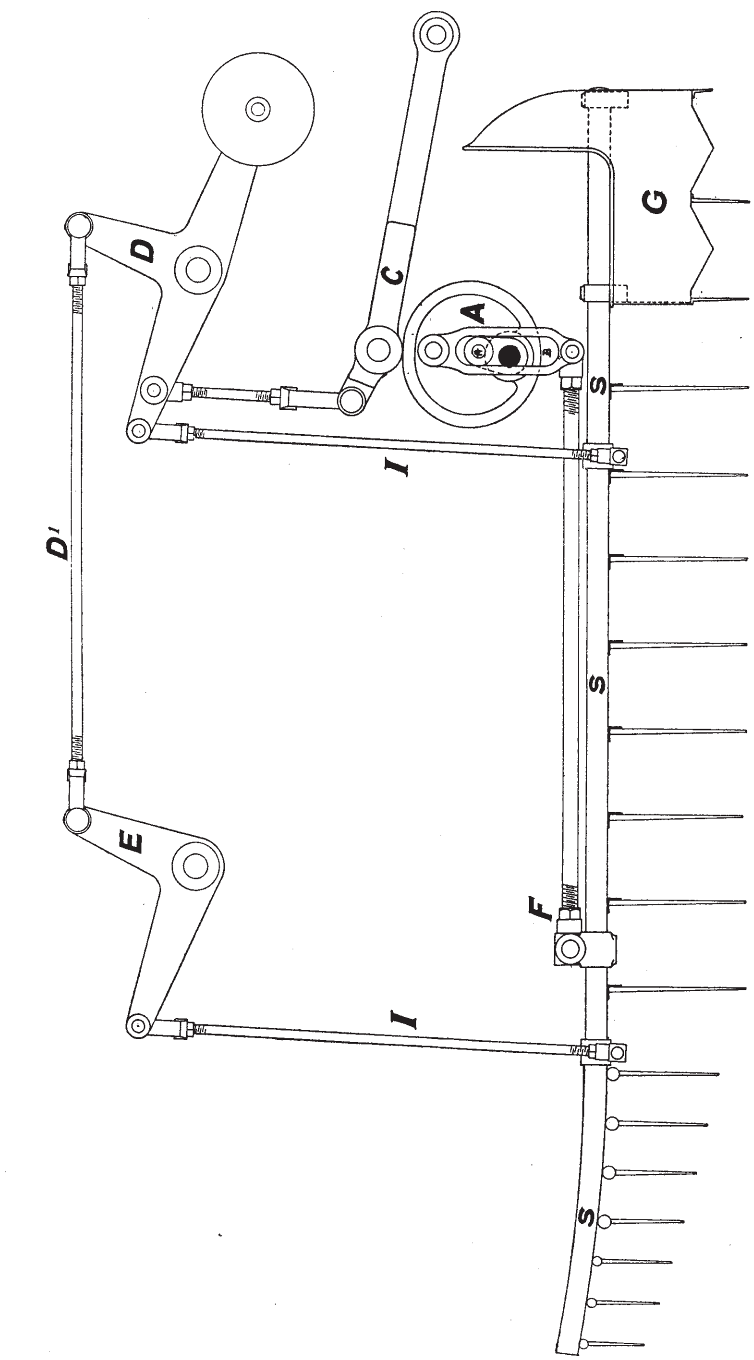


Fig. 18. Section of McNaught's Scouring Machine, showing mechanism for actuating Harrow or Fork Frame.

3. Long stapled wools. Bowls 1, 2, 3, and 4 Rake type. The bowls gradually decrease in length from the first to the fourth, No. 1, 33′; No. 2, 27′; No. 3, 21′; and No. 4. 15′.

Machines are, however, constructed and grouped to be adapted for scouring any particular classes of wool. The

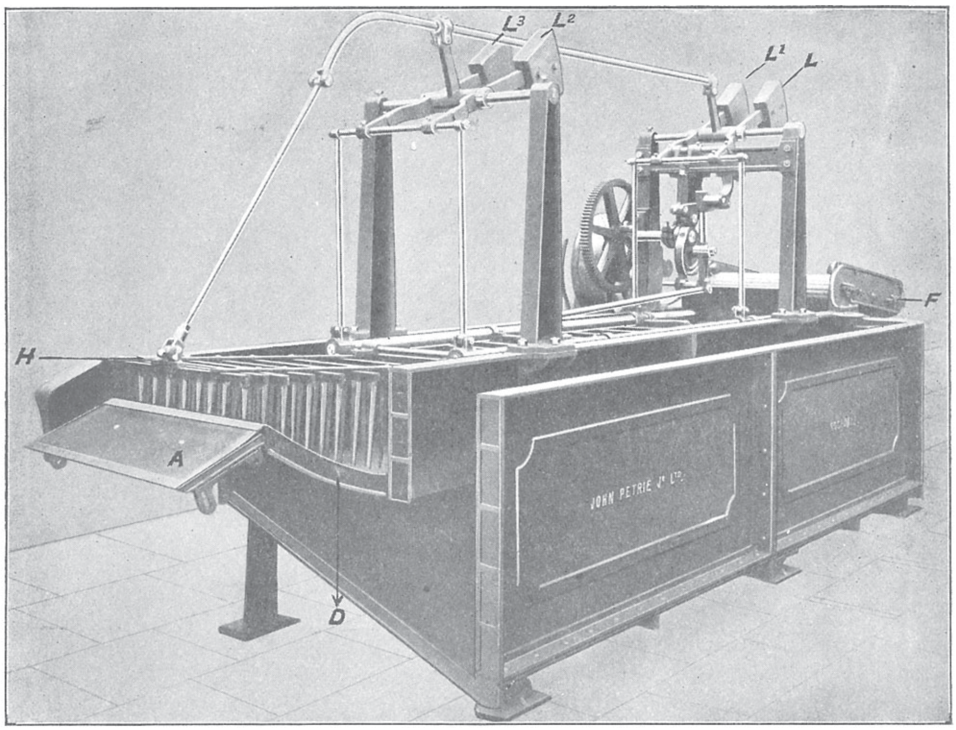


FIG. 19. Petrie's Harrow Wool Scourer.

F = Feed Sheet. L to L³ = Balancing Levers for the Harrow Frame.
H = Harrow Frame. D = Inclined Table over which the wool is carried.
A = The Delivery Table.

motion for the frame carrying the "harrow" is similar to that of the "fork" machine.

The pressure or squeezing roller mechanism is illustrated in Fig. 21. By a combination of levers, L L, and springs, J J¹, the pressure can be readily regulated and is registered on indicators attached. The upper roller, S R¹, is covered with felted cloth compressed upon the shaft, affording an elastic

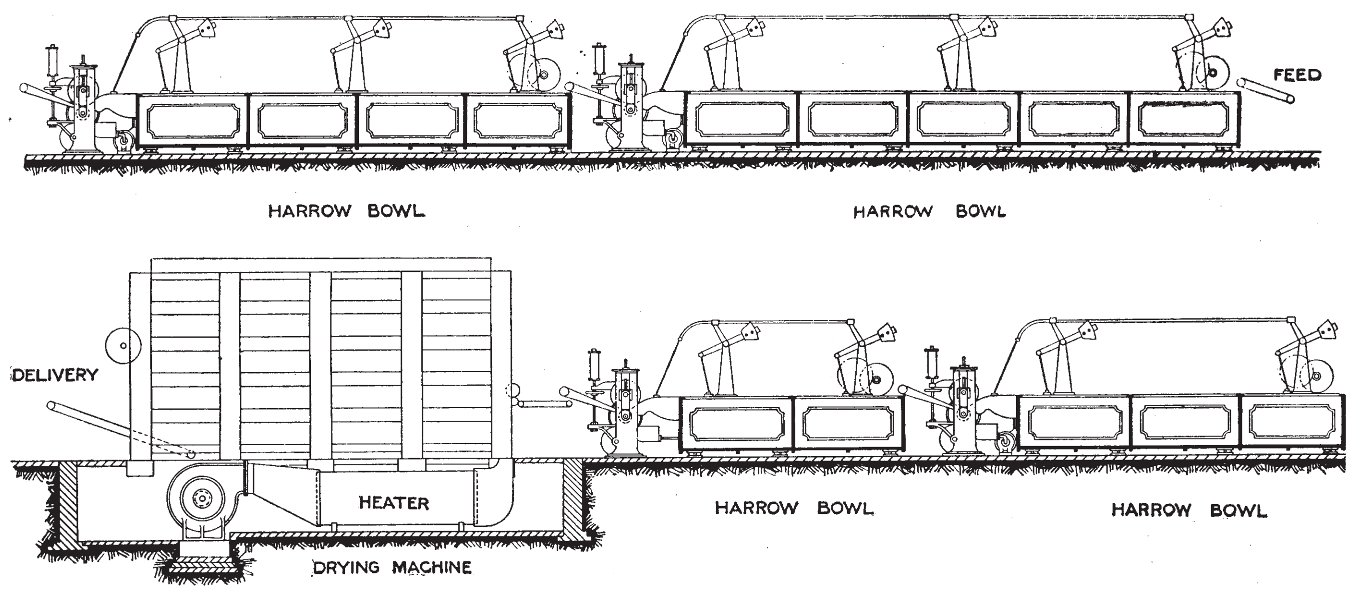


Fig. 20. Petrie's Wool Washing and Drying Machine, showing the Bowls decreasing in length from 1 to 4.

