

WOOL DRYING

Serial 471

Edition 1

INTRODUCTION

1. After wool has been scoured, it is necessary to dry it before passing it on to the next process of manufacturing, except when the wool is to be dyed in the raw state. When this is the case, the stock is taken to the dye house direct from the squeeze rolls of the washer, although a slight extraction of the water may be made in some instances by means of the hydro-extractor, a machine that will be described later.

2. Importance of Proper Drying.—The drying of the wool is an important process and one on which the condition of the stock as it is received at succeeding processes largely depends. Wool that is dried quickly with a high temperature, has a harsh, unkind feeling, and the fiber loses its suppleness, becoming stiff and brittle; the elasticity and strength of the stock are materially reduced. It is impossible to spin harsh, brittle stock into fine yarn, so that the value of the stock is deteriorated, as the finer the yarn a wool will spin, the greater is its value. If stock capable of spinning to fine numbers is rendered fit only for low numbers of yarn, because of an improper method of drying, there is always a consequent loss to the mill. Cloth made from wool thus maltreated will not have the desired soft, velvety feeling, but will be harsh and rough, the yarn spun from such wool being uneven and lacking in strength and elasticity, and requiring an excessive twist in order to have strength enough to weave.

Formerly wool was dried by spreading it in the open air and allowing the sun and wind to dry it naturally. This method, although slow and laborious, had many advantages over modern methods, and the stock when thoroughly dried

was soft and kind to the touch, none of its natural qualities being injured. The modern process of drying stock with artificial heat, while accomplished with greater speed, is liable if not carefully performed to destroy the life of the wool and render it harsh. Wool that is overheated and baked will also change color and become a dirty yellow shade. The percentage of waste in carding, spinning, and weaving will be increased if the wool is rendered harsh and brittle in the drying, and consequently the cost of the finished product, although it is of inferior quality, will be increased.

From this it will be seen that one of the chief points to be observed when drying wool is to avoid high temperatures; but as it takes longer to dry wool at a low temperature, there is a tendency in some mills to increase the temperature in order to reduce the cost of drying the stock, the fact being ignored that by so doing the saving in time is taken out of the value of the wool, and that the cost of carding, spinning, weaving, and finishing is increased relatively more than the cost of the drying is reduced.

METHODS OF DRYING WOOL

THE COLD-AIR PROCESS

3. There are two general methods of drying wool, the *hot-air* and the *cold-air process*, the former being the modern process largely in use in American mills, while the latter, although a somewhat older process, is sometimes used where the best results are desired, especially for drying fine combing wools.

The cold-air process gives results that are very satisfactory, but is slow, laborious, and expensive, as regards the time required and labor necessary for handling the stock. The wool, however, is left open, lofty, and ready, without any injury to the fiber, for the succeeding operations, not being rendered harsh and brittle by baking as is sometimes the case with stock dried by the hot-air system, nor is there the danger of yellowing the fiber.

TABLE DRYER

4. The cold-air process of drying involves the use of a table, or platform, dryer. The principle involved in a table dryer is that of either drawing or forcing air, ordinarily at the normal temperature, through the wet wool, which is spread on wire screens. These screens are so arranged that there is an enclosed space underneath them from which the air may be exhausted by means of a fan, thus drawing a current

