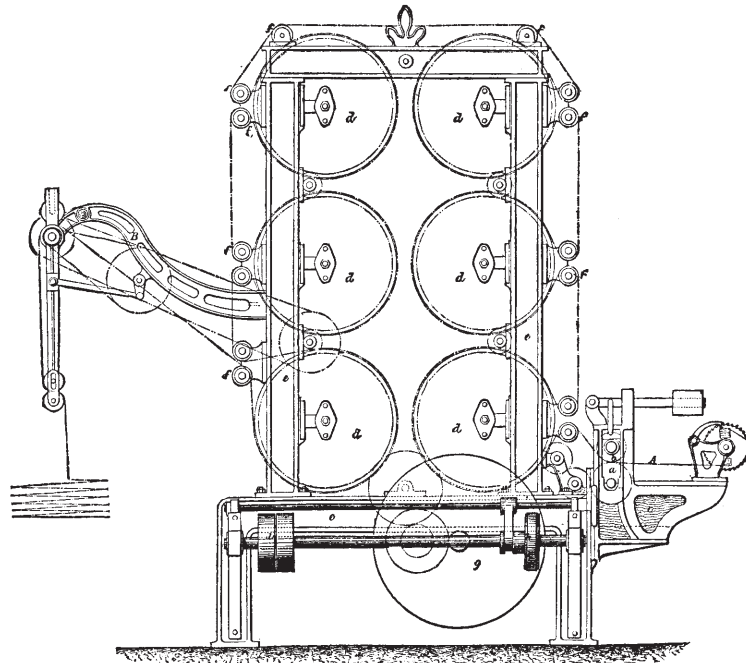


CLOTH-FINISHING MACHINES. (See also CALENDER, CALICO PRINTING, and FULLING MACHINES.) Cloth-finishing machines prepare the surface of woven fabrics, so as to improve their appearance, and often in the case of inferior goods to cover the poor quality of the material. Nearly all stuffs when taken from the loom contain certain impurities and dressings, such as glue, which have been used to keep the warp together, and which are therefore of a sticky nature. To remove these substances, washing machines are used. (See LAUNDRY MACHINES.)

*Drying Machines.*—These are contrivances for removing the water from the stuffs and for dry-

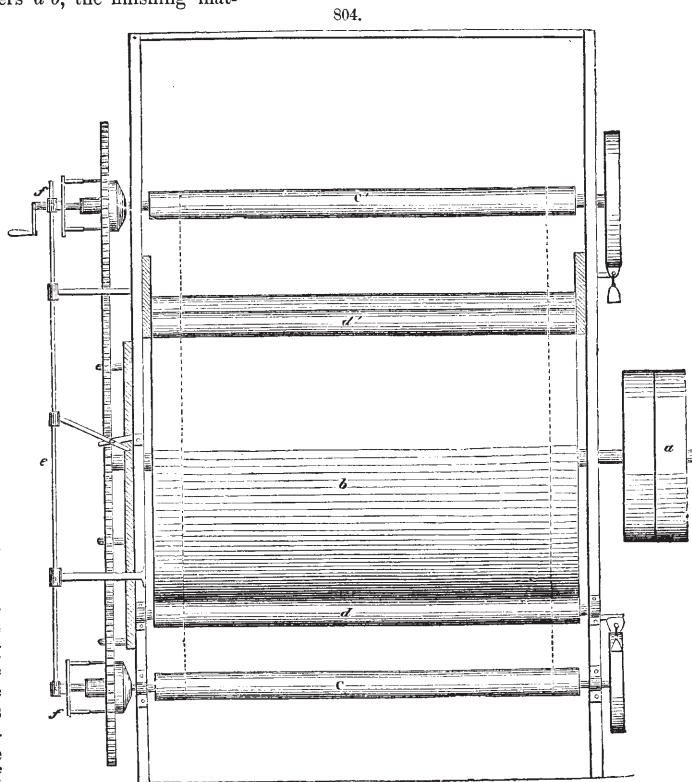
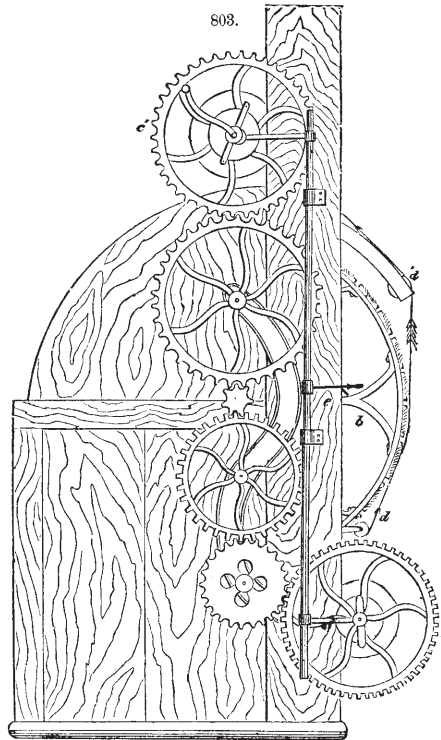
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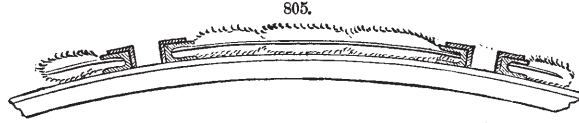
ing them. Both these classes of apparatus have the same purpose, namely, to remove from the stuff the moisture which it has absorbed during the processes of washing and fulling. This moisture is of two kinds, one part being held mechanically by the stuff, while the presence of the other part is due to the hygroscopic qualities of the material; this latter portion is known to be very predomi-

nant. The mechanically held moisture is now generally removed by means of centrifugal drying machines (see SUGAR-MAKING MACHINERY), while artificial heat is required to effect the remainder of the drying. Dr. Herman Grothe has published a work on this subject, in which he shows, by practical results obtained by the use of centrifugal machines, that the rotary drying of moist stuffs is only economical within certain limits, and that the construction of the centrifugal machines themselves is not yet perfected, as most of them have to drag with them vessels and contrivances which are much too heavy. A well-designed centrifugal machine should represent a correct combination of mass and strength, and should possess at the same time moving parts which offer little friction, and the necessarily rapid motion of which does not produce any loss of power, while the machine should also be provided with arrangements for stopping the rotary motion almost instantaneously.