and yielding surface, but one giving uniformity of pressure from end to end when the squeezing action is taking place. Under the bottom roller is the sud dish (not shown) into which the escaped liquor from the nip of the rollers runs. This dish is fitted with perforated brass plates, so that any wool falling into it may be easily removed. A centrifugal pump is employed for forcing the scour from the sud dish

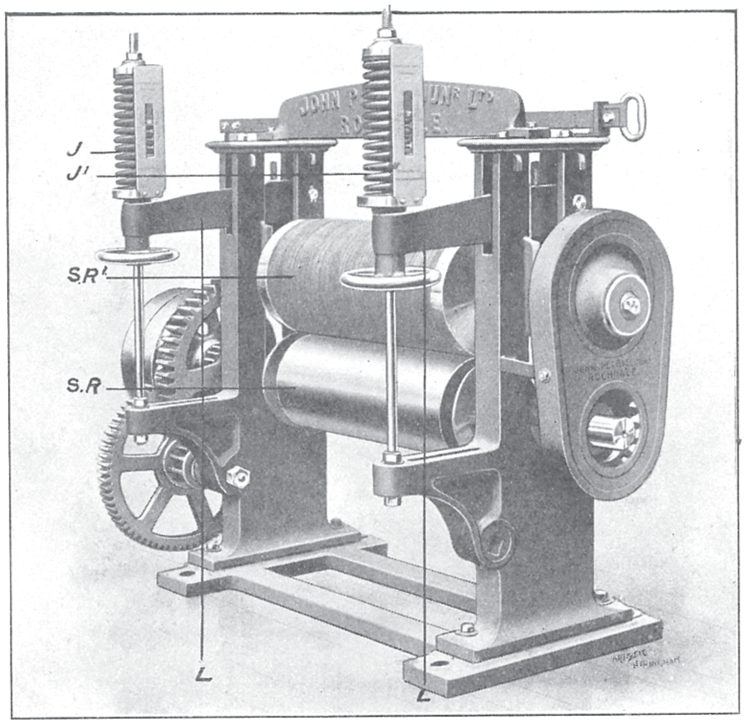


FIG. 21. Arrangement of Squeezing Rollers as applied to Petrie's Wool Scourer.

into the settling trough, alongside the machine, from which by steam-jet, transmitters, and pipes it is conveyed from the second to the third and from the third to the second bowl only necessitating, when changing the solution, the scour from one bowl in the set being run to waste.

RAKE MACHINE (Fig. 22). This class of scourer is constructed by Petrie, Dawson, Taylor Wordsworth and Co., and others. It may consist of a double steeping tank,

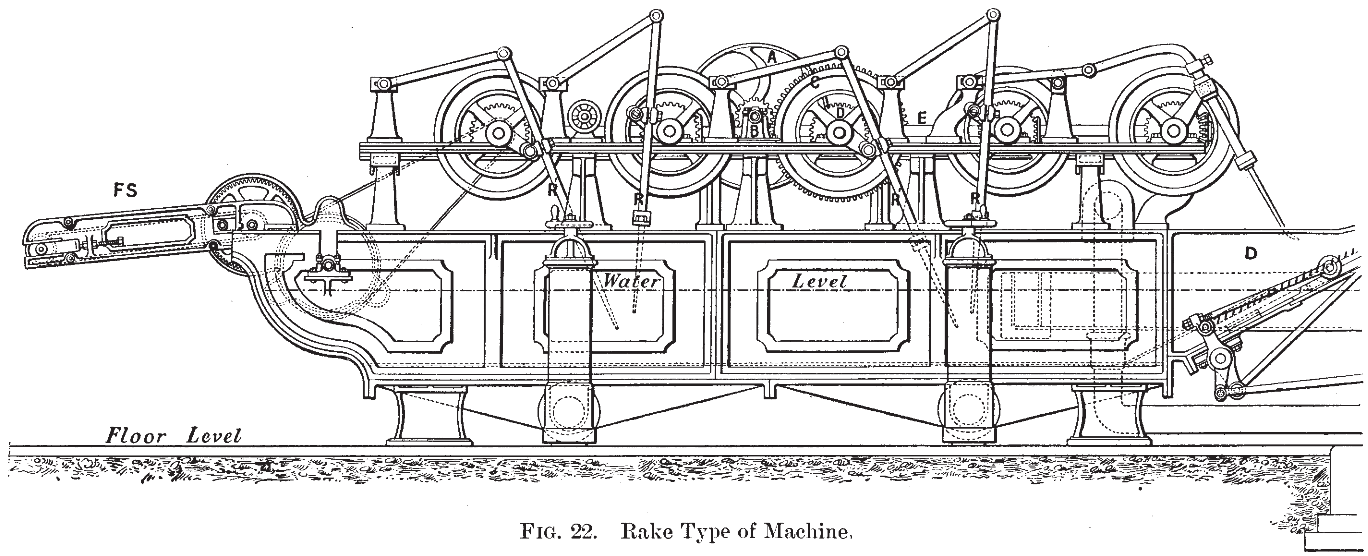


Fig. 22. Rake Type of Machine.

F S = Feed Lattice. R R^1 = Rakes. D = Delivery Table to the Squeezing Rollers.

one 6-rake bowl, and of one 5-rake bowl, being a total length of some 65 feet.

The wool from the travelling feed is forced into the scour by a revolving beater. The forks, R and R[1], are fixed in opposite positions as to stroke, being driven by the side shaft, E, and bevel wheel gearing. A is the main driving pulley carrying pinion B, geared into C, on the same shaft as D; and D drives the bevel wheel on shaft E. The forks move forward slowly over the top of the solution, then dip rapidly propelling and agitating the wool at the same time. The forks may operate in the same direction or alternate with each other. When the latter is the principle of action the wool no sooner leaves one rake than it is advanced in the bowl by the preceding rake.

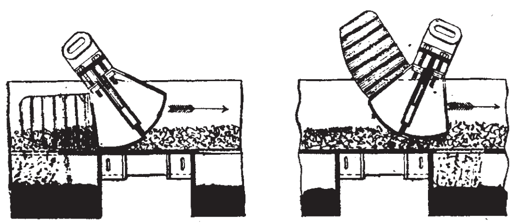


FIG. 23. Sections of "Rocker" Scourer.

THE "ROCKER" MACHINE (Fig. 23). Is made by Perry. It is defined as a double-decker scourer, having two sud bowls, one placed above the other. The solution is lifted by a centrifugal pump from the lower to the upper tank, passing through perforated plates preventing dirty and solid matter being conveyed. As the wool drops off the lattice feed, it undergoes a heavy shower of suds from above and below. To induce the wool to move forward the bowl inclines from one end to the other. A section of the machine showing the rockers which are fixed on the frame of the upper tank is shown in Fig. 23. The positions the rockers assume when the machine is at work is given at A and B. At A the immerser retains the wool under the suds and prevents any backward flow, but at B the immerser is out of action allowing the wool to travel onwards. The scour squeezed from the wool enters receiving tanks, an upper section of which is perforated, allowing hard impurities to fall to the bottom. As seen the rockers or immersers are the feature of the machine. Each is divided into two parts and worked by segment wheel gearing. The machine is most suitable for the cleansing of long wools. The "Posser" scourer is constructed on a similar principle, but in the place of "Rockers" perforated bases automatically operate on the wool, squeezing or retaining it under pressure for successive brief periods against the bottom of the upper tank.