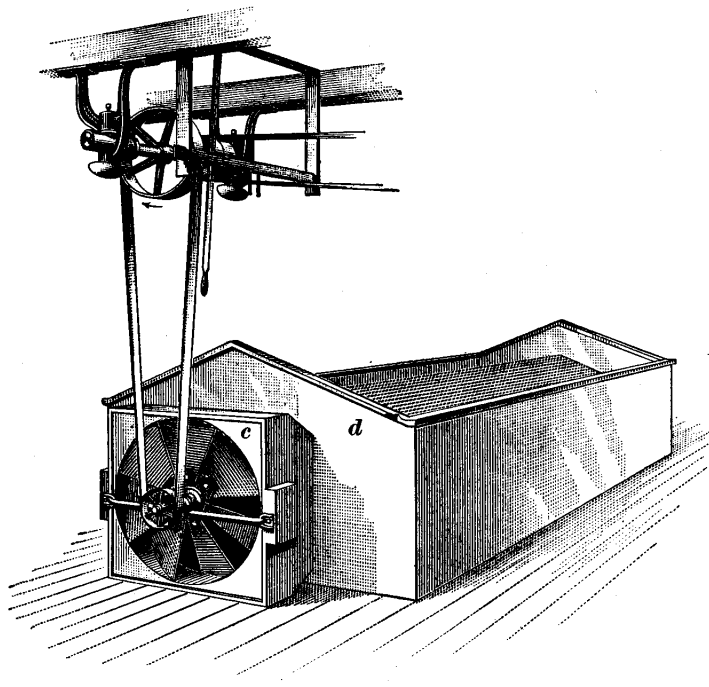


FIG. 1

of cold air through the wool; or the air may be forced by the fan into the enclosed place under the screen and thus blown through the stock spread on the screen. This latter method is to be preferred, since any process of forcing the air through the stock gives better results than by drawing it, because the wool is rendered more lofty and open when it is lifted by

the air-current than when pressed against the screen, in which case it tends to dry in matted bunches. An ordinary arrangement of a table dryer is shown in Fig. 1.

The machine consists of a wooden, box-like framework *d*, made air-tight with the exception of the top, which is covered with wire screens. At one end, a paddle-wheel fan *c* is attached, being made with an iron frame having a circular opening in which the bearing of the rotating portion is enclosed.

The fan is of the reversible type and may be used either for blowing or for suction. In this case, as the arrow on the main driving pulley indicates, the fan is creating an induced, or suction, draft. A fan with curved blades has considerably greater efficiency than one with straight blades. A fan of this type, however, cannot be reversed.

Occasionally table dryers are operated with warm air, which is forced through them by a fan placed in a separate compartment containing steam coils. This arrangement is sometimes varied by building the dryer as shown in Fig. 1 and placing steam pipes under the screen, the fan forcing the air through the pipes and screen. The disadvantage of using heat in a table dryer is that the heat is unconfined and the operation of drying is attended with more or less inconvenience to the operator. The speed of a fan for a table dryer should be from about 1,000 to 1,200 revolutions per minute.

The principal objection to a table dryer is the slowness of the operation and the lack of continuous motion, as each lot of stock must be spread wet on the screen of the dryer and when dry removed by hand. Such a dryer as shown in Fig. 1 can easily be constructed by an ordinary carpenter, with the exception of the fan, which must be purchased. Fans suitable for table dryers are usually made in sizes from 30 to 40 inches in diameter.

HOT-AIR PROCESS

5. The general method of drying wet wool from the washing machine is with some form of hot-air dryer, of which there are several of standard manufacture on the market. The drying machines in some mills are fed directly from the washers, while in others the wool is first placed in a hydro-extractor and the excess of moisture removed, after which it is fed to the dryer either by a self-feed or otherwise.

When fed directly from the scouring machine, the wool is transferred to the dryer by means of an endless apron, or lattice. This is a very economical way of manipulating the stock, as there is no handling from the time the greasy stock is placed in the self-feed of the scouring machine until it is deposited, all scoured and in a dry and lofty condition, by the delivery apron of the drying machine.

The wool is dried in a hot-air dryer by means of warm air heated by steam pipes placed either in a separate compartment or in the dryer itself and circulated by means of fans. The circulation of the heated air is a matter of prime importance, since it is generally conceded that two things produce harshness and a yellow color in drying; namely, too high a temperature and a lack of circulation, in other words a baking of the stock.

MULTIPLE-APRON DRYER

6. This type of dryer is used to a considerable extent in woolen mills, and while not so good as some other types, excellent results may be obtained with proper precautions in regard to temperature. These dryers are generally made with three or five carrying, or drying, aprons, hence the name **multiple-apron dryer**.