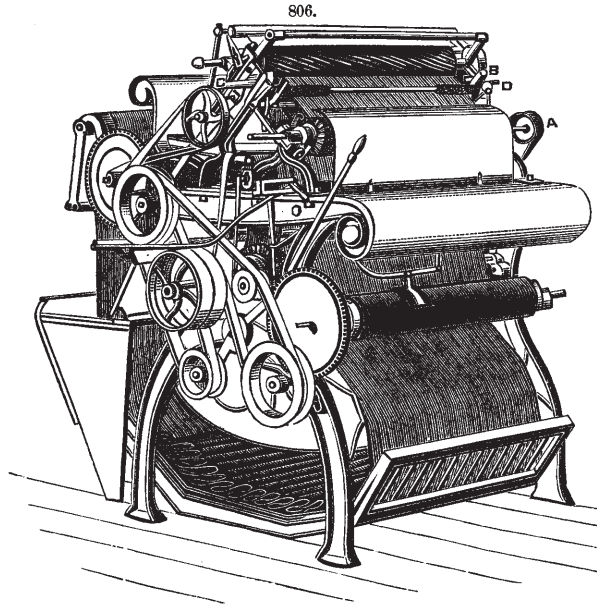
The drying machines intended for removing the more closely combined portion of the moisture by means of heat are of various systems. One of improved construction (German) is represented in Fig. 802, and is more especially adapted for calico-drying. It is arranged on the vertical system, and is used for effecting the simultaneous drying and starching of woollen and half-woollen stuffs, which are starched on one side only. For this purpose the stuff passes at first through the starching apparatus *A*, consisting of the squeezers *ab* and the box *c*, which contains the finishing or covering matter through which the lower roller *a* revolves; the stuff passing through the two rollers *a b*, the finishing matter is very uniformly transferred to and impressed upon the surface, and the small irregularities formed in weaving are thus completely covered. From here the stuff passes into the drying apparatus proper, consisting of six copper cylinders *dd* heated by steam through the hollow frames *ee*. These cylinders, which are constructed for a pressure of from two to three atmospheres, are provided with cast-iron bottoms, the latter being fixed in such a manner that they may easily be removed. The guide-rollers *ff* pass the stuff with the unstarched side on to the cylinders, so that the breaking up of the finishing matter, the clouding of the stuff, and the greasing of the cylinders are prevented, while the drying of the matter is well and uniformly accomplished. From the last cylinder the stuff



passes into the folding apparatus carried by the arm *B*. The water arising from the condensation of the steam is continually taken off from rollers and frame. The motion of the cylinder is produced by the friction-gear *g h* and the pulleys *i*; and according to the speed required for the cylinders, the friction-pulley *h* is moved along its axle either toward the centre or the circumference of the face-plate *g*.



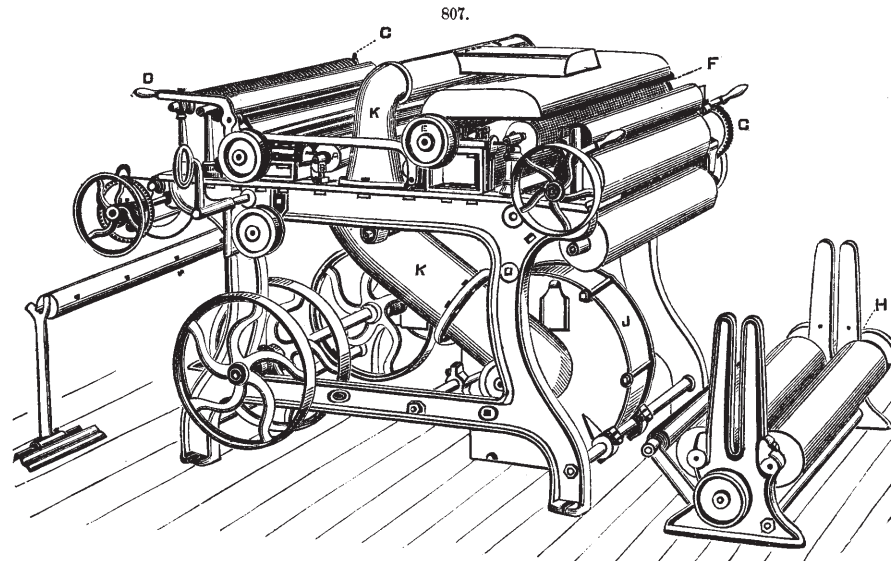
Cloth-like stuffs are placed in the fulling-mill in order to facilitate the closing or felting of the materials. (See FULLING MACHINES.) Woolen stuff is next taken to the gig-mill.



built by the Parks & Woolson Machine Company, Springfield, Vt. The rotary brush *A*, revolving in an opposite direction to that in which the cloth is moving, raises the nap which has been formed

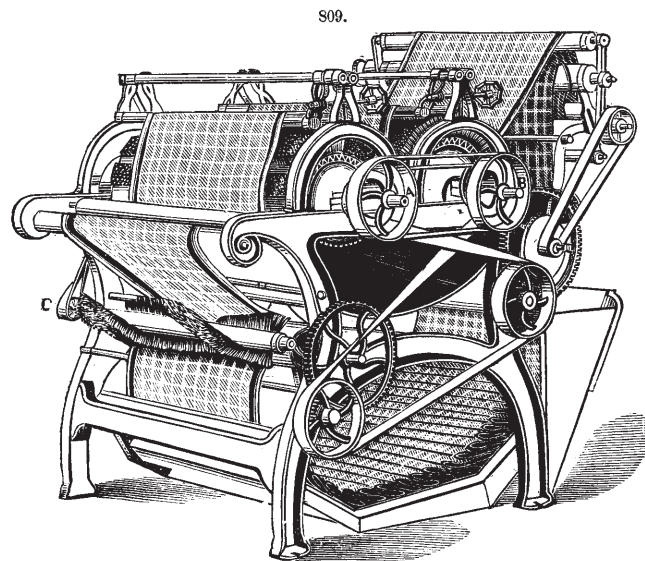
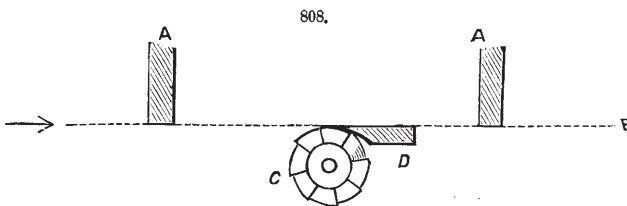
*The Gig-Mill.*—An example of this machine, which is used for napping the fabric, is given in Figs. 803 and 804. The cloth to be napped is first wound on the roller *c*, then passed down over the two straining rollers *d d* to the cloth-roller *c*. By means of the shaft *e*, which is mounted at each end with two slipping clutches *f f*, *c* is thrown out of gear, and the lower roller *c* thrown in. The cloth is then drawn downward over the revolving drum *b*, which is set with teasels, as seen in Fig. 805, until the whole length has passed over. The action of the two cloth-rollers is then reversed, *c* being thrown into gear, and the cloth passes back again over the teasels; and this is continued until the nap is sufficiently raised. The straining roller *d* may be adjusted to give more or less strain on the cloth at will.