In AMBLER'S CONDUIT MACHINE—an ingenious invention but a system not now in ordinary use—the scouring liquor and wool are continuously introduced into the tank, the solution carrying the wool with it through an inclosed channel accelerating the scouring action by a series of abrupt changes or bends, C^3, Fig. 24A, in the channel or tubular ducts. The wool from the travelling feed, D D^1, of Fig. 24 drops into the receiver, into which the scouring liquor is being forced along a feed pipe, b^1. The conduit ducts are some six inches deep and extend across the machine, and the tank containing the scour is opened at intervals automatically, the scour which has passed through the channel and run through the wool returning, after heating to the proper temperature, to this tank. For the purpose of extracting the more substantial impurities, there are outlet pipes, C^5 (Fig. 24), which have a suitable wire grating so that no wool fibre can escape into the bowl; the harder impurities fall out at the bottom and are removed at the outlet A.

The wool on reaching the delivery end of the tank, as in other machines described, passes between a pair of squeezing rollers suitably weighted and is acted upon by a fan which renders it loose and lofty.

28. *Utilization of Waste Scour Solution.*—The waste suds, resulting from scouring both wool and cloth, are, in practice, run into a series of tanks with the object of reclaiming the fatty ingredients which they contain. In order to separate

the grease from the other substances in the solution, sulphuric acid is added to the tanks. The fatty matter is thus liberated, and rises to the surface, whilst the soda and ammonia compounds remain in solution. The greasy substance thus formed is, after the water has been drained off, pumped into a filter. It remains here until partially solid, when it is cut into blocks about 18″ square.

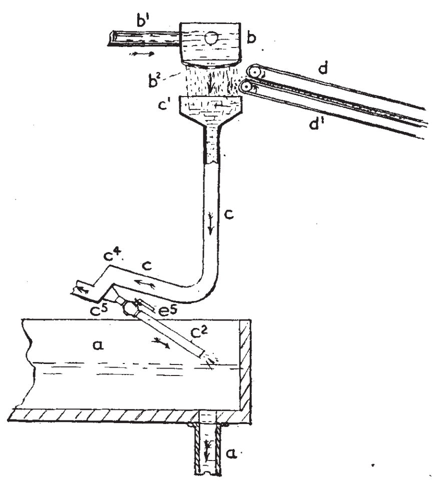


FIG. 24. Section of Conduit Machine showing Feed Arrangement.

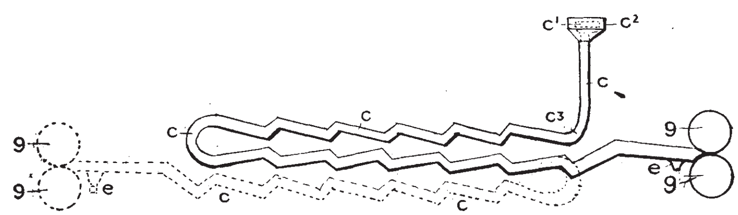


FIG. 24*a*. Section of Conduit Machine.

By applying pressure and heat a quantity of oil is reclaimed, which is used in lubricating rags before grinding, while the residuum, after pressing, is used by soap manufacturers.

29. *Drying.*—Now the wool has been cleansed of impurities it only remains to remove the moisture it contains on leaving the scouring solution. A common mode of drying consists in spreading the wool on a table possess-

ing a wire cage surface, the apertures in which admit of hot air being forced through the wool. The stand on which these cages are fixed is built in a semi-circular form, and contains a number of steam-pipes and revolving fans for driving the heat rapidly through the material. It is important when using the drying table that the wool should be spread as evenly as possible, and turned over at regular intervals, to prevent scorching some of the fibres and partially drying others. If these points are carefully attended to, the material will be well and uniformly dried.

Another machine used in wool-drying, Fig. 25, is constructed on the continuous feed and delivery system. It consists of an enclosed chamber (containing a series of shelves, or tables, one over the other, and some 18″ apart), about 20′ long, 4′ 6″ wide, and 11′ high. Hot air is forced through the machine by a fan, which makes about 1,000 turns per minute, and is placed underneath the chamber. The current of air it creates passes through the tubular heater, and from thence into the chamber, as indicated by the arrows. The temperature can be regulated as required. The tables consist of two kinds of bars, stationary and movable; the latter convey the wool through the machine. As the material reaches the end of the respective tables it is deposited on the one below, and so on till it reaches the bottom table, where it is passed on to the delivery lattice.

Drying being on this system accomplished in an enclosed chamber, the washing machine may be in the same room as this apparatus, thus admitting of the wool being conveyed by the delivering table of the scouring machine on to the feed-table of the "dryer." This mode of transferring the material from one machine to the other is shown in Fig. 25. Parts T, R, and C are the delivering end of the "scourer," being a portion of the tank, pressure rollers, and delivery lattice respectively. Necessarily this arrangement economizes both space and labour. If not adopted, the material is placed by hand on the feed-table, when it is at once carried into the machine and forced by a blast of hot air on to the upper table. It now travels over the separate shelves in succession, being dried and opened to

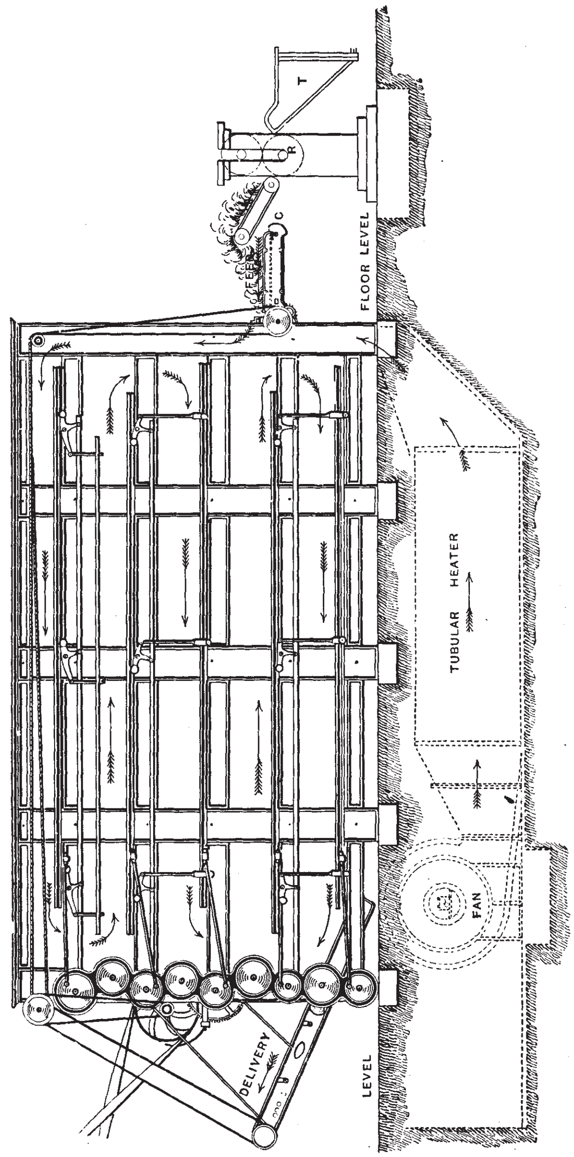


Fig. 25.

some extent during its passage through the machine by the current of hot air which moves in the same direction as the wool. As many as from 3,000 to 5,000 lb. of material can be dried in this chamber in one day.