7. **Construction.**—A section of a five-apron dryer is shown in Fig. 2; it will be seen that the principle of this machine is simply that of carrying the wool through a heated chamber by means of traveling aprons. This dryer is usually

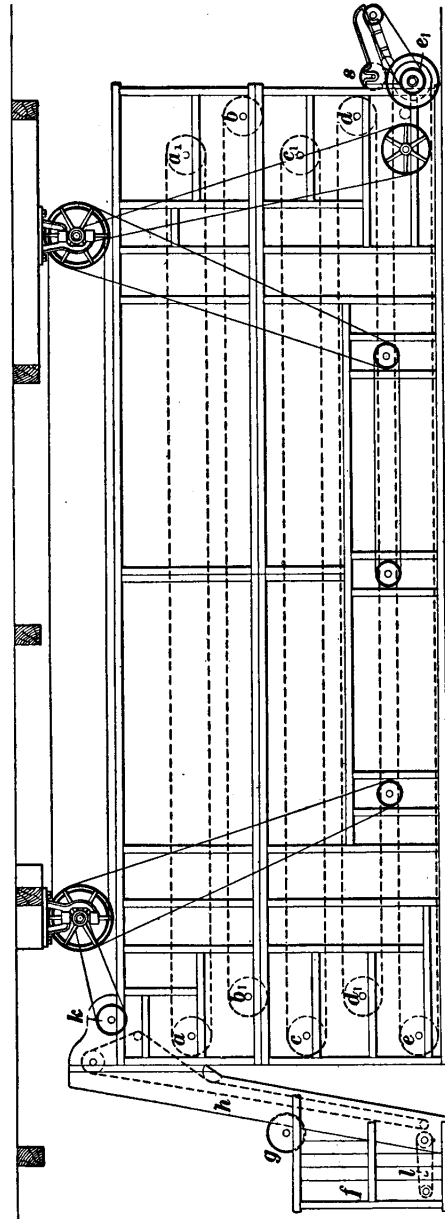


FIG. 2

constructed with a hardwood frame and has the sides enclosed either with wood or sheet-iron panels. A dryer constructed of wood and lined with tin holds the heat better and is more comfortable to work around than one constructed of sheet iron. The wood, however, should be especially kiln-dried; otherwise when the dryer is heated it will, in the course of time, shrink badly. The air is generally heated by steam pipes in a separate chamber running along the side of the machine, and blown into the drying chamber by means of powerful fans. The carrying aprons are often made of wooden slats especially prepared to withstand a heat of at least 250° F. without catching fire, but it is preferred to have them made of woven wire, since the heated air then has a better

chance to circulate through the wool, as it reaches it from the under side as well as from the top.

8. Operation.—In operation the wool is placed in the hopper of the self-feed *f*, and is pressed against the lifting apron *h* by the traveling apron *l*. The stock is taken from the mass in the hopper by the lifting apron, and any excess of wool that is taken is knocked off by a revolving comb *g*, thus evening the feed. The wool is deposited by the lifting apron on the top apron *a a*₁ of the drying machine, being stripped from the elevating apron by a beater at *k*. As the wool travels along the apron, it is subjected to currents of heated air from fans located at the sides of the machine, the heated air being supplied by compartments at the side of the machine filled with steam coils.

The wool travels along the apron from *a* to *a*₁, and then drops on to the next apron, in so doing being turned over and thus exposing to the heat the portion of the stock that was underneath while on the apron *a a*₁.

The wool travels along from *b* to *b*₁, and is then dropped on the apron *c c*₁, and so on. Each time the wool drops to another apron it is turned over, so that all portions are thoroughly exposed to the heat. At the end of the bottom apron, a squeeze roll *s* is shown. This is attached only when the dryer is used for drying carbonized wools. The object of the roll is to pulverize the carbonized vegetable matter and thus render it more easily removed by the carbonizing duster. The steam pipes in a dryer of this description are sometimes placed in tiers between the aprons, thus doing away with the fans; this, however, is quite apt to bake the stock, owing to a lack of circulation of the heated air in the chamber.