From the gig, as described, cloth passes to the *Woolen-Cloth Shearing Machine*, Fig. 806. The example we illustrate was



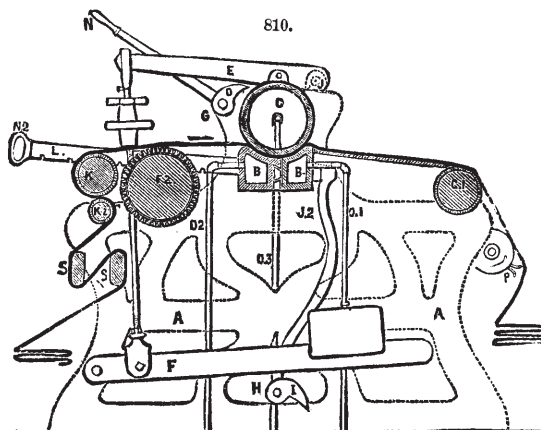
by the action of the gig, so as to prepare it for the action of the helical blades of the shear *B*, which acts against a ledger-blade, not seen in the drawing. The cloth is brought up to the point

of contact of the shear-blades by the rest-bar *C*, the distance of which from the shears is adjusted by set-screws according to the thickness of the cloth to be sheared. This rest-bar is composed at either end of small movable plates or sections, which are brought up to the proper point of contact or removed from it by a system of levers, operated by the fine-toothed wheels shown on either end of the list-rod *D*. These toothed wheels are set at such a distance from the cloth as not to touch the surface of the fabric itself, but so as to be caught and put in operation by the coarse fibres of the thick listing, and by an internal screw on the rod operate the levers, by which the movable ends of the rest are depressed, so as to allow the listing to pass through without being brought in contact with the shear. The *Cotton-Cloth Shearing Machine*, as shown in Fig. 807, has been



varied in form, though not in principle, from the original invention of Milton D. Whipple of Lowell. It consisted in holding the surface of the cloth intended to be sheared or trimmed of loose threads or knots firmly against the point of contact of the cutting blades, by means of fixed supports on stationary bars, over which the cloth passed just before reaching and after leaving said point of contact, and a little above its plane. In the modified machine shown, the cloth passes above the cutting blades, and is held down on them by the straining bars, as is seen in Fig. 808, in which *A A* are the rest-bars, *B* the cloth, passing in the direction of the arrow, *C* the revolving cutter furnished with a series of helical blades, and *D* the station-

ary or "ledger blade" of the shear. This form of machine was intended to clean and trim thin fabrics, like calicoes, mousselines-de-laine, etc., in which the body of the cloth was not of sufficient thickness or elasticity to allow of its being held by a rigid bar directly against the point of contact of the shears; but it has since come into very general use for all cotton fabrics. In the machine as represented, Fig. 807, the cloth enters over the rollers *C*, and is drawn tight by the friction-rod operated by the handle *D*, and passes first over the brush *A*, which serves to raise the nap of the cloth, and also takes up many of the loose ends and threads which are left as it comes from the loom. It then passes over the shear-blades *B*, and in the machine shown to the brush and shear *E* and *F*, which are placed above the cloth, so as to trim both sides. It is then taken by the cloth-roll *G*, which draws it through the machine, and delivered to the winding rolls *H*, by which it is wound into a roll for the folding machine. The dust and lint sheared off are taken away by the fan *J*, through the pipes or trunks *K K*. These machines are varied in construction according to the work to be performed, in some cases having four sets of cutters on one side of the cloth only, in others having cutters on both sides. The pieces of cloth are sewed together by a sewing machine, designed for the

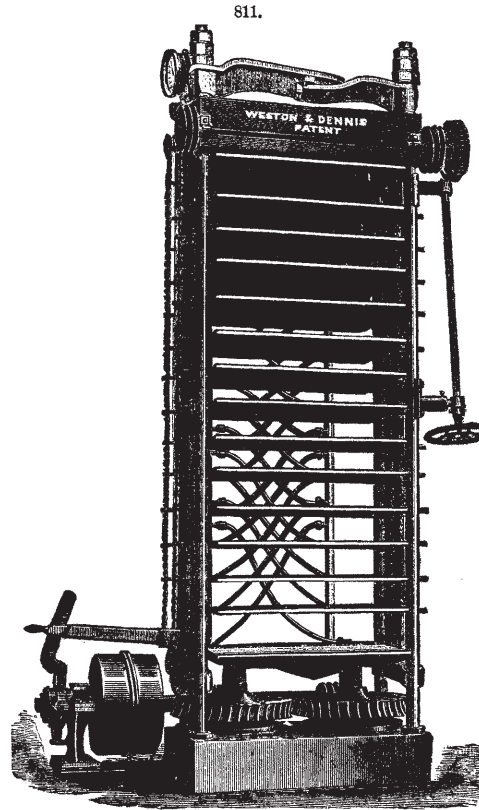


purpose, before entering the shear, so that its operation may not be interrupted at the end of each piece.

*Brushing Machines.*—For some cotton fabrics a brushing machine is also used. This serves to clean the cloth, and leave it with a slight nap or surface, and is employed for cottonades and goods of a similar description.