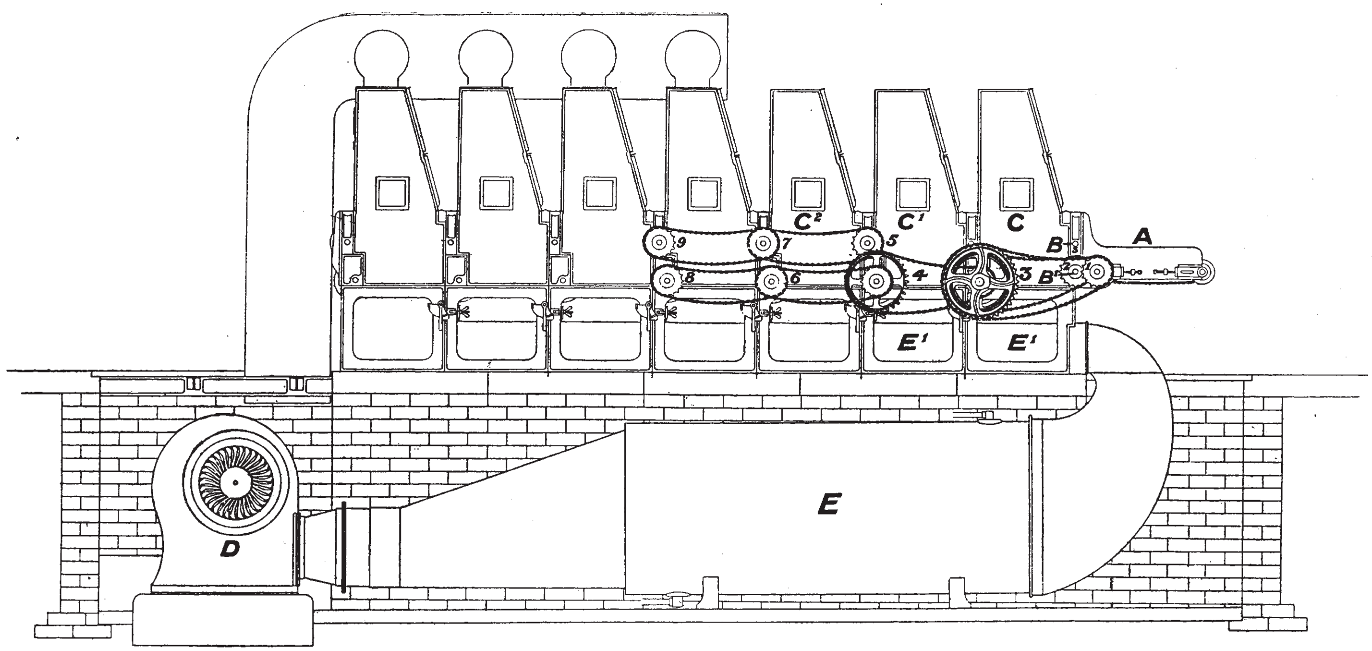


FIG. 26. McNaught's Continuous Dryer, Compartment System. Driving Gear.

McNaught's Drying Machines.—The ordinary machine is in the form of a large cylinder made of wire netting, and with the feed end fixed higher than the delivery end. Inside the cylinder is a series of bars mounted with strong curved spikes, tapering slightly in the direction in which the cylinder revolves. As the wool is delivered on to these spikes by the feed, it is carried round until it reaches the top position of the revolving cylinder, when it glides off the spikes and falls to the

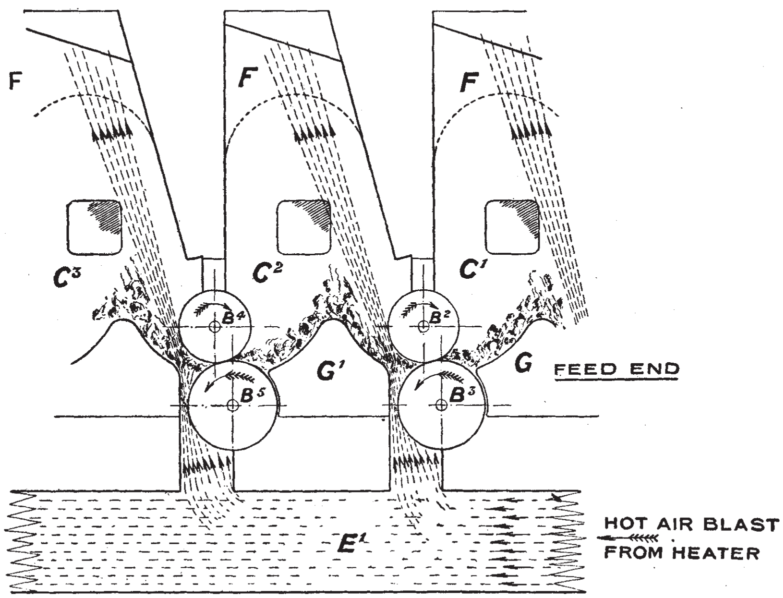


Fig. 26*a*. McNaught's Continuous Wool Drying Machine (Compartment Method), showing direction of currents of heated air and their action on the wool.

bottom, the work being repeated at each revolution of the cylinder. There is also a fixed spiked rail above and a corresponding fixed rail below the cylinder, the teeth of the cylinder bars passing between those of the fixed bars. It follows that any matted locks are combed out, opened and carried to the delivery end of the machine.

In the latest construction of machine made by this firm (Figs. 26 and 26*a*) there are two novel features : (1) a series of compartments or chambers through which the material must pass successively and in each of which the wool is treated by dry air; and (2) the parts are arranged so that, as far as possible, dry air is blown through the material.

In Fig. 26 the driving gear is shown, and in Fig. 26*a* the construction of the series of enclosed compartments. The material after scouring is placed on the feed lattice, A, and passes to the rollers, B, B^1 (Fig. 26). As the wool is entering the compartment C, and while under control of rollers, B, B^1, a blast of air, generated by the fan, D, through the tubular heater, E, and the narrow mouthpiece between the rollers, B, B^1, and the framework, is caused to act on the material and blow through it: when the wool is free from the control of the rollers it is blown into compartment C^1 as indicated in Fig. 26*a*. The air blown into chamber C^1 is allowed to escape through a fine grating or gauze, F, and out of the machine, while the wool falls on the delivery side of the plate G, and on passing between the rollers B^2 and B^3, enters the next compartment, C^2, where similar treatment is repeated, or, in the case of the last compartment, it is delivered in a suitable condition for subsequent handling.

The number of compartments in the machine varies, usually from five upwards according to the class of material, the degree of dryness required, and the weight to be dried in a given time; the speed of the machine is likewise variable, but ordinarily, the material passes through the operation in from $1\frac{1}{2}$ to $3\frac{1}{2}$ minutes. These various factors also influence the output which, in this machine, ranges up to approximately 1,000 lb. per hour.

Other features to be noted are: (1) evenness of drying, which is obtained by blowing air through the material rather than over it, as is done in many other machines; (2) economy of steam, a saving obtained by re-heating the air from the latter chambers of the machine, which only carries a small percentage of moisture; (3) the removal of an appreciable amount of fine dust and some inferior fibre, such as "kemps," etc., which are blown through wirework at F, Fig. 26*a*, the dust and refuse thus collected being periodically removed. The simple character of the machine and the small place it occupies makes it easy to regulate and to clean.

The rollers, B[1] to B[5] for the respective chambers, C[1], C[2], C[3], etc., are chain driven, as seen in Fig. 26. Here wheel 3 is for driving the feed lattice off the main shaft. By means of chain and wheel gearing, motion is given to the pairs of rollers for each compartment of the machine.

SUMMERSCALE'S ENCLOSED CHAMBER DRYER—Figs. 27 and 28—is on the endless apron system, there being three tiers of wool drying proceeding at one time. The upper lattice commences at the feed, and the last, or lower lattice, extends to the delivery rollers. The wool falls

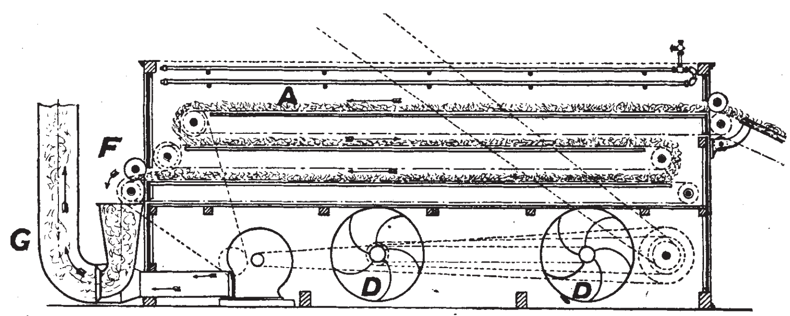


FIG. 27.

from A, Fig. 27, on to the centre, then on to the bottom lattice, underneath which is a series of steam coils. Hot air is drawn through the wool by exhaust fans D, placed under the lattice. The current of air created is shown in the cross-section drawing, Fig. 28. The lattices may be driven at different speeds. The feed and delivery rollers are so protected that the wool is not under the influence of the exhaust fan when passing between each pair. The direction in which the wool travels is denoted by the arrows. On reaching rollers, F, it is drawn into the pipe, G, and conveyed to any convenient position. Another type of machine invented by Summerscale, is of the cage construction, Fig. 29. Here the wool, as it is delivered from the scourer, is drawn by a strong current of heated air

