

relieving the warp threads of the effort of driving the cylinders, and thus preserving their valuable properties of elasticity, so essential to good weaving and to the production of superior qualities of cloth.

The drying cylinders are usually heated by injecting through one of the cylinder journals, which are tubular, low-pressure steam to exert a gauge pressure usually of about 10lb. to the sq. in., which is equal to 0.68 of an atmospheric unit of 14.7lb.

In some machines, however, the drying cylinders are heated by the injection of hot air instead of steam; whilst a French modification is designed to heat the drying cylinders of slasher sizing and calendering machines by means of hot air generated by a number of gas flames flaring from jets contained within the cylinders.

§ 210. In addition to the foregoing chief parts constituting the drying apparatus of a slasher sizing machine, there are also numerous incidental accessories and attachments, comprising, amongst others, a service of pipes to conduct steam from the boiler to the sizing machine, where it enters the cylinders through one of the two tubular journals on which the cylinders revolve. The steam service pipe is provided with valves to regulate the pressure, and also to control the supply of steam to the cylinders; with a steam gauge, and a graduated dial, on which a recording finger indicates the steam pressure, to be read at sight by the attendant; and also a safety valve, preferably of the "deadweight" type, which is adjusted to "blow-off" steam automatically when the gauge pressure exceeds the prescribed limit of about 10lb.

Another service of pipes leads from the cylinder journals, on the opposite side to those through which steam is admitted to the respective cylinders, to convey from these the waste water as it is deposited by the condensing of the exhaust steam in the cylinders. The waste water is conducted by this service of pipes from the cylinders and passed through a steam-trap to prevent the escape of steam from the cylinders before it is exhausted and condensed. The removal of water from the cylinders, as the steam condenses, is effected in a variety of ways, as described subsequently in §§ 214 and 215.

The cylinders are each constructed with a manhole, so that they may be entered for the purpose of effecting repairs internally. Also,

they should each be provided in one end, or in both ends, with an air-inlet or vacuum valve to open automatically and thus admit air as a precautionary measure against the risk of the cylinders collapsing from external atmospheric pressure—a contingency which is liable to occur in the event of a partial vacuum being created within the cylinders when the supply of steam is shut off from them. If, under these circumstances, air were not admitted to the cylinders, the internal air pressure would, owing to the sudden condensing of the confined steam, be liable to fall below that of the external atmospheric

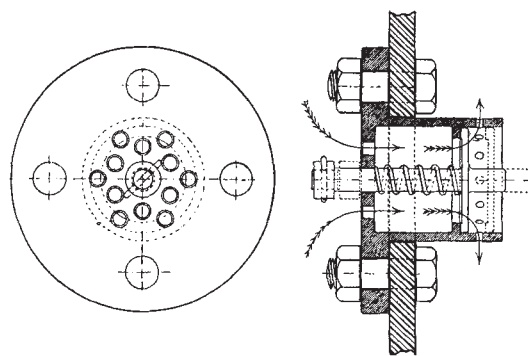


Fig. 98.

pressure, and thereby involve the risk of the cylinder ends collapsing by caving inwards.

§ 211. One of several types of air-inlet valves adapted for use on the steam-drying cylinders of slasher sizing and calendering machines is that illustrated by a front and a sectional end view in Fig. 98, and as applied by Messrs Wm. Dickinson & Sons. As indicated in the diagram, this air-valve is bolted on the outside of one of each of the cylinder ends, and consists of a flanged cylinder furnished with a piston rod containing a disc on the inner end and a stop-collar on the outer end, with an open spiral spring inserted between the flange and the disc. Also, air-holes are formed in both the flange and the inner end of the valve cylinder, which enters the steam cylinder.

Thus, under normal conditions, when the internal steam pressure is greatest, the piston rod is forced outward with the disc bearing closely against a diaphragm to close the valve, as indicated by full lines in the diagram, and thus prevent the escape of steam from the cylinder. But, in the event of the internal steam pressure falling below that of the atmosphere, the piston rod and the disc of the air-valve, assisted by the spiral spring, are forced inward until the

disc passes beyond the air-holes in the valve cylinder, as indicated by dotted lines in the diagram, thereby admitting air to the interior of the cylinder, as indicated by arrows. When the piston rod and disc have moved inward sufficiently to open the valve for the admission of air, their further movement is prevented by the stop-collar abutting against the flange of the valve. The air valves close automatically, on readmitting steam to the cylinders, immediately the internal steam pressure exceeds the external atmospheric pressure, plus the resistance of the spiral spring.

#### CYLINDER CONSTRUCTION

§ 212. Some drying cylinders are constructed with an external shell of tinned sheet iron or steel, whereas others are formed with a shell of sheet copper. If sheet iron or steel is employed, there is less risk of the joints becoming strained and fractured where the shell and cylinder ends are united, because the expansion and contraction of those parts by the heating and cooling of the cylinders in frequent and alternate succession are equal.

Iron and steel, however, are much more susceptible than copper to the corrosive influence of a moist atmosphere, and are therefore liable to rust and thus stain the yarn with iron-mould. For this reason a copper shell is preferable, because its use eliminates the risk of iron-mould. Copper is also better than iron or steel as a conductor and retainer of heat; and being more ductile than these metals, it is capable of being more easily and effectually bent over at the edges to form a short right-angular flange, which permits of a more perfect steam-tight joint being constructed where the copper shell and cylinder ends are united.

But in consequence of the unequal expansive properties of iron or steel, and copper, cylinders constructed with a copper shell were, by the older method of construction, more liable to develop structural defects at the joints, owing to the differential expansion and contraction, and therefore unequal straining, of the copper shell and cylinder ends.

By a more approved method of constructing cylinders, however, as devised by Messrs Howard & Bullough, Limited, and as illustrated by a sectional view in Fig. 99, the risk of joints frac-

turing from the unequal expansion and contraction of the shell and cylinder ends has been overcome successfully. This method of construction is applicable to both copper and also tinned sheet iron or steel shells, and is effected by flanging both the shell and the cylinder ends at right-angles, and then binding both firmly and closely together by means of strong wrought-iron junk-rings and large set-screws, with the shell bound between the respective junk-rings and

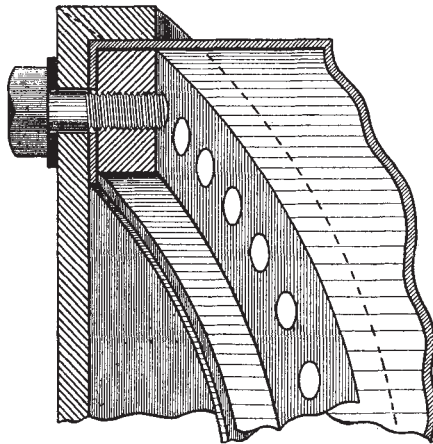


Fig. 99.

cylinder ends, as indicated in the diagram. Also, as a precaution against the risk of cylinders either collapsing or bursting, additional stability is imparted to them by means of several strong cross-bars or rods that extend between the cylinder ends, and to which they are bolted.

#### ADMISSION OF STEAM TO THE CYLINDERS

§ 213. Steam is admitted by various methods to the cylinders of slasher sizing machines, but the usual practice is to inject it through the journal at one end of the cylinder, and into a perforated cast-iron tube or pipe which constitutes the cylinder axle, whence it issues in a series of small jets, and thus diffuses by expansion within the cylinders. This practice, however, is not an economical one, by reason of the steam radiating from the centre of the cylinder, and consequently losing heat as it becomes exhausted by expansion before it comes into actual contact with the cylinder shell, where the greatest amount of heat and drying efficiency are required.

With the object of overcoming the disadvantages of that method of admitting steam to drying cylinders, and also of increasing their drying efficiency even with a smaller consumption of steam, this may be admitted to the cylinders by means of Bury & Ormerod's device, as illustrated in Fig. 100, which represents the interior of a



cylinder to which that device is applied. By this plan steam is admitted in the usual manner through one of the cylinder journals, and into the tubular cylinder axle, whence it is distributed through branch pipes that lead to a corresponding number of annular perforated pipes fixed a short space from the cylinder shell. Thus, from the small holes in the annular pipes the steam issues in a series

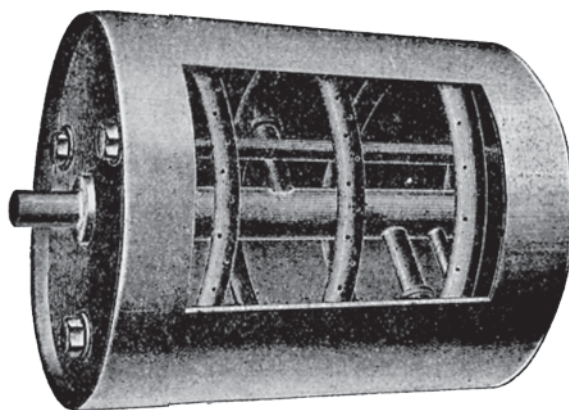


Fig. 100.

of small jets that impinge directly against the cylinder shell before the steam is exhausted of its maximum degree of heat by diffusion, as it expands within the cylinders.

#### CYLINDER WATER-BUCKETS

§ 214. After the steam has entered the drying cylinders it gradually loses pressure as it becomes exhausted of heat, and finally condenses into water, which gathers in the bottom of the cylinders, whence it requires to be expelled automatically as quickly as possible and without loss of steam, whilst the machine is in operation. Otherwise, if the water of condensation is allowed to accumulate inordinately in the cylinders, it not only very considerably diminishes their drying efficiency by cooling the cylinder shells, but it also conduces to a much more rapid condensation, and increased consumption of steam.

Further, the water becomes a constant deadweight rolling continuously in the bottom of the cylinders, thereby augmenting their

weight, which impedes their free-and-easy rotation, and thus requiring additional motive power to drive the machine. Moreover, the additional effort required to turn the cylinders imparts a greater degree of tensile strain upon the warp threads, to the detriment of their elasticity, unless the cylinders are driven negatively by means of frictional driving gear, and therefore revolve quite independently of the frictional grip of the yarn around the cylinders, as stated in § 209, and described subsequently in §§ 220 and 221.

The effectual discharging of the water of condensation from steam-heated cylinders is a problem which presents several practical

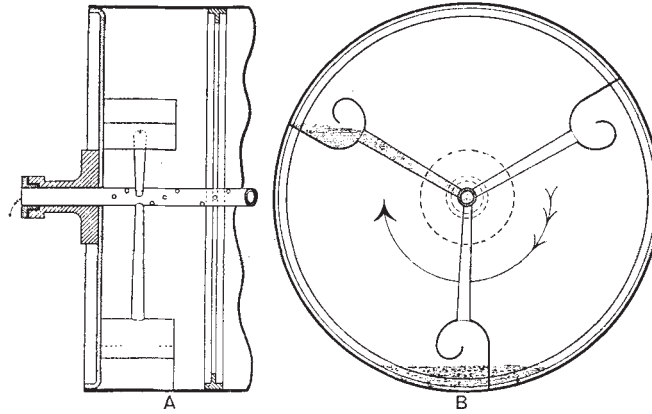


Fig. 101.

Fig. 102.

difficulties that have engaged the attention of many engineers, who have devised numerous methods of accomplishing that object. Of several types of these devices that are in use, the "water-bucket" or "ladle," of which one form is illustrated in Figs. 101 and 102, is the one most frequently applied. This simple device consists usually of two or else three buckets or ladles placed at regular intervals apart, and fixed in the angle formed by the cylinder shell and one end of the cylinder, as indicated in the diagrams (Figs. 101 and 102), which represent a sectional front elevation and an interior end elevation, respectively, of that end of the cylinder carrying the water-buckets.

From each of these water-buckets a pipe leads into the inner end of the cylinder journal, to the outer end of which there is attached,

by means of a packed gland coupling, to prevent the escape of steam, an external pipe leading into a steam trap. Therefore, as the cylinders revolve, the water-buckets arrive successively at their lowest position, and scoop or ladle the waste water of condensation, which, as the buckets ascend, flows down the outlet pipes and is thereby discharged into the cylinder journal, whence it flows along the external pipe to the steam trap which intercepts and prevents the escape of steam, although it allows the water to pass away freely, and be either returned again to the steam-boiler or else into a reservoir.

§ 215. Water-buckets of the pattern illustrated in Figs. 101 and 102 are, however, capable of taking up the water, provided the cylinders revolve in one direction only. If perchance a cylinder furnished with that form of water-bucket is mounted the wrong way about, so that it revolves in the reverse direction to that which is intended, the buckets fail to

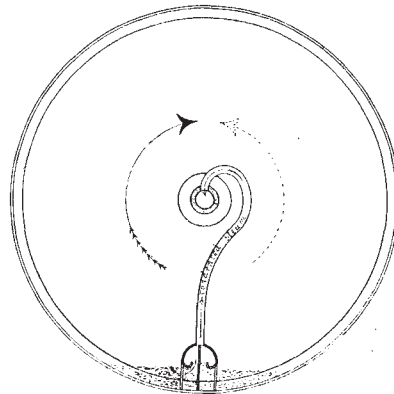


Fig. 103.

perform their function. As a precaution against such a contingency Messrs Wm. Dickinson & Sons furnish their slasher sizing cylinders with reversible-acting buckets that are capable of taking up the water of condensation in whichever direction the cylinders may revolve. This object is effected by the simple expedient of constructing the water-buckets symmetrically, and dividing the opening into two corresponding parts by inserting a mid-feather partition right across them, as indicated in the diagram (Fig. 103), which represents an internal side elevation of a cylinder provided with this improved form of water-bucket.

Another type of device for the purpose of discharging the water of condensation from steam-heated drying cylinders is that of Messrs Bentley & Jackson's, illustrated in Fig. 104, which represents the interior of a steam-drying cylinder constructed with this simple device, consisting essentially of an internal spiral gutter or channel

secured to the cylinder shell, and extending with one, or more than one, coil from that end of the cylinder at which steam enters, to the other end, at which the water of condensation is expelled, where the spiral channel approaches towards the axis of the cylinder and terminates in a receptacle which opens into the cylinder journal at that end.

Thus, as the cylinder revolves in one direction only, as indicated by an arrow, the water of condensation, lying in the bottom of the cylinder, is conveyed along by the propelling action of the spiral channel to the discharging end of the cylinder, where it is raised and emptied into the receptacle which discharges it into the cylinder

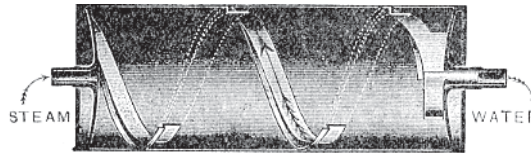


Fig. 104.

journal, whence it passes along a pipe to a steam trap, and finally escapes to return either to the boiler or to the reservoir. It is claimed, by the makers, that this device not only increases the drying efficiency of the cylinders to which it is applied, but also that the spiral channel gives them additional stability, and thereby diminishes the risk of cylinders collapsing.

#### CYLINDER EXPLOSION RISKS

§ 216. Steam-heated cylinders of slasher-sizing and other types of machines are not only liable to collapse after the supply of steam is shut off from them, unless this risk is guarded against by furnishing them on one side or both sides with a vacuum or air-inlet valve of the type described in § 211 and illustrated in Fig. 98, but they are also liable to explode and burst if, perchance, the internal pressure exceeds the maximum and uncertain limit which sometimes (though fortunately very rarely) occurs with disastrous consequences.

Accidents of this character are generally caused by some defect occurring in one or other of the parts incidental to the steam-service and exhaust-steam equipments, as the reducing valves, safety valves,

and steam traps. If such defects prevent the proper action of those parts, the steam might attain to a pressure within the cylinders greater than these are capable of withstanding, when they are liable to burst.

Hence, the possible risk of such accidents occurring without previous warning, suggests the expediency of furnishing each cylinder independently with a suitable type of safety valve to open automatically and thus allow the steam to escape from them in the event of the internal pressure attaining a prescribed limit. By adopting this course the auxiliary cylinder safety valves would constitute an additional precaution against the risk of explosions that are liable to occur as a result of defects in other directions.

Possibly a suitable type of safety valve to employ for this purpose would be one designed on a similar principle to that inherent to the vacuum or air-inlet valve illustrated in Fig. 98, but with the steam valves fixed on the cylinder end-plates in a position which is the reverse to that of the vacuum valves, so that they will open and allow the steam to blow off whenever the internal pressure attains the prescribed limit.

§ 217. In March 1911, the small cylinder of a slasher sizing machine exploded after being in use for a period stated to be not less than twenty years. This cylinder was constructed with end-plates of  $\frac{1}{4}$  in. steel formed with flanged rims 2 in. wide, and stayed with six  $\frac{3}{8}$  in. cross-bolts formed with a forged collar at each end, against which the end-plates were held by means of nuts, externally. The cylinder shell consisted of four tinned steel sheets  $\frac{1}{16}$  in. thick, soldered to the flanged rims of the end-plates, and pieced horizontally by overlapped, single-riveted, and soldered joints or seams. The shell was also supported, internally, by three circular T-iron hoops placed at regular intervals apart between the cylinder ends, to prevent the shell from collapsing.

Further precaution against this risk was taken by fixing an air-inlet or vacuum valve in each end-plate, and the water of condensation was removed from the cylinder by means of three water-buckets. Also the main steam-service pipe leading to the cylinder trunnion or journal, through which steam was admitted to the cylinder, and which had an internal diameter of 1 in., was furnished with a reducing valve, a deadweight safety valve loaded to blow off at a gauge

pressure of 12lb., and a steam-pressure gauge. The steam pressure in the boiler was equal to 100lb. per sq. in., which was supposed to be reduced finally to a gauge pressure of about 10lb. before it entered the cylinder; but in consequence of the piston or plunger of the reducing valve having worn, it failed to act properly, and thus allowed the steam to pass it and enter the cylinder at a pressure which it could not withstand.

Furthermore, the attendant in charge stated that he had not observed anything unusual, and even that steam was not blowing off at the safety valve, previous to the cylinder bursting. When this occurred, one of the seams of the cylinder shell was torn open and wrenched from the rivets right across the cylinder, and the shell was also torn away for nearly three-quarters of its circumference from the flanges of the cylinder end-plates to which it was soldered. The cylinder end-plates were bulged, the machine framing was broken in several places, and the large cylinder and the floor were also damaged by the explosion.

§ 218. Another cylinder, also the smaller one, exploded in May 1911, after being in use for a period of thirty-three years. In its general constructive features this cylinder was similar to the previous one, excepting that the end-plates were made of  $\frac{1}{4}$ in. Low Moor iron plates stayed with eight cross-bolts; and the shell consisted of four tinned iron sheets  $\frac{1}{20}$ in. thick, supported internally by three T-iron hoops. (The number of sheets of metal employed in the construction of the cylinder shells usually coincides with the diameter of the cylinders, expressed in foot-units.) The cylinder was also provided with the usual number of three water-buckets, from which tapered outlet pipes led to the discharging journal of the cylinder.

The several accessories incidental to the steam-service range of piping comprised a main steam-reducing valve; a final reducing valve for each cylinder, a safety valve loaded to blow off at a steam gauge pressure of  $11\frac{1}{2}$ lb. per sq. in., and also a pressure gauge for the large cylinder only; a vacuum or air-inlet valve in both ends of each cylinder; a manhole 15 by 10in. at one end of each cylinder; and a steam trap with an outlet valve of  $1\frac{1}{4}$ in. diameter for each cylinder.

The cylinders were supplied with steam generated in water-tube boilers, and conveyed along 70ft. of  $\frac{1}{2}$ in. piping to the main reducing valve, whence the steam passed through 32ft. of  $\frac{1}{2}$ in. piping to the

final reducing valves on the machine, where the steam pressure was further reduced from 20lb. to the working pressure required in the cylinders, to which it was admitted after passing through another 15ft. of 1in. piping leading from the final reducing valves to the admission journals of the cylinders.

But since the steam-service pipe, leading to the small cylinder which burst, was not provided with either a safety valve or a steam-pressure gauge, it was impossible at any time to ascertain, with certitude, the cylinder pressure, which was controlled primarily by the main reducing valve that was supposed to reduce the boiler steam pressure from 175lb. to a pressure of 20lb., although the actual pressure in the boiler sometimes attained to 190lb., indicating a steam-gauge pressure of 22lb. per sq. in.

The primary cause of the cylinder exploding in this instance was attributed to some defect occurring in the steam trap, which caused the outlet for the water of condensation to become choked, whereby the steam attained an abnormal pressure in the cylinder, and finally burst it. When the explosion occurred, the cylinder shell was wrenched from the rivets along one of the seams right across the cylinder, and the shell was torn clean away from the soldered joints on the flanged rims of the cylinder end-plates for nearly the entire circumference of the cylinder, thereby demolishing the wooden casing which enclosed the cylinders, and also displacing several parts of the machine.

#### METHODS OF MOUNTING AND DRIVING THE DRYING CYLINDERS

§ 219. It was stated in § 209 that the journals or trunnions of the drying cylinders of slasher sizing machines were variously mounted (*a*) in ordinary stationary cup bearings; (*b*) on roller bearings; (*c*) in ball bearings; and also that the cylinders in some machines were rotated by means of frictional driving gear, instead of imposing that function upon the warp threads, and thereby depriving them of their valuable property of elasticity.

Frictional resistance between the cylinder journals and bearings is greater with ordinary cup bearings than with roller bearings, and is least with ball bearings. Therefore, when the rotation of the cylinders devolves entirely upon the frictional surface grip and pro-



gress of the yarn, the degree of tensile strain imparted to the threads is reduced to the minimum if the cylinder journals revolve in ball bearings. But if the cylinders are driven through the medium of

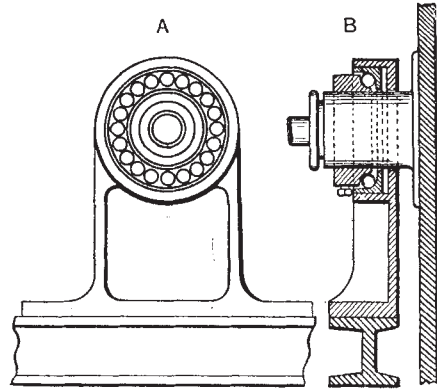


Fig. 105.

frictional clutches, these may be regulated to turn the cylinders with a surface velocity coinciding exactly with the progress of yarn from the back or slashers' beams to the weaver's beam, whereby the degree of tensile strain upon the threads is absolutely nil.

If, however, the cylinders are driven by frictional driving gear, the advantages to be otherwise derived from mounting them

on either roller or in ball bearings would be nullified so far as the effect upon the threads is concerned. And although a small reduction of driving power would be effected by adopting cylinder ball bearings in conjunction with frictional driving gear, the gain would be so inappreciable that it would not be worth the extra cost of ball bearings, albeit such a combination of cylinder bearings and driving gear has been actually adopted.

Two illustrations of the application of ball bearings to the journals of drying cylinders are given in Figs. 105 and 106, which represent Rossetter & Briggs' alternative modifications of that

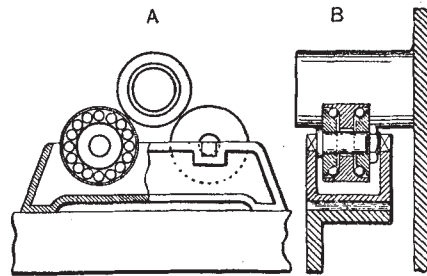


Fig. 106.

type of bearing. By one method, represented by a side and a front sectional elevation at A and B respectively, Fig. 105, the cylinder journals revolve each within an external ring of balls that are retained in position by, and roll freely around, an

angular recess formed in a hub, as indicated in the sectional diagram B.

An alternative method of supporting the cylinder journals is illustrated in Fig. 106, A and B, which represent another type of bearing consisting of a combination of both balls and flanged rollers, operating in conjunction. With this type of bearing the journals are borne by and revolve upon two flanged rollers that revolve around two internal rings of balls retained in angular recesses formed in the hub around which the balls roll freely, as indicated in the diagram B.

#### FRICITIONAL DRIVING MOTIONS FOR CYLINDERS

§ 220. One of several methods of frictional driving adapted to the cylinders of slasher sizing machines is that of Messrs Henry Livesey's, illustrated in Figs. 107 and 108, which represent a side elevation and a part plan respectively of a sizing machine to which that method of driving is applied. This device consists essentially of two flat metal friction discs in combination with, and separated by, a bevel friction wheel to constitute a simple form of frictional driving disc or clutch, as represented separately on a larger scale in Fig. 109, to be described later.

Two separate clutches are employed, one for each cylinder, and they are each operated by bevel pinions on the long side-shaft of the machine, from which motion is transmitted positively and directly to the frictional driving clutches, whence it is transmitted *negatively*, through the medium of wheel gearing, to the respective drying cylinders.

This is effected, in respect of both cylinders, by gearing a bevel pinion wheel C on the long side-shaft K, with a bevel friction wheel B mounted quite freely on the hubs or bosses of two friction discs D, E, that are situated one on each side of the friction wheel, but separated from it by interposing flannel or felt washers F, F, that are kept well lubricated as a precaution against the risk of generating frictional heat. The parts just enumerated constitute the driving clutch, of which Fig. 109 is an enlarged sketch.

The friction wheel B and the friction discs D, E, are contained on the forward portion of a short shaft or stud J, on the rear part of which there is also keyed a spur pinion wheel A, which drives a short

Fig. 107.

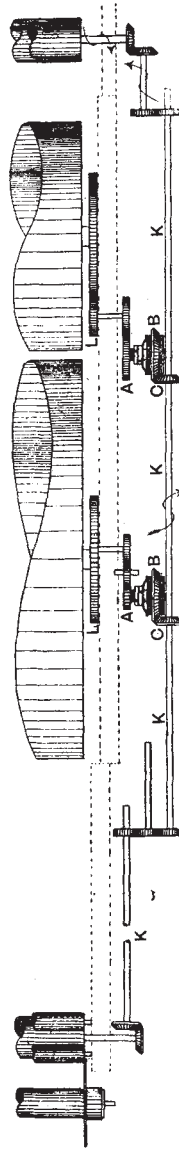
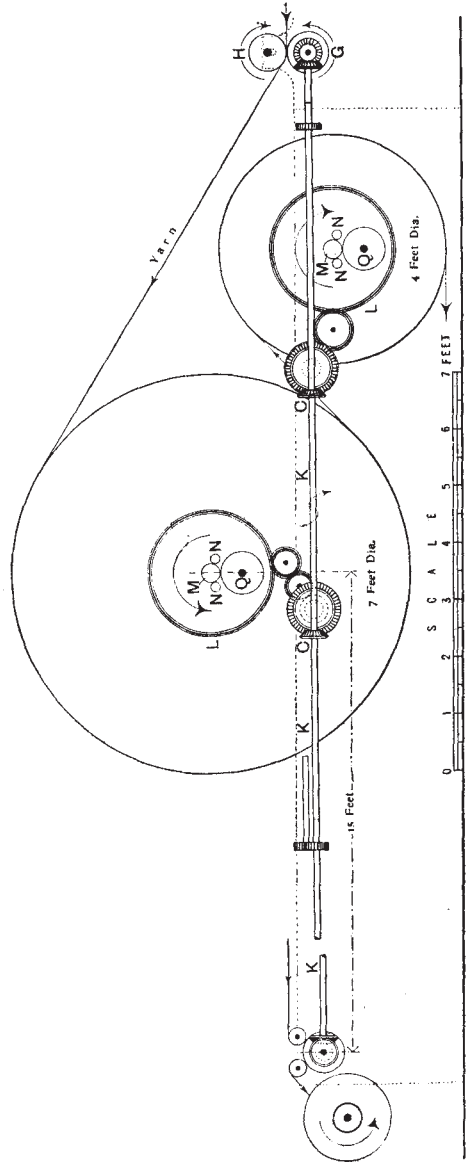


Fig. 108.—FRICTIONAL DRIVING MOTION FOR CYLINDERS.

train of wheels terminating with one L, that is keyed on one of the cylinder journals M, which are mounted on single-roller bearings Q of large diameter, and between two small steadying rollers N, to keep the cylinders in position. One of the two friction discs D is fixed on the shaft J; but the second disc, E, is quite loose, and capable of sliding freely in a horizontal direction upon the shaft, though both this disc and the shaft must necessarily revolve together by reason of a float or feather key, which is fixed in the shaft, entering a keyway or channel cut into the boss of the disc D.

Hence, the friction wheel B is capable of transmitting motion to the friction discs D, E, and thence through the trains of wheels to the respective cylinders, only by compressing the friction discs against the friction wheel until there is produced such a degree of frictional resistance between them as is necessary to rotate the cylinders with a surface velocity that will coincide exactly with the pace at which yarn is delivered to them by the sizing and finishing rollers G, H, and at which it is withdrawn from them and delivered to the weaver's beam by the tension or drawing rollers.

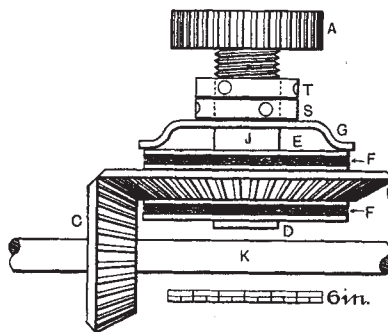


Fig. 109.

The compression of the friction wheel and discs is effected by means of a spring clamp G and a circular nut S. This is screwed up on a threaded part of the shaft J until the frictional resistance between the friction wheel and discs is sufficient to drive the cylinders with a velocity that will maintain a uniform degree of tensile strain upon the yarn without stretching the threads, and thereby destroying their property of elasticity. When, according to the judgment of the attendant, the requisite degree of tension upon the yarn is obtained, the first nut S is secured by a lock-nut T to prevent it from unscrewing accidentally, and thereby reducing the compression, and therefore the driving efficiency, of the frictional driving clutches.

§ 221. Another method of frictional driving adapted for turning the cylinders of slasher sizing machines is that of Messrs Howard &

Bullough's, illustrated by a part end elevation and a part plan in Figs. 110 and 111 respectively. By this method of driving, motion is also transmitted from the long side-shaft K to the respective cylinders, through the medium of frictional driving clutches; but in this example the friction wheels B of the driving clutches gear directly with spur-teeth formed around the rim at one end of each cylinder, as indicated in the diagrams. The degree of compression between the friction wheel B and the single friction disc D, of the respective driving clutches, is regulated by varying the tension of an open spiral

Fig. 110.

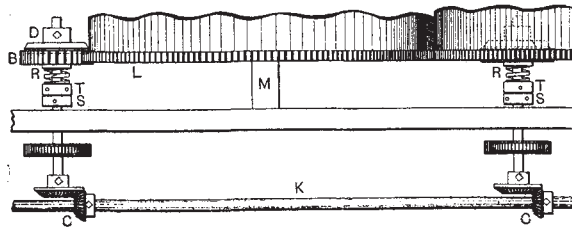
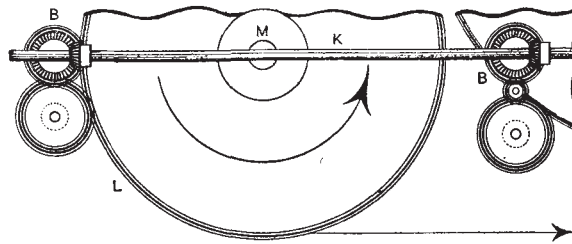


Fig. 111.

spring R by means of a circular nut S secured by a lock-nut T.

By reason of the frictional driving wheels B of this motion gearing directly with teeth formed around one end of the respective cylinders, the clutches acquire a much greater purchasing power or leverage in turning the cylinders. This circumstance, combined with the relatively high velocity with which the frictional driving wheels must revolve, gives this motion much greater driving power than is attainable by driving the friction wheels with a slower velocity and gearing them either directly or indirectly with wheels of which the teeth are nearer to the axes of the respective cylinders.

When putting into operation, for the first time, a slasher sizing machine which is furnished with frictional driving gear to rotate the cylinders, the driving clutches should be quite free from compression. Then, whilst the machine is in operation, with yarn passing through it, the clutches may be compressed gradually and cautiously until the cylinders acquire a velocity that will ensure the requisite tension upon the yarn according to the experienced judgment of the attendant, whose only guide is to feel at the yarn in its progress through the machine, and on the weaver's beam.

Also, if under any special circumstance it is deemed expedient to impose upon the warp threads the effort of rotating the drying cylinders, this may be easily and readily effected by simply releasing the compression of one or both of the frictional driving clutches, thereby leaving one or both of the cylinders quite free to revolve solely by the frictional surface grip of the threads upon the cylinder shells.

#### RELATIVE DISPOSITION OF THE DRYING CYLINDERS

§ 222. It has been observed that some slasher sizing machines differ from those of the regular standard design in respect both of the number of drying cylinders employed and also of the relative disposition of the usual 7ft. or 6ft. and 4ft. cylinders. These modifications assume a variety of different forms, chiefly according to the particular object which they are designed to accomplish. For example, some machines are constructed with only one drying cylinder; others with three cylinders; whilst some that are constructed with two cylinders of the usual diameters have those mounted in the reverse order, in relation to the other parts of the machine, from that which usually obtains.

These variations are effected usually with some specific object in view. Thus, single-cylinder machines are designed with a view to effecting economy in the consumption of steam, and also in the amount of floor space which they occupy; whereas others are constructed with an additional drying cylinder either to increase the general efficiency and productive capacity of the machines, or else with the object of adapting the machines suitably to meet some particular technical requirement involved in the manufacture of

certain classes of fabrics, such as dhooties, handkerchiefs, and others in which different colours of warp threads are employed.

In this case it is usual to construct the machine with an auxiliary size-box placed at a higher elevation, and equipped with the usual accessories, to permit of the coloured warp threads being separated and sized apart from the other warp threads to prevent the risk of these becoming stained from fugitive dye, such as would be liable to occur if the different colours of threads were passed together through the same solution of boiling size.