9. High temperatures in a dryer of this description should be avoided and it is better for the stock to have the aprons run somewhat slowly and have a lower temperature than to have a high temperature and drive the aprons faster. The temperature in this type of dryer should not be allowed to be higher than 160° F. if the best results are desired.

The speed of the drying aprons should be so arranged that with the proper temperature the stock will remain in the machine just long enough to become dry and no more. It is better to have the stock delivered slightly moist rather than too dry and with a harsh feeling.

SECTIONAL DRYERS

10. With a common, one-compartment, hot-air dryer it is imperative that a uniformly low temperature (about 160° F.) be maintained in order to prevent harshness and yellowing of the fiber, which are the chief dangers to be avoided in successful wool drying; consequently, the capacity of a dryer of this type is small and the expense of drying great. In order to render the drying of the stock more rapid and at the same time preserve the soft, kind feeling, drying machines are now constructed with two compartments, the first being heated to a high temperature and the second only to a medium temperature. It has been found that the wool is able to stand a high degree of heat when it is quite wet, but this same degree of heat would tend to injure it if dry; thus by entering the stock at a high temperature and then reducing the heat, the stock is rapidly dried and at the same time there is no injury, as when partly dry it is transferred to the other compartment where the heat is less intense.

By subjecting the wool to about 180° F. in the first compartment and then reducing the heat to 110° F. in the second compartment, it emerges from the machine in a condition that is practically equal to the results obtained by cold-air drying and has the advantage of being extremely rapid and of drying the stock in large quantities. The grading of the heat produces a soft fiber free from harshness and with its color unimpaired when dry, which is due to the fact that on entering the dryer, the stock contains a maximum amount of moisture which counteracts the bad effects of the high temperature to which it is subjected, the actual temperature of the stock being much lower than that of the heated air with which it is in contact. The greatest amount of moisture is,

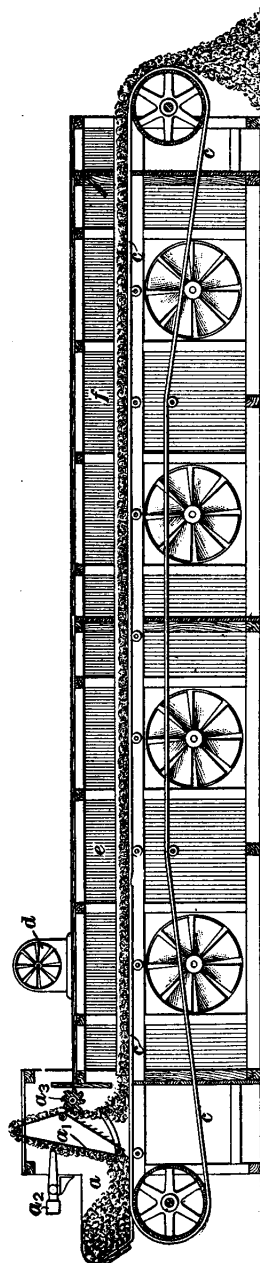


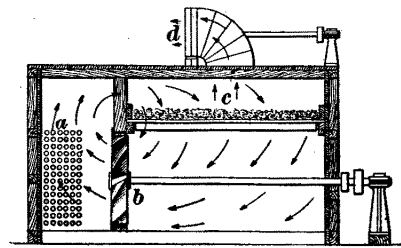
FIG. 3

(a)

of course, evaporated in the first compartment, and as the wool passes to the next compartment the heat is reduced according to the amount of moisture still remaining in the stock, until it finally emerges from the dryer soft and lofty and with its natural feeling uninjured.

11. Construction.—A longitudinal section of a two-compartment dryer is shown in Fig. 3 (a). This machine is constructed almost entirely of wood carefully kiln-dried before being put together, in order to prevent any possibility of shrinkage and consequent opening of cracks after the dryer is in operation. A dryer made of wood, if properly constructed, is to be preferred to one made of sheet iron, since the wood holds the heat better and thus makes the machine not only more comfortable to work around, but more economical to operate. It will be noticed that in this machine only one carrying, or drying, apron is used; this is made of wire cloth of $\frac{1}{4}$ -inch mesh and runs over large drums at each end of the machine. The drums are carefully trued so as to insure the perfect running of the apron, which should not run over the edges of the drums. The apron varies in width from 4 to 9 feet, according to the size and capacity of the machine.