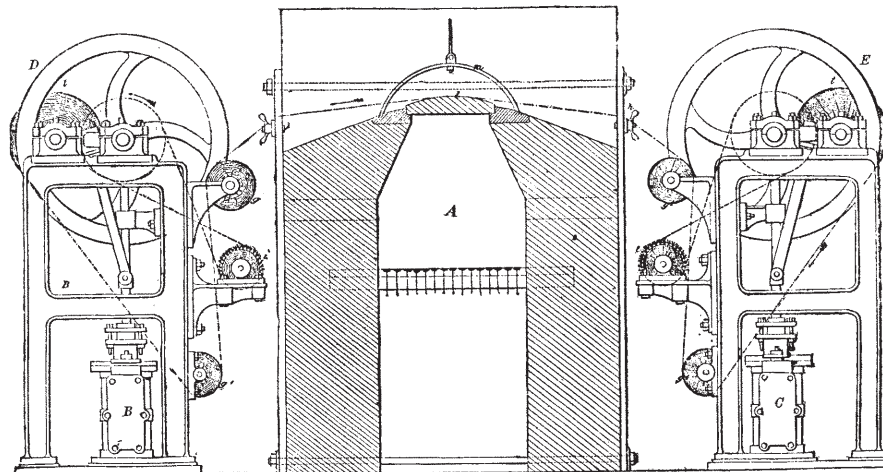
A brushing machine is also used in the manufacture of many of the finer woolen fabrics, the cloth being alternately "napped" and sheared till the desired surface is attained; and this is completed by brushing. In the machine represented in Fig. 809, the cloth, previously moistened, is submitted to the action of the rotary brushes *A* and *B*, being passed over tension-rollers as shown, in such a manner as to subject it twice to the operation of each brush. The brush *C* serves to clean the back of the cloth from the flocks, etc., left by the shears and other machines. From the brush the cloth is taken to the hot press, which completes the finish.

*Presses.*—Fig. 810 represents the Harwood & Quincy continuous press, which is used for hot or cold pressing or for steaming, with a production of 30 yards in 8 to 10 minutes. The cloth goes direct from the shearing machine to the press, where it is brushed and pressed simultaneously, thus saving much time and labor. The pressure can be regulated at will. The machine weighs 45 cwt., and takes about one horse-power to drive. *A* is the framing; *B B*, a concave bearing made in two halves, one to be used cold and the other hot; *C*, a roller running in the concave bearing; *E*, levers with the fulcrum at *J*; *F*, levers connected with the levers *E*; *G*, a shaft which by means of the cam *O* and the hand-lever *N* lifts the lever *E* and the roller *C*. The shaft *H* and its cam *I* lift the levers *F* and *J*. *F* 2 is a revolving brush; *K* and *K* 2, friction-rollers; *C* 1, a roller which takes the cloth off the roller *C*; *P*, an arrangement for plaiting the cloth. One half of the concave bearing *B* is kept cool by means of water carried to it through the



pipe *O* 1, while the other half bearing is heated by steam through the pipe *O* 2; the lever *L*, having a handle at one end, is in connection with the lever *J* 2; the roller *C* is heated by a steam-pipe *O* 3;

812.



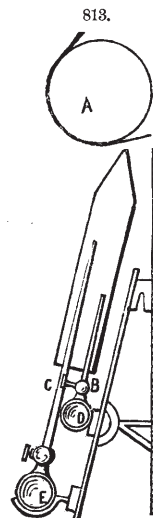
the lever *F* is furnished with a heavy weight. The action of the machine is as follows: The cloth to be pressed passes over the bars *S S* and the friction-rollers *K* 2 and *K*, then over the upper part of

the brush *F* 2, and thence between the roller *C* and the concave bearing *BB*, and finally over the roller *C* 1 and the plaiter. The bearings *BB* are heated or not as desired. The pressure may be brought by the lever *L* up to 6 tons. When no pressure is required, but the machine is to be used as a brushing frame only, the roller *C* is lifted from the cloth by means of the lever *N*. For the purpose of steaming the fabric it is necessary to heat the roller *C*, and to cover it with thick felt.

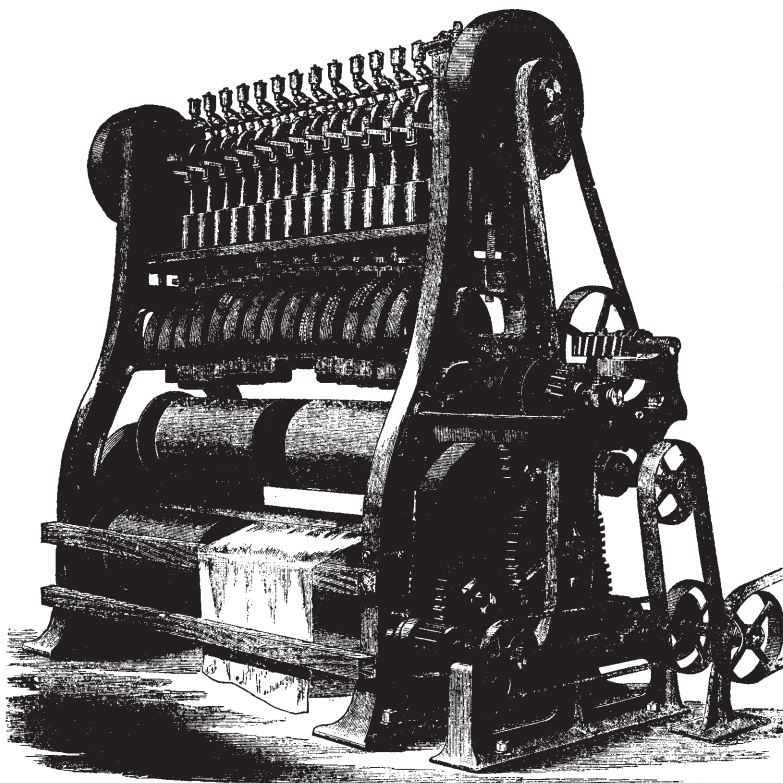
The hollow-plate steam-press, Fig. 811, is used in finishing woolen and worsted goods, which are first folded between smooth pasteboards, called "press-boards," and each piece laid between a pair of hollow iron plates. These are then heated by steam, from jointed pipes connecting each plate with an upright steam-pipe behind the press, and the whole closed up, either by screws or by hydraulic pressure, till the desired pressure and finish are obtained. A uniform heat is secured in this manner, and all the dirt and danger of fire from the old system of furnaces for heating the plates are entirely avoided.

Among other machines used in finishing cotton goods, not above mentioned, is the "napper," used for cotton flannels, which is very similar in its operation to the "gig" used for napping woolen cloths, except that wire card-teeth are used instead of teasels.