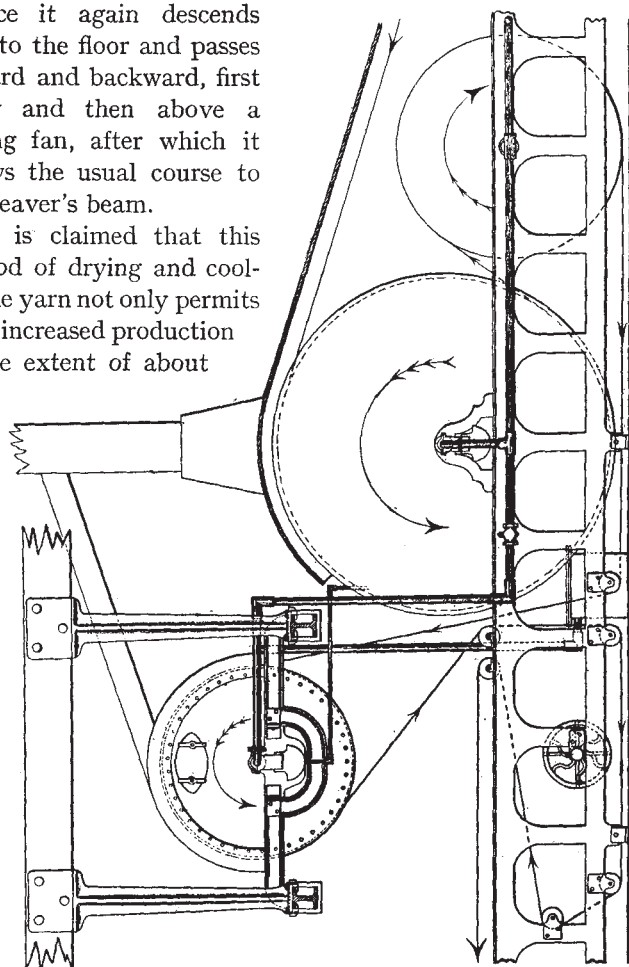
§ 223. If slasher sizing machines are constructed with only one drying cylinder, this is usually of the cavity type, having an external diameter of 9ft., and formed with an annular space having a radial depth of 6in., to constitute a steam jacket or chamber extending between an inner and an outer cylinder shell. Sizing machines constructed with a 9ft. cavity cylinder not only occupy relatively less floor space than those constructed with two hollow-drum cylinders of 6ft. and 4ft. diameter respectively, but a cavity cylinder also possesses a relatively much greater drying efficiency than the two ordinary cylinders, in proportion to the consumption of steam, which is in the ratio of 1 to 3 respectively. Thus, the drying efficiency of a 9ft. cavity cylinder supplied with steam indicating a gauge pressure of 3 to 4lb. is equal to that of two ordinary cylinders of 6 and 4ft. diameter supplied with steam indicating a gauge pressure of about 9 to 12lb. Also, the effective drying surface afforded by a cylinder 9ft. diameter, and with a yarn contact of  $300^{\circ}$ , or five-sixths of the circumference, is quite equal to that afforded by two cylinders of 6 and 4ft. diameter respectively, with a yarn contact on each cylinder of  $270^{\circ}$ , or three-fourths of their circumference.

§ 224. One of several modifications designed with the object of increasing the drying efficiency, and thereby the productive capacity, of slasher sizing machines, is that of Crook's, illustrated in Fig. 112, which represents a part side elevation of a machine constructed with an auxiliary drying cylinder having a diameter of about 4ft. This cylinder is placed at a high elevation in front of the large cylinder, and supported by an iron girder rafting suspended by roof hangers, so that the additional cylinder does not involve additional floor space for the machine. With this arrangement of three drying cylinders, the progress of yarn through the machine follows its usual course



until it is deflected from a horizontal course near the floor, and conducted upwards immediately in front of the large cylinder, to pass over the auxiliary cylinder, whence it again descends near to the floor and passes forward and backward, first below and then above a cooling fan, after which it follows the usual course to the weaver's beam.

It is claimed that this method of drying and cooling the yarn not only permits of an increased production to the extent of about



one-third, but that it also conduces to a mellower tone and superior quality of yarn, resulting from the longer exposure of the threads to the air-drying influence of the cooling fan. Also, that in consequence

of conducting the yarn along a more circuitous course, when it is not in actual contact with the hot surface of the drying cylinders, the tension of the warp threads is of a more uniform degree. Further, that heavily-sized warps are dried and finished more perfectly and with less risk of scorching the yarn on the cylinders.

§ 225. Another method of adapting an auxiliary drying cylinder to an ordinary slasher sizing machine is that of Martin's, illustrated in Fig. 113, which represents a part side elevation of a machine

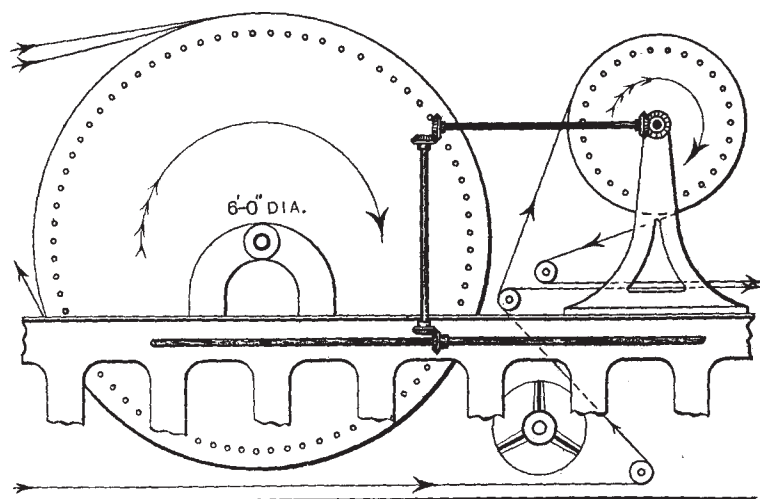


Fig. 113.

adapted expressly for sizing warps composed of both grey and coloured threads, for the production of dhootie bordered fabrics and other coloured stripe warp effects. When sizing warps of this class it is usual to separate the grey and coloured threads and pass them through separate size-boxes to prevent the risk of staining the grey yarn with dye from the coloured yarn. On emerging from their respective size-boxes, both the grey and coloured threads are conducted around the two ordinary drying cylinders in the usual manner, and on leaving the smaller cylinder the coloured yarn is then passed over the auxiliary drying cylinder to be dried more efficiently, after which both series of threads are again united and wound together on to the weaver's beam.

The auxiliary drying cylinder may be mounted either before or behind the large drying cylinder, and supported by girders fixed either to roof hangers or else to standards bolted to the machine framing. Also, it may be driven either by the surface grip of the yarn, or else through the medium of toothed gearing operated from the side shaft of the machine, as indicated in the diagram.

§ 226. A departure from the usual practice of withdrawing the yarn from the respective back beams in the creel of a slasher sizing machine, and also of passing it around the drying cylinders, is that represented in Fig. 114, which illustrates Hargreaves' modification of a sizing machine in which the respective sheets of warp threads from the several back beams are kept quite separate and distinct from each other until they are all combined into one sheet of threads as they pass underneath the copper immersion roller in the size-box; further, the large and small drying cylinders are mounted in reverse positions, relatively to other parts of the machine, to those which they usually occupy. With this arrangement of the drying cylinders the yarn is capable of extending around the large cylinder for about eight-ninths of its circumference, but for only about one-half the

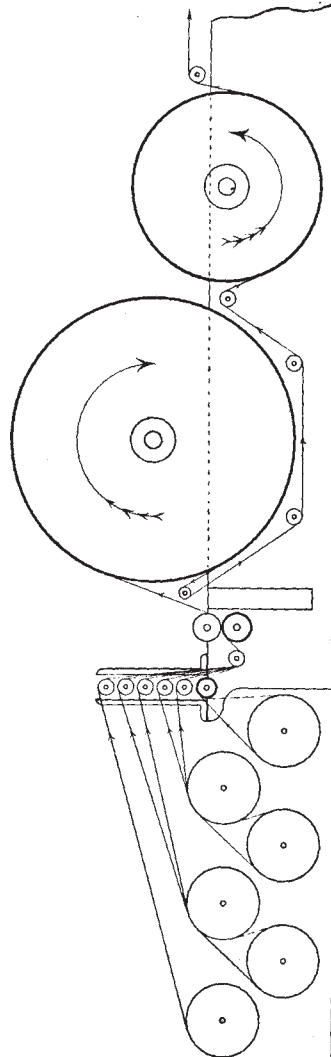


Fig. 114.

circumference of the smaller cylinder. Thus the effective drying surface afforded by the two cylinders in this case is approximately the same as that afforded by two cylinders of corresponding diameter mounted in the usual manner, and with a yarn contact on each cylinder for three-fourths of their circumference.

The object of keeping each sheet of threads separate is to permit of their immersion into the solution of size whilst the warp threads are in a more open and free state, whereby they become more thoroughly impregnated with size. Also, the closer proximity of the large cylinder to the sizing rollers has the advantage of shortening very considerably the stretch of yarn between those parts, thereby reducing the tendency of the warp threads to curl and become entangled when, on stopping the machine, they are relieved of tensile strain and therefore become slack.

#### COOLING FANS

§ 227. Slasher sizing machines are furnished with either one fan only, as represented in Figs. 112 and 113, or else with two fans, for the purpose of cooling the yarn after being dried by the hot cylinders, and before it passes on to the weaver's beam. If the yarn were wound, whilst in a warm state, on to the weavers' beams, and then allowed to cool naturally, the process of cooling would create moisture in the yarn, thereby conducing to the development of mildew, and also causing the warp threads to adhere together.

The cooling fans are mounted in front of the large cylinder, near the floor, as indicated in Figs. 112 and 113, and are driven with a high velocity to create a strong current of cool air which is fanned on to the yarn as this is deflected upward from near the floor, to be conducted under and over the dividing rods.

#### DIVIDING RODS

§ 228. It has been stated previously in § 181 that the several sheets of threads from the respective back beams are all immersed simultaneously into the solution of size, and afterwards dried as one single sheet of threads, with the result that the threads adhere to

each other, and therefore require to be separated before they are wound finally on to the weavers' beams.

This is effected by passing the threads in a prescribed manner under and over a series of iron bars termed "dividing rods" that are placed in the rear part of the headstock framing, and extend horizontally across the entire width of the machine in a little higher plane than the upper edge of the framing. The rods are disposed parallel with each other at regular intervals of 12 to 18in. apart, and at slightly different elevations, to avoid unnecessary chafing of the yarn.

The number of dividing rods employed is always one less than the number of back beams; and, with the exception of the rearmost rod (from the front of the machine), which is about 2in. diameter, the rods are of a uniform diameter of about 1¼in. Therefore, in order to divide the combined sheet of sized warp threads from six back beams into that number of separate sheets of threads, precisely as these left their respective beams, only five dividing rods are required with the threads passed under and over them in the manner indicated in Fig. 115, and specified as follows:—

Yarn from No. 1 beam passes	{	over rods No. —, 2, —, 4, — under rods No. 1, —, 3, —, 5
Yarn from No. 2 beam passes	{	over rods No. 1, 2, —, 4, — under rods No. —, —, 3, —, 5
Yarn from No. 3 beam passes	{	over rod No. —, —, —, 4, — under rods No. 1, 2, 3, —, 5
Yarn from No. 4 beam passes	{	over rods No. 1, 2, 3, 4, — under rod No. —, —, —, —, 5
Yarn from No. 5 beam passes	{	—, —, —, —, — under rods No. 1, 2, 3, 4, 5
Yarn from No. 6 beam passes	{	over rods No. 1, 2, 3, 4, 5 —, —, —, —, —

This method of separating the warp threads forcibly by tearing them asunder whilst they adhere more or less tenaciously with size, acts detrimentally upon the yarn, and not only partially destroys the beneficial effects of sizing, but the separation of the threads is also more or less imperfect, since it is possible, and in fact sometimes actually occurs, that two or more contiguous warp threads from the same back beam may pass on to the weaver's beam without being separated.

## DRIVING GEAR

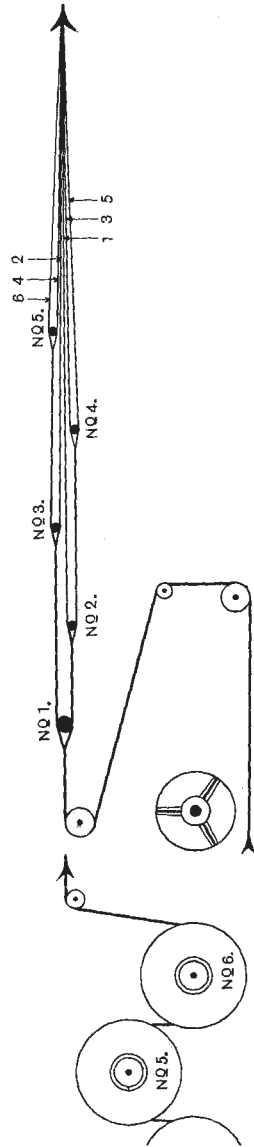


Fig. 115.

§ 229. Slasher sizing machines are usually constructed with driving gear designed both for differential speeds and also to operate the machine optionally at either the full speed or at a dead-slow speed. The special object of employing differential gearing is to provide for the varying requirements arising from the difference in the counts and strength of yarn, the number of warp threads, the character and percentage of size-paste applied to the yarn, the drying efficiency of the cylinders at different steam pressures, the atmospheric condition of the sizing room as regards both the temperature and the relative humidity of the air, and many other variable and uncontrollable factors which necessitate either an increase or a reduction of the speed with which the machine is driven.

The slow-speed driving gear is adopted as a precaution to guard against the risk of parching or scorching the yarn on the drying cylinders by enabling the machine to be operated at a dead-slow speed, instead of stopping it entirely when recovering and piecing broken warp threads, and also when removing a filled weaver's beam and replacing it with an empty one.

## FULL-SPEED DIFFERENTIAL DRIVING GEAR

§ 230. The driving gear of slasher sizing machines made by different makers varies in minor details of construction.

In some machines the driving mechanism consists of a simple train of wheel gearing which permits of a variation of speed being effected only by substituting different sizes of change-pinions whilst the machine is stopped. The more prevalent method of driving, however, is effected by the employment of two reversed cone drums that are in gear through the medium of a driving belt which may be moved along the cone drums to vary the speed of driving whilst the machine

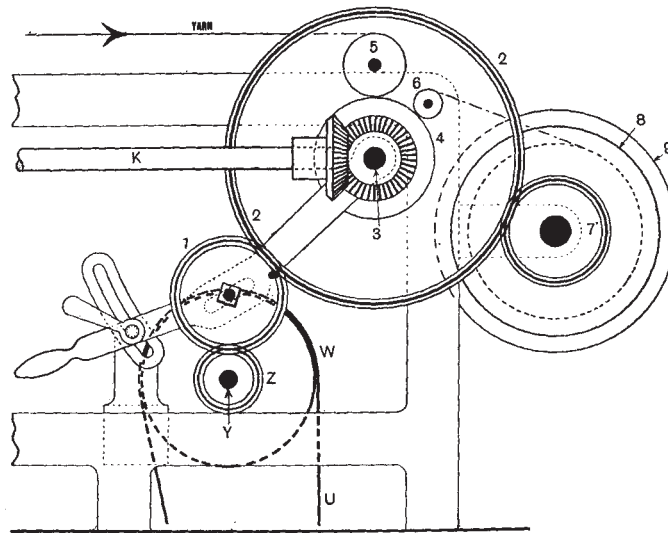


Fig. 116.

is in operation. Also, in order to obtain a still wider range of speed variation than that afforded by either change-wheel gearing or with cone drums, if each method is employed alone, the driving mechanism sometimes consists of a combination of both those methods.

An example of change-wheel driving gear is illustrated in Fig. 116, which represents a part end elevation of the foremost end of the headstock of a machine constructed by Messrs Wm. Dickinson & Son. With this method of gearing motion is derived from the main driving belt U, which runs on the fast and loose driving pulleys W that are mounted on one end of a shaft Y. On the opposite end of this shaft there is fixed the change-pinion Z, which, through the medium of an adjustable carrier wheel 1, transmits motion to a



large spur-wheel 2, keyed on one end of the shaft 3 of the tension or drawing roller 4. In addition to turning the tension roller 4, the spur-wheel 2 also drives a smaller wheel 7, which puts into operation the frictional winding motion 8 to turn the weaver's beam 9 in a manner described subsequently in § 239.

In conjunction with two supplementary drawing rollers 5 and 6, of which roller 5 is very heavy, the roller 4 draws the yarn forward from the sizing rollers and delivers it to be wound on to the weaver's beam 9. The supplementary drawing rollers cause the yarn to make a larger arc of contact with the surface of the larger tension roller, and thereby obtain a firmer grip of that roller, which is driven positively by the wheel gearing in the manner described.

The surface of the roller 5 is wrapped with several coils of cloth to prevent injury to the threads, and it is usually made slightly greater in circumference than that of the lower sizing rollers which, through the medium of the long side-shaft K and bevel wheels, derive their motion from the tension-roller shaft 3, as described in § 186. The object of having the drawing roller of greater circumference than that of the lower sizing rollers is in order to prevent the delivery of yarn by those rollers exceeding its rate of withdrawal by the tension roller, as that would cause the yarn to become slack, and thereby fail properly to grip the surface of the drying cylinders.

The advantages of this method of driving, as compared with belt driving with cone drums, are that, being positive, it is thereby more certain and reliable than the frictional grip of driving belts, which are liable to slip and thus lose their driving power. Also, the initial cost, and that of maintaining it, are less than the cone-drum method of driving.

It has the disadvantage, however, of being much less convenient than cone drums for effecting a variation of speed; for should it become necessary, as it frequently does, to vary the speed of the machine during the progress of sizing, the machine would have to be stopped entirely for the purpose of changing the pinion; and this not only necessitates either shutting off steam from the drying cylinders, or else reducing the steam pressure, to prevent the risk of scorching yarn whilst the machine is temporarily stopped, but it also hinders production.

Further, wheel gearing alone does not afford either the same

range of speeds, nor the same graduation of speed variation, between the maximum and minimum velocities, as may be obtained by the employment of cone drums.

§ 231. An adaptation of the cone-drum principle of differential driving is illustrated in Figs. 117 and 118, which represent a side elevation and a plan respectively of the headstock of a slasher sizing machine. In combination with that method of driving there is also illustrated, in Fig. 118, a plan of Hitchon's adaptation of what is

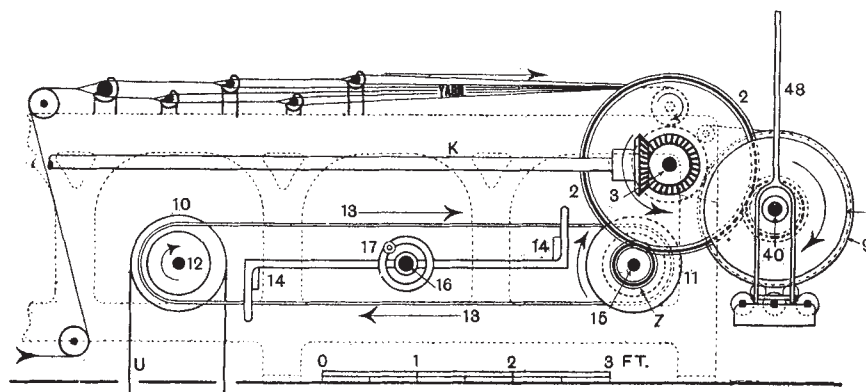
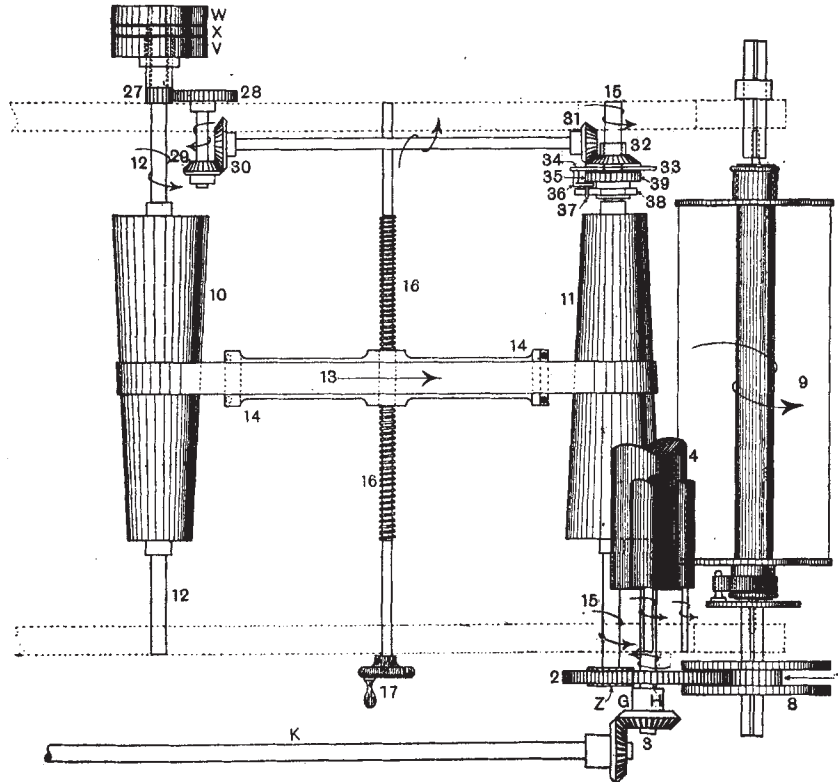


Fig. 117.

variously described as the "Lancaster" slow-driving motion and the "click" motion, which is also applied to spinning mules. The differential driving motion consists essentially of two wide cone drums 10 and 11, situated about 5ft. apart, with their axes in the same horizontal plane and parallel to each other.

When the machine is in operation at full speed, drum 10 is the prime motor which transmits motion to all other working parts of the machine. This is put into operation at full speed by passing the main driving belt U from the loose pulley V to the fast pulley W keyed on one end of the shaft 12 of the cone drum 10, which is always driven with a constant velocity. Motion is transmitted from the driving cone 10 to the driven cone 11 by means of a belt 13, under the guidance of a double belt-fork 14. On one end of the shaft 15 of cone drum 11, there is keyed a pinion wheel Z which gears with and drives a large spur-wheel 2' keyed on the large tension-roller

shaft 3, thereby rotating the tension or drawing roller 4 with a constant velocity. The belt-fork 14 is controlled by means of a worm shaft 16 furnished at one end with a hand-wheel 17 which, on being



[Fig. 118.—DIFFERENTIAL CONE-DRUM DRIVING GEAR.

turned, moves the cone belt to different parts of the surfaces of the cone drums, and thereby varies the speed with which the machine is driven. Thus, by passing the cone belt to a larger diameter of the driving cone 10, and therefore to a smaller diameter of the driven cone 11, the velocity of the latter, and consequently the progress of yarn through the machine, will be accelerated; whereas, if the cone

belt is moved in the opposite direction, the speed of the machine will be retarded.

By this method of driving, the operation of the machine devolves entirely upon the cone belt, which not only tends to slide towards the smaller diameters of the cone drums, but is also liable to become slack, and therefore slip upon them. Hence the belt loses its grip and driving power, thereby retarding the speed of the machine, and thus curtailing production. This absence of reliability and certainty of action, as well as the extra cost incurred by the additional mechanism of the cone-drum method of driving, are the chief considerations urged against its adoption.

§ 232. Numerous methods have been adopted with the object of overcoming the slipping of belts on cone drums, and thereby increasing their driving efficiency. For example, instead of employing a single wide belt, two or three narrow strips of belts are sometimes employed side by side. In some cases the narrow belts are quite separate, and in others they are connected by means of cross-bands or strips of leather. The object of this arrangement is to obtain a belt of greater flexibility, and also one that can adapt itself more readily to the inclined surfaces of the cone drums. Sometimes two or three belts have been superimposed with the object of increasing the frictional grip of the belt on the surfaces of the cone drums; but this method is not very successful, probably in consequence of the outer belts tending to run quicker than, and "creep" along, the inner belts. A method patented by Thompson is to superimpose a wide belt upon, and rivet it to, another belt of about one-half or one-third the width, and which runs in contact with the drums.

§ 233. Another form of driving belt which has proved to be very effective for cone-drum driving is one composed of leather links placed on edge and pinned together so as to constitute a wide chain belt which tapers in thickness across the width of the belt. The belt is placed in position on the cone drums by giving it a half-twist in such a manner as to cause the thicker edge of the belt always to run on the smaller diameter of both cone drums, and *vice versa*.

§ 234. Another type of differential driving gear, adapted to some slasher sizing machines made by Messrs Butterworth & Dickinson, Ltd., is that illustrated in Figs. 119 and 120, which represent a side elevation

and part sectional plan, respectively, of what is known as the "Hunter" type of variable speed driving motion, which permits of a

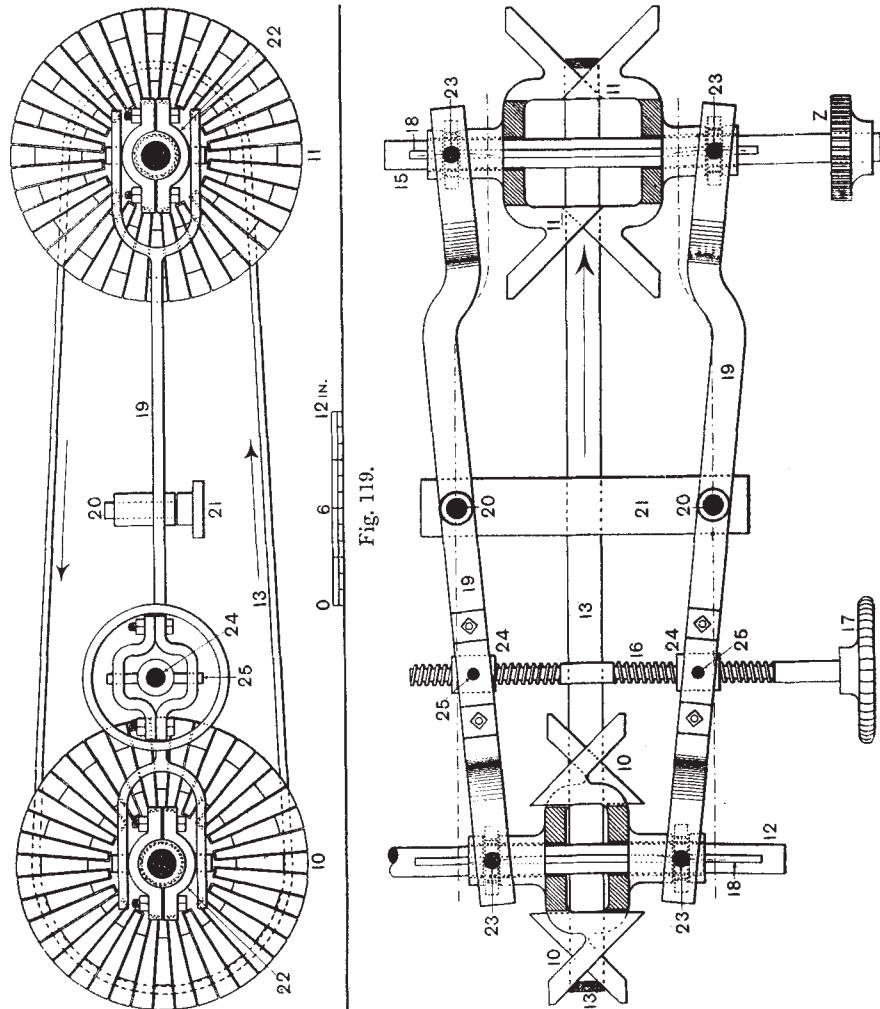


Fig. 119.

Fig. 120.—"HUNTER" TYPE OF DIFFERENTIAL DRIVING GEAR.

differential velocity being effected whilst the machine is in full operation, without the employment of either change-wheels or cone drums. The central feature of this ingenious device consists of two special

forms of grooved pulleys 10 and 11 that are capable of being either expanded or contracted in the direction of their axes, whereby their diameters are reduced or enlarged respectively. These two pulleys correspond to, and are employed in lieu of, the two cone drums represented in Fig. 118 and described in § 231. Thus, the pulley 10 on the main driving shaft 12 corresponds to the driving cone which, through the medium of a thick belt 13, transmits motion to the pulley 11, on the shaft 15, and which corresponds to the driven cone.

With this present method of driving, however, the tread of the pulley belt 13 is always in the same prescribed circuit, and the speed of the machine is regulated by varying the diameters of the driving and driven pulleys in a converse ratio, simultaneously, and in a manner to be described presently.

The pulleys 10 and 11 each consist of two complementary and reversed halves, as indicated in part section. Each half of the pulleys is constructed with a long hub or boss, from which there radiate twenty angular staves or arms disposed at regular intervals apart. When the two complementary halves of a pulley are united, their respective arms slide freely between each other in dovetail manner, and thus become intermeshed and freely interlocked, after the character of a multiple claw-clutch. The hubs of the pulleys are capable of sliding quite freely in a horizontal direction upon their respective shafts, which are furnished with long feather or float keys 18, that enter mortised grooves or keyways cut into the hubs of the pulleys, so that both the shaft and its pulley must revolve together in unison.

The expanding and contracting of the pulleys are effected by means of two long levers 19 fulcrumed on studs 20 fixed at opposite ends of a cross-rail 21. These levers are forked at each end for the purpose of spanning hoops or rings 22, each of which enters an annular recess formed near the outer end of each hub; and a swivel connection is formed between the lever forks and hoops, by means of pins 23. Each lever is also formed with a loop to receive a bush or sleeve 24, which is attached to its lever by means of a pin 25 to form a swivel connection with it. Bushes 24 are each formed with an internal screw thread—that of one bush being a right-hand thread, and that of the other a left-hand thread—to receive corresponding threads

formed respectively at opposite ends of a worm-shaft 16, furnished at one end with a hand-wheel 17.

By turning the hand-wheel 17, levers 19 are moved in reverse directions, and thus cause the respective pulleys 10 and 11 to expand and contract simultaneously and conversely in an exactly corresponding measure, thereby changing their relative circumferences, and varying the speed with which the machine is driven, accordingly.

By this method of driving, the difficulty experienced with cone-drum driving, arising from the tendency of the cone belt to slip, is entirely avoided by reason of the pulley belt always running in a V-shaped groove formed by the radial angular staves of the pulleys.

#### SLOW-SPEED DRIVING GEAR

§ 235. A slow-speed driving motion is an almost indispensable adjunct of a slasher sizing machine, as it very considerably increases the efficiency of that machine. The slow-speed driving gear really constitutes an auxiliary driving motion which operates quite independently of that by which the machine is driven at full speed, although both schemes of driving gear are operated by the same main driving belt, but from independent driving pulleys.

The special function of the slow-speed driving gear is to transform the relatively high velocity of the driving pulley and transmit it with a considerably-reduced value to the various parts of the machine. This object is usually effected through the medium of what is known as the "Lancaster" or "click" slow-driving motion, of which one of several modifications is represented in conjunction with the cone-drum driving mechanism illustrated in Fig. 118, whilst the details of that device are represented on a larger scale by a part sectional front, and a side elevation, at A and B respectively, in Fig. 121.

The original conception of this device was designed and employed to drive, as the prime motor, the first or driving cone 10, with a very slow velocity, which was transmitted to the driven cone 11 through the medium of the cone-driving belt 13, as it does when the main driving belt is running on the full-speed driving pulley W to drive the machine at full speed. That application of the slow-speed driving gear, however, was found in practice to be mechanically



defective and unreliable from the fact that a driving belt loses power as its velocity diminishes.

This circumstance, therefore, led to the adoption of wheel gearing as a medium for transmitting motion positively to the second or driven cone 11, which thereby becomes the *prime motor*, and is therefore quite independent of the cone-driving belt whenever the slow-speed driving gear is in operation to drive the machine at a dead-slow speed. And in one form or another this method of slow driving in conjunction with cone drums is adopted in all slasher sizing machines of modern construction.

§ 236. One of several adaptations of the "Lancaster" slow-driving motion is that of Hitchon's, as illustrated in Figs. 118 and 121. This motion is put into operation by passing the main driving belt U (Fig. 118) on to a narrow-rimmed pulley X which is mounted freely on the shaft 12 of the driving cone drum 10, and placed preferably *between* the loose pulley V and the fast or full-speed driving pulley W, which is keyed on the end of the cone-drum shaft 12. The narrow pulley X, and a pinion wheel 26, are fixed at opposite ends of a long sleeve or hub 27, which, being mounted loosely on

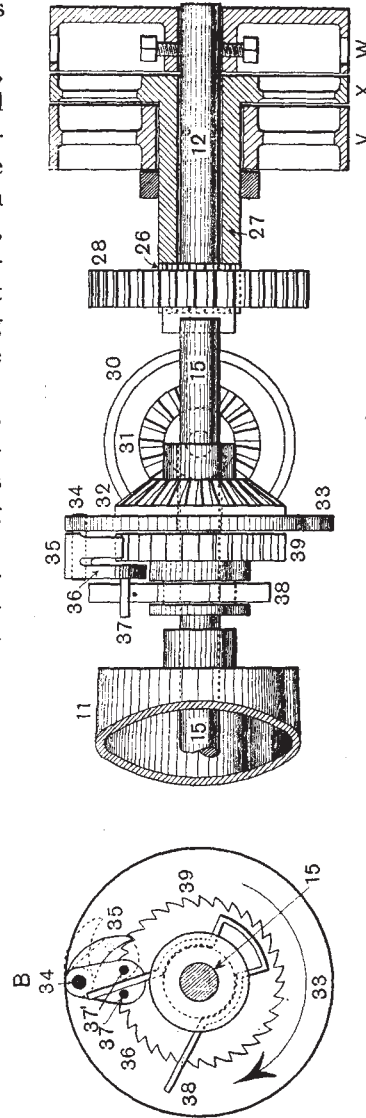


Fig. 121.—"LANCASTER" SLOW-MOTION DRIVING GEAR.

the drum shaft 12, revolves quite freely and independently of that shaft; whilst the loose pulley V is mounted and revolves freely upon the hub of the slow-driving pulley X.