In three- and five-apron dryers there is considerable annoyance, expense, and delay from the breaking of aprons, due to constant bending around drums of small diameter. This difficulty is almost entirely done away with in the single-apron dryers, owing to the large drums over which the apron passes. The apron is driven by a pair of cone pulleys, the driven one communicating motion to a vertical shaft by means of a pair of bevel gears. To the vertical shaft a worm is attached, which works in connection with a worm-gear on the end of the drum shaft. The apron may be immediately stopped by means of a lever, which when operated withdraws a clutch driving the worm. The three-step cone pulleys allow three speeds of the aprons without changing gears or pulleys, and this is ample range for ordinary work. The more



(b)

FIG. 3

moisture the stock contains, the longer it will have to remain in the dryer and, consequently, the slower the apron will have to be driven, and vice versa. The drying of the wool is accomplished by circulating heated air alternately through the stock and steam coils placed in a compartment at the side of the machine. The air is drawn through the layer of stock on the apron by means of powerful steel-blade fans. In a two-section dryer there are four fans, two in each compartment. A transverse section of the machine is shown in Fig. 3 (b), which illustrates the mode of circulating the heated air. As will be seen, the dryer is divided into two compartments laterally as well as transversely; in one section are placed the steam coils *a* that heat the air. A fan *b* draws the heated air through the wool, which is spread on the traveling wire apron *c*. As the heated air comes in contact with the damp wool, the water is driven off in the form of steam and a constant current of moisture-laden

air is removed from the dryer by means of a fan placed in the flue *d*.

The large fans for circulating the air are coupled together by belts, and are driven directly from an overhead countershaft, two such shafts being required for driving the machine. From the first countershaft, the apron and fans are driven; the speed should be about 400 revolutions per minute. The second countershaft is driven from the first and drives the self-feed by two belts, one driving the elevating apron through a pulley on a stud, to which is fastened a pinion gear that drives a large gear on the top roll of the apron, and the other driving the stripper, or doffer, beater by a pulley fastened on its shaft. Attached to this shaft is a sprocket gear, which drives a similar sprocket on the feed carrying a crank driving the oscillating comb of the feed through a connecting-rod.

12. Operation of Sectional Dryer.—In operation, the stock is either taken from the scouring machine directly or is first run through a hydro-extractor, which will be described further on, and then placed in the hopper *a* of the self-feed. [See Fig. 3 (*a*).] There is no necessity for a traveling apron in the bottom of the hopper to keep the stock pressed against the lifting apron, as the drying apron is carried outside of the drying chamber and forms the bottom of the self-feed hopper. The elevating apron *a*₁ takes the stock and carries it to the oscillating comb *a*₂, where the feed is evened and any large bunches of stock knocked back into the hopper. The moist wool is stripped from the elevating apron *a*₁ by the beater *a*₃ and deposited on the traveling wire apron *c* on which the stock passes into the first drying compartment *e*, where the wool is subjected to a strong current of air, heated to about 180° F. and the moisture removed by the fan *d*. The stock then passes to the second compartment *f*, where the heat is reduced to 110° F. and the drying completed, whereupon the wool is delivered onto the floor or into trucks by the drying apron.

The dryer here described is built either for carbonizing or for drying, and when built for the former purpose is arranged

to dry the wool completely in the first compartment, and subject it in the second compartment to a dry heat, which effectually carbonizes the previously chemically treated vegetable matter in the stock. The carbonizing dryer may be used for a wool dryer, but the ordinary dryer does not make an efficient carbonizer, although the stock can be carbonized with one. Carbonizing requires a higher heat than is ordinarily used for drying, and the wool must be dry before it is subjected to this heat. The process of carbonizing will be treated of later.