*Singeing Machines.*—For the expeditious removal of the flocky and fibrous projections from the surface of cotton stuffs, singeing machines are employed, by the aid of which the flock, etc., is burned off. In Fig. 812 is represented a machine of this description, constructed by the Zittauer Maschinenfabrik und Eisen-giesserei of Zittau, Germany. This consists of the hearth *A* (above which the singe-plate *l* is placed in a cast-iron frame), and of the brushing and winding apparatus *D* and *E*, driven by the two small steam-engines *B* and *C*. By means of suitable clutches the singeing apparatus may be put out of work without stopping the engine. The stuff passes from the cloth-beam *t* over the rollers *g*, against the brush *i*, and, going over the adjustable knife *h*, passes over the heated plate *l*, whence it finds its way over the corresponding parts of the other machine. If a further singeing is required, the machines are reversed, and the manipulations are repeated, but in the opposite direction. The brush *i* serves to raise the fibres of the stuff before arriving at the



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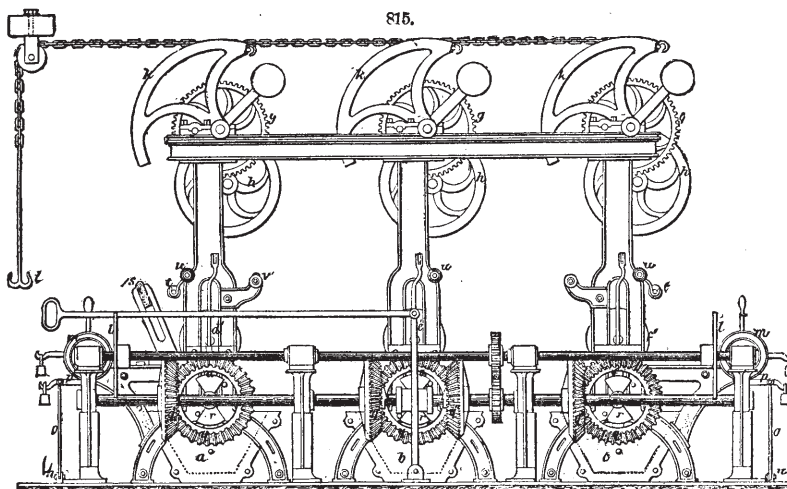
singeing plate, so that they may be more quickly caught by the heated surface. The cover *m* is placed over the plate *l* as soon as the machine is stopped; this is done in order to prevent the

air from coming into contact with the heated plate *l*. The speed with which the stuff passes over the plate varies according to the thickness and condition of the stuff and the temperature in the room.

Fig. 813 represents the burner used in an improved gas singeing machine devised by M. Blanche. *D* is the gas-pipe and *B* the gas-burner. *E* is the air-pipe and *C* the air-tube. The gas and air mingle in the conical tube shown, and are ignited at its orifice, the flame impinging on the cloth as it passes around the roller *A*.

*The Beetling Machine.*—An improved form of this apparatus, of English construction (Patterson's patent), and exhibited at the Paris Exposition of 1878, is represented in Fig. 814. Its peculiarity consists in its bringing to bear on the cloth a number of hammers or fallers worked at a high speed, these hammers being worked by eccentrics on a shaft which extends across the top of the machine, and there being interposed between the eccentric rods and the hammers a spring connection which relieves the working parts from the recoil of the blows, and materially reduces wear and tear. The spring connection is made by suspending each hammer from a leather belt attached to a semicircular steel spring, as shown. In the old-fashioned beetling machines the hammers or "fallers" were lifted by cams, and allowed to fall by gravity, while the utmost speed at which they could be run was about 60 blows per minute. In the machine here represented the hammers give 420 blows each per minute, while the striking effect of each blow is the same as in the old machine. The hardness of the blow can, however, be varied by altering the speed. The cloth being operated upon is carried by one of three rollers which revolve in bearings carried by disks, as shown, these disks being themselves capable of revolving. The three cloth-rollers can thus be brought successively under the action of the hammers, and the operation of the machine is thereby rendered continuous, the filling and stripping of the rolls not interfering with the beetling.

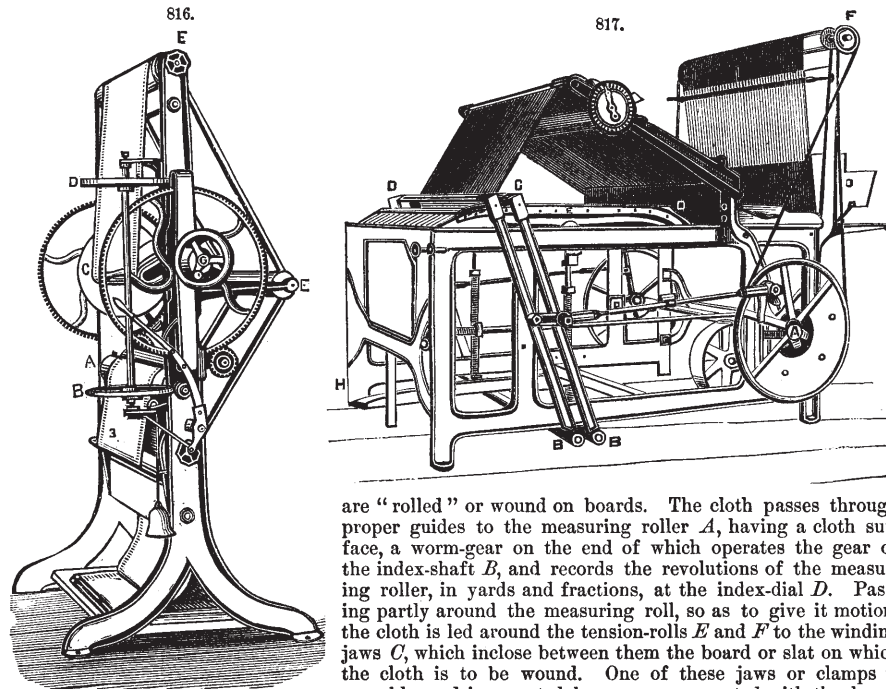
*Craping Machine.*—Cotton, linen, and half-woolen stuffs are usually soaked with a finishing fluid, in order to procure a certain stiffness, smoothness to the touch, and often lustre. In order to do