When the slow-driving motion is in operation, the main driving belt U runs partly on the rim of the loose pulley V, and also partly on the rim of the narrow slow-driving pulley X, whence motion is transmitted to the cone drum 11 through the medium of a simple train of carrier wheels 27, 28-29, 30, and 31, and the Lancaster click-motion mounted on one end of the cone-drum shaft 15, which it drives with a very slow velocity.

The details of this ingenious device are better represented by a part sectional front, and a side elevation, at A and B respectively, in Fig. 121. A bevel wheel 32, and a disc 33, are secured together and mounted freely on the end of the drum shaft 15, which may revolve quite independently of the wheel 32 and disc 33, although these latter cannot revolve without also rotating the cone drum 11 with a corresponding velocity.

Near the rim of the disc 33 is a stud or pin 34, on which there is freely hinged a catch or pawl 35, cast with a pendant weight 36, from one side of which there project two short pins 37 and 37<sup>1</sup> fixed about one inch apart. These two pins are intercepted by one of two projecting ends of a thin steel spring clamp 38, which spans and grips an annular channel or recess formed in the extended hub of a ratchet wheel 39, termed the "click" wheel, keyed fast upon the cone-drum shaft 15. Hence the cone drum 11 and the ratchet wheel 39 must always revolve together with a corresponding velocity whenever the driving is effected through the medium of the slow-speed driving gear, which is put into operation in the following manner:—

On passing the main driving belt U from the loose pulley V to the slow-driving pulley X, the disc 33, with its catch 35 and weight 36, commences to revolve slowly in the direction indicated by an arrow in diagram B, and thus causes one of the short pins 37 to bear against the spring clamp 38. The frictional resistance of this spring against the hub of the "click" wheel 39 will then cause the catch 35 to become deflected until it engages with a tooth of that wheel and thereby puts the machine in operation at a dead-slow speed.

If the main driving belt U is passed from the slow-driving pulley X to the full-speed driving pulley W, the slow-driving mechanism

at once becomes inoperative, although it continues to move involuntarily by reason of frictional resistance between that mechanism and that of the full-speed driving gear.

The slow-driving motion is put out of action automatically as soon as the cone drum 11 and the "click" wheel 39 attain a velocity greater than that of the disc 33. When that velocity is attained, the spring clamp 36 bears constantly against the short pin 37<sup>1</sup>, and thereby raises the pawl catch 35 and keeps it clear of the teeth of the "click" wheel 39, as indicated by dotted lines in the diagram B.

If, on the contrary, the main driving belt is passed from the full-speed driving pulley to the slow-speed driving pulley X, the driving cone drum 10 and the cone belt 13 become inoperative, albeit the slow-driving mechanism does not become the driving factor until the velocity of the driven cone drum 11 has so far diminished that it is on the point of falling below the velocity with which it is driven by that mechanism.

When that point is reached, however, the fractional and momentary disparity which occurs between the velocity of the disc 33 and that of the cone drum 11 causes the pin 37 to bear against the spring clamp 38, whereby the pawl 35 is deflected until it engages with a tooth of the "click" wheel 39, thereby maintaining the velocity of the cone drum 11, and therefore the speed with which the machine is driven, at the dead-slow speed to which it has declined.

§ 237. A simplified adaptation of the "Lancaster" slow-driving motion to slasher sizing machines is that of Messrs Wm. Dickinson & Sons, and which is represented in Fig. 122. With this modification of the driving gear, the reduction from the maximum velocity of the driving pulleys to the minimum velocity of the driven cone drum is effected more quickly, and also by the employment of fewer working parts, which ensure more direct and therefore easier driving, than by the former method.

These objects are attained by gearing the bevel pinion wheel 27 on the hub of the slow-speed driving pulley X, directly with the bevel wheel 30, and also by employing a single-thread worm 31 to drive a worm-wheel 32, which is mounted loosely on the cone-drum shaft 15, and corresponds to the bevel wheel 32 in Figs. 118 and 121. Also the stud 34, on which is hinged the catch or pawl 35 with its pendant weight 36, is fixed to an arm 33, instead of to a disc, secured

to the wheel 32. In all other respects this device is similar to, and operates in the same manner as that described in the preceding section, 236.

A commendable feature of both of the foregoing slow-speed driving gearing is the particular arrangement of the slow-speed

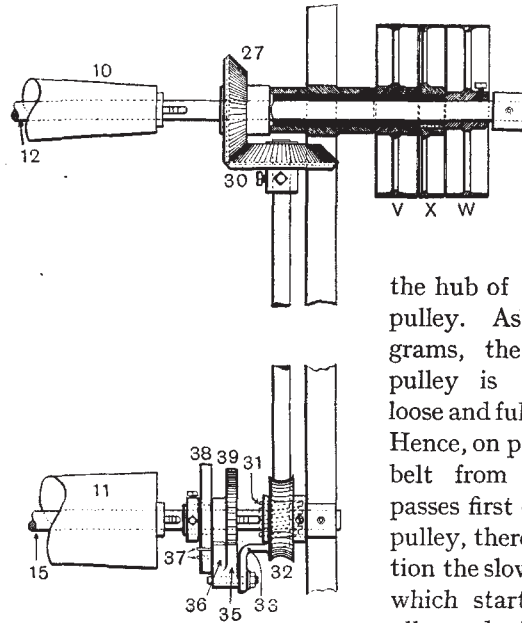


Fig. 122.

driving pulley in relation to the loose and full-speed driving pulleys, and also the incidental advantage, afforded by that arrangement, of mounting the loose pulley on

the hub of the slow-speed driving pulley. As indicated in the diagrams, the slow-speed driving pulley is situated *between* the loose and full-speed driving pulleys. Hence, on passing the main driving belt from the loose pulley, it passes first on to the slow-driving pulley, thereby putting into operation the slow-speed driving motion, which starts the machine gradually, and without undue straining of either the driving mechanism or

the yarn, before the driving belt passes on to the fast pulley to operate the machine at full speed. Also, the hub of the slow-driving pulley provides a much larger and therefore steadier and more durable bearing for the loose pulley, than if this were mounted directly on to the shaft as formerly.

An improved form of "click" motion designed primarily for use on spinning mules, but one that is equally applicable to slasher sizing machines, is that represented in Fig. 123, which illustrates a double-acting "click" motion. This improvement is effected by constructing the device with two catches or pawls, thereby ensuring greater certainty of action, and also increasing its durability.

## FRICTIONAL BEAMING OR WINDING-ON MOTIONS

§ 238. The operation of winding the yarn, after it has been sized and dried, with both a uniform tensile strain and velocity, finally on to the weaver's beam, is a function of a slasher or other type of beam-warp sizing machine which might not readily appear to present any great mechanical difficulty to its successful accomplishment. Nevertheless, the attainment of that object satisfactorily is a problem that has taxed the ingenuity of textile machinists and inventors, as evinced by the numerous and varied devices which they have designed to accomplish it. The difficulties presented will become manifest when the precise conditions under which it is performed are known; and this knowledge will enable the relative merits of the respective appliances by which it is variously accomplished to be correctly appraised.

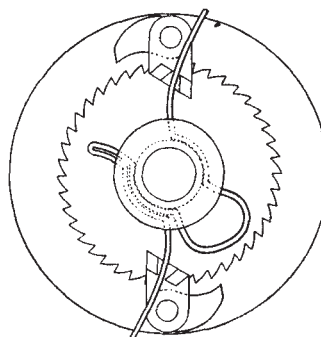


Fig. 123.

In order to ensure uniform sizing and drying of the yarn, and also a uniform degree of tensile strain upon it during its progress through the sizing machine, it should be withdrawn from the back beams and passed through the solution of size paste, thence conducted around the drying cylinders or through an air-drying chamber (according to the particular type of sizing machine employed), and then wound finally on to the weaver's beam with a constant velocity throughout, notwithstanding the gradually-increasing girth of the beam as successive layers of yarn are wound upon it.

To permit of these conditions being observed, it is imperative to employ some method of driving the weaver's beam so that its angular velocity may diminish gradually and automatically from a greater speed at the commencement of an empty beam to a slower speed as it becomes filled with yarn, and in a ratio inversely proportionate to its increasing girth, so as to maintain a surface or winding velocity of the beam that will coincide exactly with the rate with which the yarn is delivered to it by the tension or delivery rollers.

Winding-on motions of the type under present notice are invariably designed to transmit motion to the weaver's beam by frictional and therefore negative driving, which is both unmechanical in principle and unreliable in practice. This method of driving, however, has the supreme advantage of enabling the weaver's beam to diminish its angular velocity automatically as its diameter increases, and thereby accommodate its surface velocity to that with which yarn is delivered to it, albeit the frictional winding motion itself continues to revolve with a constant velocity which always bears the same ratio to that with which the yarn is delivered to the weaver's beam.

In fact, the frictional winding-on motion of a slasher sizing machine transmits motion to the weaver's beam in such a manner that it permits of the velocity of the latter being actually regulated and controlled by the pace with which yarn is delivered to it, although the velocity of the winding-on motion is of such a value that it tends always to rotate the weaver's beam *quicker* than the delivery of yarn to it will allow.

§ 239. One of several approved forms of frictional winding-on devices adapted for slasher sizing machines is that of Hitchon's, illustrated in Fig. 124, which also indicates the manner in which it transmits motion to the weaver's beam.

With a view to better demonstrating the operation of this device and displaying the details of its construction, the upper portion in the diagram represents a sectional view to expose the internal and obscure parts; whilst the manner in which the frictional device itself derives its motion is represented in Fig. 125. Thus, a pinion Z, fixed on one end of the second or driven cone-drum shaft 15, gears with and drives a large spur wheel 2 fixed on one end of the delivery roller shaft 3, through the medium of which wheel motion is transmitted to a friction wheel 7. This wheel constitutes the prime motor of the frictional winding-on device, which is usually mounted at one side of the machine only; but with one at each side of very wide machines.

As indicated in Fig. 124, the frictional driving wheel 7 is constructed with two inner flanges 7<sup>1</sup>, that extend some distance beyond the teeth of the wheel, on each side of it, and terminate each with a broad rim which projects outward at right angles to the flanges. In combination with the flanges of the friction wheel 7 are two outer

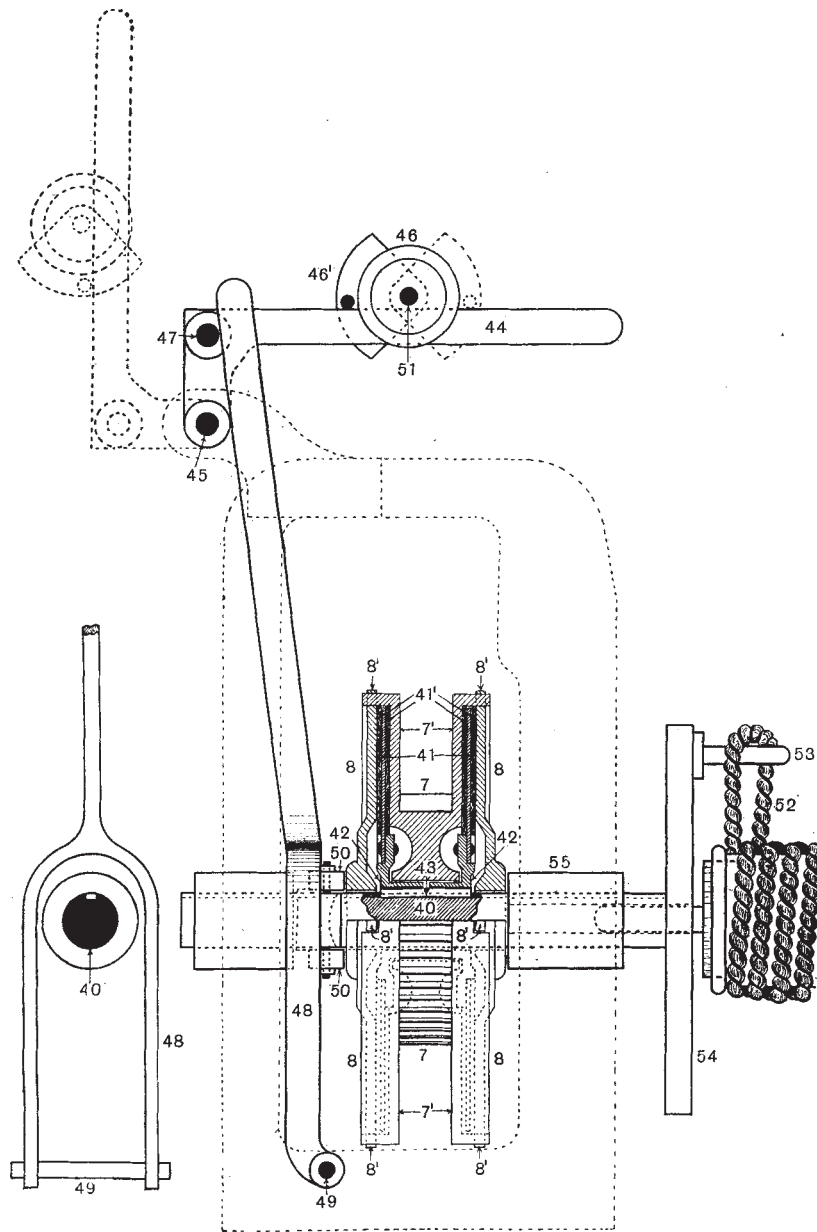


Fig. 124.—FRICTIONAL WINDING-ON MOTION.



discs 8, each cast with lugs 8<sup>1</sup>, that project slightly beyond the rims of the wheel flanges, and freely enter recesses formed in the rims, in which the lugs become locked.

Hence, the friction wheel 7, with its flanges 7<sup>1</sup>, and also the outer discs 8, always revolve together and with a corresponding velocity, but quite independently of the beam shaft 40, upon which they are all mounted quite loosely and in a manner that permits of a slight horizontal sliding movement by those parts upon the shaft, albeit the wheel flanges 7<sup>1</sup> and discs 8 impart rotary motion to that shaft,

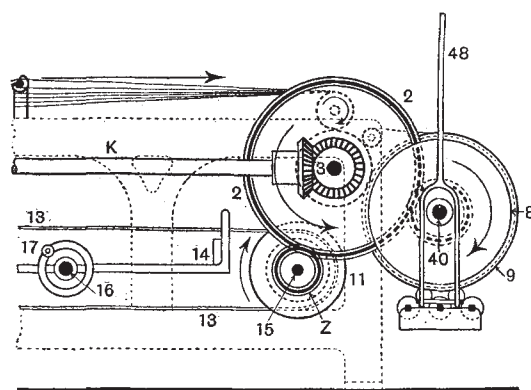


Fig. 125.

and thence to the weaver's beam, in a manner to be described presently.

The positive motion of the friction wheel 7, with its flanges 7<sup>1</sup> and outer discs 8, is transmitted frictionally to the beam shaft 40, through the medium of a pair of thin sheet

steel friction discs 41, each of which is riveted to separate hubs 42, and enclosed within two thick felt washers 41<sup>1</sup>. These hubs are mounted loosely upon the beam shaft 40, along which they are capable of a slight horizontal movement, although they cannot revolve without also rotating that shaft.

This is effected by the employment of a feather key 43, which is fixed into the shaft and freely enters a keyway cut into the hubs of the friction discs 41. The hub of the friction wheel 7 revolves freely upon the hubs of the friction discs 41, whilst the hubs of the outer flanges 8 revolve freely upon the beam shaft 40.

§ 240. It will now be manifest that by compressing the steel friction discs 41 between the outer discs 8 and the flanges 7<sup>1</sup> of the friction wheel 7, whilst this wheel is revolving, any degree of frictional resistance up to the highest possible limit may be induced between those discs and flanges for the purpose of rotating the beam shaft 40.

The required degree of compression between those parts is effected by means of an L-lever 44, termed the tension lever, fulcrumed on a stud 45 and furnished with an adjustable compound weight 46 and a stud 47.

When the tension lever is placed in a horizontal position, as indicated by full lines in the diagram, the stud 47 bears against the upper and free end of a vertical friction lever 48, fulcrumed on a stud 49, and furnished with two anti-frictional bowls that bear against the hub of the adjacent outer flange 8, thereby compressing the several discs and flanges together sufficiently to create such degree of frictional resistance between them as is necessary to turn the weaver's beam with a velocity that will ensure both a constant rate of winding-on the yarn, and also a uniform degree of tensile strain upon the warp threads, from the commencement to the finish of a weaver's beam.

The degree of frictional resistance between the friction discs and flanges may be varied by adjusting the weight 46 along the tension lever 44. Thus the amount of compression between those parts, and therefore their driving efficiency, may be either increased or reduced by placing the weight farther from, or nearer to, the fulcrum stud 47 of that lever respectively, and is regulated as required according to the discretion of the attendant, who is guided in his judgment by feeling occasionally at the tension of the yarn, and also at its density on the weaver's beam, during the progress of sizing.

The circular weight 46 is furnished with an auxiliary quadrant weight 46<sup>1</sup> pivoted on a pin 51 to enable this weight to be turned over on either side of the principal weight 46, and so effect a slight variation of pressure on the tension and friction levers, without the necessity of disturbing the position of the principal weight on the tension lever. The object of this contrivance is to enable the yarn to be wound with slightly *less* tension at the commencement of a new warp, until the yarn attains a firm and even foundation on the weaver's beam, whereupon the auxiliary weight 46<sup>1</sup> is then turned over so as to exert a little *greater* pressure on the tension lever.

Thus, when commencing a new warp on an empty beam, the auxiliary weight 46<sup>1</sup> should occupy the position relatively to the principal weight 46, as indicated by full lines in the diagram; after which it should be turned over to the position indicated by dotted

lines to exert more pressure on the tension lever, and thereby slightly increase the velocity and driving power of the frictional winding-on device.

When this is in operation, motion is transmitted, in the first instance, from the frictional driving wheel 7 and the outer discs 8 to the internal friction discs 41, thence to the beam shaft 40, and finally from this to the weaver's beam through the medium of a rope 52, a chain, or a leather band. This is first coiled several times around one of the iron ruffles on the beam ends, and then lashed securely to a lug-pin 53 bolted to a large disc 55, or else to an arm secured on the inner end of the beam shaft 40, which is bored out at that end to form a tubular hole to receive the beam pike or gudgeon, whilst the gudgeon in the opposite end of the beam is supported in a similar manner by entering another beam shaft, both of which are adjustable in a lateral direction to accommodate beams of different width.

§ 241. A distinctive feature which the makers, Messrs Howard & Bullough, Ltd., claim to be an exclusive one in the construction of this device, is that none of the pressure on the flannel washers is expended in useless friction against stationary parts of the machine, but that it is all fully utilized in performing effective work. Thus, when the friction discs are under compression, the outer disc nearest to the weaver's beam abuts against a stationary sleeve bearing 55, to receive the beam shaft 40; whilst the corresponding outer disc is in rolling surface contact with two anti-friction bowls or runners 50 that are mounted on the vertical friction lever 48.

As, however, these outer discs 8 are driven positively by the flanges of the friction wheel 7, and not frictionally as in some other devices of this class, the frictional resistance between the hub of the disc and beam shaft bearing 55 does not impose the least tax upon the flannel washers, which therefore give less trouble and are also more durable.

It may here be stated, incidentally, that some attendants keep the flannel washers thoroughly lubricated with the object both of increasing their efficiency and of prolonging their usefulness; whilst others prefer to keep those washers quite dry without employing any lubricant whatever, and with equally effective results in each case. It is quite obvious, therefore, since each of these practices has its

respective votaries, that neither of them possesses any distinctive advantage over the other, and that their relative merits are dependent upon varying circumstances.

§ 242. With the object of eliminating all unnecessary friction in the operation of the frictional winding-on device as constructed by Messrs Butterworth and Dickinson, Ltd., and illustrated by a front and an end elevation in Fig. 126, A and B respectively, the friction disc next to the machine framing is caused to bear against two anti-frictional rollers 56, instead of the stationary beam shaft

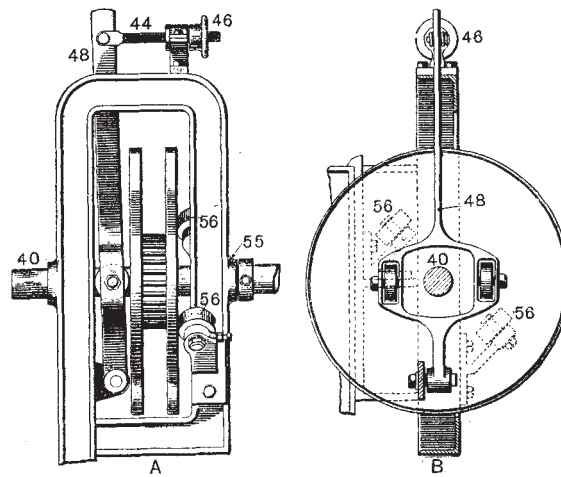


Fig. 126.

bearing 55, as in the device illustrated in Fig. 124. Also, instead of employing a horizontal tension lever provided with an adjustable weight for the purpose of regulating the degree of compression against the several friction discs, that object is effected by means of a hand-wheel 46, screwed on to a threaded rod 44, which is hinged on the upper end of the vertical friction lever 48, as indicated in the diagram.

§ 243. Frictional winding-on devices of this type are constructed with various modifications by their respective makers, but they all embody the same general principle and essential features, and differ in minor details of construction only. Thus, some are constructed with only one set of frictional driving discs, whilst others are con-

structed with those parts in duplicate to permit of either one set only or both sets of discs being employed to obtain driving power of lesser or greater efficiency, according to the requirement of the work in progress. Also, the compression of the frictional discs is effected in a variety of different ways, for each of which the respective makers claim some special advantage.

Thus in the earlier forms of these devices the degree of compression upon the discs is regulated by means of a hand-wheel and clamp spring contained upon a worm-screw cut on the outer end of the beam shaft. The hub of the hand-wheel impinges against the clamp spring which is placed between that wheel and the outermost friction disc against which it bears, thereby forming a flexible or yielding contact instead of a hard and rigid one between the hand-wheel and the friction disc. This method of compressing the friction discs is, however, superseded by the more approved and efficient arrangement of compound leverage, of which the power is regulated either by means of an adjustable weight, as exemplified in Fig. 124, or else by means of a hand-wheel on a threaded rod, as in Fig. 126, each of which methods comprises several modifications that are of equal merit. Either of these alternative devices is preferable to the earlier method, as they enable the degree of compression between the friction discs to be regulated with much greater precision, and thereby permit of the tensile strain upon the yarn being maintained at a more uniform value.

§ 244. An example of a compound frictional winding-on motion constructed with duplicate sets of friction discs, by which it is adapted for either extremely light or very heavy work, is that illustrated in Figs. 127 and 128, which represent a part sectional front elevation and a plan, respectively, of Haworth's modification.

Either one set of friction discs only, or both sets of discs, may be put into operation as required by the attendant, who controls a lever for that purpose. Thus, when sizing warps containing comparatively few threads, or those composed of fine counts of yarn, one set of friction discs only may be employed to obtain the requisite driving power to turn the weaver's beam; but for warps containing a greater number of threads, or those composed of stronger or coarser counts of yarn, it might be necessary to employ both sets of discs to obtain greater driving power.

When the machine is in operation, motion is transmitted from a pinion wheel on the end of the second or driven cone-drum shaft to a wheel 56 keyed on the end of a short shaft, on which there are also mounted two pinion or driving wheels 57 and 58, that gear with and drive two friction wheels 7 and 7<sup>1</sup>. These are mounted quite freely on the wide hub of a central friction disc 41, and this is mounted freely on the beam shaft 40, which it drives through the medium of a feather key 43 in the manner described previously in § 239.

The first of the two driving pinions, 57, is keyed fast on the shaft, whereas the second pinion 58 is loose, and revolves quite freely on that shaft. The first pinion 57 drives the second pinion 58 through the medium of a

clutch, of which the two complementary counterparts 57<sup>1</sup> and 58<sup>1</sup> are formed on the contiguous ends of the hubs of the respective pinion wheels, as indicated in the plan, Fig. 128. The hub of the second driving pinion 58 is also recessed to form an annular

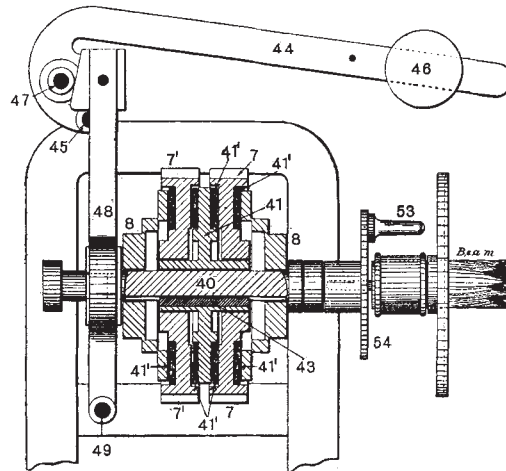


Fig. 127.

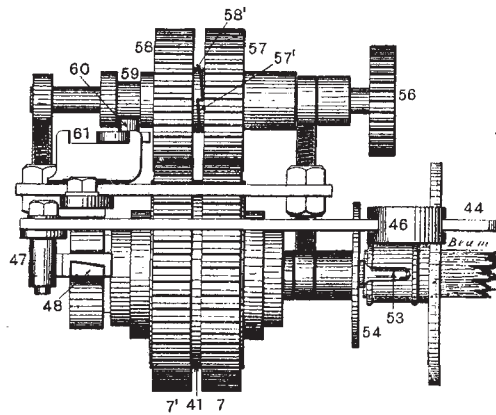


Fig. 128.

groove or channel 59 for the reception of an anti-frictional bowl 60 carried by a vertical controlling lever 61, by means of which the attendant may slide the second pinion 58 on the shaft, either to engage or disengage the clutch, and thereby employ either both sets of frictional driving discs or one set of discs only respectively as required. Frictional contact is made between the frictional driving wheels 7 and 7<sup>1</sup> and the central friction disc 41 by the usual means of four thick flannel washers 41<sup>1</sup>, and the degree of compression between them is regulated in a manner similar to that represented in Fig. 124, and described previously in §§ 239 and 240.

§ 245. Although some modification of the type of frictional winding-on motion under review is invariably employed on slasher and other types of beam-warp sizing machines, and albeit these devices perform their function with a greater or lesser measure of success, their efficiency, nevertheless, depends almost entirely on the skill, intelligence, and diligence of the attendant. Hence, the liability of these devices—whatever merits they possess mechanically—to produce variable results as regards the degree of tension upon yarn and its density on the weaver's beam.

These variations arise chiefly from the circumstance that, with such devices, the driving power is exerted at a point which always occupies a definitely fixed position in relation to the beam axis, albeit the radius of the winding surface of the beam is constantly varying in relation to that point as successive layers of yarn are wound on to the beam. The said fixed point is the lug-pin or stud 53 in the disc 54, which is situated approximately midway between the surface of the bare beam barrel and the rim of the beam flanges.

It follows, therefore, that unless some method is adopted to counteract it, the driving efficiency of the frictional winding-on device will diminish in value as the winding surface of yarn recedes from the beam axis, thereby gradually diminishing the tensile strain upon the yarn, and therefore producing soft-wound warps that are so troublesome during weaving.

The loss of driving efficiency from this cause, however, is counter-balanced by the attendant adjusting, at intervals, the movable weight 46 on the tension lever 44 in such a manner as will *increase* the compression between the frictional driving discs and thereby maintain their driving efficiency, and therefore the tension upon the



yarn, at a constant value from the commencement to the finish of a weaver's beam.

§ 246. The compression of the frictional winding discs suitably to ensure the proper degree of tensile strain upon the yarn is usually regulated promiscuously according to the judgment and experience of the attendant, who is guided solely by the sense of touch as he feels occasionally at the yarn to estimate the degree of tension to which it is submitted, as the warp threads extend between the tension or delivery rollers and the weaver's beam. He then slightly *increases*, if necessary, the degree of compression between those discs, periodically and according to his discretion, in order to increase the frictional resistance between them, and thus obtain greater driving power commensurate with the gradually-increasing diameter of the weaver's beam as this becomes filled with yarn, with the twofold object of maintaining both a uniform degree of tension upon the yarn and also of winding it more compactly on the weaver's beam and thus obtaining warps of greater length. The function of regulating the compression of the frictional winding discs during the progress of winding-on may, however, be performed automatically and with much greater precision and regularity by means of a special auxiliary attachment, of which there are at least two different modifications to be described presently.

One of the earliest forms of these devices, as constructed by Messrs Platt Brothers & Co., Ltd., and represented by a side and a front elevation in Figs. 129 and 130, respectively, consists essentially of a quadrant wedge 67, formed near the forward end of an arm 65, fulcrumed on a stud 66, and communicating, by means of a connecting-link rod 64, with the forward end of an arm 63, extending from one end of the shaft 62, which supports the yarn-pressing rollers. The quadrant wedge 67 tapers to a thin edge at the lower end and intercepts two bowls or runners 68, that are mounted respectively on studs fixed in the upper ends of two similar vertical friction levers 48, that are situated one on each side of the frictional winding discs 8, and fulcrumed on studs 49, in such a manner as to cause their lower ends, that are furnished with anti-frictional bowls 50, to approach towards, and bear against, the two outer discs 8, and thus compress all the friction discs together from both sides, simultaneously, instead of applying pressure on one side

only, as in the several modifications described previously. This method of compressing the frictional winding discs together affords the incidental advantage of entirely preventing a side thrust of one of the outer discs against any stationary part of the machine framing,

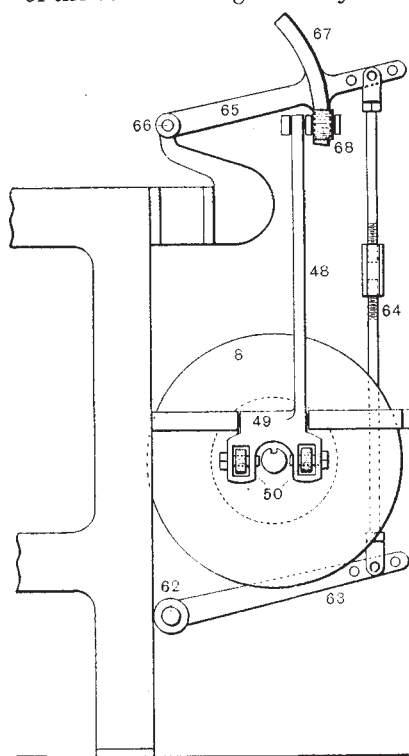


Fig. 129.

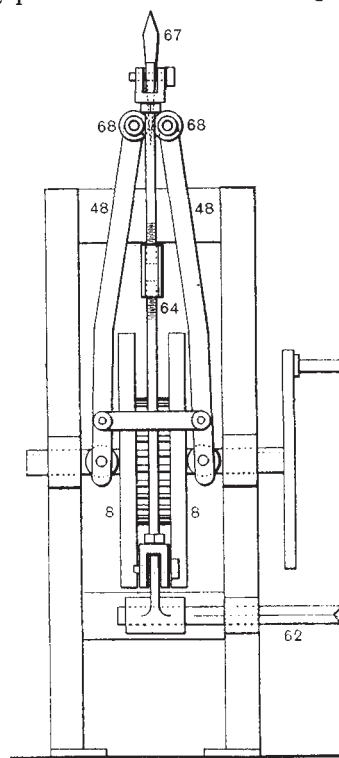


Fig. 130.

AUTOMATIC FRICTIONAL WINDING-ON DEVICE.

as explained in § 241, thereby requiring less motive power for driving the machine.

As the operation of sizing proceeds, the curved wedge 67 descends in unison with the yarn-pressing rollers, thereby bearing with a constantly-increasing pressure against the runners 68, on the friction-levers 48, and thus increasing the compression of the frictional winding discs automatically and continuously in a measure

coinciding exactly with the gradually-increasing diameter of the weaver's beam, without any attention or adjusting of parts, irrespective of the counts of yarn or number of warp threads being sized. Also, on depressing the yarn-pressing rollers for the purpose of replacing a full weaver's beam with an empty one, the runners 68 on the friction-levers 48 enter recesses that are formed in the upper end of the curved wedge 67, thereby relieving the friction discs, temporarily, of compression, during that operation, after which the curved wedge returns automatically to its initial position when the yarn-pressing rollers are replaced in contact with the bare barrel of the empty beam.

§ 247. Another device of this character, of more recent invention than that described previously, is that of Rigby's modification, of which a side and a front elevation are represented in Figs. 131 and 132 respectively.

This ingenious device is conceived with the twofold object of controlling and regulating—without personal attention, after the initial adjustment of the parts—both the degree of compression between the friction discs and also that of the pressing rollers against the yarn on the weaver's beam.

These objects are effected entirely by the expansion of the yarn diameter of the weaver's beam. Thus, on one end of a strong cross-shaft 62, on which is mounted the carrier to support the yarn-pressing rollers (not shown), there is secured a short arm 63, from the end of which there extends a vertical connecting-rod 64, attached adjustably to the horizontal arm of an elbow-lever 65, fulcrumed on a stud 66.