Plate IX

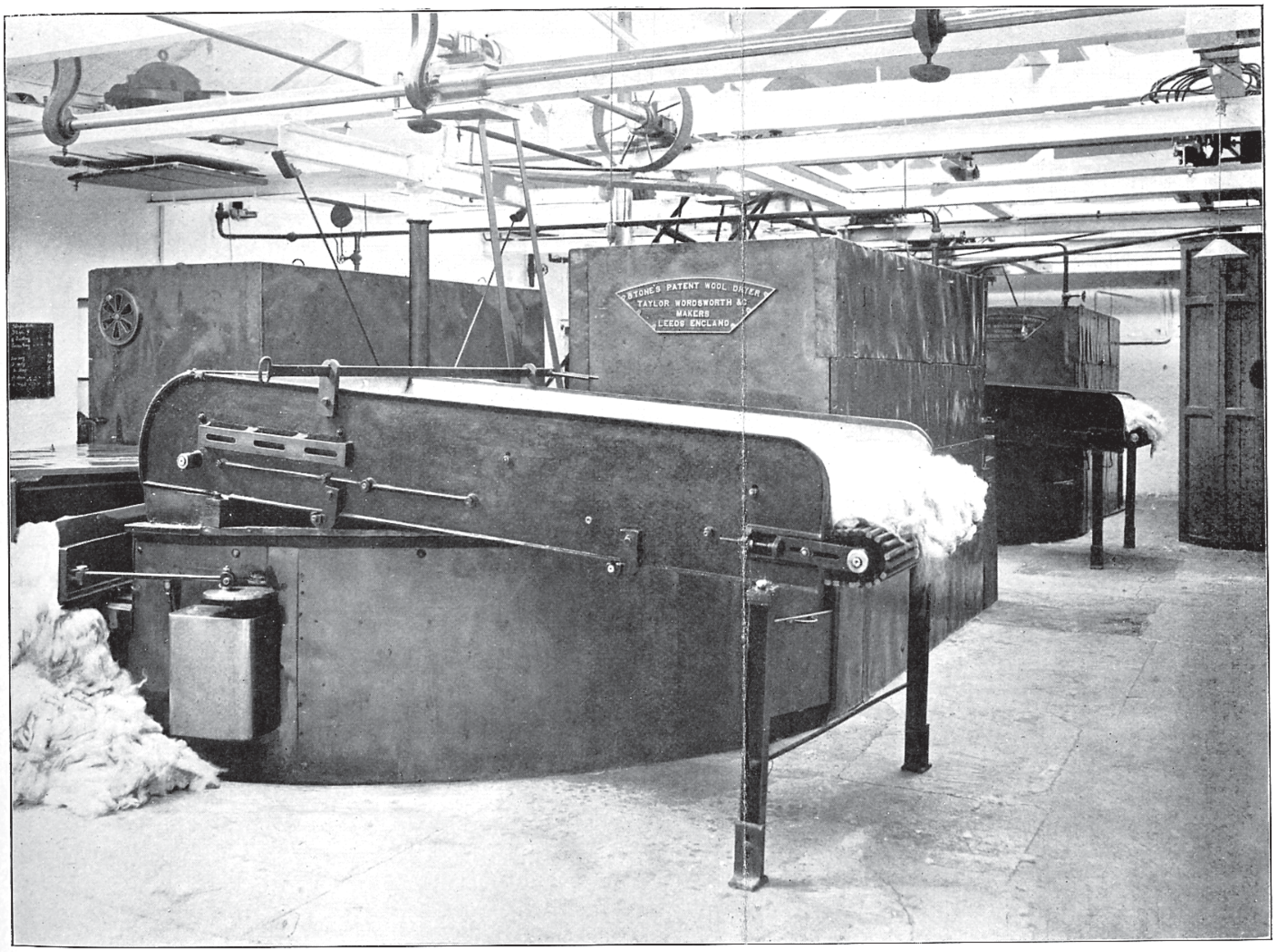


Fig. 29*a*. Installation of Stone's Dryer.

into the conveyor tube or pipe, C, being blown or forced forward into the drying cylinder, in which there is a revolving cage, D, covered with wire netting, and hollowed between each stay or support. The air blows the wool into the recesses against the wire netting, which retains it until the heated air has been thoroughly passed through each staple or lock. As it is whizzed round by the cylinder and dried, it is drawn off into the conveyer, F, the cooled air which has acted upon the wool escaping by the outlet tube, G. Again, the dried wool may be conveyed in overhead tubing from one

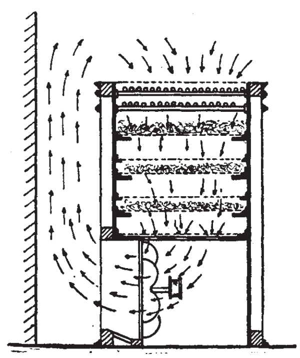


FIG. 28.

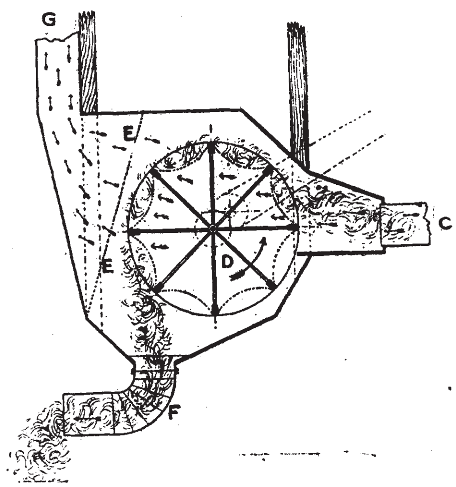


FIG. 29.

room to another to the machine or place where it is next required.

STONE'S DRYER (Messrs. Taylor Wordsworth and Co.) for wool and also usable for cotton, rags, etc., is of a different construction from the machines considered. It consists of the ordinary lattice feed, on which the material may be placed by hand, which conveys the wool on to a perforated drying table deriving heat from coils of steam pipes fixed above it. This arrangement effectively prevents the accumulation of dust, and any portion of the fibrous material collecting on the coils. By means of a pair of centrifugal fans, currents of hot air are drawn

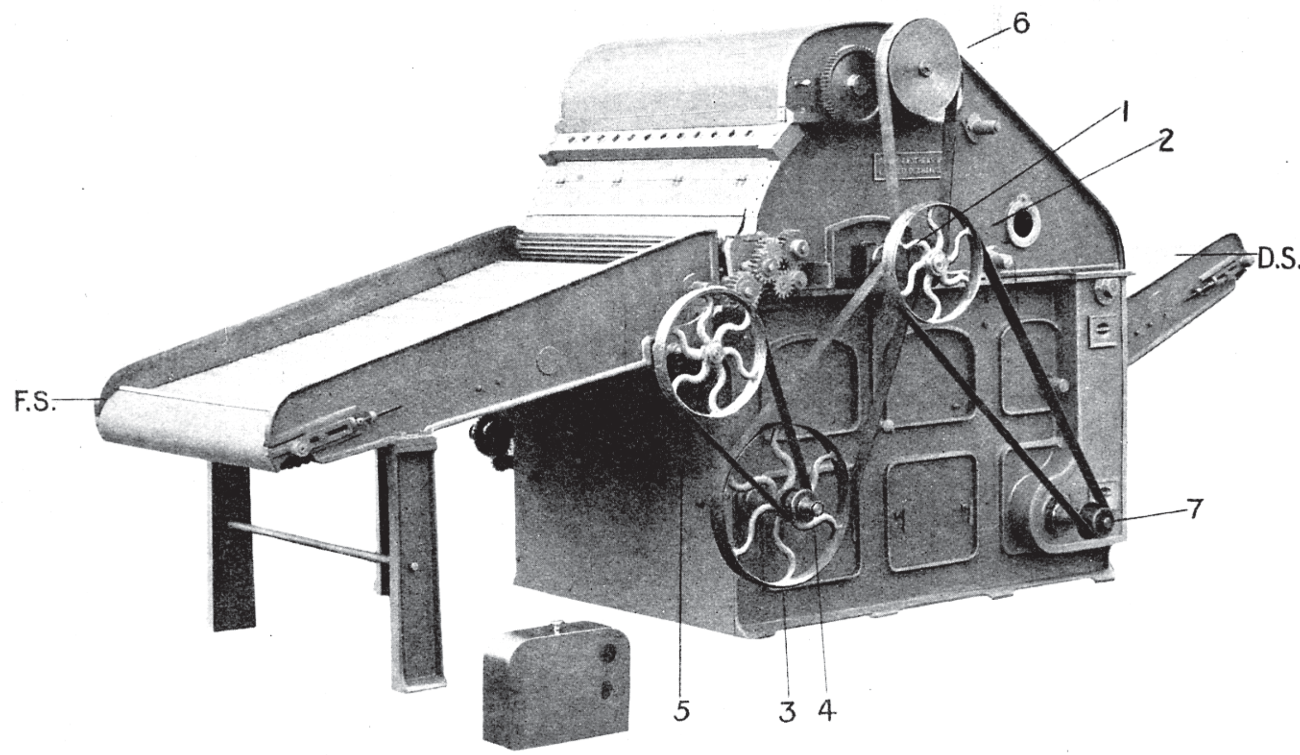


FIG. 30. Platt's Self-acting Teazer or Wool Willow.