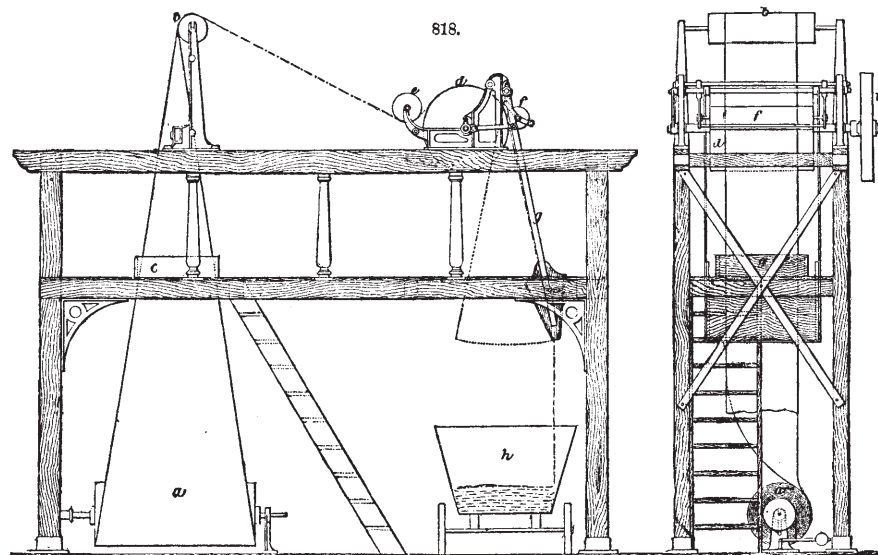
this in a suitable and uniform manner, special machines are used. Starching machines, which may either be fixed to the cylinder drying machines, or may be used as independent machines, belong to this class. Craping machines are generally used for effecting a continued washing, boiling, and rinsing of woolen or half-woolen stuffs in an alkaline solution, for the purpose of finishing, or as a necessary preparation for the process of drying, or to provide the stuffs after being cleaned with finishing matter. This machine is an important element in the finishing process. As will be seen from Fig. 815, it is provided with three boxes, *a*, *b*, and *c*, which contain the different fluids to be used for the finishing of the stuff or for the removal of impurities, such as fat or grease, from it. Three rollers, carried in strong frames, and running against a series of pressing or squeezing rollers *d' e' f'*, project partly into these three boxes *a b c*. These rollers and boxes may be used in various ways, according to the quality of the stuff; thus the latter is either wound round the rollers, which are fixed in such a manner that the stuff is saturated by the fluid, while the rollers rotate and the squeezers partly press the fluid into the material, and partly squeeze it out of it, or the stuff is placed in the fluid, and is simply passed through the squeezers. By means of the wheel-gear *g h* at the top of the frames, the upper rollers or squeezers *d' e' f'* can be lifted, in order to afford space for the winding of the stuff around the lower rollers. The shafts of wheels *g g g* are provided with sectors *k k k*, over which a chain is passed carrying at its end the rod and hook *i*, from which weights of various sizes, according to the requirements of the case, are suspended in order to press the rollers *d' e' f'* firmly against the lower rollers. The material, which may be passed in or out of the machine from either side, is, after coming from the squeezing rollers, wound upon copper steam-rollers by means of the friction-gear *l m*, which allows the speed of the steam-rollers to be exactly regulated as required, by moving the disk to the necessary distance from the centre of the disk *l*. By means of the foot-boards *n*, the rods *o*, and the levers *p*, the workman at the machine can instantaneously stop the winding up of the stuff by throwing the friction-disks out of gear. Motion is transferred

to the rollers by the bevel-wheels  $q q' q''$ , and each pair of rollers can be worked or put out of gear independently of the other rollers by means of suitably arranged couplings  $r$ . By means of the wooden rails  $s$  the stuff is guided into the machine without any folds;  $t t$  are guide-rollers, and  $v v$  and  $u u$  are stretching rods for the different boxes.

*The Measuring and Winding Machine, Fig. 816, from the Parks & Woolson Machine Company, is of a kind generally used for putting up a large class of narrow woolen and worsted fabrics, which*



are "rolled" or wound on boards. The cloth passes through proper guides to the measuring roller  $A$ , having a cloth surface, a worm-gear on the end of which operates the gear of the index-shaft  $B$ , and records the revolutions of the measuring roller, in yards and fractions, at the index-dial  $D$ . Passing partly around the measuring roll, so as to give it motion, the cloth is led around the tension-rolls  $E$  and  $F'$  to the winding jaws  $C$ , which inclose between them the board or slat on which the cloth is to be wound. One of these jaws or clamps is movable, and is operated by a screw connected with the hand-wheel shown, so as to clasp and release the board at pleasure. After each piece is rolled and measured, the index-plate is thrown out of gear, and reset at zero for the next piece.

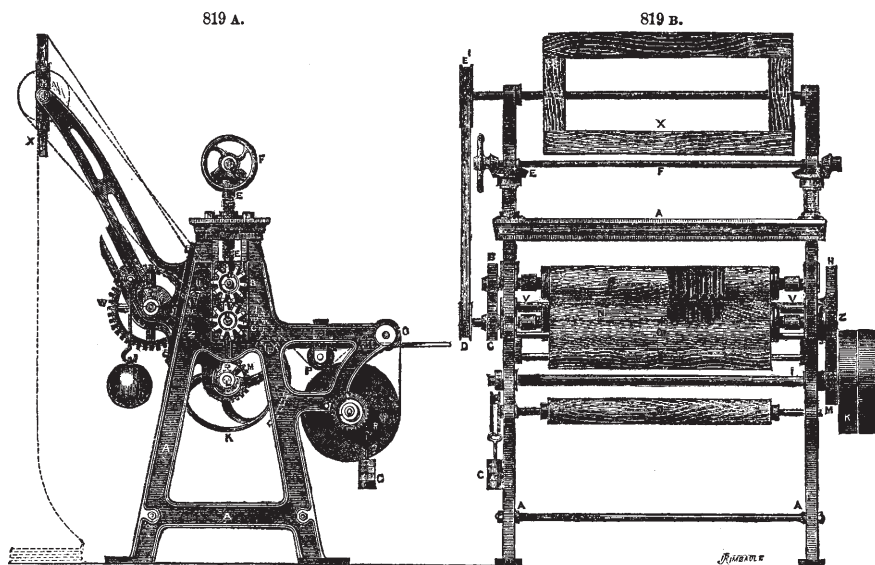


*The Cloth-Folder, Fig. 817, is widely used for cotton cloths, prints, and other light fabrics. The crank-disk  $A$ , on the main shaft, gives motion to the two parallel levers  $B B$ , supported on a stud, and connected at the top by a funnel-shaped mouth-piece at  $C$ , through which the cloth is brought from*