The vertical arm of this elbow-lever 65 is engraved with a graduated scale of divisions, and through the medium of an adjustable horizontal connecting link 67 communicates with a vertical arm 68 fulcrumed on a stud 69, and also engraved with a scale of divisions corresponding to those on the elbow-lever. The vertical arm 68 is also furnished with a bowl or runner 70 that bears constantly against the upper edge of the horizontal tension-lever 44, which in turn acts upon the vertical friction lever 48 to compress the frictional driving discs, as explained previously in § 240.

Therefore, as the pressing roller shaft 62 oscillates slowly in response to the gradually-increasing diameter of the weaver's beam,

the short arm 63 descends, and thereby depresses the horizontal arm of the elbow-lever 65. Hence the vertical arm of that lever oscillates

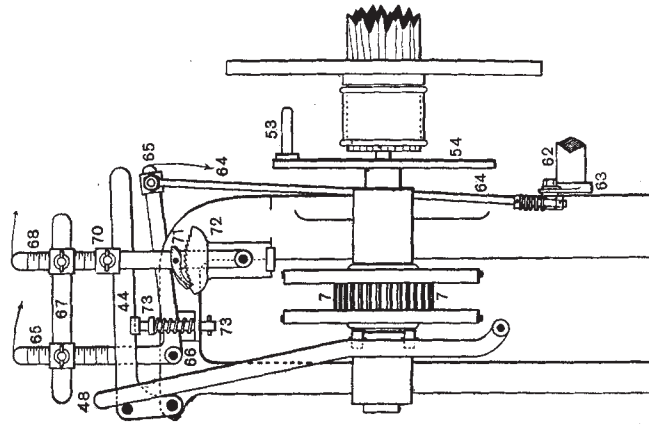


Fig. 132.

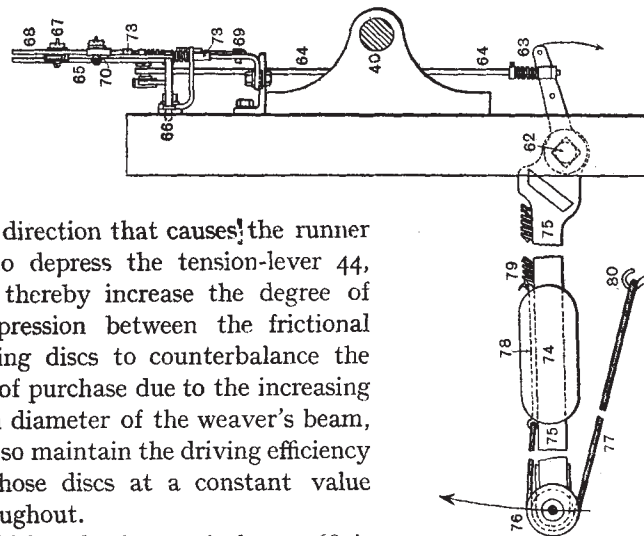


Fig. 131.

AUTOMATIC FRICTIONAL WINDING-ON AND YARN-PRESSING DEVICE.

in a direction that causes the runner 70 to depress the tension-lever 44, and thereby increase the degree of compression between the frictional driving discs to counterbalance the loss of purchase due to the increasing yarn diameter of the weaver's beam, and so maintain the driving efficiency of those discs at a constant value throughout.

Although the vertical arm 68 is quite free to advance, it cannot retract, but is held forward by means of two half-pitch retaining pawls or catches 71 that are pivoted freely on that arm, and encounter ratchet teeth formed

in the upper edge of a bracket 72. This provision, however, necessitates a flexible or yielding connection being formed preferably between the vertical rod 64 and the short arm 63 on the pressing roller shaft 62, as indicated in the diagrams. Otherwise, if this precaution were not adopted, a rigid connection of those parts would involve the risk of straining and breaking them, owing to the slight oscillation of the pressing roller shaft caused by the rolling surface contact of the pressing rollers against the yarn on the weaver's beam.

Also, the replacement of the various parts to their initial starting position, when commencing each successive weaver's beam, is performed instantly by the attendant without in any way disturbing the original adjustment of the several connections. This is effected by means of a stud 73, which, under the influence of a compressed spiral spring, bears upward constantly against the lower edge of the horizontal tension lever 44, and thereby always tends to raise that lever automatically whenever it is liberated from the control of the runner 70 on the vertical arm 68.

Thus on the completion of each weaver's beam the attendant raises the retaining pawls 71 on that arm from the ratchet teeth, and replaces the runner 70 to bear in its initial position upon the tension lever, and thereby reduce the compression of the frictional driving discs for the commencement of the next weaver's beam. Also, by the aid of the graduated scales engraved on the vertical levers 65 and 66 the position of the connecting link 67 on these levers may be recorded, so that when conducting similar classes of work in the sizing machine the connecting link may be secured in exactly the same position to ensure corresponding results.

§ 248. As stated in the previous section, this device is also adapted automatically to regulate and control the degree of compression by the pressing rollers against the yarn on the weaver's beam. That object is effected by means of a sliding weight 74 carried by an arm 75 extending from the pressing roller shaft 62, and provided at the free end with a grooved pulley 76 around which there passes a chain or rope 77. One end of this rope is attached preferably to a hooked rod 78 that passes between the weight and the upper face of the arm 75, on which it slides freely; whilst the opposite end of the rod is connected to a spiral spring 79 attached to a retaining pin on that

arm. The opposite end of the rope 77 is then secured to a hook 80, fixed adjustably either in the floor or to the machine framing.

Thus, as the weaver's beam increases in diameter and depresses the yarn-pressing rollers, the shaft 62 oscillates slowly and raises the arm 75 in the direction indicated by an arrow, thereby increasing the distance between the fixed hook 80 and the rope pulley 76, thus causing the weight to slide towards the end of the arm 75 as this assumes a steeper inclination.

This has the effect of counterbalancing the loss of force exerted by the weight, and either maintaining or even increasing the degree of compression by the pressing rollers upon the yarn on the weaver's beam. The function of the spring 79 is to keep the rope 77 always under tension, and thereby ensure the return of the weight 74 automatically and readily to its initial position on the arm 75 when re-adjusting the pressing rollers at the commencement of a new weaver's beam.

\* By means of this combined automatic friction and pressing motion, the adjustment necessary to ensure both a constant tension and an increasing pressure upon the yarn is both continuous and of a uniformly increasing value from the commencement to the completion of a weaver's beam, and not of an intermittent and variable character, as when the adjustment is effected promiscuously at the discretion of the attendant; thereby ensuring more firmly wound and compact weavers' beams containing a relatively greater length of yarn.

The inventor of this device states that by its aid he has sized warps containing as few as 600 threads of 60's T, and also warps containing from that number up to as many as 6000 threads of various counts of yarn, ranging from 28's T to 100's T, successfully, during a period extending over twelve months.

#### YARN-BEAM PRESSING ROLLERS

§ 249. The pressing rollers of a slasher sizing machine are employed for the purpose of levelling the yarn, and also of compressing it firmly and compactly on to the weaver's beams, thereby producing firmly-wound warps having an even surface and a uniform yarn diameter across the entire width of the beams, and also enabling warps of considerably greater length to be wound upon them.

The degree of compactness with which yarn is wound on to a

weaver's beam, however, is also dependent upon the degree of tensile strain imparted to the threads between the delivery rollers and the weaver's beam. Therefore, since the degree of yarn tension is regulated by the compression of the several discs of the frictional winding-on device, it follows that both this and the pressing rollers should operate in harmony with each other, in a manner similar to that described and illustrated in §§ 247 and 248.

Yarn-beam pressing rollers are constructed in a variety of different forms, and consist essentially of one or else two iron rollers supported in such a manner that they bear constantly, and revolve freely, in contact with the yarn surface of the weaver's beam, against which they are retained by means of a heavily-weighted arm extending rearward from the pressing roller shaft, from which there also extends, forward, a carriage or frame to support the pressing rollers.

§ 250. One of the several modifications of yarn-pressing rollers is that illustrated in Figs. 133 to 135, which represent an end elevation, a front elevation, and a plan, respectively, of Ormerod, Crook & Crossley's yarn-pressing device, as constructed by Messrs William Dickinson & Sons. The central feature of this device consists essentially of a tubular roller 81, formed in two exactly similar and complementary half lengths that are united, endwise, in such a manner as virtually to constitute a single roller. This is capable of expanding in length, automatically, until it bears across the entire width of the warp between the beam flanges, thereby preventing the risk of selvage warp ends building up too quickly against the flanges; also averting such other defects as are liable to occur, and which prove a source of constant trouble to the weavers, who are expected to produce cloth having perfect selvages, and free from warp threads of unequal tension.

The expansion of the pressing roller is effected by forming several long notches in one end of each half-roller, and interlocking these after the manner of a claw or box clutch; and also by mounting the pressing roller freely upon two pairs of anti-frictional rollers 82, that are placed at opposite ends of a swing beam 83. One of the rollers in each pair is conical, with the larger diameter innermost, so as to force the respective halves of the pressing roller outward from the centre as it revolves, and also to keep it expanded continuously during winding-on.



The pressing roller bears constantly against the yarn by the gravitation of an adjustable weight 74, secured to a long arm 75, extending rearward from one end of the shaft 62, which also supports the pressing roller. Hence, as the yarn diameter of the weaver's beam gradually increases and thereby depresses the pressing roller in a corresponding measure, the oscillation of the pressing roller shaft raises the weighted arm, which cannot descend until it is returned by

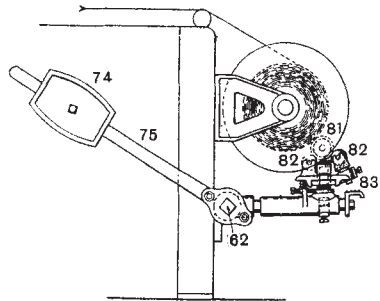


Fig. 133.

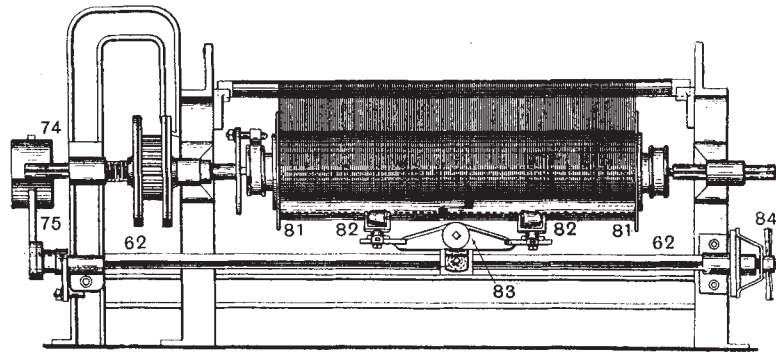


Fig. 134.

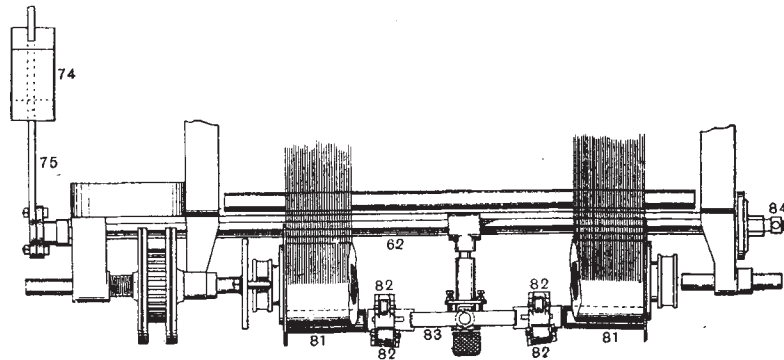


Fig. 135.

the attendant to its initial starting position at the commencement of a new weaver's beam. The return of the weighted arm is prevented by means of a simple contrivance of either a ratchet wheel and stop-catch or pawl, or preferably by a friction clutch controlled by a handle, as indicated at 84, on the right of Figs. 134 and 135.

By regulating the amount of frictional resistance between the discs of this clutch, the degree of compression by the pressing roller against the yarn may be either increased or diminished, as required, without the necessity of either adjusting the weight 74, on the arm 75, or of substituting other weights, for that purpose.

Also, the attendant may return the pressing roller to its initial position against a new beam when he is in *front* of the machine, instead of doing this from the side, as would otherwise be necessary in order to liberate the stop-catch from the ratchet wheel.

Since the weighted arm 75 occupies a horizontal position at the commencement of winding-on, and assumes an inclined position as it ascends, it follows that as the weight 74 attains a higher elevation it will lose its purchase on the arm, with the result that the compressive force of the pressing roller will therefore diminish gradually and constantly from the commencement of winding-on, to the completion of a weaver's beam, instead of remaining either constant, or preferably increasing slightly, as the yarn diameter of the beam increases.

It is with the object of overcoming this defect, which is inherent to all ordinary applications of yarn-beam pressing rollers, that Rigby conceived the idea of causing the weight to slide automatically further away from the pressing roller shaft, and thereby cause the pressing roller to exert either a constant or an increasing degree of compression against the yarn surface of the weaver's beam throughout the operation of winding-on, in the manner described previously in § 248.

§ 251. Another adaptation of a single pressing roller is that illustrated in Figs. 136 to 138, which represent a sectional elevation, a plan, and a detail, respectively, of one of Hitchon's modifications as made by Messrs Howard & Bullough, Limited. This device consists essentially of a single tubular roller 81, which is made shorter than the width between the flanges of the weavers' beams, and to which

is imparted a slow reciprocal traverse between the beam flanges, so that no part of the yarn surface escapes its action altogether.

This object is effected by supporting the pressing roller upon two pairs of anti-frictional bowls 82, mounted in castor or swivel bearings placed at opposite ends of the swing beam 83, and also by operating those bowls in such a manner that they become inclined in opposite directions, from the vertical, alternately, thereby causing the pressing roller to slide first to one extreme end of the beam and then return to the opposite end, slowly, and in alternate succession.

This peculiar action of the anti-frictional bowls is obtained by fixing on the extended axle of one of those bowls, 82<sup>1</sup>, a worm 85, which gears with a worm-wheel 86 mounted on a stud bearing 87 projecting from an arm 88. This arm extends from the bearing which supports that bowl, as indicated on a larger scale at A, Fig. 138.

From the rear of the worm-wheel 86 there projects a pin 89, which is fixed eccentrically to the wheel axis, and freely enters an inclined slot formed in a stationary bracket 90, shown detached, at B, Fig. 138. Also, the swivelled bearings of the anti-frictional bowls are connected by means of two parallel rails 91, and a cross-rail 92, as indicated in the plan, Fig. 137.

Therefore, as the leading anti-frictional bowl 82 revolves, the pin 89 slides freely along the inclined slot in the stationary bracket 90, thereby causing the arm 88 (which extends from the bearing of the leading anti-frictional bowl) and also its appurtenances to oscillate slowly through an angle of about 14°, as indicated in Fig. 138.

This action causes the anti-frictional bowls to incline first to one side and then to the other side, in alternate succession, during each complete revolution of the worm-wheel, with the object of imparting to the yarn-pressing roller a reciprocal traverse between the warp beam flanges in the manner described.

§ 252. A third example of a yarn-beam pressing device is that illustrated by a front elevation, an end elevation, and a plan, in Figs. 139 to 141, which represent another of Hitchon's modifications of this type of device.

Unlike the two previous examples, however, the one under present notice is constructed with two pressing rollers 81 and 81<sup>1</sup>, supported on three pairs of anti-frictional bowls 82, and placed one

immediately behind the other, as seen in Fig. 140. The rear roller 81 consists of one tubular length which is shorter than the width

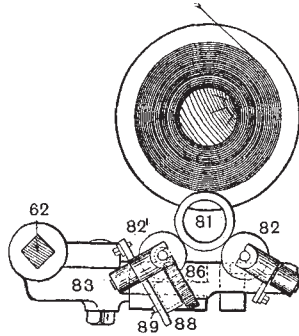


Fig. 136.

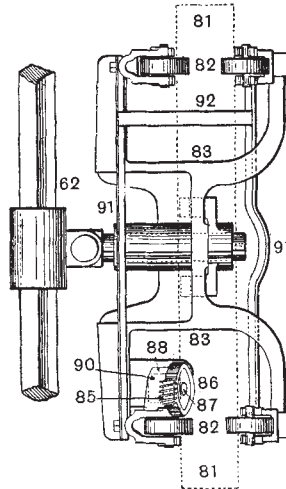


Fig. 137.

between the beam flanges, and bears always in the same place against the yarn surface of the beam; whereas the front roller 81<sup>1</sup>

consists of two shorter tubes, of which the total length is shorter than the beam width. These are each contained freely on opposite ends of a solid shaft or mandrel formed with a central forged collar that fits into a retaining slot to keep the mandrel constantly in the same position, whilst the two portions of the front

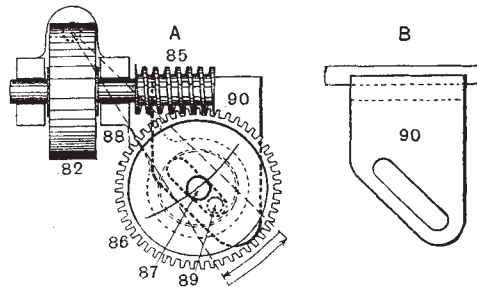


Fig. 138.

roller are forced apart from the centre until they extend across the entire width of the warp and bear close up to the beam flanges, thereby spanning the short intervals of space between the ends of the rear pressing roller and beam flanges.

The expansion of the front pressing roller is effected by inclining outward the front pair of anti-frictional bowls 82', that are mounted in swivelled bearings, and on which that roller is supported, as represented in Fig. 139. After this roller is fully expanded, at the commencement of a new beam, it is maintained

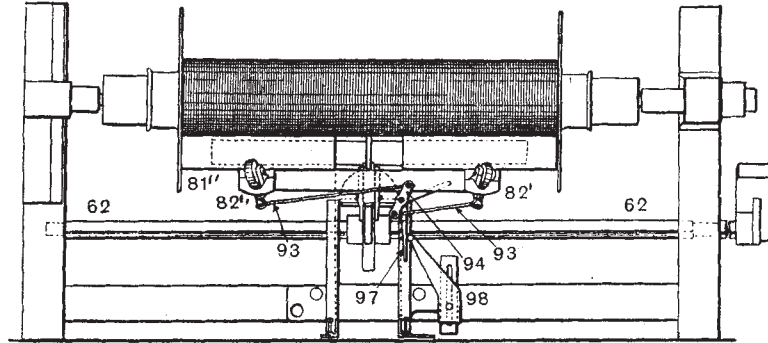


Fig. 139.

at the maximum extension until the beam is nearly filled with yarn, when the roller begins to contract, automatically, to prevent the two portions from running outward beyond the beam flanges, and thereby involving the risk of spreading the yarn, and cutting the threads, on the rims of those flanges.

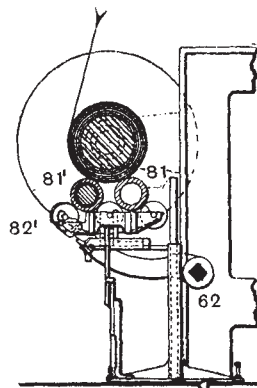


Fig. 140.

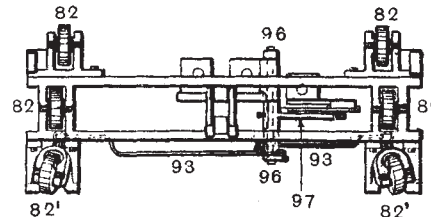


Fig. 141

The contraction of the front pressing roller is effected by reversing the inclination of the front pair of anti-frictional bowls until they assume the position indicated in the plan, Fig. 141, drawn to a larger scale. The two castor bearings of those bowls

are each connected, by means of link rods 93, to opposite ends of a short arm 94, secured to the forward end of a shaft 96, to which there is also secured an elbow lever 97.

At the commencement of winding-on, when the pressing rollers are at their highest elevation, the vertical and drooping arm of the elbow lever bears lightly against the upper end of an adjustably fixed bracket 98 until the beam is nearly filled, thereby keeping the front pair of anti-frictional bowls inclined outward, and keeping the pressing roller fully extended, as seen in Fig. 139. But when the beam is nearly filled, the depression of the pressing rollers causes the horizontal arm of the elbow lever 97 to come into contact with the upper end of the stationary bracket 98, and thus oscillate the short arm 94 in a direction that reverses the inclination of the front pair of anti-frictional bowls, as seen in Fig. 141, thereby causing the front pressing roller to contract, for the purpose described.

§ 253. Two other modifications of double-roller yarn-beam pressing devices, also designed by Hitchon, are sometimes employed in very wide machines. In one of these devices the two pressing rollers are each shorter than the beam width, and they bear constantly in the same relative position, with one roller close against each beam flange, to ensure the compression of yarn across the entire width of the beam without imparting to the rollers any lateral movement. In the second of these devices both pressing rollers are of equal length, but only one-eighth of an inch shorter than the beam width, and they bear constantly in the same position against the yarn surface.

But whatever particular forms yarn-pressing devices may assume, and however perfect they may be mechanically, they cannot ensure the formation of perfectly wound, firm, and level warp beams unless the barrels of these are quite true, and revolve truly in their bearings during the operation of winding-on, and are also provided with perfectly straight flanges that are fixed truly and secured firmly in position on the beam barrels, to ensure their steady rotation.

§ 254. In some machines, however, instead of yarn-pressing rollers of the usual form, there is employed an improvised and crude pressing device consisting either of a flat or a round heavy iron bar which extends between the beam or tube flanges and bears downward upon the yarn. This bar is secured to two iron arms that are

hooked to, and suspended from, a cross-bar in front of the machine, to permit of the pressing-bar rising freely as the beam increases in diameter. This method, however, is generally confined to warps composed of coarse and strong yarn, as the excessive friction produced by a *stationary* pressing bar would act detrimentally upon fine yarn, against which a presser should bear with a *rolling* contact.

#### CUT-MARKING AND MEASURING MOTIONS

§ 255. Many varieties of cotton fabrics that are known in the trade as "piece-goods" are woven from warp and weft yarn of the grey or natural colour of the raw cotton staple, and produced as continuous pieces of cloth of considerable length. The cloth is then sold either in its original grey state, or else it is bleached, dyed, or printed in the piece, and afterwards cut up into unit-lengths of any prescribed dimension up to 120yds. or more, to constitute what are termed cut-lengths, "dhotie scarves or shawls," turbans, handkerchiefs, and many other articles for domestic use.

Each length-unit is indicated, at the required intervals apart in the continuous piece-length of cloth, by means of some distinctive mark, usually consisting of cross-bands or stripes of coloured or other different kinds of weft, to produce what are variously termed "fancy headings," cross-borders, or "cut" (cutting) marks. Also, in some cases, the weaver "strains up" the warp and cloth, by means of the taking-up motion, to produce short gaps or "frets," without any picks of weft, across the cloth where it is to be severed.

The intervals at which these "headings" or other distinctive cloth-marks are to be inserted by the weaver are indicated previously upon the warp threads by smearing them with coloured stains termed "cut-marks," that are impressed upon the yarn during its progress through the slasher sizing machine, and just before it passes on to the weaver's beam.

These cut-marks are produced automatically by means of an auxiliary device termed the cut-marking motion, which also operates in conjunction with a measuring motion, and of which there are various modifications of two chief types.

Some of these devices are constructed to make only one cut-mark at regular intervals of any prescribed length, uniformly; whereas



others are designed to make a double impression at once, with two separate and distinct marks placed three or four inches apart, lengthwise of the warp; whilst other modifications are constructed with duplicate sets of parts to operate alternately when it is required to produce cut-marks of two different colours, and placed either at uniform or varying distances apart.

Also, some sizing machines are equipped with two separate cut-marking motions, placed one on each side of the machine, to operate in conjunction either simultaneously or alternately to impress two marks of the same or of different colours, one on each side of the warp, according to requirements.

§ 256. In machines of pre-modern construction, the cut-marking and measuring motion is operated by the tin guide-roller situated in the extreme rear of the headstock, in the same plane as the dividing rods, and known as the tin measuring roller, which revolves entirely by surface contact with the yarn, whereby the effort of driving the cut-marking motion devolves entirely upon the warp threads.

This objection, however, is entirely eliminated in modern machines, in which the measuring and cut-marking motion is driven by the heavy iron nip-roller that rests upon, and is driven by surface contact with, the large iron or wooden tension or drawing and delivery roller situated in the extreme fore-part of the machine. In either case the roller employed to operate the marking and measuring motion constitutes the measuring roller, which is always made with a standard circumference of 14.4in. (=  $\frac{2}{3}$ ths of a yard) in English machines.

§ 257. A cut-marking and measuring motion of the prevailing type for marking single impressions, at one side of the warp only, is illustrated by aside elevation and plan in Figs. 142 and 143 respectively. This device consists essentially of a striking hammer A and a colour block or disc B, that are controlled by a simple combination of wheel gearing and a stepped cam C, of which an enlarged side view is shown detached at E', Fig. 142.

The hammer is placed above the warp threads, with the colour block immediately below them, so that the cut-marks will be impressed upon the yarn several inches from one side, and between the iron measuring or nip-roller 5, and an adjustable wraith or comb D, which is fixed in front of the foremost dividing-rod for the purpose of regulating the width of the warp suitably to that of the weaver's beam.

The striking-hammer is secured to a short stud or shaft E, which freely enters a sleeve-bearing F, supported by a fixed bracket G. In its normal position, as represented by full lines, the hammer is held quite clear, by a space of several inches, above the warp threads until it is required to strike a cut-mark, when it descends quickly, as indicated by dotted lines, thereby deflecting those warp threads beneath it to produce a momentary contact with the colour block,

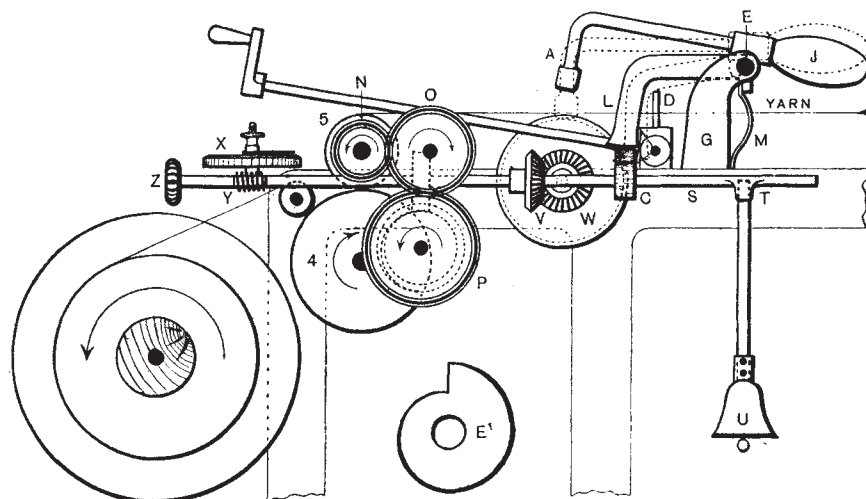


Fig. 142.

and thus stain them with a mark of about  $1\frac{1}{2}$  in. by  $\frac{1}{2}$  in., after which the hammer rebounds instantly to its normal position.

The recoil of the hammer is effected by means of a heavy counterweight J at the rear end of the hammer to overbalance it. The colour block is usually a circular wooden disc fixed on one end of a short shaft K, both of which revolve together with a slow velocity.

The rim of the colour disc is covered with cloth to produce a soft pad against which the threads are struck by the hammer without the risk of injuring them, and it revolves with its lower portion immersed in a solution of colouring material, of any vivid hue, contained in a narrow chamber, which entirely encloses the disc excepting for an opening at the top where the rim is exposed, as indicated in the diagrams.

The hammer A descends upon the yarn and strikes a cut-mark for each revolution of the stepped cam C; and the intervals of length between successive cut-marks are determined by the velocity with which that cam revolves, in relation to the velocity of the measuring roller 5. Bearing constantly downward against the rim surface of the stepped cam C is the free end of an  $\Gamma$ -shaped arm L, termed the cam lever, extending from the same bearing as that which supports the striking hammer, and which is always held downward by means of a blade spring M.

A free union or clutch joint between the shanks of the cam lever

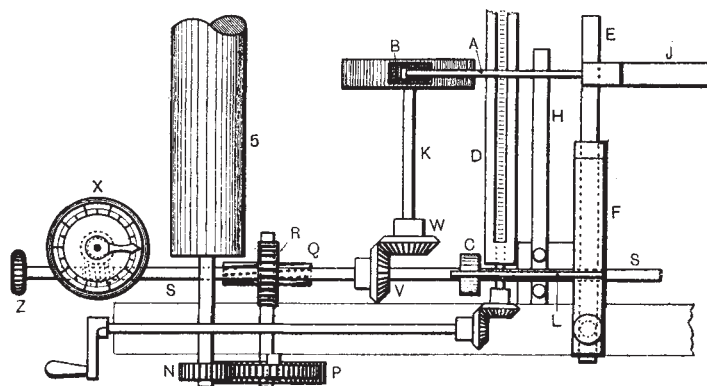


Fig. 143.

and striking hammer permits of each of these arms oscillating independently and instantly on the step of the cam passing from underneath, and thereby releasing the cam lever. Whenever this occurs, that lever descends with a sudden impulse, and thereby projects the striking hammer upon the warp threads to impress a cut-mark, after which it rebounds to its initial position in the manner described.

§ 258. As stated previously in § 256, the cut-marking and measuring motion is operated primarily from the measuring roller 5, which transmits motion to the stepped cam C, through the medium of simple wheel gearing designed to reduce the relatively high velocity of the measuring roller to the very slow velocity of the stepped cam.

The wheel gearing commences with a pinion or driving wheel N fixed on one end of the measuring roller shaft, and termed the "measuring roller wheel," which, through the medium of a simple

carrier wheel O, transmits motion to a wheel P mounted on a short stud, and known as the "stud-wheel." This is compounded with a single-thread worm Q, of large diameter, which gears with a worm-wheel R termed the "bell-wheel," fixed on the same shaft S as that on which the stepped cam is also fixed, and known as the "bell-shaft."

The bell-wheel contains a constant number of teeth—namely, 45—and is moved only one tooth during each revolution of the worm Q and stud-wheel P. These will, therefore, require to make 45revs. to revolve the bell-wheel and stepped cam once, to mark successive cut-lengths of the warp. The bell-wheel is so named from the fact that a tongue T projecting from one side of the bell-shaft is caused to ring a bell U, and so warn the attendant of each approaching cut-mark, so that he may keep a record of the number of cut-lengths wound on each weaver's beam. The bell-shaft also contains a bevel wheel V, which, through the medium of a similar bevel wheel W (but preferably one tooth larger) fixed on the short shaft K, which also carries the colour disc, revolves that disc with a very slow velocity to bring up the colouring material. By having a difference of one tooth more or less between the bevel wheels V and W, it will prevent the colour hammer from striking in succession always on the same part of the rim of the colour disc.

§ 259. As stated in § 257, the intervals of length between successive cut-marks are determined by the relative velocity of the measuring roller, which is of a constant value, and that of the stepped cam, which may be regulated according to the length of cuts required. The length between the cut-marks varies in a measure inversely proportionate to the speed of the cam, which may be varied by changing the size either of the measuring-roller wheel or the stud wheel P, or of both of those wheels, in order to obtain the correct ratio between them for the prescribed cut-length. This ratio is calculated on the basis of a measuring roller with a standard circumference of 14.4in. and a bell-wheel R with 45 teeth, which are constant factors.

Therefore, since the bell-wheel and stepped cam make one revolution for each cut-mark, the worm and stud wheel must always make 45revs. for any length of cut; whereas the number of revolutions by the measuring roller varies according to the length of cut, and is

obtained by dividing the cut length, in inches, by the circumference of the measuring roller in inches—viz., 14.4in. =  $\frac{2}{3}$ ths of a yard.

The most convenient method of calculating the number of teeth in the roller wheel and stud wheel is to obtain a constant number of such a value that the ratio between this number and the length of cut expressed in inches, or else in yards, will be in direct proportion to the number of teeth in the roller wheel and stud wheel respectively. Thus,  $14.4 \times 45 = 648$ , the constant for inch units of length; and  $\frac{14.4 \times 45}{36} = 18$ , the constant for yard units of length.

A set of change-wheels for this purpose usually comprises 104 wheels, ranging in size from 17 to 120 teeth, of which any two wheels may be employed in combination to give the required ratio of teeth.

*Example 1.*—What sizes of roller wheel and stud wheel are required to indicate cut-lengths of 32yds. 18in.? In this example the ratio of the R W and S W is 648 to 1170 respectively; but as wheels of that size are impracticable, any two wheels in the nearest practical ratio may be employed. Therefore—

$$\begin{aligned} \text{R W} &= 648 \text{ or } 36 \text{ teeth} \\ \text{S W} &= 1170 \text{ or } 65 \text{ teeth} \end{aligned}$$

which in this case is the only practical combination.

$$\text{Proof: } \frac{14.4 \times 45 \times 65}{36} = 1170 \text{ in.}, \text{ or } 32\frac{1}{2} \text{ yds.}$$

*Example 2.*—What sizes of R W and S W are required to indicate cut-lengths of 40yds.? In this example the ratio of the R W and S W is 18 to 40 respectively. Therefore—

$$\begin{aligned} \text{R W} &= 18 \text{ or } 27 \text{ or } 36 \text{ or } 45 \text{ or } 54 \text{ teeth} \\ \text{S W} &= 40 \text{ or } 60 \text{ or } 80 \text{ or } 100 \text{ or } 120 \text{ teeth} \end{aligned}$$

$$\text{Proof: } \frac{14.4 \times 45 \times 40}{18 \times 36} = 40 \text{ yds.}$$

§ 260. In combination with the cut-marking motion as represented in Figs. 140 and 141, there is also a cut-measuring motion to indicate cut-lengths of warp wound on. This is a very simple device, consisting of a fixed dial-plate X on the face of which there revolves a finger operated by a single-thread worm Y on the bell-shaft S, which transmits motion to a worm-wheel fixed at the bottom of the finger stud.