F.S. = Feed Lattice.
D.S. = Delivery Lattice.
1 = Belt Pulley for driving Pulley 6 carrying the Pinion E, Fig. 32.
2 and 7 = Belt Pulleys for driving the Fan.
3 = H, Fig. 32.
4 = H^1, Fig. 32.
5 = C', Fig. 32.

through the material, after which it is ejected in an open, free, and lofty condition from the drying table. All parts of the machine in contact with hot air are lined with asbestos and made either of tin or iron, the latter metal being employed for all wearing parts. The machine being self-cleaning, different coloured materials may be satisfactorily dried successively.

The operation practised in carbonizing is similar to that in wool drying, but the speed of the drying table is decreased and that of the temperature increased.

Some 1,000 to 15,000 lb. of wool may be dried per day of ten hours on this dryer, which is made in various sizes.

A general view of an installation of Stone's drying machines is given in Fig. 29*a* (Plate IX).

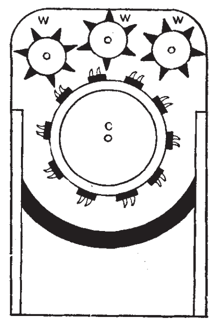


FIG. 31.

30. *Teazing.*—The condition of the material after drying is such as to necessitate its being subjected to some operation that will, in a measure, open and disentangle the fibres before being passed on to the scribbling machine. The technical name for this operation is teazing or willowing. Fig. 30 is a view of the teazer, showing belt driving, and Fig. 31 a section of the working parts, consisting of one main cylinder or drum, C, with ten arms, each mounted with two rows of teeth tapering from the base to the point; and three small rollers, W, termed workers, fixed above the cylinder, and studded with teeth, which work between those of the latter when the machine is in motion. These parts are all enclosed, and are driven by belt and wheel gearing on the outside of the framework. The wool is spread on the feed sheet, FS, Figs. 30 and 32, which carries it into the interior of the machine, where it is received by the teeth of the main cylinder. In the modern forms of teazer, intermittent motions are applied to both the feed and delivery rollers and lattices, so that the amount of material fed into and removed from the machine at each

operation may be regulated, as well as the time allowed for teazing each lot of material constituting a "feed."

The principle of the machine is this: a large and centre drum, making from 400 to 500 revolutions per minute, charged with wool, working against, or turning in a contrary direction to, a series of three smaller rollers, making from 30 to 40 revolutions per minute; so that no sooner is the material forced round by the main cylinder than the teeth of the workers come in contact with the entangled locks, effecting a thorough separation of the fibres. In addition to thus opening the wool and preparing it for the oil and for the action of the wires of the scribbler, teazing also removes any particles of dirt or other impurities which the fibres retain after the scouring process.

The construction and working of the teazer may be explained by reference to Fig. 32, a machine in which there are only two workers, and the third worker substituted by a spiked bar.

The intermittent motion of the feed section is controlled by the cam, F C, and lever, L, mounted with the antifriction roller, S P. The drive is off H^1, a strap passing round C and H. On the shaft of the pulley, C^1, the cam and its pulleys run loosely. At the end of the shaft there is a pulley for driving the rim pulley, F S^1. According to the size of the pulley, F S^1, used for driving, the speed of the cam, F C, and of the feed sheet, F S, may be varied. When the concave of the cam comes in contact with S P the feed sheet is out of action.

The workers in this type of machine are not driven by belting, but by wheel gearing. The pulley, D^1, receives motion from C, and carries pinion, E, geared into F and F^1 on the shafts of the workers. When the wool has been sufficiently opened its ejection from the interior of the machine is done by the small pulley on the main shaft, setting H in motion, which is mounted with a pinion, H^1, and, turning I and J, drives K, which actuates cam, L^1. This cam, by operating lever, M, lifts the door, N, so

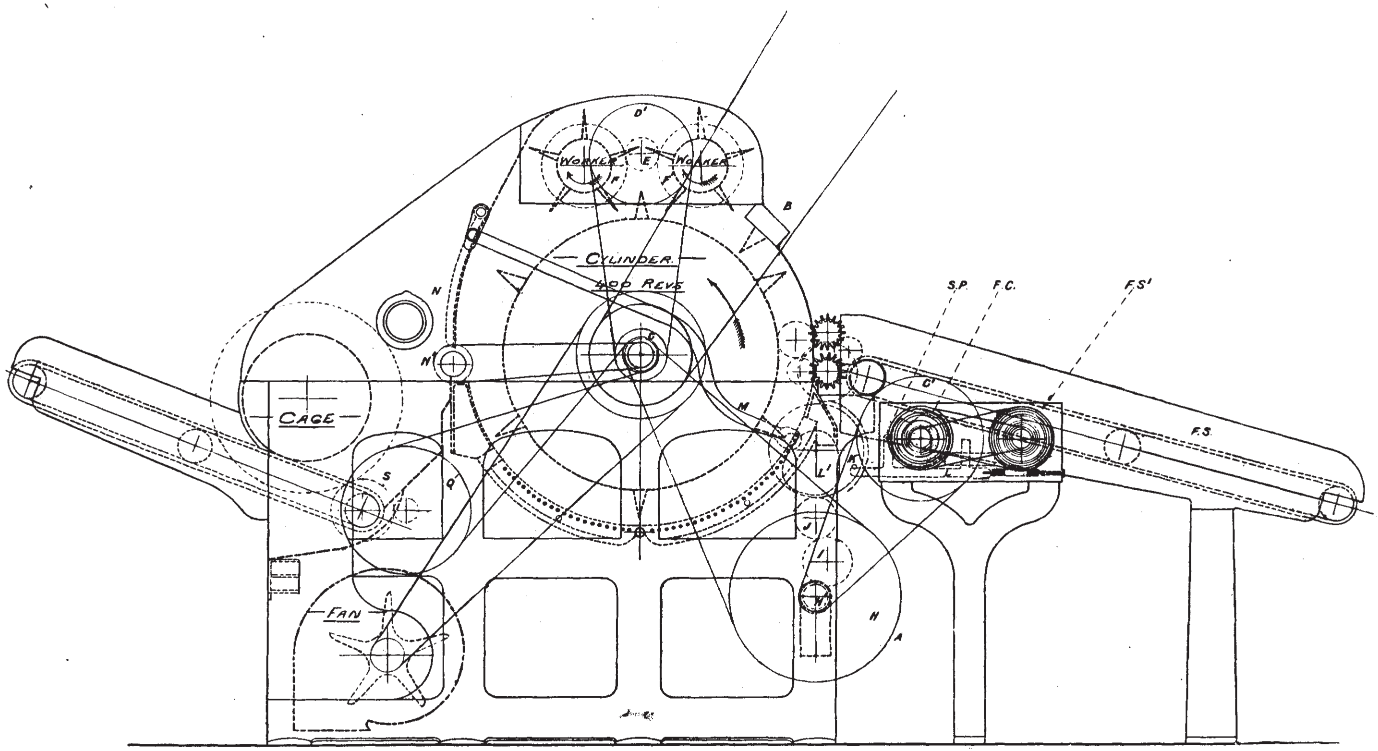


FIG. 32. Side Elevation of Platt's Willow or Teazer.

that the material is conveyed by N^1 on to the delivery lattice.

The delivery motion is controlled by the cross belt passing round the small pulley on the main shaft and pulley Q, the pinion on which operates S, turning the delivery motion and also the wheel-gearing which gives movement to the cage.

The cylinder revolves from right to left, throwing the worked material out of the machine at the position shown, and not at the bottom, as is frequently done. The fan, driven by the large pulley on the main shaft, removes the dust which drops through the grating into the bottom of the machine.

31. *Burr-Extraction.*—At this stage in the manipulation of the fibres some classes of wools, Buenos Ayres, for instance, have to be submitted to a special process, arising from the presence of vegetable matter, seeds, burrs, etc., in the fleece. Burrs are the most troublesome to remove, being entangled in the matted parts of the wool. They have a minute prickly surface and cling tenaciously to the fibres. The purpose of the *burring* process is to destroy or extract such vegetable impurities from the staple with little or no waste of fibre, and without injury to the strength and other properties of the wool. When these are not completely removed before reaching the scribbler, they are liable to enter in small portions into the condensed sliver, and thus prove injurious to the spun thread, Fig. 33.