the delivery roll *F*. This mouth-piece is inclined alternately to the right and left by the motion of the bars *B B*, so that the lower edges of it insert the cloth between the stationary bars *D D*, the under faces of which are covered with card-teeth, and the floating table *E* supported by springs, which yield sufficiently to admit of the entrance of the edge of the mouth-piece with a thickness of cloth at each vibration of the same, and retain the fold as the mouth-piece is withdrawn. When the piece is folded, and at the same time measured, a pressure of the foot on the lever *H* drops the table *E*, and admits of the removal of the cloth. Another form of folding machine, of German construction, is represented in Fig. 818. It consists of a frame about 14 feet high, carrying at the bottom the cloth-beam *a*, from which the stuff passes half folded to the roller *b*, and thence to the rollers *e* and *d*. The stuff is pressed against the cylinder *d* by the roller *f*, while the laying down into the trolley *h* is effected by the lever *g* worked from the shaft carrying the pulley *i*.

*Stretching Machine.*—During the process of drying the maintenance of the stuff at its correct width is of great importance, and always has been a difficult matter on account of the shrinkage which takes place. Side and front elevations of a machine devised by J. Ducommun & Co. of Mulhouse are given in Figs. 819 A and 819 B. It consists of fixed and solid frames *A* carrying the main shaft *I* with the pulleys *K* and the spur-wheel *M*, which transfers the motion by means of the wheel *Z* to the roller *N*, the latter being geared to the second roller *a* by the pinions *C* and *B*. These stretching rollers appear cylindrical externally, as shown in the engravings, but they consist of an India-rubber tube drawn over a grooved core, as shown at *Y* in Fig. 819 B. These cores of the two stretching rollers are arranged in such a manner that the grooves of the one correspond in position and shape with the projections of the other roller; this cannot be seen, however, unless the



two rollers are pressed together by means of the screws *E*, worked by the shaft *F*, when the grooves are shown through the India-rubber tube. The stuff *R* is unrolled from the roller *Q*, and passes over *O*, under *P*, and over the elliptical roller *T*; it is taken up either by the laying or distributing apparatus *X*, or by the roller *V*, in which latter case it has to pass the table *U*, and is stretched during winding up by the roller *W*. Even a superficial examination of the rollers *a* and *N* will show that the stuff passing between them must be stretched. The machine also effects the breaking up of the finishing matter, and makes even very strongly finished stuff soft to the hand. (See *Engineering*, xv.) S. W. (in part).

CLUTCH. See COUPLINGS AND CLUTCHES.

COAL. See BOILERS, STEAM.

COAL-BREAKER. See BREAKER OR CRUSHER.

COAL-CUTTING MACHINES. Apparatus used for effecting mechanically the separation of the coal from the inclosing rocks. The value of machinery for this purpose over manual labor consists in the greater rapidity with which the work is executed, and the smaller waste that is made in the operation, so that the production of a given quantity is obtained at a much less cost than by hand. The coal itself is also brought down in much larger pieces, while the danger incident to "holing" by hand is altogether removed. One of the principal drawbacks, however, appears to be the cost in the first instance of conducting the motive-power, which is derived from compressed air, from the surface to the workings below.

Gladhill's machine (English) acts on the coal by means of an endless chain armed with teeth or blades, revolving around a shive or solid plate secured over the coal. The apparatus is driven by compressed air brought from the surface through pipes, under a pressure of from 35 to 40 lbs. per square inch. The chain consists of flat links, each link being enlarged at one end for the purpose of holding the blades. The chain is made of cast-steel, and the width of each cutter is 2½ inches.

The machine advances automatically in proportion to the clearing of the coal by means of capstans, placed at both the forward and after ends of the frame, so as to work both ways. The inventors claim that it will advance 300 to 350 feet with a depth of 3 feet in 8 to 10 hours, producing 75 to 90 tons of coal, assuming the vein to be  $2\frac{1}{2}$  feet thick. The movements of this machine are not, however, adapted to the undulations and irregularities found in most coal-mines.

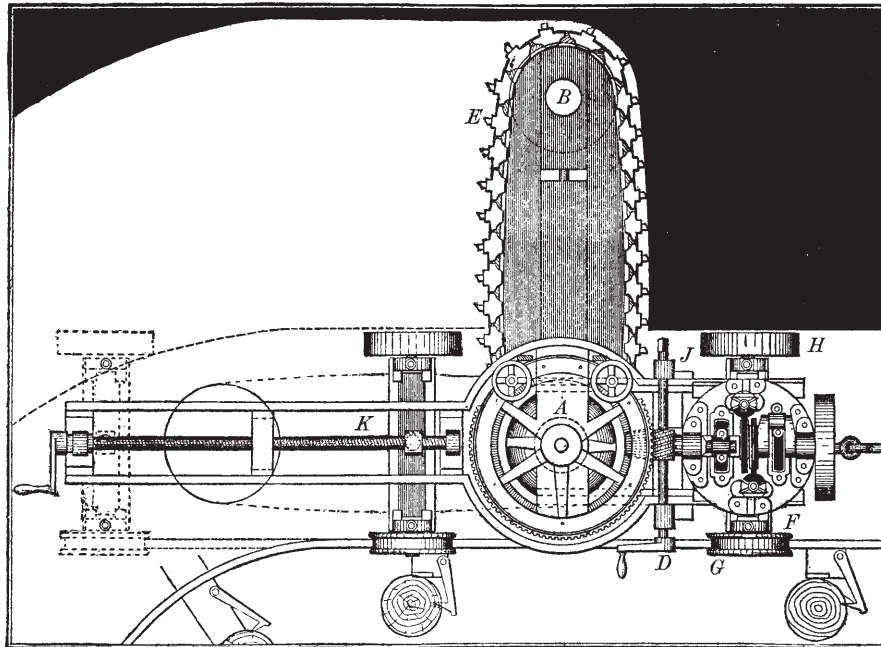
Holmes & Payton's machine (English) has for its cutting tool a strong steel blade, which is attached to two eccentrics in order to give it rigidity; the teeth are inserted in the plate and operate like picks, each tooth advancing on the same plane and describing circles according to the impulse of the eccentrics. The length of the plate is 3 feet. The teeth of the cutting blade act by blows, as do the picks used in hand labor. About 300 blows per minute are struck, and the opening of the cut is from three-fourths of an inch to one inch to a depth of 3 feet. The inventors claim an advance of 8 to 12 inches per minute, according to the hardness of the rock or coal.