The dial-plate is usually graduated in both quarters and unit-

lengths of cuts to indicate either up to 10 or else 20 cuts for one revolution of the finger, according to whether the worm-wheel on the finger stud contains 10 or 20 teeth respectively.

Before commencing each new weaver's beam, the step of the cam C is set close up to the cam lever L. This is effected by means of a small hand-wheel Z on the forward end of the bell-shaft S, which is turned until the step of the cam stops against that lever; after which the finger is also re-set to zero on the dial-plate.

§ 261. An example of a double cut-marking motion to impress marks of two different colours either at equal or unequal distances

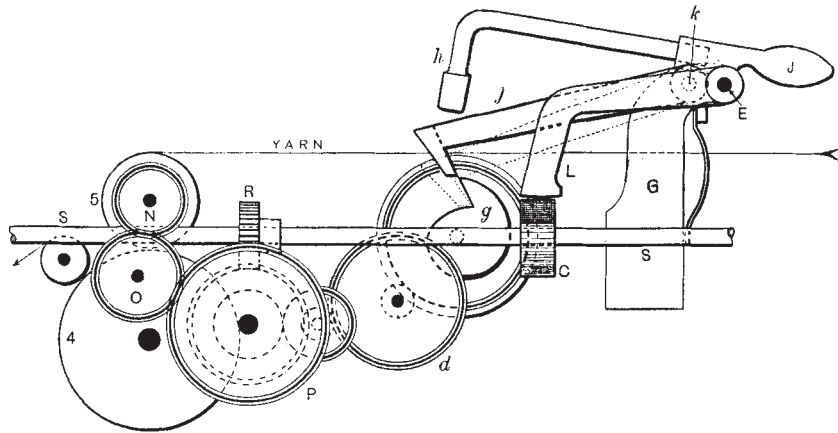


Fig. 144.

apart, as required for dhootie and other varieties of fabrics, is that illustrated in Figs. 144 and 145, which represent an elevation and a plan of one of Hitchon's cut-marking motions.

In addition to the usual cut-marking mechanism similar to that just described, the present device also embodies a supplementary striking hammer, colour block, and stepped cam, operated by separate wheel gearing which may be regulated so as to impress one mark only, or any number of extra marks, between the regular cut-marks which indicate the extremities of a cut-length.

Thus, a pinion wheel *a* on the usual stud-pin transmits motion, through the medium of compound carrier wheels *b*, *c*, *d*, and a change pinion *e*, to a wheel *f*, which carries the additional stepped cam *g* to

govern the action of the supplementary striking hammer *h* controlled by the extra cam lever *j*, both of which are secured to the same cross-bar *k*.

The cam wheel *f* and the stepped cam *g* are secured together, but mounted quite freely upon the shaft *K*, which carries and rotates both of the colour blocks *B* and *l* which are driven in the usual manner, by means of lever wheels *V* and *W*, from the bell-shaft *S*. Therefore, the wheel *f* and its stepped cam *g* may be driven with any desired velocity according to the number of extra coloured marks required

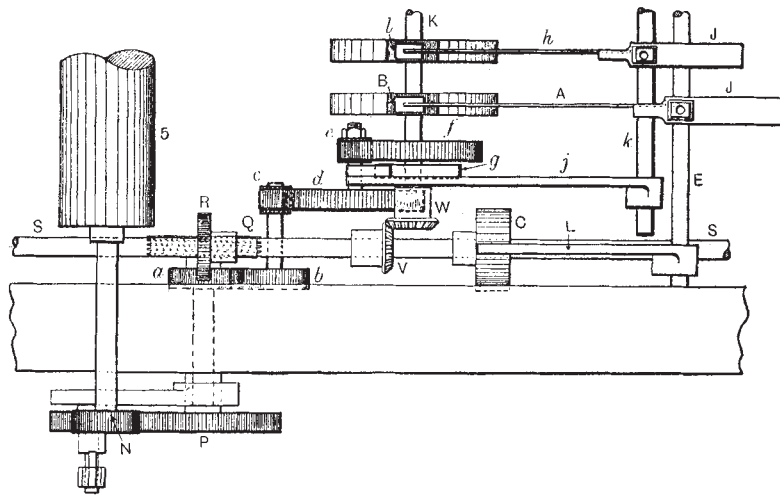


Fig. 145.

between the ordinary cut-marks, and quite independently of the speed of the colour blocks.

The velocity of the additional stepped cam *g*, and therefore the intervals between the extra marks, is regulated by employing different sizes of change pinions *e*. The wheel gearing is such that the cam makes one revolution, and thus causes the supplementary hammer to strike once for every 10 teeth contained in the change pinion *e*. Therefore, the number of extra marks required in each cut-length of warp multiplied by 10 equals the number of teeth in the change pinion required to give that number of marks.

§ 262. As stated in § 255, some cut-marking motions are adapted



to mark, at one stroke, a double impression upon the warp threads, with two distinct marks, at an interval of about 4in. apart lengthwise, and placed at the extremities of each cut-length, to indicate where the cloth is to be subdivided. The chief object of impressing

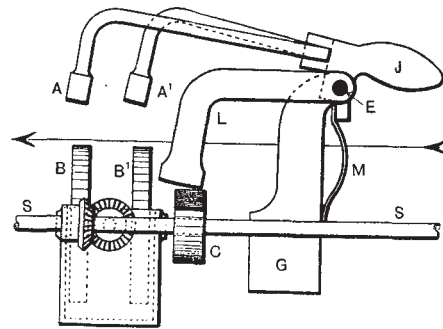


Fig. 146.

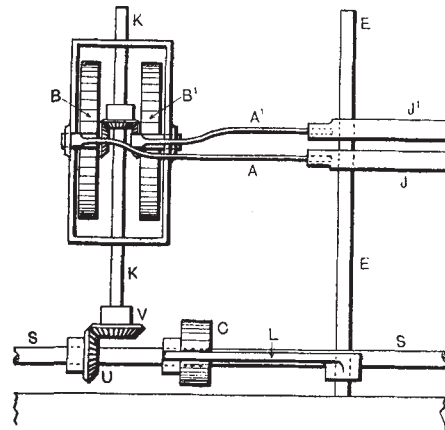


Fig. 147.

place the two heads in tandem about 4in. apart, so that each hammer will strike upon colour blocks B and B<sup>1</sup> which are disposed at right angles to the warp threads, and driven through the medium of bevel-wheel gearing, as indicated in the diagrams.

§ 263. Another of Hitchon's modifications in the details of cut-marking motions is that illustrated in Fig. 148, which represents an improved form of marking hammer head and colour blocks that are

double cut-marks is to make them more conspicuous than single marks, and thereby reduce the risk of these escaping observation by the weaver, and "weaving-in" before the "headings" are inserted, as sometimes occurs inadvertently.

By means of another of Hitchon's modifications, illustrated by a part elevation and plan in Figs. 146 and 147, a double cut-mark is impressed by a single stroke of two separate marking hammers A and A' that are secured by the same bar E, and controlled by the stepped cam C on the bell shaft S, as in the single cut-marking motion illustrated in Figs. 142 and 143. In the present device the hammer shanks are bent in such a manner as to

capable of impressing both double and single coloured marks in alternate succession, and at regular intervals apart, for successive revolutions of the stepped cam.

Double marks are struck to subdivide the warp into cut-lengths of the required dimension; and single marks, known as "middle" or "middling" marks, are impressed exactly midway between two cut-marks to indicate where the weaver is required to insert "fancy" cross-stripes, as exemplified in what are known in the weaving trade as "madapollams," and many other varieties of cloth.

In the present modification, the striking hammer A is formed with three distinct faces, disposed lengthwise, and controlled in the usual manner by means of the stepped cam on the bell shaft. Three separate colour blocks B, B', and B<sup>2</sup> are employed—one for each face of the marking hammer, of which the two outer faces descend on the two outer colour blocks B and B<sup>2</sup>, to impress the double cut-marks; and the central face descends on the middle colour block B' to impress the "middle" marks.

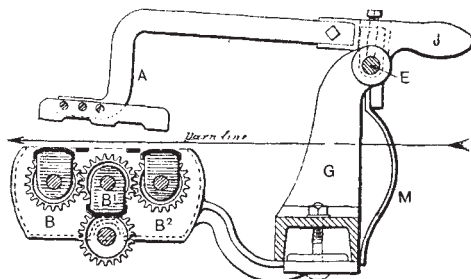


Fig. 148.

to impress the double cut-marks; and the central face descends on the middle colour block B' to impress the "middle" marks.

The three colour blocks are geared by means of toothed wheels, each containing an equal number of teeth. These are driven from the bell shaft with a corresponding velocity, but at exactly one-half the speed of that shaft and of the stepped cam, whereby the respective colour blocks make only one revolution for each descent of the marking hammer.

The colour blocks are adjusted in such relative positions to each other that first the two outer colour blocks only are uppermost, and then the central block only is uppermost, alternately, for each successive revolution of the stepped cam, and at the moment when the marking hammer descends, thereby impressing double cut-marks and single marks in alternate succession, as described.

§ 264. Another example of a warp measuring and marking motion is that illustrated in Figs. 149 to 151, which represent part

elevations and a plan of Heatley & Field's modification as constructed by Messrs Butterworth & Dickinson, Ltd. This modification is

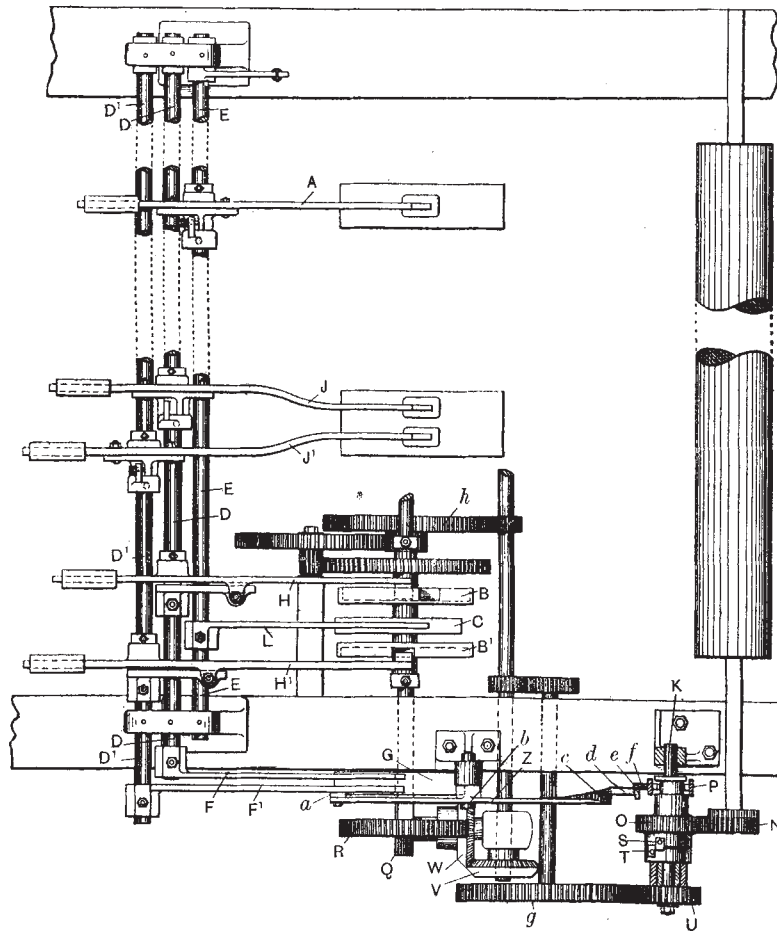


Fig. 149.

adapted expressly for measuring and marking off warps into any desired number of length-units to constitute a series of shawls or scarves of uniform length, and also to provide an additional short interval of warp impressed with a cutting-out mark exactly midway

between the last and first marks of consecutive series of shawls. This object is effected by employing two sets of marking mechanism operating in unison, and driven by a change pinion wheel on one end of the measuring-roller shaft whence, through the medium of a clutch, motion is transmitted to the entire combination of marking mechanism in such a manner that its operation may be stopped automatically for a short interval, although the warp still continues to proceed along its course.

Thus, through the medium of a simple train of wheels commencing with the change pinion N, on the measuring-roller shaft, and terminat-

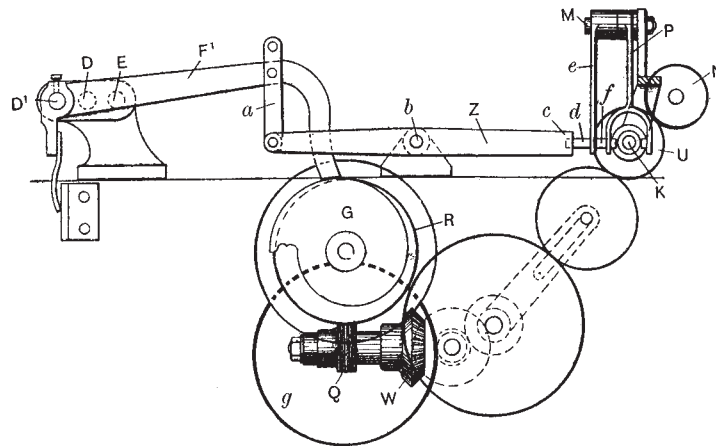


Fig. 150.

ing with a large spur wheel *h*, motion is transmitted to a stepped cam C, and two notched discs, B, B', all of which make only one complete revolution for *each shawl length* of warp. In combination with the stepped cam C there is a cam lever L secured to a cross-bar E, with the free end of the cam lever bearing downward constantly upon the rim of the stepped cam C, to govern the action of a marking hammer A, which is also mounted with a flexible joint on the same cross-bar E, that contains the cam lever L, and which is employed for impressing only the *second and subsequent marks*, including the last one, of each series of shawls.

Through the medium of another train of wheels branching from the previous train and consisting of two bevel wheels V, W, and a

worm Q, gearing with a worm wheel R, motion is transmitted to another stepped cam G, which makes only one revolution for *each complete series* of any prescribed number of shawls including the interval of warp that separates one series of shawls from another series. This second stepped cam is employed to control the action of two cam levers F, F', that are fixed on the ends of separate cross-bars, D, D', on which there are also mounted, with flexible joints, two disc or timing levers H, H', that are controlled by the joint operation of the second stepped cam G and the notched discs B, B', to govern the action of two supplementary marking hammers J, J', which are also mounted with flexible joints on the same cross-bars

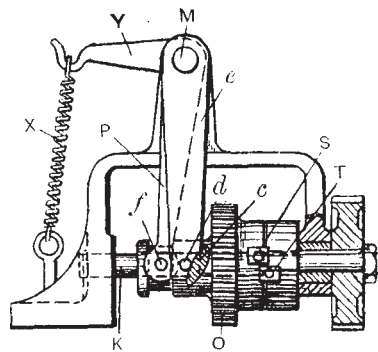


Fig. 151.

D, D', containing the cam levers F, F', and the timing levers H, H', respectively. The marking hammer J is employed for impressing only the *cutting-out mark*, whilst the hammer J' impresses only the *first mark* of each series of shawls, in a manner to be described presently.

§ 265. The measuring-roller pinion N gears constantly with a clutch change wheel O, which revolves freely on a short shaft K, on which it is also capable of sliding, but without moving out of gear with the teeth of the roller pinion N, whereby the clutch wheel O revolves continuously whenever the machine is in operation. The clutch wheel O is constructed with a long boss or hub extending on both sides of that wheel and of which the rear end is formed with a recessed annular groove or channel spanned by the forked end of a pendent arm P, fulcrumed on a stud M; whilst the opposite or near end of the hub is furnished with a projecting lug S which, by the sliding movement of the clutch wheel O, either engages with, or else disengages from, a similar lug T, projecting from the hub of another clutch change wheel U, keyed fast upon the shaft K.

The sliding movement of the first clutch wheel O is effected by means of the clutch fork P, which is controlled in one direction to

disconnect the clutch wheels O, U by the descent of the cam lever F<sup>1</sup>; whereas the reverse movement of the clutch fork P, to connect the clutch wheels, is effected immediately by the sudden reflex action of a distended spring X, secured to the hooked end of a short arm Y, which projects from the upper end of the clutch fork, so that the spring always tends to keep the clutch wheel O in its normal position, whether the lugs S, T are engaged or disengaged.

The free end of the cam lever F<sup>1</sup> is connected by means of a link-rod *a* to one end of another lever Z, fulcrumed centrally on a stud *b*. An inclined edge *c*, formed on the opposite end of that lever, engages with a stud *d*, projecting from the lower end of a pendent arm *e*, fulcrumed on the same stud M as that on which the clutch fork P is also fulcrumed, and with the lower end of the pendent arm *d* bearing against a stud *f*, projecting on one side, at the lower end, of the clutch fork P.

Therefore, on the descent of the cam lever F<sup>1</sup>, the lever Z oscillates and thus causes the inclined edge on the free end of that lever to move both the pendent arm *e* and also the clutch fork P, so as to disconnect the clutch wheels O, U momentarily, and thereby put the entire combination of marking mechanism out of action, temporarily, until such a length of warp has passed forward as corresponds to the extra length required between the last shawl mark of one series and the first shawl mark of the next series of shawls. The interval between those two extreme shawl marks is determined by the relative sizes of the measuring roller change pinion N and the first clutch wheel O, which may be in such a ratio as to permit of the measuring roller making one, or more, or less than one complete revolution before the lug S, on the first clutch wheel O, again encounters that on the second clutch wheel, to resume the operation of the marking mechanism. As the stepped cam G revolves slowly the lever F<sup>1</sup> returns gradually to its normal position and passes on the opposite side of the stud *d*, projecting from the pendent arm *e* without imparting to the clutch fork P, any movement whatever.

§ 266. After the marking hammer A has descended to impress the last shawl mark of one series of shawls, the second stepped cam G then liberates the two cam levers F, F<sup>1</sup>, which descend, not to the bottom of the cam step, but only a sufficient distance to permit

of the disc or timing levers H, H<sup>1</sup> to bear downward upon the rims of their respective discs B, B<sup>1</sup> until notches cut in the rims of those discs are brought immediately underneath the ends of their respective timing levers H, H<sup>1</sup>. When this occurs, the timing levers descend suddenly and thereby operate first the marking hammer J to impress the *cutting-out mark*, and then the marking hammer J<sup>1</sup> to impress the *first shawl mark* of the following series of shawls, in succession, and at such intervals apart as is predetermined by the relative adjustment of the stepped cam C, and the discs B, B<sup>1</sup>, and also by the relative sizes of the change wheels N, O and U, g. After the timing levers have descended through the notches and below the rims of their respective discs, they rebound instantly, but cannot return from inside to the outside of those disc rims until they have made a complete revolution, when the timing levers again ascend automatically, through the notches, into their normal position.

With the descent of each timing or disc lever, their respective cam levers F, F<sup>1</sup> are thereby depressed from their neutral position until their free ends bear downward against the rim of the cam G. Therefore, when this further movement occurs, in respect of the cam lever F<sup>1</sup>, only—which operates in conjunction with the timing lever H<sup>1</sup>, governing the marking hammer J<sup>1</sup>, to impress the *first shawl mark* of each series—the lever Z oscillates and thereby disconnects the lugs S, T of the clutch wheels O, U momentarily, to put the marking mechanism out of operation in the manner and for the purpose described previously.

§ 267. A later example of a shawl-marking motion is that illustrated in Figs. 152 and 153, which represent an elevation and a plan of Henderson's modification, as constructed by Messrs Grimshaw & Brock. This device, like the shawl-marking motion described in the two previous sections, operates automatically without the necessity to stop the machine at the end of each series of shawls and then draw forward, by hand, as formerly, a short length of warp to produce the interval between two consecutive series of shawls.

With this present modification, the shawl-marking hammer R is governed by a ratchet-wheel B, termed the "shawl-marking wheel," which, through the medium of wheel gearing, is operated from a pinion D, on one end of the shaft of the measuring roller A; whereas the cut-marking hammer S is controlled by means of a separate



segment tooth C, termed the "cut-marking tooth," which is adjustable and may be fixed, in relation to the teeth of the ratchet wheel

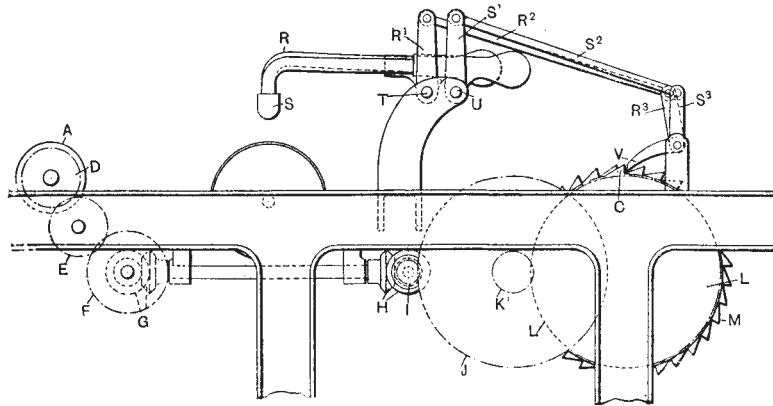


Fig. 152.

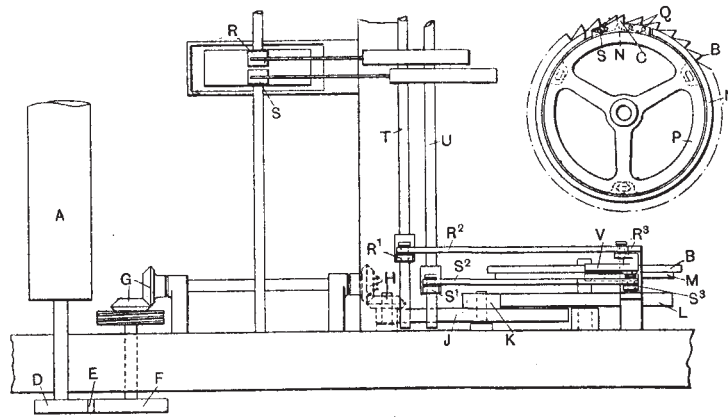


Fig. 153.

B, according to the interval required between two consecutive series of shawls.

Motion is transmitted from the measuring roller A to the shawl-marking wheel B through the medium of a train of wheels commencing with the pinion D and terminating with a large wheel L secured to the ratchet wheel of which the teeth extend partly across a gap N

formed in a ring M, to one end of which the cut-marking segment tooth C is riveted (as indicated in the detached diagram, Fig. 153) in such a manner that the gap in that ring may be expanded or contracted in order to adjust the segment tooth to the teeth of the ratchet wheel as required.

The marking hammers R and S are each mounted upon separate shafts T and V, and operated through the medium of short arms and connecting-link rods  $R^1$ ,  $R^2$ ,  $R^3$ , and  $S^1$ ,  $S^2$ ,  $S^3$  respectively. Therefore, successive teeth of the ratchet wheel raise a pawl V and the shawl-marking hammer R, which descend as each of those teeth releases the pawl V to impress a shawl mark for each tooth; whereas the cut marks are impressed by the marking hammer S only after each complete revolution of the segment tooth C, and therefore of the ratchet wheel B, with which it revolves.

§ 268. A cut-marking and measuring motion of a distinctly different type from any of the previous modifications is that illustrated in Figs. 154 to 159, which represent different views and details of another example of Hitchon's devices of this class, and one that has met with considerable approval. This improved type of device is designed with the primary object of enabling a warp to be subdivided into unit lengths of any measurement without the necessity of changing wheels for that purpose, as is required with marking motions of the previous type, whereby the changing from one cut-length to another is effected instantly and with precision.

This device also combines a length indicator in addition to that which simply indicates the number of "cut-lengths" that are wound on; so that by reading the two indicators in conjunction, they record, at sight, the exact length of warp that has passed on to the weaver's beam. These objects are accomplished by a modification of the same inventor's measuring and automatic stop-motion adapted for beam-warping machines, as described and illustrated in §§ 147 to 149 of the previous chapter.

The operation of these two devices depends chiefly upon the application of a type of spur wheel that is provided on one side with what may be described as "peg" or "riding" teeth. In two wheels of this type that gear with each other there is usually a difference of only one tooth between them. Therefore, after two

such wheels have made a prescribed number of revolutions, which is in a measure inversely proportionate to the respective number of teeth they contain, the "peg" teeth encounter and ride upon each other.

If both wheels are mounted on fixed bearings they must stop whenever the riding teeth meet, as in the Geneva stop-winding motion; or else the two wheels may reverse their movement and revolve in the reverse direction until the peg or riding teeth again encounter each other. If, however, one of the two wheels is mounted

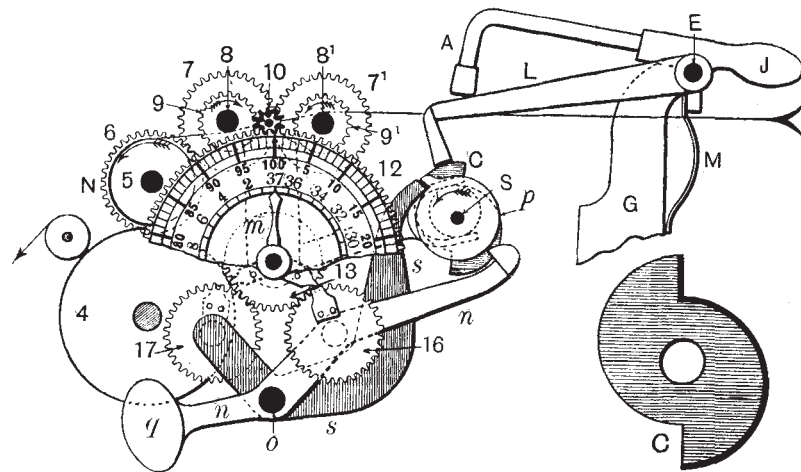


Fig. 154.

on a movable bearing secured to an arm or lever, as exemplified in Hitchon's measuring motions under present notice, the meeting of the two riding teeth causes the movable wheel to part momentarily from the driving wheel, and thereby vibrate the arm or lever on which the movable wheel is mounted, for the specific purposes for which these respective devices are designed.

The distinctive feature of this new type of cut-marking and measuring motion, as represented in Figs. 154 and 155, consists essentially of a graduated dial wheel and plate 12, with an index finger M, constituting a length indicator which, through the medium of an ingenious combination of spur-wheels provided with peg or riding teeth, levers and cams, controls the operation of the colour-

marking hammer A in a manner to be described. The length indicator is operated primarily from the measuring or nip roller 5, which, through the medium of ordinary wheel gearing commencing with a pinion wheel 6 on the far end of the measuring roller and terminating with a small pinion 11, transmits motion to the dial wheel 12.

Thus, the measuring roller pinion 6, with 36 teeth, gears with a spur-wheel 7, with 35 teeth, which in turn drives a similar wheel 7<sup>1</sup>.

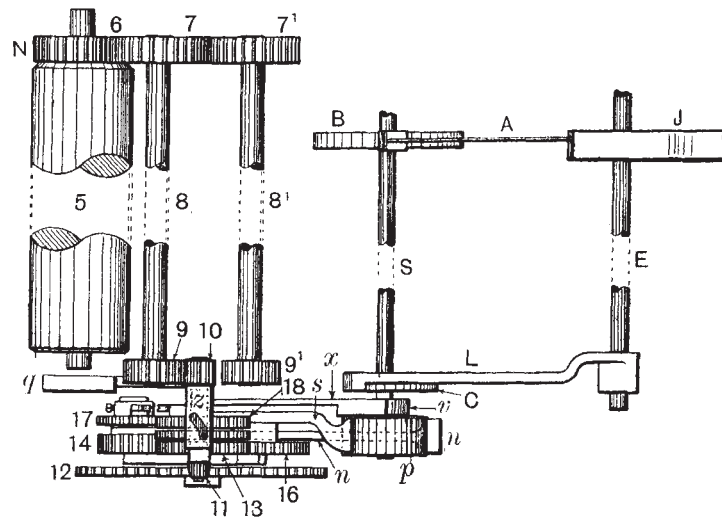


Fig. 155.

These two wheels 7 and 7<sup>1</sup> are fixed respectively on the rear ends of two iron "sheeting" or yarn-spreading rollers 8 and 8<sup>1</sup>, that revolve in reverse directions and assist in spreading the yarn into a more evenly distributed sheet of threads as these pass *over* the rear roller 8<sup>1</sup>, and *underneath* the front roller 8, as indicated in Fig. 154. On the fore ends of the two "sheeting" rollers there are fixed two pinions 9 and 9<sup>1</sup> respectively, each containing 30 teeth, with which there gears, in alternate succession, another wheel 10, with 15 teeth. This wheel is secured to the rear end of a short spindle shaft on the fore end of which there is mounted a small pinion 11, with 7 teeth, which drives the dial wheel 12, containing 100 teeth,

with a velocity of one revolution for every 100in. of warp length, thus:--

$$\frac{14.4 \times 35 \times 15 \times 100}{36 \times 30 \times 7} = 100 \text{ in. per rev. of dial wheel.}$$

§ 269. From this point, the dial-wheel now becomes the essential factor which controls both the measuring and cut-marking mechanism. On the front of that wheel there is fixed a white enamelled plate containing two separate scales—namely, an inner scale to indicate units of 100in. each up to 37 hundred inches =  $102\frac{1}{2}$  yds., and an outer scale to indicate inch units up to 100in. The figures on the inner scale of “hundreds” are always read from the point of the index finger *m* wherever they may be; but the figures on the outer scale of unit inches are read only when they are in the zenith, directly over the axis of the dial.

Both the dial and recording finger revolve with a slightly different velocity and in the same direction simultaneously, but in reverse directions alternately, in a manner and for a purpose explained in the last paragraph of this section. The recording finger *m* is secured on the fore end of a spindle shank which passes quite freely through the hollow hub of the dial-wheel. On the hub of that wheel there is fixed a pinion 13, containing 38 teeth, and also provided with a “peg” or “riding” tooth 13' on the front, as represented on a larger scale in Figs.

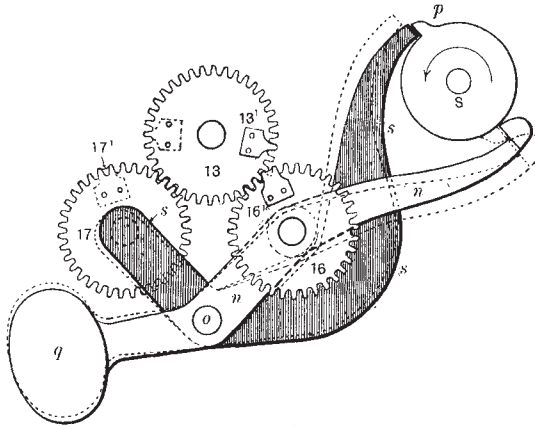


Fig. 156.

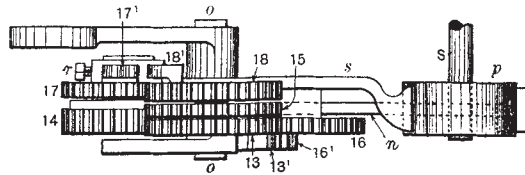


Fig. 157.

156 and 157. Through the medium of a simple carrier wheel 14, having a wide rim and 37 teeth, the dial pinion 13 transmits motion to the finger wheel 15, with 37 teeth, secured to the spindle carrying the recording finger. Hence the relative velocity of the dial-plate and the recording finger is in the ratio of 37 to 38revs. respectively.

Thus, if the finger and dial are both set to zero on their respective scales—*i.e.*, to 37 (3700) and 100 respectively, as represented in

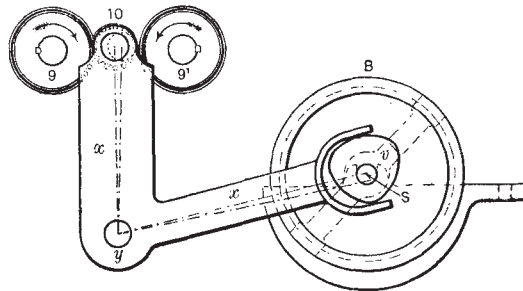


Fig. 158.

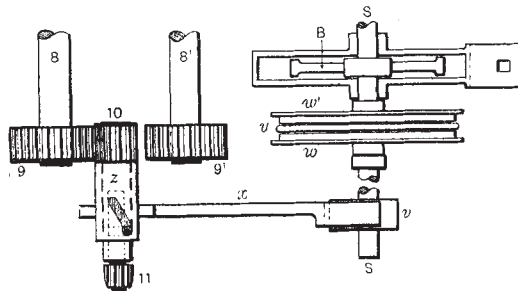


Fig. 159.

Fig. 154 — and the dial is then turned one revolution in an anti-clockwise direction, the finger will make  $1\frac{1}{37}$ th of a revolution, and therefore point to 1 (100) on the inner scale. After the second revolution of the dial, the finger will point to 2 (200), and so on, thus advancing one unit, representing 100in. each, for every complete revolution of the dial-plate. Therefore, when this has made 37revs., the index finger will

have made 38revs., and both will again indicate zero on their respective scales. The dial pinion 13 also gears with another wheel 16, containing 37 teeth, and provided with a riding tooth 16<sup>1</sup> on the front. This wheel is mounted on one side of a lever *n* fulcrumed on a bar *o*, and formed with a hook at the end of the longer arm which extends immediately below a hooked disc *p* fixed on the extreme fore end of a shaft *S*, as represented on a larger scale in Figs. 156 and 157.