Burrs may either be chemically or mechanically extracted. The former process consists in steeping the wool in a diluted bath of sulphuric acid for about half an hour, when it is taken out, allowed to drain, and then dried at a temperature of about 95° C. When the moisture has been absorbed from the material, the acid attacks the burrs and other small seeds, reducing them to carbon, after which the wool is rinsed in an alkali solution to remove the acid, and then again dried. In this process, the vegetable substance is dissolved by the sulphuric acid, while the wool

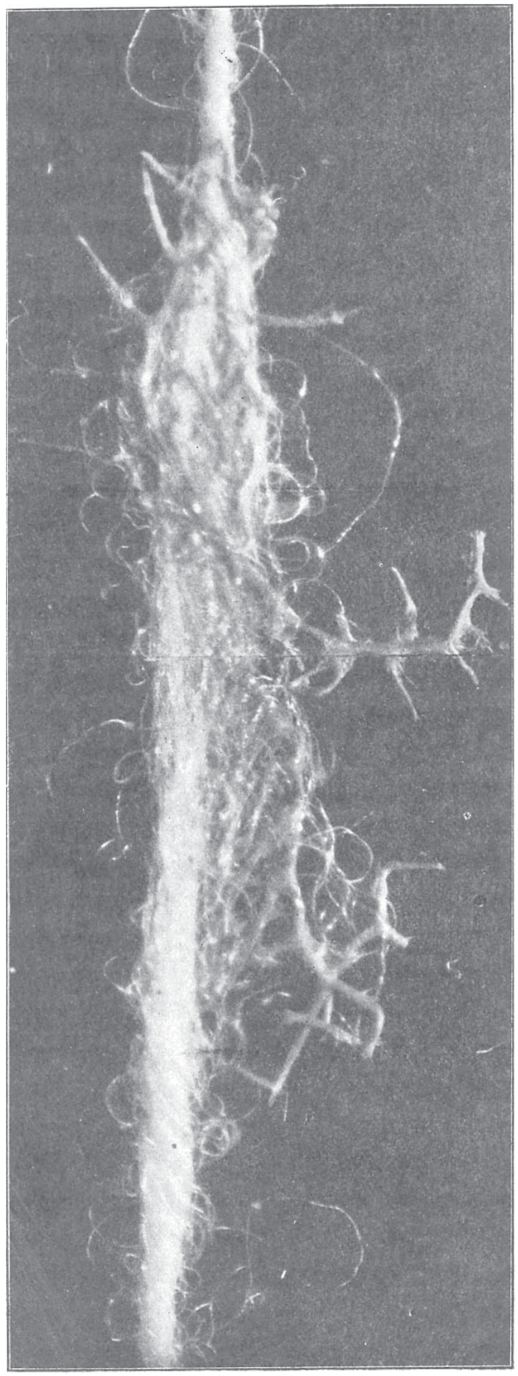


Fig. 33. Burr in a Woollen Thread.

remains sound; but in the mechanical method, the burrs are not destroyed, but actually beaten or combed out of the material. For wools containing a large quantity of broken and small burrs, motes, and seeds, the chemical method of extracting is preferable; but for fine wools containing large burrs the burring machine is usually employed, as it preserves the natural strength and colour of the fibres.

The burring machine (Fig. 34) in general use consists of the following parts: feed sheet and rollers, revolving fan, lattice sheet, revolving brush *for passing the wool on to the swift or cylinder*; main cylinder, burr rollers, grid, and a large roller for beating the burrs on to the same; and lastly, revolving brush *for removing the wool off the cylinder*. These parts are all enclosed in a strongly built frame, somewhat similar in construction to that of the teazer. The wool, after having been placed on the feed sheet, is conveyed by the feed rollers into the interior of the machine, when the fan forces it on to the lattice sheet. This sheet immediately conveys it to the revolving brush, which yields it up to the teeth of the cylinder. Now, as the latter revolves, the burr roller, which turns in the opposite direction, beats, lashes, and opens the wool, the result being that in a short time the larger burrs commence to hang somewhat loosely on the surface of the cylinder, in which condition they are readily knocked on to the grid by a roller mounted with spiked arms for that purpose. The distance at which the burr roller, Fig. 34*a*, is set from the cylinder varies according to the length of the staple of the wool operated upon. As the material gets free from burrs it is removed out of the machine by the delivering brush.

32. *Chemical Burr Extraction.*—McNaught and Petrie make special steeping, carbonizing, neutralizing and drying plant for burr extraction. Each system comprises the following: (1) Steeping in a diluted sulphuric acid bath; (2) Burr crushing and drying for carbonizing; (3) Teazing or willowing; (4) Neutralizing in an alkali bath; and (5) drying.

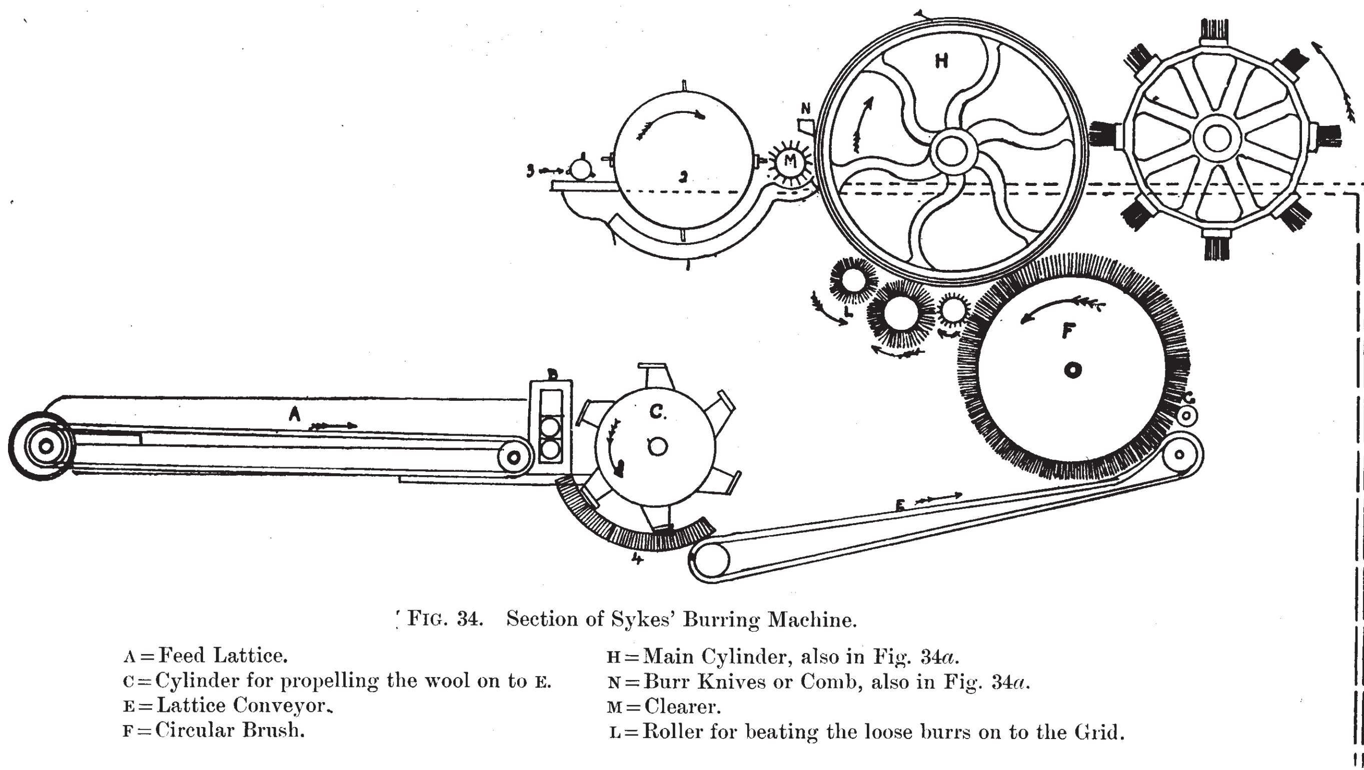


Fig. 34. Section of Sykes' Burring Machine.