For complete descriptions of this and the foregoing machine, see "Reports of Judges of Group 1, Centennial Exposition, Coal-Mining Machinery," by A. Jottrand.

Firth's machine, used in the mines of the West Ardsley Coal and Iron Company, near Leeds, England, consists of a pick worked by a bell-crank lever, the action being exactly the same as that of a miner when engaged in undercutting.

There are also various forms of rotary machines. In Hurd's machine a number of steel cutters or teeth are placed on an endless chain or band, moving longitudinally around a long arm. These cutters form a groove in the coal. This apparatus is reported to have worked in a 20-inch seam, making a semicircular sweep of 6 feet 6 inches in 4 minutes, with only 25 lbs. pressure on a 6-inch cylinder with 6 inches stroke, cutting a groove of  $1\frac{1}{4}$  inch. The Monitor coal-cutter, Fig. 820, is one

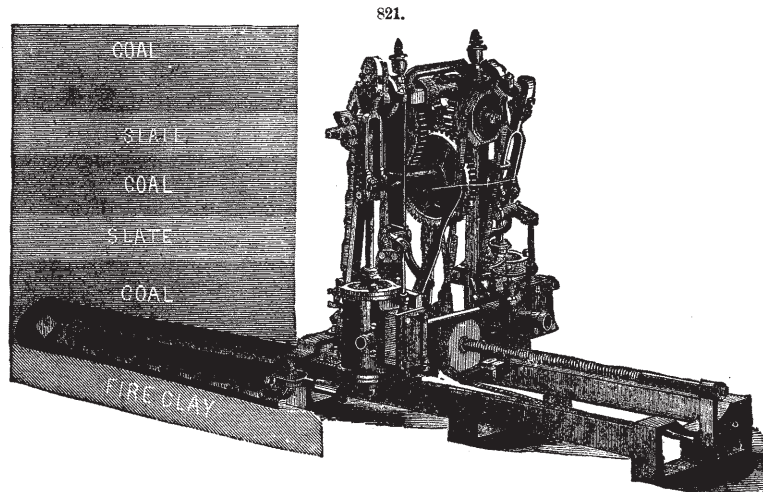
820.



of the latest forms of this type of machine. *A* shows the inner and supporting part of the cutter-arm; this is joined to the frame *D* by means of a pivot-hinge that holds the arm horizontally, but allows it to be raised or depressed on either edge, by means of which the cutter can be made to lead up or down in the coal, to follow the irregularities of the bottom, to avoid interlaminated strata of rocks, etc. The arm can also be raised or lowered without otherwise changing its relative position to the machine. *B* is the outer portion of the cutter-arm, and is geared to *A* in such a manner that it can be thrown out or in to lengthen or shorten the arm as required. Attached to *B* is the wheel that acts as a carrying wheel for the chain *E* at the outer extremity of the arm, and attached to a shaft, is a similar wheel that acts as a driver for the cutter-chain. *F* is a double-cylinder vertical-trunk engine, 8-inch bore and 7-inch stroke. The whole is attached to the framework *J*. This, in turn, is supported by the wheels *G*, *H*, etc. The wheels are all plain flanged wheels, as shown by *G*. While working, the machine requires but one rail of the common T iron, 9 lbs. per yard. The forward wheel is kept on the rail by means of the second flange *G*, which is slipped on and held by means of thumb-screws. The other two wheels are rimmed into the broad flanges *H*, made in two more sections, which run directly on the bottom. When in shape for moving, the wheels *G* *H* are drawn to the end of the frame *J* by the screw *K*, and the cutter-arm swings under the frame *J* by means of the screw-shaft *D*, which engages the teeth of the segmental

gear attached to the frame *J*. The machine is fed forward by means of a power windlass, operated by air. The windlass consists of an upright drum, driven by a small rotary engine, so geared that it will wind slowly enough for the lightest feed, or fast enough to pull the machine up the grade from the gangway very rapidly. The feed can be varied instantly by the throttle-valve to suit the varying strata that are being cut—a useful advantage, as in many places in the same breast one yard can be cut in half the time with the same power that it would require to cut the next yard. The capacity of the machine, of course, varies greatly with the nature of the material cut. The following will show what the machine is stated to have accomplished in what is about the average hardness of splint coal: Weight of machine, 3,800 lbs.; depth of cut (extreme), 4 feet; depth of cut (average), 3 feet 6 inches; thickness cut out, 2 feet 6 inches; pressure used per square inch, 25 lbs.; cut along face (average) per hour, 20 yards; space between props and coal, 42 inches; gauge of track, 29 inches. Exceptional work, 15 yards in 20 minutes; 30 yards in 55 minutes; 5 yards in 4½ minutes.

The essential features of the Lechner coal-cutting machine, Fig. 821, are the cutter-bar and the modes of driving it. The cutters in this case revolve in a vertical plane. The form of the axle is square, and motion is communicated to it by a couple of pitch chains, which not only drive by contact with the axle itself, but also by engaging a set of narrow cutters, which enter the open portions of the chain. In this manner only thin films of coal are left uncut where the chains work, and get broken off quite imperceptibly by coming into contact with the links of the chain. In addition to the wrought-iron bars which form the framing to which the cutter-bar and the driving gear are



attached, another set of similar bars at the side of them form the stationary framing on which the whole machine slides. The forward motion is given by means of a stationary screw, round which a nut revolves, and this motion is arrested by moving a handle which separates the two halves of the nut in a similar way as the screw and nut are disconnected in most screw-cutting lathes. To bring the machine back again, a bolt attached to the stationary framing is, by means of a handle, thrown into gear with one of the pitch chains, which are kept revolving to clear away the dust. Either steam or compressed air can be used for driving, motion being communicated by suitable means from the pair of cylinders to the pitch chains. The machine weighs 750 lbs., and can be handled by two men. The cut which it makes is 6 feet deep, 3 feet wide, and 4 inches high.