The shorter arm of the lever *n* is cast with a heavy counterweight *g* to overbalance that lever, and yet permit of its vibrating slightly whenever the riding teeth on the dial pinion 13 and the lever wheel 16 meet each other, and thereby depress the hooked end of the lever *n*. This occurs only when the index finger and also the outer scale on the dial-plate both indicate zero simultaneously, as represented in Fig. 154.

On the hub of the carrier wheel 14 there is also mounted an adjustable pinion 17, containing 37 teeth and secured to the hub of the carrier wheel by means of a set-screw *r*, so that both of these wheels revolve together as one wheel. This pinion 17 is provided with a riding tooth 17<sup>1</sup> at the back, and gears with a wheel 18, containing 38 teeth, also provided with a riding tooth 18<sup>1</sup> at the back, and mounted quite freely on the hub of the finger wheel 15.

Both the carrier wheel 14 and the pinion 17 are mounted together on one side, and near the end, of the shorter arm of a second lever *s* (shaded), also fulcrumed on the bar *o* that supports the first lever *n*. The longer arm of this second lever *s* is formed with a blunt end, and is cast much heavier than the shorter arm which it overbalances and yet permits of that lever vibrating slightly whenever the riding teeth on the pinion 17 and the wheel 18 meet each other, and thereby raise the blunt end of the lever.

By previously adjusting the pinion 17 and the wheel 18, in relation to the index finger and dial-plate, in a manner to be explained presently, the vibration of the second lever *s* is timed to occur precisely, and only, when the figures at the point of the index finger and those that are in the zenith on the outer scale of the dial-plate jointly indicate the prescribed length of cut, expressed in unit inches.

The adjusting of those two wheels 17 and 18, and also of the dial-plate and recording finger, to mark any prescribed length of cut, is accomplished easily and quickly by first releasing the pinion 17, then sliding the small pinion 11 backward out of gear with the dial-wheel, and turning this wheel until the required length of cut is indicated jointly by the index finger and also the outer scale on the dial-plate. The small pinion 11 is then replaced in gear with the dial-wheel, when the pinion 17 and the wheel 18 are turned until their respective riding teeth meet, after which the pinion 17 is again



secured on the hub of the carrier wheel 14, and the adjustment is complete.

For example, if it is required to mark a warp into cut-lengths of 62yds. (2232in.), the dial would be turned until the index finger pointed to 22 (2200) on the inner scale, with the division mark denoting 32in. on the outer scale, in the absolute zenith over the axis of the dial-wheel; after which the riding teeth on the pinion 17 and the wheel 18 meet each other in the manner just described, and with the wheel 10 in gear with the pinion 9 on the front "sheeting" roller 8 as indicated in the diagram, Fig. 155.

Therefore, when the sizing machine is put into operation, the dial-wheel will revolve first in a clockwise direction for  $22\frac{32}{100}$  revs., when a cut-length of 2232in. has passed on to the weaver's beam, and both the index finger and the outer scale on the dial-plate will indicate zero simultaneously. This position of the index finger and dial-plate always coincides with the meeting of the riding teeth on the dial pinion 13 and the wheel 16 on the hooked lever *n*, whereby that lever is depressed, as described in the first paragraph on p. 279.

The instant that lever vibrates the shaft S makes one-half of a revolution with the twofold object of deflecting the marking hammer to impress a cut-mark on the warp threads, and also to transfer the wheel 10 from the pinion 9 on the front "sheeting" roller 8, and put it into gear with the pinion 9<sup>1</sup> on the *rear* "sheeting" roller 8<sup>1</sup> automatically; thereby immediately reversing the movement of both the dial-wheel and index finger. These will then revolve in an anti-clockwise direction until they jointly indicate the prescribed cut-length of 2232in., when the riding teeth on the pinion 17 and the wheel 18 meet, and thereby raise the second lever *s* to permit of the shaft S making another half of a revolution, to impress another cut-mark, and at the same time transfer the wheel 10 back again from the pinion on the rear "sheeting" roller to that on the front roller, and so again reverse the movement of the dial-wheel and index finger. These will now revolve again in a clockwise direction until they both indicate zero simultaneously, on their respective scales, and so on continuously until the weaver's beam is completed.

§ 270. The intermittent rotation of the shaft S is effected primarily, not from the measuring roller which operates the length indicator, but from the second or driven cone-drum shaft of the

main driving gear. Thus, through the medium of a narrow leather belt, motion is transmitted from a small flanged pulley, on the conedrum shaft, to a narrow disc  $u$  fixed on the shaft S, on which there are also fixed the hooked disc  $p$ ; an eccentric cam  $v$ ; a double-stepped cam C; and the colour block B.

On each side of the disc  $u$  there is mounted a single-flanged loose pulley  $w$  and  $w^1$ , which serve merely to retain the narrow belt in its proper track. The narrow rim of the disc  $u$  is rounded to prevent it from cutting into the driving belt that runs continuously on the rim of that disc, which it is constantly endeavouring to turn, and thus rotate the shaft S to impart the intermittent movement to the eccentric cam  $v$  and the double-stepped cam C.

The driving power of the narrow belt, and therefore the intermittent rotation of the shaft S, are, however, held under restraint by causing the projecting hook on the rim of the disc  $p$  to catch and thus stop against either the blunt end of the lever  $s$  or else against the hooked end of the lever  $n$ . Both of these levers vibrate in alternate succession, and thereby liberate the hooked disc to permit of the shaft S making half a revolution, when its further movement is arrested by first one and then the other of those two levers, until the hooked disc is again liberated for the purpose of impressing cut-marks upon the warp threads, and also of reversing the movement of the length indicator and its appurtenances, in the manner described in the last paragraph of the previous section.

The eccentric cam  $v$  is spanned by the forked end of the horizontal arm of an L-lever  $x$  fulcrumed on a stud  $y$ , as represented in Figs. 158 and 159. In a sleeve bearing  $z$  carried at the upper end of the vertical arm of that lever there is mounted a short spindle shaft, on the opposite ends of which there are contained the wheel 10, and the small pinion 11 which gears with the dial-wheel.

Hence, with each intermittent movement of the cam shaft S the eccentric cam  $v$  oscillates the L-lever, and thereby transfers the wheel 10 from the pinion on one "sheeting" roller, to gear it with that on the other roller, with the object of reversing the movement of the dial-wheel, the index finger, and other parts incidental to the length indicator. At the same time, the double-stepped cam C releases the cam lever L, and thereby deflects the marking hammer on to the colour block to impress a cut-mark on the warp threads.

## SHEETING OR YARN-SPREADING ROLLERS

§ 271. One of the evils to which slasher-sized and cylinder-dried warps are liable, and one that is detrimental to the quality both of the yarn and the cloth produced from it, is that which results from the clinging or adhering together of two or more contiguous warp threads that sometimes pass on to the weaver's beam without being separated. This not only impedes the weaver by those threads pulling and sometimes breaking either against the lease-rods or else the shedding harness in the loom, but it also involves the consequent risk of producing imperfections in cloth.

This evil of clinging warp threads results from the passing of yarn, in the form of an evenly-distributed sheet of threads, through a solution of hot size paste, and conducting it immediately around heated drying cylinders whilst the threads are in contact with each other, and without any means of separating them and keeping them apart whilst they are still moist with size.

The risk of warp threads clinging to each other is, of course, minimised by employing a number of dividing-rods for the purpose of separating the threads after these leave the drying cylinders, and immediately before they pass finally on to the weaver's beam. This division of the warp threads, however, is but a very imperfect one, and consists of separating the yarn into such a number of divisions or sheets of threads as correspond with the number of back beams from which they are withdrawn, as described in §§ 181 and 228.

But, even with this precaution, frequently two warp threads may be found clinging to each other, and in some warps containing a considerable number of threads even three contiguous threads have sometimes been found adhering together. Whenever this occurs it follows that those threads must necessarily come from the same back beam, since all warp threads that are withdrawn from the same beam are passed uniformly above and below the same dividing-rods in the manner explained in § 228, and as illustrated in Fig. 115.

§ 272. Correlated with the evil of warp threads clinging together during the operation of slasher sizing, there is also another defect which arises in consequence of passing the yarn in "half-beers"

of, say, five or more threads through an expansible and contractible half-reed or spreading comb, by which the width of warp is adjusted to that of the weaver's beam. On emerging from that reed, the threads tend naturally to run together in groups or "half-beers," instead of spreading out to form an evenly-distributed sheet of threads as they pass on to the weaver's beam. Hence, these groups of threads tend to form ridges and furrows, and thereby produce an uneven surface of yarn on that beam, with the result that the warp threads are of slightly unequal tension.

Numerous expedients have been devised with the object of remedying these two evils of clinging and grouping warp threads, by assisting them to separate and spread out into an even sheet of threads. In most sizing machines the remedy is left entirely to the levelling influence of the yarn - pressing rollers, which, by

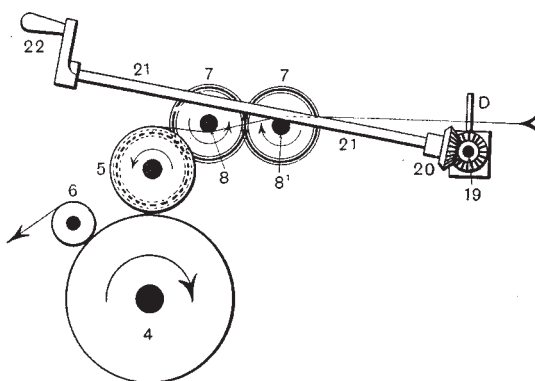


Fig. 160.

force of compression against the yarn surface of the weaver's beam, causes the more prominent ridges of threads to become imbedded, without, however, effecting an even distribution of those threads.

Thus, after leaving the dividing-rods, the warp threads pass, almost immediately, in "half-beer" groups, through the expansible and contractible reed D (Fig. 160), which is situated about midway between the last dividing-rod and the cut-marking colour-block. The yarn is then conducted, *en masse*, first *over*, and then *under*, two iron "sheeting" or yarn-spreading rollers 8' and 8 respectively, whence it passes over the measuring roller 5, and between this and the large tension or drawing roller 4, thence over a small iron guide roller 6, and finally on to the weaver's beam.

§ 273. The type of reed or comb usually employed to distribute the sheet of warp threads to the required width is similar to that

employed with the same object in beam-warping machines and as illustrated in Fig. 45. Such a reed is constructed with several long spiral springs that extend for the entire length of the reed, and of which the coils are intertwined and intercepted by the reed wires in such a manner that the extension and contraction of the springs increases and reduces the width between those wires uniformly.

This adjustment is obtained by securing the opposite ends of the springs respectively to two bolts, one of which receives a right-hand thread, and the other a left-hand thread, that are formed at opposite ends of a rod extending along the entire length of the reed-base. On one end of that rod there is fixed a bevel wheel 19 gearing with a similar wheel 20 on the rear end of an inclined shaft 21. On the fore end of this shaft there is fixed a handle 22, to permit of the warp being adjusted whilst the attendant stands in front of the machine, and with the weaver's beam under his immediate observation.

By their impinging more or less against the vertical reed wires, these tend to impart to the respective "half-beer" groups of threads a quarter twist or turn from their original horizontal plane, thus, .... .... ...., and thereby cause the threads of each separate group to assume a vertical plane, thus,  $\begin{matrix} \vdots \\ \vdots \\ \vdots \\ \vdots \end{matrix}$ . It is then the function of the "sheeting" or spreading rollers 8 and 8' to reverse the effect of the reed wires by replacing the groups of threads from their vertical to a horizontal plane, and thereby spread them into an evenly-distributed sheet of threads.

One of the earliest forms of reeds employed for this purpose consisted of round wire pins inserted in a long piece of india-rubber, about an inch square in cross-section, and was expanded or contracted to the required width by simply stretching the rubber foundation of the reed.

§ 274. In sizing machines of earlier date, the "sheeting" bars were quite stationary, but in those of modern construction they are usually mounted freely in their bearings to permit of those bars revolving simply by their frictional surface contact with the sheet of yarn as this passes over and under them respectively. The rotation of the sheeting rollers not only tends to effect a better distribution of the warp threads than when they are stationary, but it also prevents their incision from the constant chafing by those threads.

In some machines as made by Messrs Howard & Bullough, Limited, the effort of turning the "sheeting" rollers is not imposed upon the warp threads, but they are driven positively through the medium of wheel gearing operated from a pinion on one end of the measuring-roller shaft, as represented in Figs. 154 and 155.

A still later improvement, however, adopted by that firm is to mount the "sheeting" rollers eccentrically to the respective axes of the spur-wheels by which they are driven, as illustrated in Fig. 161. By this means the eccentric motion of those rollers keeps the yarn moving continually upward and downward alternately, with the twofold object of effecting both a more perfect separation and distribution of the warp threads.

Some machine makers, however, adopt the extreme contrary method of fixing two, and sometimes three, oval-shaped iron "sheeting" bars,

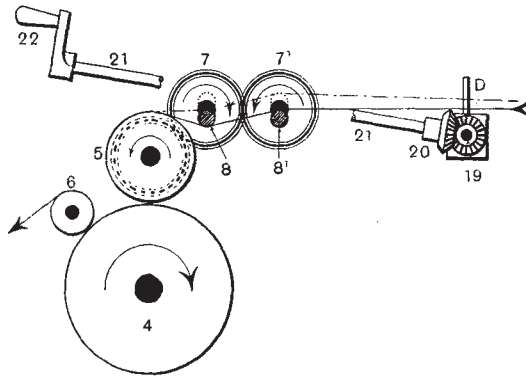


Fig. 161.

instead of perfectly round ones, for the purpose of effecting an even distribution of warp threads, and of which two different applications are represented at A and B, Fig. 162.

§ 275. Also sometimes other measures are adopted with the object either of minimising or averting the risk of warp threads clinging and grouping together during sizing. For example, one method is to interpose an additional reed  $D'$  between the usual reed  $D$  and the measuring roller 5, as represented by a part elevation and plan in Figs. 163 and 164. Both of these reeds are precisely similar in construction, excepting that instead of the wire dents of the additional reed  $D'$  being quite vertical, they are inclined at an angle of about  $25^\circ$  from the vertical, as represented in Fig. 165.

The objects of inclining the dents of that reed are to effect a more thorough separation of the warp threads by causing them to

spread out as they bear preferably against the *upper* surfaces of the inclined reed wires; and also to ensure the turning or twisting



Fig. 162.

of the half-beer groups of threads always in the same direction, uniformly, as indicated in Fig. 166. Instead of employing an additional reed, however, some attendants attain the same object by

Fig. 163.

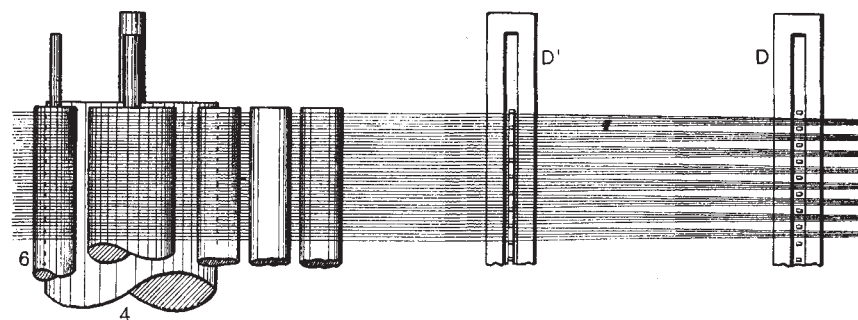
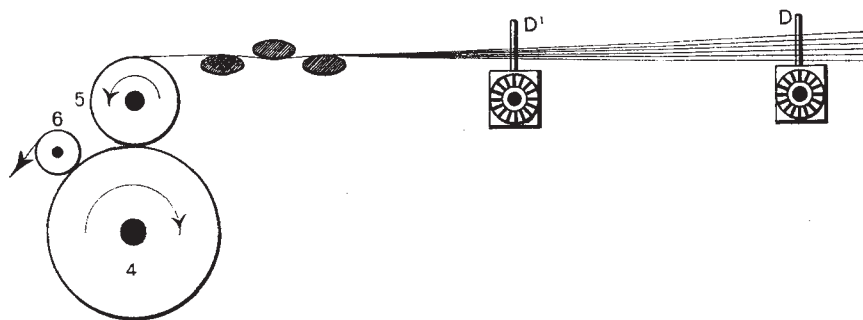


Fig. 164.

inclining the dents of the usual reed or comb in a manner similar to that represented in Fig. 165.

Instead of the usual form of half-reed or comb constructed with



flattened reed wire, and of which the dents are arranged in one long straight row, as represented at D, Fig. 160, there is sometimes employed a vandyked reed of the type illustrated in Fig. 167. Reeds of this type are constructed with round steel wire, and with the dents arranged in zig-zag rows on a number of short bars that are

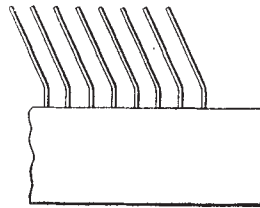


Fig. 165.

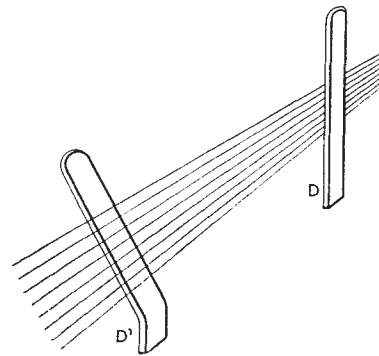


Fig. 166.

hinged together freely to permit of the reed being expanded and contracted. This is effected by means of reversed screw threads formed at opposite ends of a rod which extends along the reed-base as in the previous form of reed, but without the aid of the intertwined spiral springs that are employed for that purpose in the former reed.

The advantages claimed for reeds of the vandyke type over those of the straight type are that the employment of round steel wire

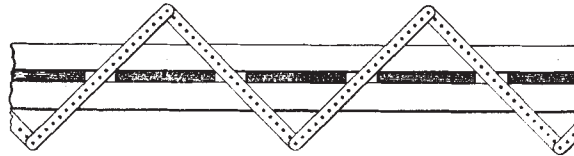


Fig. 167.

gives greater strength and firmness to the dents, and also that the positive adjustment of the reed ensures a more perfectly even and precise distribution of the dents than is possible by the aid of spiral springs that become clogged with lint and dust, and are therefore uncertain and unreliable in their action.

Another example of a reed constructed with inclined dents,

and intended for use in sizing machines, is that illustrated at A and B, Fig. 168, which represents a part front and a sectional view of a reed designed more particularly for "dresser" sizing of warps of which the threads are passed in pairs only, and whilst they are still moist with size-paste, between successive dents of the reeds.

Excepting for the inclination of the reed wires, the reed is similar to one of ordinary construction, with upper and lower ribs bound together with pitched twine or cord, and of which the dents, therefore, are closed and fixed. This, of course, necessitates the passing

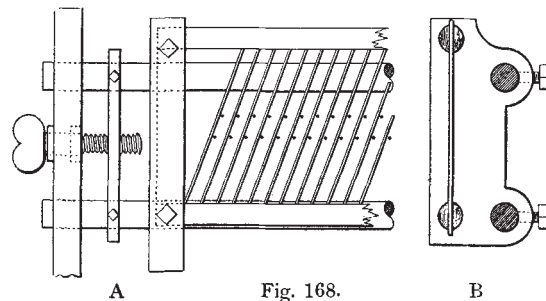


Fig. 168.

of warp threads between the dents of such a reed, in the first instance at least, by the operation of "drawing-in," and those of subsequent warps by that of "twisting-in," instead of by the method of "laying-in," as with the usual form of half-reed or comb in which the dents are open at the top.

#### ECONOMY IN STEAM CONSUMPTION FOR SIZING

§ 276. Of the several economic problems incidental to warp sizing by means of any of the different types of machines in vogue, the more difficult ones are those of securing (1) the most effective results with the least consumption of steam for boiling the size, and also for drying the sized yarn; and (2) an effective system of heating and ventilating the sizing room to ensure the best atmospheric conditions, in respect of temperature and humidity, by removing the vapour of partially-condensed steam that issues chiefly from the boiling size, and also from the yarn, as this is submitted, after being sized, to the process of drying.

These two objects may be attained more or less successfully only by conforming to certain conditions that are imposed by the special technical requirements of warp sizing, as regards the constructional features of the room in which that operation is conducted, as well as the position of the building in relation to the steam-boiler house and other adjacent buildings.

Although it is impossible to specify exact particulars and conditions that would best meet the special requirements of sizing rooms generally—since these particulars may be acquired only from definite knowledge and data respecting local and special circumstances—yet there are certain expedients and precautions of general application which, if adopted, conduce to greater efficiency and economy both in the consumption of steam and also in ventilation.

The chief economic difficulties encountered in the operation of sizing by means of slasher sizing machines consist of an excessive condensing of steam both in the main service pipe leading from the steam boilers to the sizing department, and in the drying cylinders, with the consequent loss of heating power in those cylinders; and also of the atmosphere becoming surcharged with vapour of partially-condensed steam that lingers in the air, and thus prevents the yarn from drying sufficiently. This not only causes the warp threads to cling to each other, and also to the drying cylinders, but it also conduces to the subsequent development of mildew in cloth.


§ 277. Consistent with all other essential considerations affecting the relative disposition of the various departments of a weaving mill, in order to facilitate the transit of yarn in the various stages of its progress through the preliminary operations of weaving, the sizing department should be situated as near as convenient to the boiler house, with the object of reducing the length of main service piping necessary to convey steam from the boilers to the sizing machines, thereby preventing excessive condensation of steam in that piping, with a corresponding loss of pressure and efficiency.

The steam service pipes should not have a diameter larger than is necessary to supply the volume of steam required for sizing purposes; nor should they, if it can be avoided, pass outside and thus become exposed to cold air that would induce the condensation of steam. Also, the main service pipe should be insulated for its entire length by covering it with a good non-conducting material,

such as magnesia, silicate cotton (slag-wool), asbestos, cork, hair-felting, or other suitable material, of which there are numerous preparations for covering steam boilers, steam pipes, and drying-cylinder ends, with the object of preventing the radiation of heat from them, and thereby reducing the condensation of steam.

For only one sizing machine and the usual size-mixing plant, a main service pipe of 2in. in diameter is recommended, with an increase in diameter of  $\frac{1}{2}$ in., 1in.,  $1\frac{3}{8}$ in.,  $1\frac{1}{2}$ in., and 2in., for from two to six machines, respectively; and with branch pipes of not more than 1in. to  $1\frac{1}{4}$ in. to supply steam to the drying cylinders, size-boxes, and size-mixing becks.

The joints of all steam-pipes, and also the glands or stuffing-boxes of the cylinder journals where these are connected to the steam-pipes, should be well packed and made perfectly steam-tight; and all leakages of steam, however small, should be stopped immediately on discovery.

All branch pipes leading to the drying cylinders, size-boxes, and size-boiling becks, should pass from the upper side of the main service pipe with a syphon bend, thus , to prevent the evil known as "priming," or the passing either of water that escapes from the steam boilers, or else that of condensation, together with steam, down the branch pipes and into the cylinders.

Also, all steam-pipes that run horizontally should be set with a slight inclination in such a direction as will assist the water of condensation to gravitate towards the steam-traps, and thereby reduce the risk of that water lodging in the pipes, especially after the steam is shut off for a prolonged period.

Further, all the water of condensation, unless it is contaminated with oil, grease, or other harmful impurities, should be conducted back again to the steam boilers and not run to waste.

§ 278. An additional precaution which is sometimes adopted is that of applying to the cylinder ends a large circular mat or pad composed of any suitable non-conducting material to prevent the radiation of heat, and thereby reduce the condensation of steam within the cylinders. Such mats are sometimes secured detachably, by means of several radial iron bands that are clamped to the rims of the cylinder ends, to permit of their easy removal whenever that becomes necessary for the purpose of effecting repairs within

the cylinders; and sometimes the mats are fixed in position more effectively by boarding them up, and thus enclosing them completely. In either case, care should be taken to leave vent-holes in the pads so as not to interfere with the free-and-easy action of the air-valves in the cylinder ends.

This method of insulating the cylinder ends, however, is disparaged by some, who prefer to utilise the radiant heat therefrom for the purpose of maintaining the required temperature in the sizing room.

In fact, in a specific instance of comparative tests that were conducted with the object of ascertaining the difference in the amount of steam consumed, in a stated period, by the *large* cylinder of a slasher sizing machine, when sizing 1140 warp threads of 20's T, and with a steam pressure of 14lb. per sq. in.—first with the cylinder ends uncovered, and afterwards covered with insulating mats—it was found that the volume of water of condensation recovered in one hour was virtually equal in both tests and measured practically 13gall. (=130lb.), but with an *excess*, however, of about *one-half* (0.05) per cent. when the cylinder ends were *covered* with the non-conducting mats which, by these tests, proved to be useless.

§ 279. Although the cost of generating steam consumed only for sizing purposes represents a considerable proportion of the productive cost of manufacturing certain classes of textile fabrics, and especially those comprised under the trade description of "grey cloth" as distinguished from the bleached and coloured varieties, there is, nevertheless, very little available information or data relating to that subject, for the purpose of formulating a basis on which to calculate the proportionate cost of this important item.

The absence of such information is, no doubt, owing chiefly both to the practical and technical difficulties which are encountered in conducting, with sufficient accuracy, the tests and observations that are necessary to furnish reliable data. Hence, it is the usual practice in most weaving mills to include in the item of "general working expenses" a proportionate sum for the cost of coal, water, and other miscellaneous expenses incidental to cloth manufacturing, and to base the amount of that sum on a certain percentage of that paid in wages for weaving.

The amount of coal consumed in vaporising a definite volume of water may be calculated from known data. Therefore, if all

the water of condensation formed during a specified period were collected from the steam-traps and measured, the volume of water thus obtained would furnish an approximate basis on which to calculate the amount of coal and water consumed in respect of the drying apparatus only, but not for size-mixing and boiling also.

There would, therefore, still be a considerable disparity between the original volume of water that was vaporised into steam and consumed for sizing purposes only, and the volume of water recovered from the steam-traps, from the fact that a great quantity of steam is consumed in boiling the size with which it combines, and is, consequently, quite irrecoverable.

Also, if the small branch pipes that serve steam to the drying cylinders, size-boxes, and size-boiling becks, pass from the *upper* side of the main service pipe with a syphon bend, as indicated in § 277, and, further, if the water of condensation from the drying cylinders of each sizing machine, in addition to that which condenses prematurely in the main service pipe, were passed respectively through separate steam-traps, it would then be possible to estimate the respective volumes of steam utilised effectively for drying the yarn, and that which condenses prematurely, and therefore passes through the steam-trap without serving any useful purpose whatever.

Therefore, by conducting careful and systematic observations and tests extending over a period of several weeks, to allow for different results arising from atmospheric changes and from other variable factors, such observations would provide sufficient data to establish a reasonable basis on which to calculate, at least approximately, the expenditure incurred in respect of coal and water required to generate the volume of steam consumed for sizing purposes only.

The actual consumption of steam for that purpose, and also the relative cost of producing it, will, of course, vary considerably, even during equal specified periods, not only in different weaving mills, but also in the same mill, according to the relative proximity of the sizing department and steam boilers: the structural features of that department; the type of steam boilers; the type and dimensions of the drying cylinders—that is, whether they are of the usual “drum” or of the “cavity” type; the fluctuation in the price of coal; the different varieties of warps to be sized; the character and grade of sizing, and many other varying factors.

Thus, the condensation of steam will be relatively greater when sizing warps composed of coarser counts of yarn, or containing a greater number of warp threads, and also with the heavier grades of sizing, because of the longer period of time or greater heat required for drying the yarn. Under these circumstances, therefore, either the speed of the machine is reduced, or else the steam pressure in the cylinders is increased in order to augment their drying efficiency, according to requirements.

It is manifest, therefore, that if the proposed observations and tests are to be of any practical value, it will be necessary to extend them over a prolonged period in order to comprehend all the variable conditions just enumerated, and also to observe the different results in respect of warps composed of dissimilar counts of yarn or containing a different number of warp threads, and with different percentages of size applied to them.

§ 280. From observations that were conducted with this object in view, and of which the results were recorded in a foreign textile journal, it was ascertained that the volume of steam condensed in the cylinders of a sizing machine during the first hour following a prolonged interval of rest exceeded four times the volume consumed during each of the succeeding hours, when it became of a normal and practically constant value. In one specific instance these observations extended over a period of ten hours' continuous working, and were conducted during the operation of sizing a warp containing 2530 warp threads of 30's T, 12,000yds. in length.

With coal at a high price (which, however, is not stated) it was estimated that the productive cost of steam consumed amounted to a sum of 21·25 pence during the first hour, after which it declined to only about 4·91 pence, at which sum it remained constant during each of the succeeding nine hours, and aggregated a total sum of 65·4 pence for the ten hours' continuous working.

Therefore, on the reasonable assumption that a corresponding volume of steam is also consumed for boiling size in the size-boxes and boiling becks, the total productive cost of steam condensed in respect of that particular warp amounts to a sum of 130·8 pence, which is equivalent to a sum of 0·1086 pence per pound of the *net* weight of yarn sized.

§ 281. The abnormal rate of condensation of steam in the drying



cylinders during the first period of working, after a prolonged interval, is owing chiefly to the cooling influence of the water of condensation that lodges in them and becomes quite cold before the machine is restarted. Consequently, on resuming work, this cold water rolls continuously at the bottom of the cylinders, thus absorbing a considerable amount of heat from them, and thereby retarding their drying efficiency. This evil, however, may be easily averted by the simple expedient of fixing in one end of each cylinder, and at a point as near as possible to the cylinder shell, a plug-tap, with an internal bent piece of piping extending near to the shell. By adopting this or similar means, the water of condensation could be expelled and drained completely from the cylinders by simply opening the tap and then turning on the steam for only a few seconds.

In certain instances, therefore, it might prove to be more advantageous and economical to work the sizing machines continuously throughout the entire working day, or until the back beams are depleted of yarn, without stopping for meal-times, whereby the relative consumption of steam is reduced. But if, on the contrary, work is suspended for a long interval before the "set" of back beams is exhausted, the steam service pipes, drying cylinders, size-boxes, and temperature of the atmosphere in the room will cool down during that interval. Consequently, on resuming work, the condensation of steam will be much greater up to a certain period, when it declines gradually until it assumes a normal and practically constant value.

Continuous working, of course, incurs additional expense for auxiliary driving power to drive the sizing machines whilst the main driving gear is stopped; besides imposing additional physical strain and discomfort upon the attendants by depriving them of regular intervals of rest during meal-times---disadvantages that will not, in some instances, compensate for the advantages that may accrue from continuous working.

#### VENTILATING AND HUMIDIFYING

§ 282. Considerable diversity of opinion exists amongst both engineering and textile experts concerning the best position and constructional features of sizing rooms, and also the relative merits

of different methods of heating and ventilating those rooms in order to ensure the temperature and humidity of the air that will be most congenial both to the yarn for weaving purposes, and also to the peculiar conditions under which the operation of sizing is conducted.

Consequently there are many examples of faulty construction, imperfect methods of heating and ventilating of sizing rooms, in some of which it is quite impracticable to conduct the operation of sizing with reasonable economy and satisfaction. Indeed, success in this direction may be attained only by conforming to such conditions and requirements as are prescribed from definite knowledge of the practical details of the operation of sizing, and also of the atmospheric conditions that are most favourable to its successful accomplishment.

A relatively high temperature of air, ranging from about 70° to 80° F. (20° to 26·6° C.), according to the character of yarn and the grade or percentage of size, is found from experience to be the most suitable for a sizing room. For strong yarn of coarse and medium counts, and the heavier grades of sizing, the lower temperature might be suitable for maintaining that percentage of humidity which is necessary to retain the size on the yarn; but the higher temperature is preferable for delicate yarn of fine counts with pure and the lighter grades of sizing.

Air of a high temperature, if not too dry, imparts to the yarn a soft, supple, and mellow tone or "feel" without leaving it dry and harsh, and also conduces to a pure and clear atmosphere with a suitable percentage of humidity. This arises from the fact that air of a higher temperature is capable of absorbing and retaining in suspension, as invisible vapour, a much greater weight of water without increasing the relative degree of atmospheric humidity.

§ 283. The maximum weight, in grains, of vapour per cubic foot of saturated air (= 100 per cent. humidity) at temperatures ranging from 60° to 90° F. (15·56° to 32·22° C.) is specified in the following table:—

Temperature (Fahr.)	60°	62°	64°	66°	68°	70°	72°	74°	76°	78°	80°	82°	84°	86°	88°	90°
Grains of Vapour per Cubic Foot of Saturated Air	5·8	6·2	6·6	7·0	7·5	8·0	8·5	9·1	9·7	10·3	11·0	11·7	12·4	13·2	14·0	14·8

The position and structural features of a sizing room should, therefore, be of such a character as will conduce both to steam economy and to a warm and relatively dry atmosphere. These objects may be attained successfully by erecting the sizing room in close proximity to the steam boilers, and also by avoiding, as far as practicable, undue exposure, within the room, of cold building materials, as iron, stone, bricks, concrete, cement, slates, and glass.

All these materials absorb heat from the atmosphere, and thereby reduce the temperature of the air, in their immediate vicinity, to that of the "dew-point," when condensation begins, and the excess of vapour in the air is deposited as dew on those materials.