13. Capacities of Sectional Dryers.—The following table shows the capacity of two-compartment dryers of different sizes, both for ordinary drying and for carbonizing. It will be noticed that the capacity for carbonizing is much less than that for drying, owing to the slower speed at which the apron is necessarily driven in order to perform the carbonization efficiently. As the capacity of a dryer depends on the amount of moisture in the stock, the following capacities are based on the assumption that the stock has been well hydro-extracted and does not contain more than 60 pounds of water per 100 pounds of dry wool.

CAPACITY IN POUNDS PER DAY OF 10 HOURS

Drying Pounds	Carbonizing Pounds	Width of Apron Feet	Length, Exclusive of Self-Feed		Horsepower
			Feet	Inches	
4,000	2,000	4	37	6	11
6,000	3,000	6	39	1	12
9,000	4,500	9	39	1	14

14. Another type of sectional dryer is shown in Fig. 4, the steam coils in this machine being placed over the carrying apron instead of in a compartment at one side. In this case the fans are carried in a horizontal instead of a vertical plane. In operation, the stock is fed on the

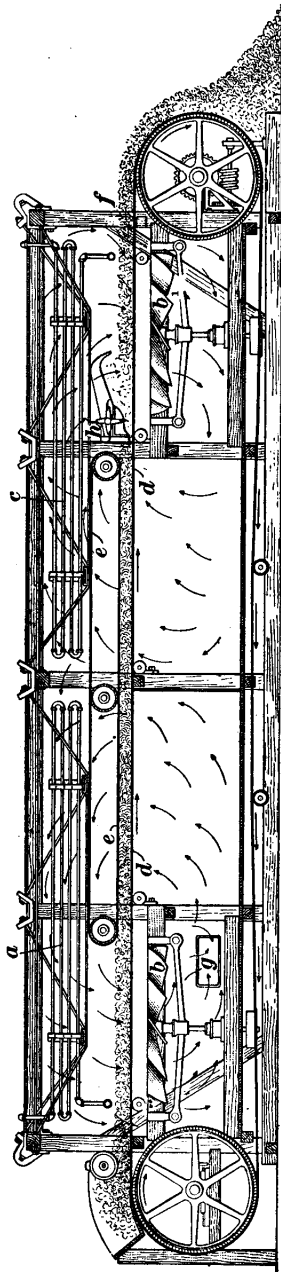


FIG. 4

carrying apron and passes into the first compartment of the machine, where the air heated by the steam coils *a* is drawn through the wool on the apron *d* by the fan *b*, which also forces it through the wool again, as indicated by the arrows showing the circulation of the heated air. The stock then passes into the second compartment of the dryer, where the heat is reduced and the wool is subjected to the air heated by the steam coils *c* and circulated by the fan *b*. Besides the carrying apron, there is another apron *e*, shown in the illustration, the purpose of which is to keep the stock from being blown off the apron at those points where the current of heated air is passing upwards. This apron and also the carrying apron are made of wire screens, those usually employed in dryers being about $\frac{1}{4}$ -inch mesh. The inlet of air in this machine is at *f*, while a current of moisture-laden air finds its exit from the machine at *g*; thus it will be seen that the general direction of the air is against the motion of the stock.

At *h*, there is a revolving beater for the purpose of opening up the stock before it leaves the machine, thus making it emerge in an open and lofty condition instead of in the more or less

matted condition in which it is received from the washer. Sectional dryers are sometimes built with more than two compartments, although two are sufficient for all ordinary purposes.