A = Feed Lattice.
C = Cylinder for propelling the wool on to E.
E = Lattice Conveyor.
F = Circular Brush.
H = Main Cylinder, also in Fig. 34*a*.
N = Burr Knives or Comb, also in Fig. 34*a*.
M = Clearer.
L = Roller for beating the loose burrs on to the Grid.

Routine of Treatment. After scouring, the wool is placed in the steeping tank similar in construction to an ordinary scourer, but made of wood and white metal on account of the acids employed. The average working strength of this bath is 7° to 8° twaddle. It is better to add the acid some time before commencing steeping owing to the temperature of the bath being raised when the acid is first added; and also to allow the fumes of nitric acid gas given off—which tinge the wool yellow—to be removed. The solution should be freely agitated before using. The time occupied in the process varies from fifteen to twenty minutes in wools containing seeds, motes, etc., to sixty minutes in wools containing burrs and considerable quantities of hard vegetable matter.

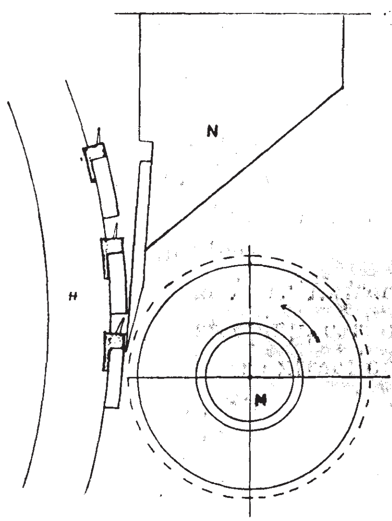


Fig. 34*a*. Section of Sykes' Burring Machine, showing relation of the Cylinder Blades to the Comb.

Carbonizing follows. It comprises on the McNaught's system burr crushing and drying in the cylinder machine described on page 68. The *battoir* or crusher is part of the feed motion of the dryer, but possesses, in addition to the ordinary rollers, several pairs of fluted rollers between which the wool is attenuated and the burrs and vegetable substances are thoroughly crushed or broken. Such rollers nearly touch each other, and are held in position by springs. By Petrie's system, the steeped wool after being squeezed or pressed is treated in the chamber drying machine.

The wool may now be teazed to effectually shake out any vegetable impurities and better prepare it for carding, and then neutralized. This is done in an alkali bath. The first bowl contains clean water, and should be drained off: to the second bowl, some alkali—such as soda ash—may be added; third bowl of ordinary construction, a percentage of soap and alkali used to produce a bath that will leave the wool free from all acid traces. The wool is now dried and ready for subsequent operations.

33. *Oiling.*—Having deprived the wool, by scouring, of its natural lubricant, the "suint," its condition is such that if passed on to the scribbler without being oiled, much waste of fibre would ensue. After washing and drying, the fibres lack adhesiveness, and hence a quantity would, if not lubricated, be cast off the different cylinders of the carding machines in the scribbling processes, and form what are called flyings or droppings. Oil is applied to the wool to minimize the production of such flyings, and also to soften and impart smoothness to the fibres. By affording these qualities to the material, it causes the filaments to glide past each other with as little friction as possible, and facilitates separation and re-adjustment of the same, preserving, by so doing, to some extent, the natural length of the staple.

There are various compositions used in oiling wool, but one of the best lubricants is olive or Gallipoli oil. Unctuous to the feel, and almost colourless, it is suitable for this purpose. About two gallons of this oil are applied to 120 pounds of wool.

Oleines, which are also largely used as wool-lubricants, are obtained by pressure from animal fats, and are known in the trade as tallow oleines, lard oleines, and neat's-foot oil. That, however, applied to wool is mainly derived from oleic acid, separated from stearine, a mixture of which occurs as a result of one of the processes in the manufacture of candles. By distillation, oleine is obtained from the oleic acid, while the stearine is used in candle production. If due care has not been observed, the oleine is liable to be contaminated with the sulphuric acid employed in some stages of its manufacture, which injuriously affects the wire teeth, or "card-clothing," covering the cylinders of the scribbling machines. This necessitates frequent grinding and cleaning of the cards. The wool also suffers by the action of the acid, its colour being injured, which implies the production of a less valuable cloth and consequent loss.

A hand method of oiling wool is that of using an ordinary can with a large T-shaped nozzle. A layer of material is spread on the floor, then the oil distributed over it as evenly as possible, the operation being repeated till a large sheet or bed of wool has been piled up. Another method is to apply the oil as the wool is fed into the Teazer, or Fearnought. An oil tank is placed over the feed sheet, and the oil or prepared solution is sprayed by a revolving brush on to the material. The supply of oil should be quite uniform and regulated as required. Whatever method of lubrication is adopted, the object should

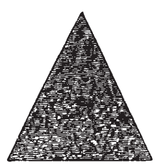


FIG. 35.

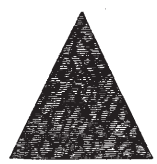


FIG. 35*a*.

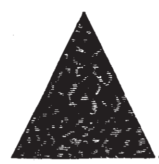


FIG. 35*b*.

be to impart the same quantity of the lubricant to every portion of the wool.

34. *Blending.*—This is an important section in the routine of yarn manufacture—both woollen and worsted. It comprises (1) the blending or mixing of two or more qualities of materials; and (2) the blending of dyed materials of similar or different qualities for producing various shades of "mixture" yarns.

Strictly, there is more latitude for the blending of fibres of different lengths and qualities in producing woollen than worsted yarn. Uniformity of length of staple is of greater value in the latter than in the former. Without this quality a level roving—one in which the fibres are straightened and regularly overlap each other would be difficult to obtain. In woollen carding and spinning it is a common practice to blend say a New Zealand wool with an average staple of 2½ to 3 inches with mungo only having a staple of a fraction of an inch in length. "Levelling" in making a worsted thread is dependent upon frequent doublings and draftings—or the repeated combination of a number of slivers, and drawing them out between pairs of rollers having dissimilar surface speeds. Now the distance between the front and back pair of such rollers in each drawing and roving box, has necessarily to be ad-

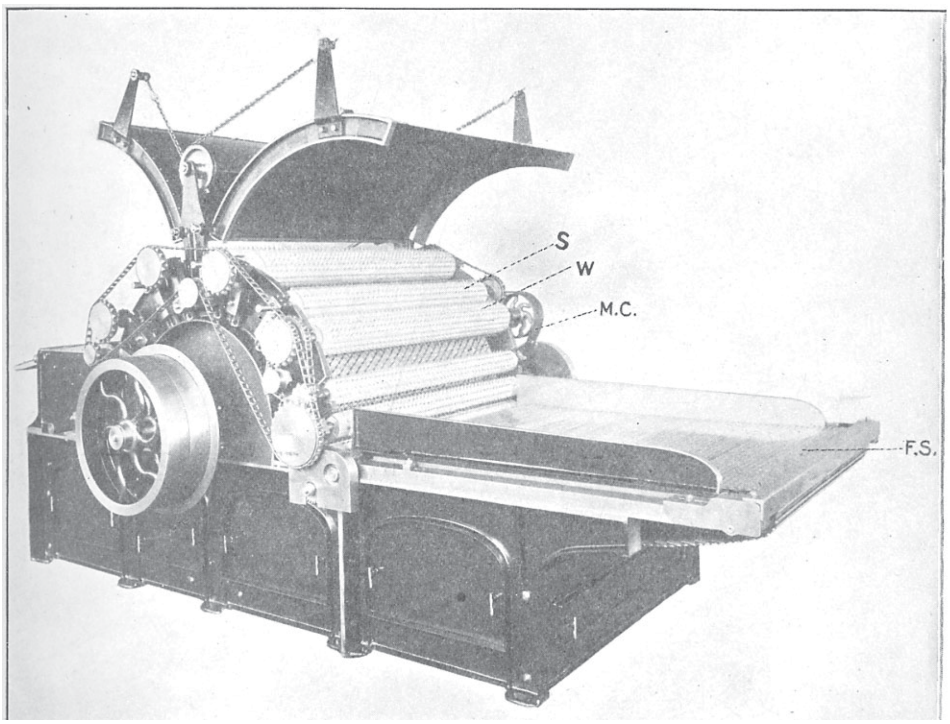


FIG. 36. Platt's Fearnought or Tenter-hook Willow.

justed to the mean between the average longest and the average shortest fibres in the material being treated; and such a working adjustment would not be feasible, and a satisfactory yarn spun, if there were an excessive degree of difference between the average lengths of the wools used.

BLENDING CALCULATIONS comprise: (1) Ascertaining the cost per lb. when the quantities and prices of the several materials are known; (2) Finding of the relative