§ 284. On the basis of the foregoing considerations, therefore, the essential conditions which should be observed in the construction of sizing rooms are specified as follows:—

#### 1. POSITION

A sizing room should be in close proximity to the steam boilers, to minimise the condensing of steam in the main service pipe. If erected as a single storey, the floor should be well elevated from the earth to permit of a good current of air in the space beneath it. If, however, the room is in a storeyed building, it should be uppermost, to permit of *vertical* ventilating trunks passing outside through the roof, to expel vapour from the room by means of natural ventilation only, without having recourse to fans.

This object may only be effected successfully, however, by having the trunks exposed sufficiently to permit of the free access of air-currents to the orifices of those trunks. These will then operate on the same principle as that of tall chimney-flues in which up-draughts or currents of air are induced naturally.

If the ventilating trunks are surrounded by lofty adjacent buildings, these will tend to obstruct the air-currents, and thereby impede natural ventilation by creating atmospheric stagnation around those trunks.

If, however, the room is in a lower storey of a building, either *vertical* trunks of inordinate length would be required to extend outside through the roof, or else *horizontal* trunks would require to pass outside through a side wall, in which case the vapour could

be expelled only by the aid of an extraction fan mounted in the orifice of the trunk to create a draught or air-current.

## 2. FLOOR

§ 285. The floor should be double-boarded with tongued and grooved thick boards of closely grained hard wood, such as birch, maple, or similar wood, to keep the floor quite dry and warm. Flags, stone pavement, concrete and cement are most unsuitable materials for the floor of a sizing room, as they keep the temperature low, thereby causing excessive condensation of vapour, and consequently a floor which is always cold and wet.

## 3. WALLS



§ 286. The walls should be constructed with a wide cavity, and plastered and wainscotted on the inside, with tongued and grooved boards extending from the floor to the roof (or ceiling if in a lower storey), and previously soaked thoroughly in creosote oil to preserve the wood from decay.

## 4. WINDOWS

§ 287. All windows, and especially those facing any point of the compass in the north-east quadrant, should be double-glazed, with a space of at least six inches between the two panes of glass.

The cushion of air in the wall and window cavities serves better to insulate the interior from the exterior by constituting a neutral stratum of air which reduces the radiation of heat from the room, and makes the air within less susceptible to atmospheric changes without. Further, the risk of excessive condensing of vapour against the cold panes of single windows is thereby eliminated.

## 5. ROOF

§ 288. The roof should be of angular formation, and constructed either with one long steep slope for a small room, or else with shorter steep slopes of the saw-tooth () or the bay () type of roof for larger rooms.

The entire roof should be slated or tiled, and, if practicable, without sky-lights. If, however, these are necessary, they should be double-glazed like the side windows, and the slates or tiles of the roof should be underboarded, with ample air space allowed between the roof and boards. These boards should be well soaked with creosote oil, and also lined on the upper side with roof felting. The steep slopes of the roof will ensure quicker draining after rain or snow, and thereby prevent the roof from remaining in a wet and cold state.

#### 6. DIMENSIONS

§ 289. The dimensions of a sizing room depend chiefly, of course, on the number of sizing machines and the dimensions of the size-mixing plant which it is required to contain. The room should be lofty, so as to afford ample air-space; and sufficient floor-space should be allowed for extending the capacity of the beam-creels if that course becomes necessary.

A larger volume of air conduces to a more equable temperature, because it is less susceptible than a small volume of air to variation of temperature.

#### 7. HEATING

§ 290. Heating may be effected by means of a steam-pipe of about 2in. diameter, suspended at an elevation of 7 or 8ft. from the floor, and extending around the room, as well as between two adjacent sizing machines.

#### 8. VENTILATING

§ 291. A system of ventilating for the supply of fresh air to a sizing room (apart from that for removing the vapour from the drying cylinders and size-boxes) may be effected by means of inlets formed in the walls, at about the floor level, and by directing the air up vertical ducts that open into the room about 7ft. to 8ft. above the floor, and from which the air is diffused without creating perceptible currents of cold air that would act detrimentally on the yarn.

Foul air may be expelled from the room through outlets formed in the highest parts of the walls or roof; but care should be taken to adopt a form of ventilator for this purpose that will prevent the possibility of reverse currents or down-draughts of cold air passing on to the yarn.

#### 9. SIZE-MIXING BECKS

§ 292. If possible, the size-mixing plant should be situated in a separate room immediately adjoining the sizing room, but not actually in that room. By adopting this course it would conduce to a much drier atmosphere in the sizing room by keeping it free from the vapour that issues from the size-boiling becks and pans. If, however, these cannot be isolated, an auxiliary ventilating trunk, similar to those adopted for removing the vapour from the sizing machines, should be erected above them, so as to conduct the vapour outside through the roof.

#### 10. PROTECTION OF WOOD AND IRON WORK

§ 293. All wood-work should be treated periodically with creosote oil or other antiseptic material for preserving wood from the destructive effects of a moist atmosphere. Also, all structural iron-work should be protected with anti-corrosive material, and, if possible, encased either with wood or non-conducting material, both to protect it from the influence of moisture and to reduce the condensation of vapour in the air in its immediate vicinity, thereby conducing to a warmer and therefore a drier atmosphere.

#### VENTILATING SIZING ROOMS

§ 294. The function of removing from sizing rooms the vapour that issues from the size-boxes, and that which is also expelled from the yarn as this passes over the drying cylinders, is performed by a variety of different methods of ventilating, respecting the relative merits of which there is great diversity of opinion not only between ventilating engineers, but also between textile experts.

Thus, whereas some advocate the principle of natural ventilation only, some advise the adoption of mechanical ventilation by means

of a forced draught induced by the aid of what is variously termed an "exhaust," "extraction," "suction," and "pressure" type of fan; whilst others again recommend a combination of both natural and mechanical ventilation. These conflicting opinions are, of course, the result of varying experiences, gained under different circumstances, of the respective systems of ventilating which their several advocates have found to give the best results.

It is manifest, therefore, that there has not yet been devised any particular system of general application to all sizing rooms, and that each instance requires to be considered independently from definite knowledge of all the circumstances that bear specially upon it.

§ 295. The removal of vapour from sizing machines is usually effected by means of a system of ducts or flues that span across and open immediately above the size-boxes and drying cylinders, whence the vapour is conducted into and expelled from large vertical or horizontal trunks that emerge through, and terminate several feet above, the roof, or else they terminate in a side wall, as determined chiefly by the situation and structural features of the sizing room, the number of machines employed, and personal preference.

For example, if the machines are contained in a room situated either on the ground floor or in a storeyed building, and with only the roof above, it is usual to adopt the vertical type of ventilating trunk, of which there are three chief modifications—namely:—

1. Sagar's modification of two separate and distinct trunks that project vertically and independently from the size-box and cylinder cover of each machine, as represented in Figs. 169 and 170.

2. Lancaster and Waddington's modification of a single trunk extending vertically and directly above the size-box only, and into which there opens a short inclined duct leading from the roof of the cylinder cover, as represented in Fig. 171; and

3. Stanworth's modification, also consisting of a single trunk projecting vertically and about midway between the size-box and centre of the large cylinder, and into which there open, near the base of the trunk, two separate short ducts, one of which is slightly arched and leads from immediately above the size-box, whilst the second duct is straight and leads with a slight inclination from the roof of the cylinder cover, as represented in Fig. 172.



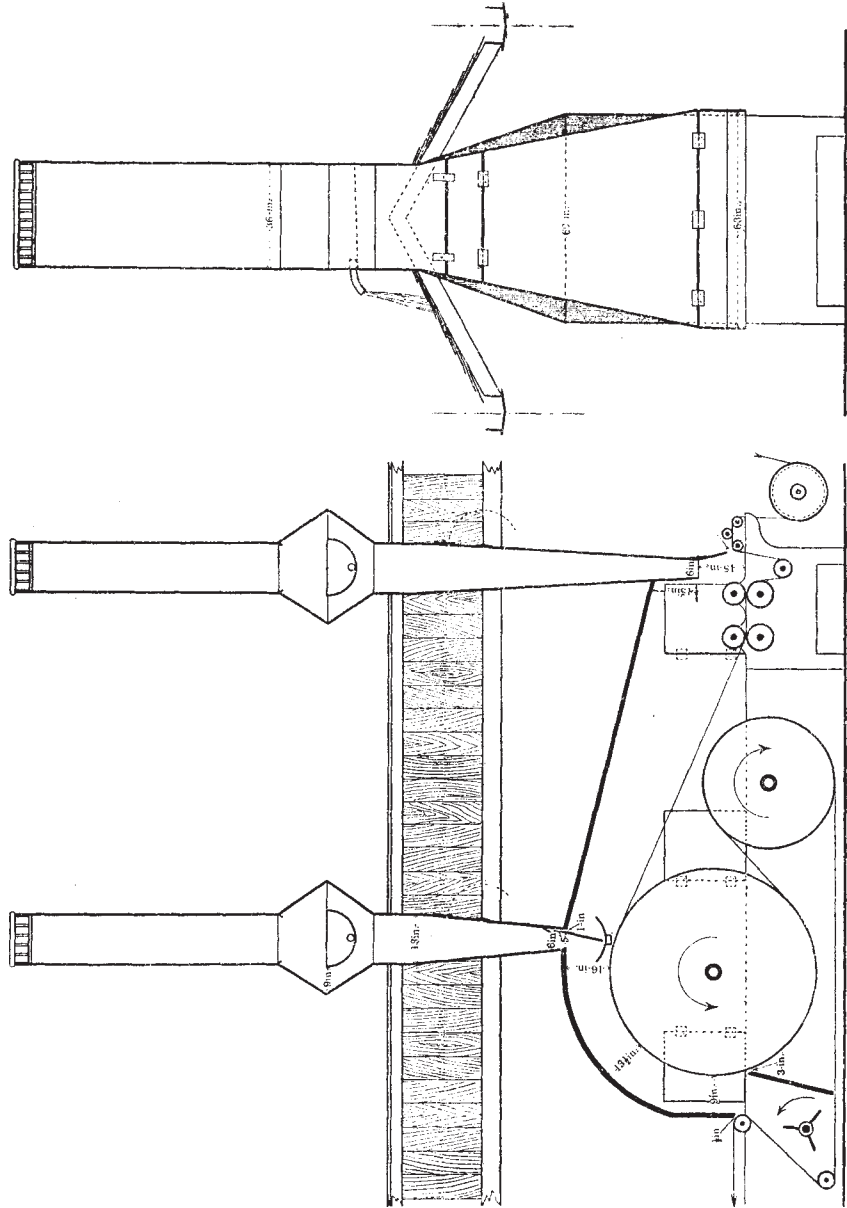


Fig. 170.

Fig. 169. SAGAR'S TWO-TRUNK SYSTEM OF VENTILATING.

§ 296. Under favourable circumstances, vertical trunks generally operate effectively by natural ventilation only, without the assistance of extraction fans. In some instances, however, in which the single-trunk system is adopted, ventilation may be effectually

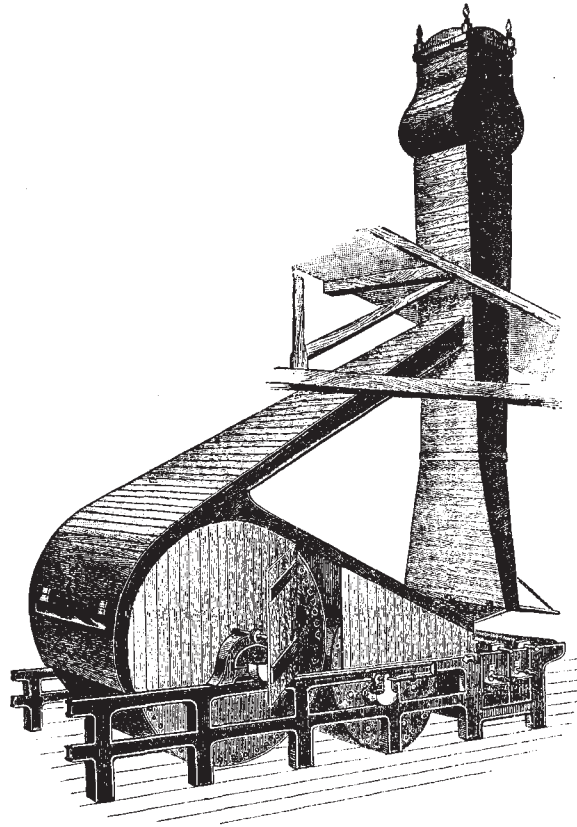


Fig. 171.

accomplished only by mounting such a fan in the trunk immediately above the junction of the short duct with that trunk, as illustrated in Fig. 173.

The particular method of constructing vertical trunks as represented in Figs. 169 and 170 was conceived by Mr Ibzan Sagar, who evolved that method by observing the well-known law governing air-movement by natural ventilation as exemplified in the construction of modern fire-grates that are formed with a very narrow

initial aperture which expands into a comparatively large cavity constituting the flue, whereby a continuous draught is induced solely by natural means.

After many years' practical application under different circumstances and climatic variations, this form of ventilating trunk has proved to be one of the most effective and economical methods in

vogue for removing vapour from sizing machines entirely without the assistance of fans. One of these trunks extends from the roof of the cylinder enclosure, and another from the size-box of each machine, whence both trunks pass through the roof for a distance of 8ft. above the ridge.

The dimensions of the trunks and cylinder cover, along with other measurements of important details as specified by Mr Sagar, and which it is essential to observe in order to ensure the greatest efficiency by this system of ventilating, are indicated in the diagrams.

At a point immediately outside the roof of the sizing-room each trunk is formed with a wide cavity in which there is fixed a zinc or copper-sheathed wooden trough to catch both rain-water and any water condensed from the vapour, as this is cooled suddenly in

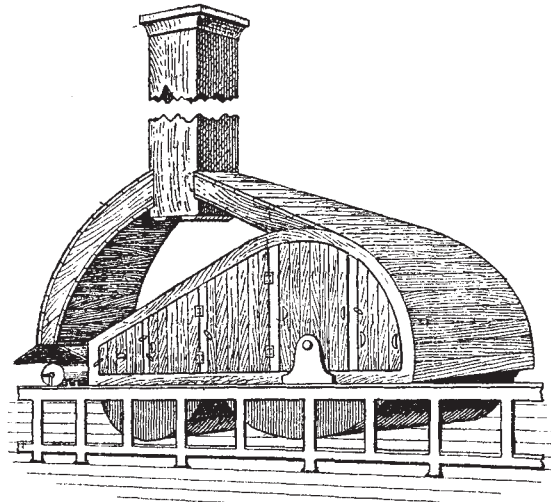


Fig. 172.

that portion of the trunk which is exposed to the cool air outside. From each water-trough there projects a short outlet pipe through which the water runs on to the roof, and is thereby prevented from dropping on to the drying cylinders and sizing rollers.

Additional precaution is also taken to guard against the risk of condensed vapour dropping from the lower portion of the cylinder trunk on to the large cylinder. This is effected by fixing immediately above and across the entire width of the cylinders, so as to overlap the cylinder ends, and below the aperture of the trunk, a zinc or copper trough, which should incline slightly from a space of about  $2\frac{1}{2}$ in. from the face of the cylinder at one end to a space of about  $1\frac{1}{2}$ in. from the cylinder at the opposite end, whence the water trickles

down on to a large zinc plate or tray which is usually fixed to the floor underneath the size-box and drying cylinders, to collect waste water that drips from the steam-pipe joints, valves and glands.

The stream of vapour is directed upwards from the front of the large cylinder and into the trunk by fixing between that cylinder and the cooling fan a large wooden baffle that reclines backward from

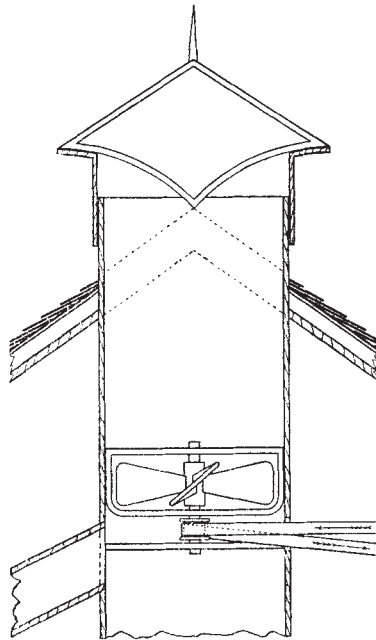


Fig. 173.

the lower edge which is placed immediately above the sheet of warp threads as these extend between the small cylinder and the lower guide-roller, with the upper edge of the baffle fixed 3in. from the face of the large cylinder.

Also, the risk of any vapour escaping from the cylinder trunk and passing over to the rear of the cylinder is effectually prevented by fixing just below the aperture of that trunk another wooden baffle that reclines backward from the lower edge which is placed in the water trough and enters the trunk for a distance of 3in., with the upper and rear edge of the baffle chamfered and fixed a space of 1in. from the trunk, as indicated in Fig. 169,

thus permitting of the small amount of vapour which is expelled from the yarn by the small cylinder being drawn into that trunk.

§ 297. If Lancaster and Waddington's single-trunk method of ventilating is adopted, with the improved form of trunk having a narrow initial aperture, as in Sagar's modification, and also as represented in Fig. 171, it generally operates satisfactorily under favourable structural and atmospheric conditions.

But if this method of ventilating by means of the old form of trunk, constructed with a wide bell-mouth, should prove inadequate, it is sometimes found necessary to mount in the trunk a 24in. ex-

traction fan placed immediately above the junction, as represented in Fig. 173, and of which the blades should either be constructed of brass or else coated or plated with sheet lead or zinc, the better to resist the corrosive influence of the vapour.

Instead of employing ventilating trunks of the vertical type for the purpose of removing vapour from sizing machines contained in a roofed storey, that object is sometimes accomplished by Gregson's modification, consisting of only one main trunk extending horizontally across any number of successive machines, and then turning upward to pass vertically through the roof, as represented in Figs. 174 and 175. In fact, if the machines are contained in a lower storey, the horizontal type of trunk, terminating in a side wall, as represented in Fig. 176, becomes a virtual necessity.

Further, a horizontal trunk may be employed successfully for this purpose only by the aid of a forced draught induced by means of an extraction fan mounted in the main trunk, into which there open short ducts leading separately from the size-box and cylinder cover of each machine, as represented in the diagrams.

To ensure efficiency by this method of ventilating, a fan 3ft. diameter for two or three machines, and one 4ft. diameter for four machines, are advised by Mr Sutcliffe, a ventilating engineer, who states that he would not employ ventilating trunks of any type whatever for any number of sizing machines, but would build the room in one span, with the roof at an angle of about  $45^\circ$  and under-boarded, and in which he would fix, between every two adjacent machines, a 3ft. fan, which he affirms would keep the sizing room quite clear of free vapour.

#### DATA RELATING TO SLASHER SIZING MACHINES

§ 298. Slasher sizing machines are constructed in a variety of different sizes that vary in both length and width, chiefly according to the type, diameter and width of the drying cylinders, and also according to minor structural modifications adopted by different makers.

They are, however, constructed in various standard widths, ranging in multiples of 6in., ordinarily from 60in. to 90in. wide on the face of the cylinders, and expressed by index numbers of the

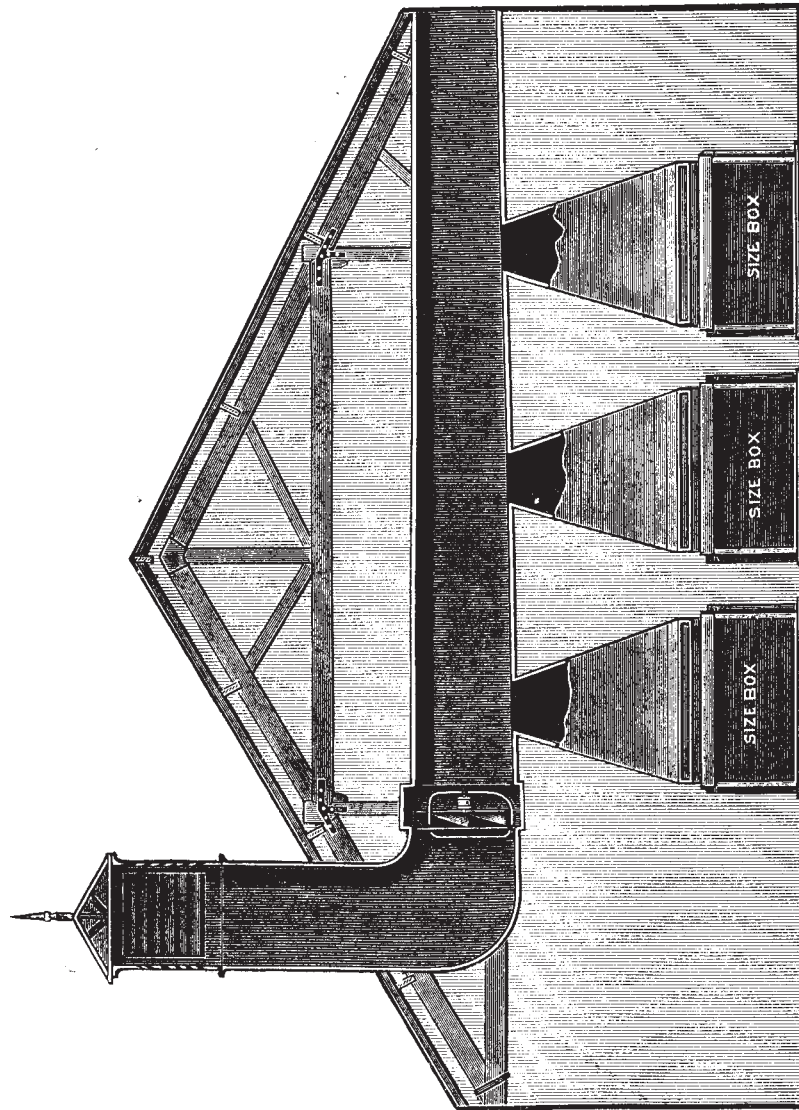


Fig. 174.—GREGSON'S HORIZONTAL TRUNK SYSTEM OF VENTILATING.

same series as those which indicate the width of the drums in beam warping machines, excepting that the cylinders of sizing machines are uniformly 6in. *wider* than the drums of beam warping machines of the same denomination, to allow a margin of 3in. at each side of the cylinders over and above the maximum width of warp.

The respective widths of drums in beam warping machines, of cylinders in sizing machines, of reed-spaces in looms, and maximum width of cloth for corresponding index numbers of beam warping and sizing machines, are expressed in inches in the following table:—

Index of Machine	9/8's	6/4's	7/4's	8/4's	9/4's	10/4's
Width of drum . . .	54	60	66	72	78	84
Width of cylinders . .	60	66	72	78	84	90
Reed-space of loom . .	52	58	64	70	76	82
Maximum width of cloth	50	56	62	68	74	80

Machines of other widths than those specified above are made specially to order.

#### DIMENSIONS

§ 299. The floor-space occupied by sizing machines of the same denomination varies slightly according to such variable factors as the type of size-box, the number of sizing and finishing or squeezing rollers, the number and diameters of the drying cylinders, the method of driving, and the capacity of the beam creel or stand.

Machines of the same denomination and by the same maker are of uniform width over-all, but those by different makers vary as much as 18in. in width. The accompanying dimensions are those of 9/8's sizing machines constructed with 6ft. and 4ft. drying cylinders, and including a beam creel to support up to six back beams:—

Width=7ft. 6in. to 9ft. over-all, and increasing 6in. for each higher denomination.

Length=30ft. 6in. to 38ft. 6in. over-all, increasing 3ft. for every two back beams above six beams; and varying according to the difference in the diameter of either of the two cylinders.



A 9ft. cavity cylinder sizing machine with a beam creel to support six back beams occupies a floor space of—

Width=8ft. 6in. Length=36ft.

#### WEIGHT

§ 300. The net weight of a 9/8's machine with 6ft. and 4ft. cylinders, and a 6-beam creel, ranges from about 67 to 103cwt.;

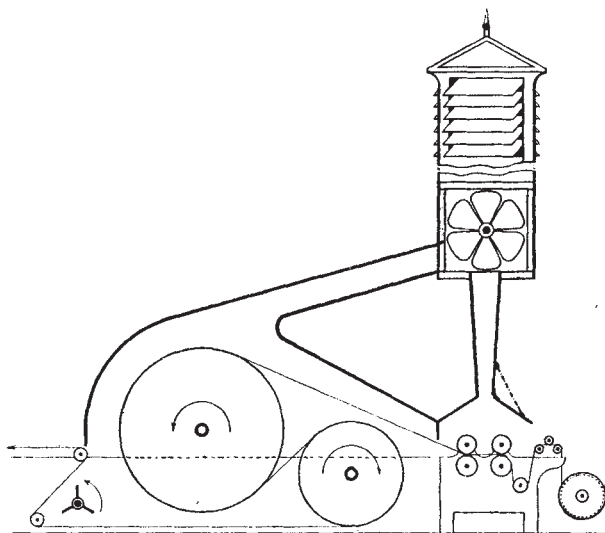


Fig. 175.

and that of a 9ft. cavity cylinder machine of the same capacity= about 80cwt.

#### COST

§ 301. The cost of a 9/8's machine equipped with only the most essential parts of the simplest character ranges from about £120 to £150, to which must be added a sum ranging from about £60 to £75 for incidental and necessary items, comprising the steam-service piping, steam-valves, steam-gauges, steam-traps, ventilating trunk, and many other essential accessories, but not including devices or mechanical attachments of a special character, or those for performing special functions, all of which are charged for as extra items.

## DEPRECIATION

§ 302. The rate of depreciation of a slasher sizing machine does not exceed 5 per cent. per annum, including the cost of general repairs; renewing cylinders, broken and worn-out parts; oil and belting.

## RATIO OF SIZING MACHINES TO LOOMS

§ 303. The number of looms that can be accommodated by one sizing machine ranges in actual practice from about 200 to about 500, with a fair margin in each direction, and is determined chiefly

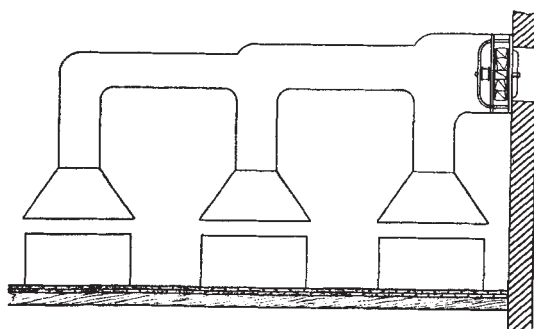


Fig. 176.

by the particular character of warps as regards the counts and quality of the yarn, total number of warp threads, picks per inch, length of warps, character and grade of sizing, and many other variable factors.

For cloth of medium width ranging from about 42in. to 54in., containing about 64 picks per inch, and produced from warps composed of yarn of low, medium, and fine counts respectively, the approximate number of looms that could be served by one sizing machine may be reasonably based on the following estimates:—

For counts of warp yarn up to 30's T., one machine for 300 looms.

For counts of warp yarn from 30's T. to 60's T., one machine for 400 looms.

For counts of warp yarn from 60's T. upward, one machine for 500 looms.

## POWER

§ 304. The power required to drive a 9/8's slasher sizing machine is estimated to range approximately from  $1\frac{1}{2}$  to 2 I.H.P., according to the speed of working, number of back beams, and number of warp threads.

## SPEED

§ 305. The velocity of the driving pulleys depends on the particular form of driving gear employed, as this varies in different machines. If the usual cone-drum method of differential driving is adopted, with the driving pulleys mounted on the shaft of the first or driving cone, the velocity of those pulleys may range from about 160 to 210 revs. per min. according to the diameter of the drying cylinders, number of warp-ends, counts of yarn, and other considerations. The lower speed is suitable if the cylinders are only 5ft. 6in. and 3ft. 4in. diameter respectively; but if these are 7ft. and 4ft. diameter, the higher speed will be required.

The relative velocity of the drying cylinders may, of course, be regulated by the attendant, according to his discretion, and within extreme limits ranging approximately in the ratio of 2 to 5, by means of the differential full-speed driving gear as described in § 180. For warps composed of coarse yarn, or those containing a greater number of warp ends, and also for the heavier grades of sizing, it is sometimes desirable to work the machine at a slower speed to allow more time for drying the yarn efficiently; but for warps composed of delicate yarn of very fine counts, or those containing comparatively few warp ends, and also for the lighter grades of sizing, it is sometimes expedient to work the machine at a slow speed, with a reduced steam pressure in the cylinders, and also to pass the yarn over either the small or else the large cylinder only, with the object of reducing to the least possible degree the tensile strain upon the warp threads.

## PRODUCTION

§ 306. The productiveness of a slasher sizing machine is dependent upon so many variable factors that information respecting this

item can be of value only when it is based on actual data relating to specified classes of work, of which the following table gives six typical and authentic examples:—

Example.	Counts of Yarn.	Number of Warp Ends.	Production per Working Hour.	
			Yards of Warp.	Pounds of Yarn.
No. 1.....	30's T.	3000	1800	214
No. 2.....	36's T.	1600	2250	119
No. 3.....	40's T.	3500	1700	177
No. 4.....	50's T.	4000	1000	95
No. 5.....	100's T.	5000	800	48
No. 6.....	140's T.	6000	600	30

#### WASTE

§ 307. The amount of waste material incidental to the operation of slasher sizing should not exceed about 30yds. of warp for each set of back beams, irrespective of the length of yarn they contain. Thus, on a total length of, say, 15,000yds. the above amount of waste is equivalent to only 1 in 500, or one-fifth of 1 per cent., and is therefore practically a negligible amount.

#### CHARACTER AND AMOUNT OF LABOUR

§ 308. Male operatives only are employed on slasher sizing machines, with one skilled attendant to each machine, and one or more than one labourer, according to the number and productiveness of the machines. The number of labourers employed is usually one for each machine up to three, then three labourers for four or five machines according to requirements.

These labourers are paid 18s. to 20s. per week, and their duty is to assist the attendants by performing work incidental to slasher sizing, as, for example, creeling full and removing empty back beams; removing full and replacing empty weavers' beams; mixing the size and supplying it to the size-boxes, where this function is

not performed automatically; repairing defective back beams; and performing other minor duties as they arise.

In some mills it is customary to employ intelligent labourers to assist the skilled attendants, and thus give them the opportunity of learning the trade with a view to promotion as skilled attendants.

#### RATE OF WAGES

§ 309. The rate of wages paid, and the basis of payment adopted for slasher sizing, vary considerably not only in different districts but even in the same locality, according to the character of work and special circumstances.

Thus, some sizers are paid fixed and regular wages, of which the respective amounts range from 36s. to 50s. per week, work or play, but without any extra payment for overtime; whilst others are paid fixed wages of similar sums, but with a proportionate addition for overtime, and a deduction for lost time; and some are paid similar fixed sums for the schedule number of working hours per week, but with extra payment for overtime.

Instead of paying a regular fixed wage, however, many firms in the East Lancashire district pay their sizers on the basis of piece-work rates for actual work performed, and for which the amount of wages is calculated on the basis of a recognized standard list of prices, of which the Blackburn Standard List is that generally adopted, as follows:—

#### BLACKBURN STANDARD LIST.

##### FOR SLASHER SIZING.

##### *Standard Basis:*

Number of warp-ends : 2460 to 2510 inclusive.

Length : 100 "cuts" of  $37\frac{1}{2}$  yds. each, equal to a total length of 3750 yds.

Price :  $28\frac{1}{2}$  pence.

*Additions and Deductions.*—*One halfpenny* extra to be paid for every 50 or fractional part of 50 warp-ends over and above 2510, for every 100 "cuts" of  $37\frac{1}{2}$  yds. each, or 3750 yds.; and *three-eighths of a penny* less to be paid for every *complete* 50 warp-ends below 2460, for every 100 "cuts" of  $37\frac{1}{2}$  yds. each, or 3750 yds.

Other lengths of "cuts" to be paid for proportionately.

An addition of 10 per cent. is now paid on this list, which is adopted for yarn of medium counts ranging from about 30's to 50's T. inclusive. For yarn of coarser and finer counts than these extremes the rate of payment is by special agreement.

*Example 1.*—Calculate the amount of wages to be paid, in accordance with the above list, for sizing yarn for 80 weavers' beams, each containing 3480 warp-ends, 1100yds long, equal to a total length of 88,000yds., per week of 57½hrs., thus :—

Length by proportion :

$$3750 : 88,000 :: 28.5 : 669 \text{ pence.}$$

Extra warp-ends :

$$3480 - 2510 = 965 ;$$

therefore,  $965 \div 50 = 19 + i.e., 20 \text{ at } \frac{1}{2}d. = 10 \text{ ,,}$

$$\text{Total} = 679 \text{ pence.}$$

$$\text{Plus 10 per cent.} = 68 \text{ ,,}$$

$$\text{Net price} = 747 \text{ pence.}$$

The amount of wages, therefore, is £3, 2s. 3d. per week.

*Example 2.*—Calculate the amount of wages to be paid for sizing yarn for 64 weavers' beams, each containing 1980 warp-ends, 1400yds long, equal to 89,600yds. per week of 57½hrs., thus :—

Length by proportion :

$$3750 : 8960 :: 28.5 : 681 \text{ pence}$$

Less warp-ends :

$$2460 - 1980 = 480 ;$$

therefore,  $480 \div 50 = 9 + i.e., 19 \text{ at } \frac{3}{4}d. = 3 \text{ ,,}$

$$\text{Total} = 678 \text{ pence.}$$

$$\text{Plus 10 per cent.} = 68 \text{ ,,}$$

$$\text{Net price} = 746 \text{ pence.}$$

The amount of wages, therefore, is £3, 2s. 2d. per week.

Other and independent price lists and rates of wages are adopted by different firms, according to agreement, for work of a special character.