HYDRO-EXTRACTORS

15. Hydro-extractors, already referred to in Art. 12 are not designed to dry the stock, but are largely used for removing the bulk of water from wet wool, cloth, yarn, etc., and are indispensable to a dye house or scouring plant. In some mills, the stock is rinsed in a rinsing box instead of in the last bowl of the scouring machine, in which case it is necessary to run the stock through an extractor before drying or sending it to the dye house, unless the rinsing box is provided with a pair of squeeze rolls. In some cases when the stock is fed to the dryer directly from the squeeze rolls of the washer, an extractor is not necessary; but although the squeeze rolls remove a considerable amount of moisture, the production of the dryer is reduced, owing to the excessive amount of moisture that must be dried out and that could be much more rapidly removed by extracting. Stock that is run through a hydro-extractor contains from 6 to 12 per cent. less moisture than stock from the squeeze rolls of the washer. This represents a considerable saving of time and heat in drying the stock, thus making the hydro-extractor an economical machine for the mill.

Hydro-extractors are also used for extracting the acid solution used in carbonizing, before subjecting to heat; in fact, any place where it is desirable to remove rapidly a large percentage of moisture in saturated raw stock, yarn, or cloth, the hydro-extractor is an economical machine. When used for acid work, the basket of an extractor should be galvanized or lead-lined so that the acid will not attack and destroy it.

SELF-BALANCING EXTRACTOR

16. This type of hydro-extractor, shown in Fig. 5, consists of a wrought-iron casing *a* supported by standards *b*. These standards are cupped out to receive the ball-shaped

heads of the supporting rods *c*, which lead down to the lower flange of the casing and are there attached by similar ball-and-socket joints. The necessary adjustments for leveling the outer casing and parts carried by it are secured by means of turnbuckles on the supporting rods. These may be securely fastened by means of check-nuts.

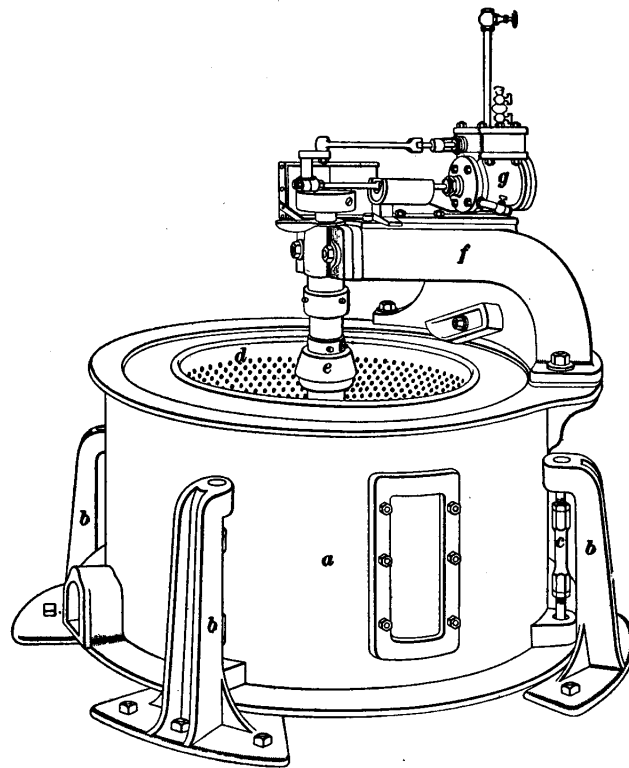


FIG. 5

The basket *d* of the extractor is made of perforated metal and is built on a central shaft *e* supported at the top by a housing *f* that rises from one side of the outer casing and extends to the center of the machine. The basket is driven by a small steam engine *g* carried on the housing. The machine therefore requires no belting or shafting of any

kind. The engine is attached directly to the shaft of the basket, and the loaded basket serves as a flywheel when the extractor is in operation. This allows the basket to be started very quickly, as no time is lost by belt slipping, etc., and the machine is at full speed in a few seconds.

In operation, stock saturated with water or other liquids is placed in the perforated basket and the steam admitted to the engine. In a few seconds, the basket is revolving at a high rate of speed and the water is being driven through the perforated sides of the basket by the centrifugal force generated by the rapid rotation. The water removed from the basket is retained by the outer casing, from which it passes off as waste water through a suitable outlet in the casing. In a few moments the bulk of the water contained in the stock is removed and the machine may then be stopped, emptied, and another lot placed in the basket. The extractor should not be allowed to run too long, however, in an attempt to remove too much moisture, or the stock will be rolled and matted. The vibration of the basket is a feature of all hydro-extractors that it is impossible to remedy and is due to the unequal loading of the heavy, wet material. In this extractor, however, the difficulties that would ordinarily arise because of this unavoidable vibration are overcome by carrying the entire machine on movable supports. The machine is thus entirely suspended and is free to vibrate in any direction, if unevenly loaded, thus preserving the parts in their original relation to one another without imparting any of the shaking to the floor or the building in which it is located. This manner of balancing an extractor is far superior to the old way of allowing the basket to wobble, or gyrate, inside the outer casing, which remained stationary, thus requiring a greater space between the basket and casing and necessitating a larger machine for the same capacity. The self-balancing hydro-extractor is made in various sizes, with baskets from 30 to 54 inches in diameter. The speeds at which they run vary from 1,000 revolutions per minute for a 30-inch, to 850 or 900 revolutions per minute for a 54-inch, basket.

WESTON HYDRO-EXTRACTOR

17. While this machine is not of the self-balancing type, but instead has a gyrating basket, many of them are in use and give excellent satisfaction. One advantage of this type is that it is very easy to load and unload, as there is neither housing nor shaft in the way, the entire top of the machine being open and clear. This fact renders the capacity of the machine larger than that of a self-balancing extractor.

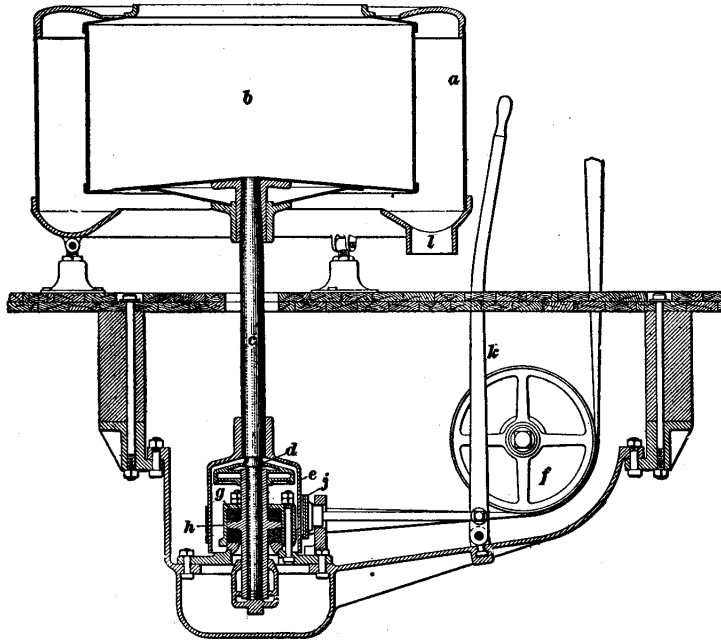


FIG. 6

The machine shown in section in Fig. 6, consists of an outer casing *a* enclosing a perforated basket *b*, which is fastened to a spindle *c* and rotates on the pivot *d*. A pulley *e* is attached to the lower end of the spindle, motion being imparted to the basket by means of a belt passing around this pulley, to which it is guided from a driving shaft by means of two guide pulleys, the one shown being marked *f*.

In order to reduce the vibration and at the same time furnish a certain freedom of motion, the pivot box is supported by rubber cushions *g* carried in a gland *h*. That the machine may be stopped quickly, a brake shoe *j* is arranged to be pressed against the pulley *e* by means of a brake lever *k*. The working parts of the machine are all enclosed in a water-tight, cast-iron trough, or casing, which is bolted to the floor under the extractor; but where this machine is to be erected in basements they are carried in a bedplate set on masonwork.

In operation, the stock to be extracted is placed in the basket *b*, which if unevenly loaded gyrates within the casing *a* until a speed is attained that makes it assume an upright position. The water thrown from the stock is retained by the casing and finds an exit through the outlet at *l*.