#### WEEKLY EARNINGS

§ 310. The amount of wages earned by slasher sizers who are paid piecework rates ranges from 40s. to 64s. per week, with a general average wage of about 45s. per week.

## CHAPTER VIII

### AIR-DRYING TAPE SIZING MACHINES

§ 311. It has been observed previously, in § 179, that in some tape or beam warp sizing machines, the process of drying the yarn, after being saturated with size, is effected by submitting it to the influence of dry air, of a relatively high temperature, which quickly absorbs the moisture from the yarn, instead of passing the yarn around, and in actual contact with, the surface of steam-heated cylinders, as in the ordinary type of slasher sizing machines.

The principle of air-drying is generally conceded to be superior to that of cylinder-drying, inasmuch as it does not tend to flatten the warp threads, which is one of the chief objections to cylinder-drying; whereas air-drying preserves the roundness, fulness, smoothness and elasticity of those threads, and also imparts to the yarn a softer and mellow tone or feel when handled. Air-drying also reduces the tendency of the warp threads to cling together and dry in contact with each other, thereby enabling them to separate more readily at the dividing rods with less risk of raising the free ends of the exposed fibres composing the yarn.

The relative steam consumption in respect of drying the yarn is, however, usually considered to be greater in air-drying than in cylinder-drying machines, albeit during the past few years air-drying sizing machines have attained to such a high degree of proficiency as regards their relative productive capacity and steam consumption that they are gaining considerably in favour with manufacturers, who are now adopting them much more extensively than formerly.

In fact, they are now frequently adopted in preference to cylinder-drying machines; and in cases where the cylinders have worn out, or require to be repaired, many manufacturers prefer to discard them entirely and adopt one or other of the several methods of air-drying which bid fair, in the immediate future, to gain supremacy over



cylinder-drying, which is declining in favour with many manufacturers.

§ 312. Air-drying sizing machines consist of two distinct types, each of which comprises several modifications, namely:

(1) Those variously described as Scotch or linen dressing or sizing machines, in which the yarn is completely exposed to view throughout its entire progress from the warpers' beams to the weaver's beam, and in which the yarn is dried by fanning on to the threads a current of hot air radiated from one or two small steam-chests situated below the sheet of threads and on each side of a central headstock, as represented in Fig. 177; and

(2) Those constructed with a large enclosed hot air-chamber extending either horizontally or else vertically between the sizing apparatus and the headstock of the machine, and in which the yarn is conducted with a circuitous course in a series either of horizontal or vertical sheets of threads, whereby a very considerable length of warp is submitted, for a comparatively long period, to the drying influence of hot air confined within the drying chamber, and which is generated by a service of steam-pipes supplied with high-pressure steam.

Both of these types of machines comprise numerous modifications in the details of their construction, especially those of the second type, which differ considerably in their general outward appearance, in the construction of the drying chambers, in the method of heating them, and also in the particular manner of conducting the yarn through them.

Of these various modifications there are several distinctive makes of machines that are respectively characterized by certain special features whereby they have established their superiority over other machines of their type, and have therefore met with a greater measure of appreciation in the weaving trade.

#### SCOTCH DRESSING OR SIZING

§ 313. Dresser sizing is the earliest method of sizing beamed or taped warps by machinery, and is still the prevailing method adopted for sizing warps for the production of linen damask and similar classes of fabrics. It is also sometimes employed for warps com-

posed of very fine cotton yarn for the manufacture of superior qualities of certain varieties of cotton fabrics, of which the warps require to be only very lightly sized with "pure" size, with the sole object of facilitating the operation of weaving by the simple process of making the threads smoother and stronger, without materially increasing their weight or bulk.

This particular method of sizing yarn, which is invariably described as "Scotch dressing," should not be confused, as frequently it is, with that system of preparing coloured striped warps and which is also known as "Scotch dressing," although there is nothing whatever in common between these two quite different and distinct operations.

It is advisable, therefore, to describe briefly the operation of Scotch dressing as observed in this particular method of preparing striped warps, and which consists essentially of first splitting off or separating from reserved ball-warps, that have been previously dyed or else bleached and sized, such number of warp threads of the respective colours as are required on the weaver's beam; after which the yarn is transferred from the respective sections, *in succession*, and wound *separately* with the threads evenly distributed between the dents of a reed, on to a *corresponding number of flanged warpers' beams*, virtually to constitute a "set" of "back" beams of coloured yarn.

The threads are subsequently withdrawn from all the back beams *simultaneously*, and passed in groups of two or three threads between successive dents of a reed, in which they are distributed according to the required warp pattern, and from which they emerge to be wound finally on to the weaver's beam, either by means of a "tension" or a "presser" beaming or winding-on machine, and in a manner similar to that adopted in the preparation of coloured striped warps by the more modern method of beaming known as "dry-slashing"—so-called, because this operation is accomplished by means of a machine (constructed by Messrs Butterworth & Dickinson, Ltd.), which is virtually the headstock, including the usual type of frictional winding-on motion, of an ordinary slasher sizing machine.

§ 314. The system of preparing coloured striped warps by the method of beaming known as "Yorkshire dressing" is identical in all respects with that of Scotch dressing, excepting that the warp

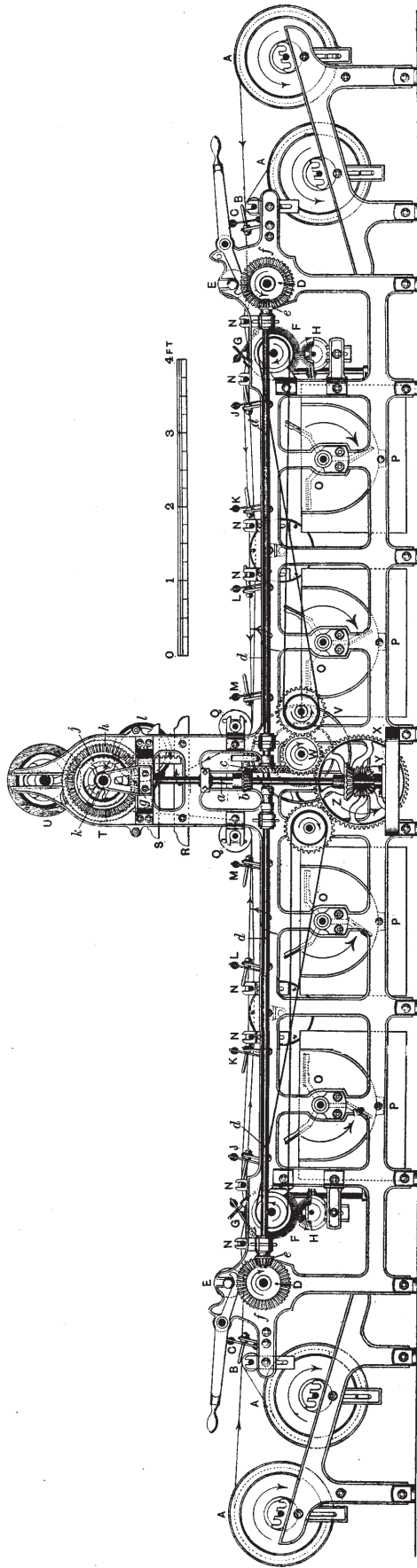


Fig. 177.—SCOTCH OR LINEN DRESSING OR SIZING MACHINE.

threads from the several sections of differently-coloured yarn are disposed according to pattern, with two or three warp threads passing together between successive dents of a reed, and wound immediately and concurrently on to a weaver's beam without the intermediate operation of winding the yarn from each of those sections separately on to a series of flanged beams, and then from these on to weavers' beams, as in Scotch dressing.

The process of Scotch dressing or sizing, however, is characterized by the applying of either hot or cold size or starch paste to warp yarn as this is withdrawn simultaneously from a "set" of any number of "back" or warpers' beams, in the form of an evenly-distributed sheet of threads which, by means of brushes, reeds, dividing rods and leasing healds, are kept quite separate and distinct from each other from the moment of leaving the back beams until they pass on to the weaver's beam; and also by effecting the drying of the yarn by means of hot air fanned from steam-heated radiators above which the yarn is conducted.

By observing these extreme precautions of keeping the warp threads well separated from each other, the clinging, sticking, or crossing of warp threads is virtually impossible, and the threads are also left perfectly smooth and round. This high degree of perfection in sizing may, however, be obtained only at great expense, in consequence of the very slow rate of progress with which the yarn is conducted through the sizing machine, and also because of the high rate of wages paid for dresser sizing, which requires highly-skilled attendants. For these reasons, dresser sizing is almost entirely superseded in the cotton trade by the more modern and productive method of slasher sizing, and it is now retained, in the cotton trade, only for the purpose of sizing warps of fine yarn for cotton fabrics of special quality.

#### SCOTCH DRESSING OR SIZING MACHINES

§ 315. Scotch dressing machines as made by different makers embody the same general features of construction, although they differ in numerous minor details of their equipment the better to adapt them suitably to the special requirements of the particular class of warps and character of yarn for which they are chiefly intended.

A typical example of a modern dresser sizing machine is that illustrated in Fig. 177, which represents a side elevation of one of several modifications of this type of machine as constructed by Messrs W. Dickinson & Sons. This machine is constructed with duplicate parts in almost every detail, excepting those of the driving gear constituting the headstock, which occupies a central position, with the various parts arranged symmetrically on either side of the headstock, and from which all the working parts of the machine are operated. Thus, a beam creel or stand is placed at each end of the machine to support the back beams that are divided into two sets, with an equal number in each set, and from both of which the warp threads are withdrawn simultaneously.

After being sized and dried independently in their respective sections of the machine, the two groups of warp threads converge towards a point where they both become merged into one sheet of threads as they pass finally to be wound on to the weaver's beam, which is mounted in the upper part of the headstock and turned through the medium of frictional driving gear, which ensures a constant rate of winding, notwithstanding the gradually-increasing diameter of the beam as it becomes filled with yarn.

The particular form of beam creel which is invariably employed in conjunction with dresser sizing machines is that which extends with a slight inclination from the ends of the machine, to permit of the warp yarn being withdrawn uniformly from the upper surfaces of the back beams as quite separate and distinct sheets of threads, which are thereby not only under better observation by the attendant, for the quicker detection of broken and missing warp threads, but are also more easily accessible for recovering and piecing those threads than when the back beams are arranged in two horizontal tiers with an alternate disposition, as in the form of creel which is almost invariably adopted in conjunction with slasher sizing machines, and as described in §§ 183-4.

Further, the object of dividing the back beams into two equal sets, that are placed at opposite ends of the machine, is to prevent overcrowding the threads on those beams and so keep them more thoroughly separated from each other.

§ 316. In their progress from each set of back beams A to the weaver's beam T, the several sheets of yarn from the respective

beams in each "set" all converge towards a guide roller B, on the surface of which they unite to form one sheet of threads, with two threads passed together uniformly between successive dents of the first of several brass reeds C, whence they are conducted between a pair of sizing and squeezing or finishing rollers D and E respectively, that revolve in close surface contact.

The lower sizing roller D revolves partially immersed in the size paste or starch contained in a narrow size-box or trough and which is brought up to the yarn by that roller which is constructed of cast iron and is either clothed or bare, at the option of the attendant. The upper squeezing or finishing roller E, which is also of cast iron, and sometimes encased in a thin copper shell wrapped with cloth, is of considerable weight, and serves the twofold object of impressing the size thoroughly into the threads, and also of expressing from them surplus size, which returns to the size-box.

After leaving the sizing rollers, the threads are passed immediately over a revolving yarn-brush F, between the bristles of which the yarn is deflected by means of a half-round brass rod extending across the second brass reed G, between the dents of which the threads are passed in pairs. The brush F revolves slowly in opposition to the progress of the yarn for the purpose of laying down the projecting fibres, and also of distributing the size equally on the threads, which thereby become perfectly rounded and smooth. A second and smaller brush H is placed immediately below, but in contact with, the bristles of the yarn-brush F, and revolves in opposition to that brush for the purpose of cleansing it of particles of size paste or lint that may cling to it. After leaving the second reed G, the warp threads are passed in pairs through four more brass reeds J, K, L and M, that are placed in succession and at different intervals apart.

In addition to separating the warp threads in pairs by passing them through the several reeds, the respective sheets of threads from the several back beams are also separated by means of dividing rods N, that are placed at frequent intervals apart, whereby the risk of threads clinging together and drying in contact with each other is entirely avoided.

During the interval between the second and third, and also between the fourth and fifth reeds, the yarn is submitted to the drying

influence of hot air, which is fanned upward on to the threads by means of two fans O which revolve immediately above two steam-chests or radiators P that are heated with high-pressure steam at a pressure ranging from about 10 to 15lb. per sq. in., according to whether the counts of yarn being sized is finer or coarser respectively.

After leaving the sixth reed M, the warp threads pass under a

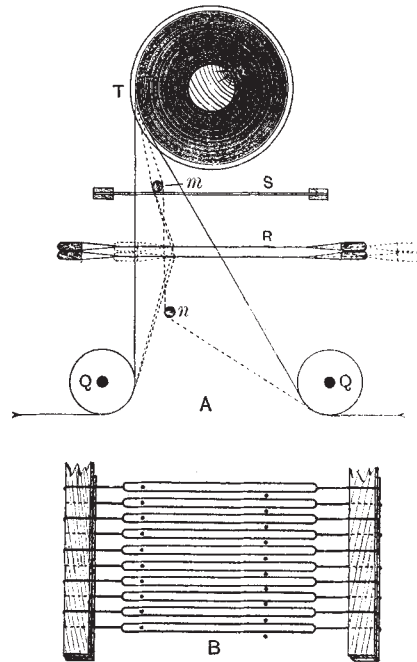


Fig. 178.

light-ribbed guide-roller Q, whence they are deflected upward from a horizontal to a vertical course, and passed separately first through two leasing-healds of special construction, that are fixed horizontally in a frame R, thence in pairs between the dents of a very wide horizontal reed fixed in a frame S. On emerging from this reed, both sheets of warp threads unite to form one sheet of threads that pass on to the weaver's beam T, which is sometimes surmounted by a heavy presser roller U that bears downward on the yarn by gravitation, and thereby conduces to the formation of a firmly-wound and compact beam.

On the completion of each weaver's beam the attendant strikes an "end-and-end" or "loom-ing" lease in the final extremity of each warp, for the purpose of drawing-in or twisting-in. With the object of enabling those leases to be formed in the warp whilst the yarn is still contained in the sizing machine, the leasing-healds R are knitted with very long eyes 14in. in length, through which all warp threads from one set of back beams are passed uniformly, whereas those from the other set of back beams are passed *between* them, as indicated in the plan of those healds at B, Fig. 178.



A lease is obtained by first inserting a rod or stave  $m$  between the two separate sheets of warp threads, above the reed  $S$ , on which that rod rests, then by bringing a second rod  $n$  to bear right across, on the outside of those warp threads that pass *between* (not through), the heald eyes, so as to force those threads inward towards the centre of the headstock. At the same time the leasing healds also are pushed inward towards the centre until the two sheets of warp threads, which constitute the odd and the even series respectively, pass and cross each other, and thereby produce an "end-and-end" lease or crossing, as indicated by dotted lines at  $A$ , Fig. 178, and which is preserved by inserting a lease-band or cord between the two divisions of warp threads thus obtained.

#### DRIVING MECHANISM

§ 317. The driving gear of some dresser sizing machines is adapted for differential driving, which is effected through the medium of two reversed cone drums as usually adopted in slasher sizing machines, and with the same object of enabling the working speed of the machine to be varied, within prescribed limits, according to the number of warp threads and counts of yarn being sized, the steam pressure, and other variable factors.

The machine represented in Fig. 177, however, is constructed with driving mechanism which is designed to work the machine at a constant speed only, without any means of varying it. Thus, the driving gear consists of a loose pulley and a fast driving pulley  $V$ , mounted on the rear end of the main driving shaft, on the fore-end of which there is also fixed a small pinion  $W$ .

Through the medium of a large spur-wheel  $X$  and bevel wheels  $Y$ ,  $Z$ , the pinion  $W$  transmits motion first to a vertical shaft  $a$ , and thence, through the medium of bevel wheels  $b$  and  $c$ , to a long side shaft  $d$ , on the opposite ends of which there are fixed small bevel pinions  $e$ . These gear with larger bevel wheels  $f$  fixed on one end of the lower sizing rollers  $D$ , which are driven positively, and, in conjunction with the upper squeezing or finishing rollers  $E$ , they not only serve the function of impregnating the warp threads with size paste, but they also withdraw the yarn from the back beams and deliver it to the weaver's beam at a constant rate of speed.

The vertical shaft *a* also transmits motion to a frictional winding-on device by which the weaver's beam is driven negatively and in such a manner that its velocity diminishes automatically and in a measure which ensures a constant rate of winding, notwithstanding the constantly-increasing yarn diameter of that beam as successive coils of yarn are wound upon it. Thus, a small bevel pinion *g* (Fig. 177) gears with and drives a large bevel friction-wheel *h* secured to a friction-disc which, on being compressed against another friction-disc or plate, operates the frictional winding-on device and thereby turns the weaver's beam T, with a gradually-diminishing velocity.

The degree of compression between the friction-discs, and therefore their driving power, is regulated by means of a hand-wheel *j* mounted on a screwed stud, and with a clamp spring *k* intercepting the hubs of the hand-wheel and friction-wheel, to constitute a yielding or flexible contact between them.

When a weaver's beam is completed, the heavy presser roller U is raised by means of racks and pinions operated by a hand-wheel *l* to permit of the removal of that beam and its replacement by an empty one, after which the presser roller is again lowered until it bears against the new beam.

§ 318. The headstock of some dresser sizing machines is constructed with two separate beaming or winding-on devices, as represented by a side and a front elevation in Figs. 179 and 180, thereby enabling two weavers' beams to be produced independently and concurrently either from two corresponding sets or from two different sets of back beams, as may be required.

Also, in addition to the steam-heated radiators, some machines are furnished with two auxiliary drying cylinders of about 20 in. diameter, one of which is placed in each half of the machine in lieu of one of the two radiators, and around which the warp threads may be passed with the object of accelerating the process of drying the yarn, and thereby increasing the productiveness of the machine. That procedure, however, tends to nullify the advantages of hot air-drying by flattening the warp threads, and also making them less supple.

Dresser sizing machines are also usually equipped with a measuring and cut-marking motion placed either on one side only, or else on both sides, of the headstock, for the purpose of marking the

warps into cut-lengths of any prescribed dimensions, and also of indicating the number of cut-lengths of warp that pass on to the weavers' beams.

§ 319. When starting or gaiting a new machine with the first set of back beams, it is necessary to pass the warp threads separately through the several reeds and leasing healds by the operation of drawing-in; but the threads of subsequent sets of back beams are attached to the final extremities of the previous warp threads by the more expeditious operation of twisting, described in § 355.

The hot air-radiators are heated with steam at a pressure of about 12lb. per sq. in. when sizing 50's T., and at a correspondingly reduced pressure for yarn of finer counts. Also dresser sizing machines are situated in closed rooms that are protected from draughts of cold air and maintained at a high temperature, ranging from 90° to 100° F.

The driving pulleys revolve with a velocity of about 230revs. per min., and yarn is sized at the rate of about only 180 to 210yds. of 60's T. per hour, according to the number of warp threads and other circumstances.

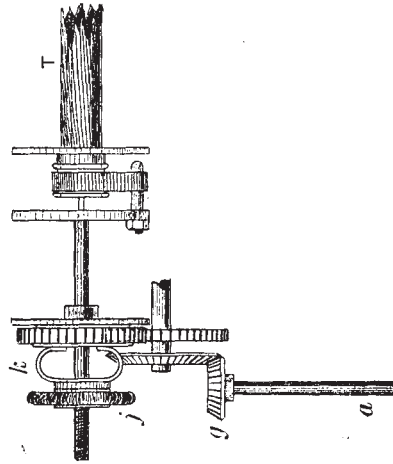


Fig. 180.

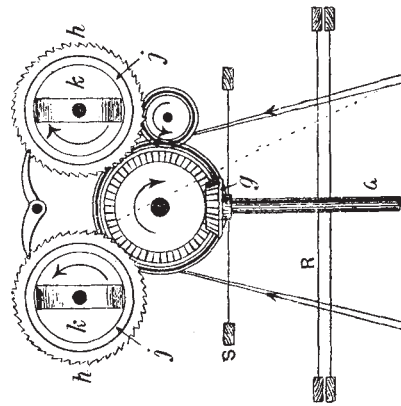


Fig. 179.

The relative amount of wages paid for dresser sizing and slasher sizing for work of a similar character and on piece-work rates is in the ratio, approximately, of 9 to 1 respectively. For example, in two specific instances the following sums are paid for the work specified—namely: (1) A dresser sizer receives a sum of 6s. 8d. and a slasher sizer a sum of 9d., for sizing 3860 warp threads of 60's T., 720yds. long; and (2) sums of 5s. and 6¼d. respectively, for sizing 2870 warp threads of 50's T., 720yds. long.

If, however, a fixed sum is paid, the amount of wages is 50s. per week for both dresser sizing and slasher sizing alike, although the dresser sizer only is paid both for working and playing, and also during holidays.

#### AIR-DRYING SLASHER SIZING MACHINES

§ 320. Although slasher sizing machines of the type in which the yarn is dried by conducting it through an enclosed chamber of hot air have been in use for a period of about fifty years, it is only during the past few years that they have established their irrefutable claim to superiority over the heated cylinder method of drying yarn during sizing, and they are now, in one form or another, being adopted more extensively and meeting with a greater measure of appreciation than they have received hitherto.

Their more extensive adoption is due chiefly to the great improvements that have been effected in the application of the principle of air-drying, and also in the construction of the machines, for some modifications of which it is claimed that their relative productive capacity is at least equal to, and, indeed, much greater than, that of cylinder-drying machines.

These improvements have been effected chiefly in the direction of increasing the drying efficiency of the machines, with a relatively smaller consumption of steam; and also of submitting to the drying influence of the hot air a considerably greater continuous length of yarn at the same time, and thereby keeping it exposed in the drying chambers for a longer period, whereby the progress of yarn through the machines, and therefore their productiveness, are greatly increased.

Other improvements consist of economy of floor-space occupied by the drying chamber; of a reduction in the power required to drive the machine; also of relieving the warp threads of excessive tensile strain resulting both from the greater length of warp yarn exposed at once in the drying chamber, and from its being deflected over a greater number of guide rollers. These objects are achieved by mounting the gudgeons of the guide rollers either on roller bearings or in ball bearings in order to reduce frictional resistance to the least possible amount.

The drying chambers of most modifications of air-drying sizing machines may be readily adapted to the sizing apparatus and head-stock of any ordinary cylinder-drying machine, by simply removing the drying cylinders and erecting one or more than one air-drying chamber in their place.

§ 321. One of several modifications of air-drying slasher sizing machines, of which the drying chamber is readily adapted to present cylinder-drying machines from which the cylinders have been removed, and one that has merited a high reputation for efficiency, is that of Messrs Tattersall & Holdsworth's, as illustrated perspectively in Fig. 181, and also by a scale diagram, in Fig. 182, which represents a sectional elevation throughout the length of the air-drying chamber which is situated between the size-box and the head-stock of the machine, of which only the adjoining portions are shown in the diagram.

In its general construction, this air-drying chamber, as constructed by Messrs Butterworth & Dickinson, Ltd., consists essentially of two distinct sections, comprising an air-heating chamber containing a steam-heated multitubular radiator situated in the lower part, and a yarn-drying chamber forming the upper part of the structure, which is divided by thin partitions into a series of seven horizontal and shallow compartments extending across the entire width, and along the entire length of the drying chamber, as represented in the diagram.

In its progress through the sizing machine, after emerging from the last pair of sizing rollers, the sheet of warp threads passes immediately between a pair of guide rollers A that are mounted in front of a narrow aperture extending across the rear end of the drying-chamber, and through which the yarn enters the lowest com-

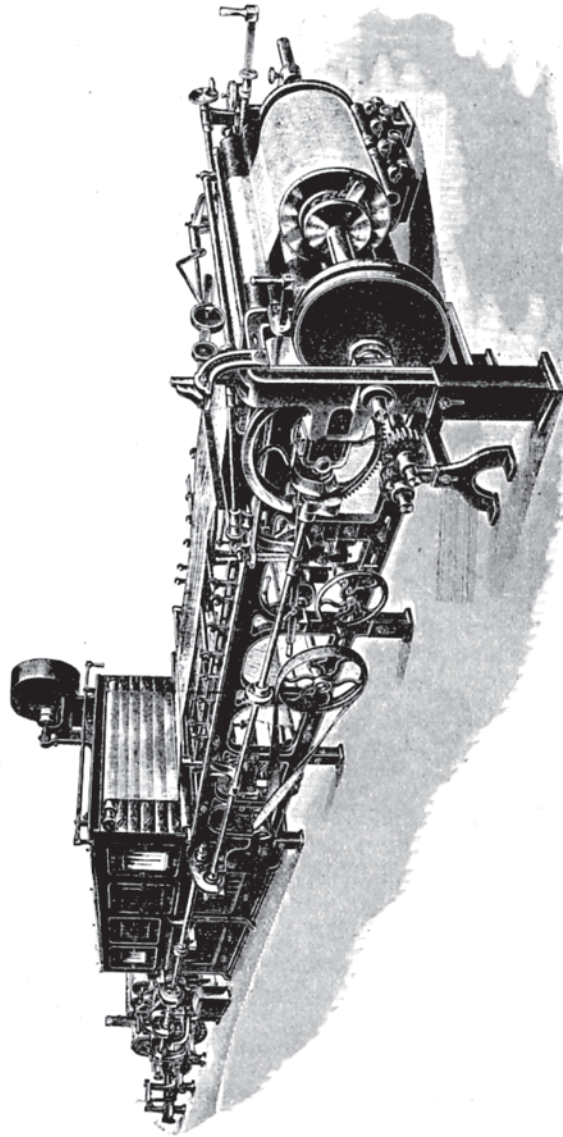


Fig. 181.—TATTERSALL & HOLDSWORTH HOT AIR-DRYING SLASHER SIZING MACHINE.

partment of that chamber, whence it passes forward and backward in alternate succession along the entire length of the seven compartments, at each extremity of which it returns around guide rollers B until it enters the uppermost compartment, from which it emerges finally through a narrow aperture extending across the fore-end of the drying chamber, and is immediately deflected downward by passing it over a guide-roller C, and thence underneath another guide-roller D mounted in the lower and rear part of the head-stock, where the yarn is cooled by means of a revolving fan E, and afterwards separated by conducting it under

and over a series of dividing rods, whence it passes along its course in the usual manner, to be wound finally on to the weaver's beam.

In a drying chamber of 10ft. in length, the yarn traverses a total distance of about 70ft. from the moment of entering until the time when it emerges from that chamber; and, assuming a yarn delivery at the rate of 1000yds. per hour, the yarn would therefore remain exposed to the drying influence of the hot air for a duration of nearly  $1\frac{1}{2}$ mins. With the object of preventing excessive tensile strain upon the warp threads by passing such a considerable and continuous length of yarn through the drying chamber, simultaneously, all the guide-rollers are mounted on roller bearings immersed in oil-baths to reduce frictional resistance to the minimum.

§ 322. The construction and method of heating the drying chamber, and also the method of propelling the hot air along the several compartments through which the yarn is conducted, constitute distinctive features in the construction of this particular modification, of which a sectional rear elevation and plan are represented in Figs. 183 and 184 respectively.

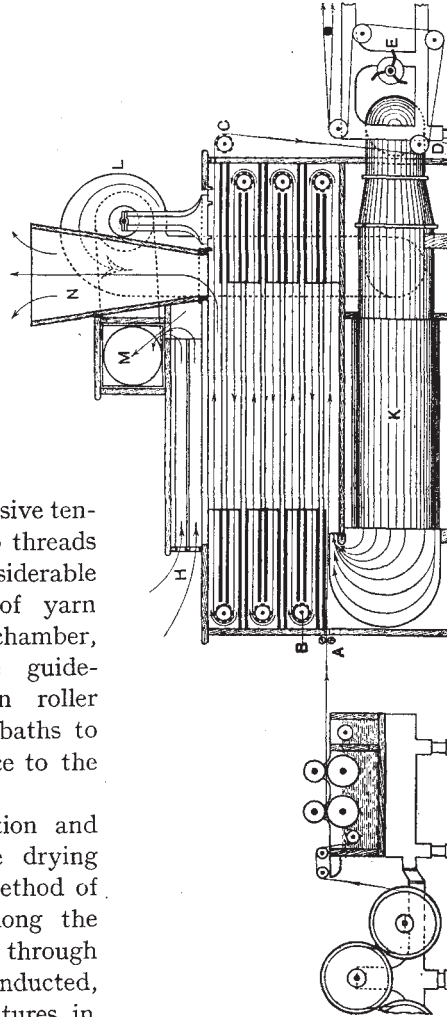


Fig. 182.—TATTERSALL & HOLDSWORTH HOT AIR-DRYING CHAMBER.



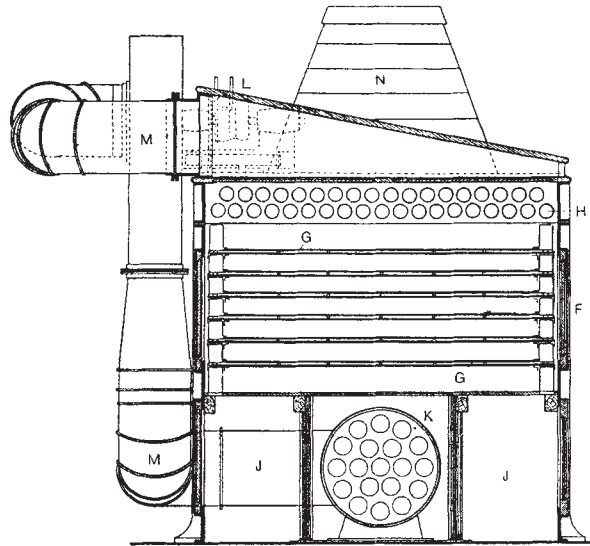


Fig. 183.

These objects are attained by constructing the drying chamber with a number of small air-ducts or channels *F* extending along the interior of both sides of that chamber, and also by leaving spaces to form shallow air-cavities *G* between the partition boards that separate the seven compartments into which the drying chamber is divided, and through which the yarn is conducted along its course.

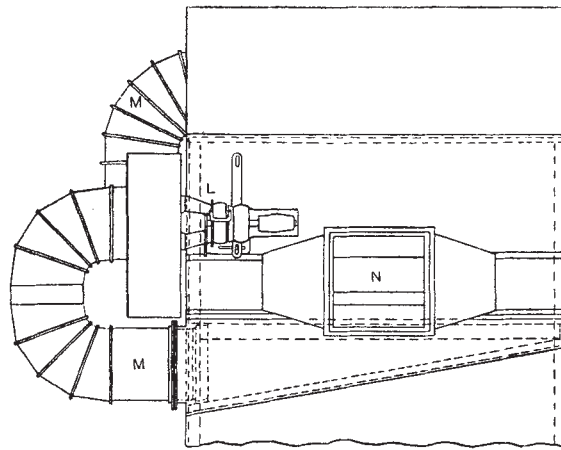


Fig. 184.

Both the side channels *F* and the shallow air-cavities *G* communicate with each other by means of small holes to permit of air passing from the cavities into the side channels, in a manner to be described presently. In addition to those air passages there is also a series of air-tubes *H* contained in a

separate compartment extending along the roof of the drying chamber, as represented in Figs. 182 and 183, besides two isolating chambers J extending one on each side of the large multitubular heater K, which occupies a position in the lower division of the drying chamber midway between the two isolating chambers.

The special object of constructing the drying chamber with these air-channels, cavities, tubes and isolating chambers is to provide means for previously warming the supply of fresh and dry air which is abstracted from the sizing room and passes through gratings fixed in the sides of the drying chamber, and also through small apertures formed in each end of that chamber, and thus enters the isolating chambers, cavities, side channels and tubes, in which the fresh air becomes warmed by abstracting heat radiated from the heater and the drying chamber.

From all these various passages, the warmed fresh air is directed by the operation of a fan L into a large tube or duct M, whence it is propelled along an extension of that duct which passes downward and opens into the rear end of the multitubular heater K, which consists of a large cylindrical steam-chest containing a great number of air-tubes through which the warmed fresh air is forced, and from which it issues as a current of hot and dry air having a temperature of about 212° F. (100° C.), and enters the rear end of the lowest compartment of the drying chamber. The stream of hot air then passes forward and backward in alternate succession along the several compartments, following the same course as that of the yarn, and finally, with its charge of vapour absorbed from the yarn, it emerges from the uppermost compartment and enters a short vertical flue or duct N that opens into a larger ventilating trunk, whence it is expelled into the atmosphere outside.

§ 323. The isolating chambers J, side channels F, and air-tubes H, not only serve to insulate the upper division of the drying chamber from the relatively cool air of the sizing room, and thereby prevent the radiation of heat from that chamber, and also from the heater, into the cooler atmosphere of the room, but these various air-passages also perform the additional function of a steam economiser by warming the fresh air before it is allowed to enter the heater, in a manner precisely analogous to the method of heating water by passing it through the tubes of an economiser before the water enters

a steam-boiler, thereby utilising the waste heat that passes from the furnaces, along the flue, and which would otherwise be lost by radiation and diffusion.

The tubular heater is tested up to a pressure of 250lb. per sq. in., although it is usual to work it with a steam pressure of only about 90lb. per sq. in., which, by testing, was found to produce air-temperatures of 212°, 172°, 160°, 162°, 157°, and 141° F. at the several guide rollers in successive ascent from the first or bottom roller to the sixth or topmost roller. Also, the steam consumption was found to be relatively small, as indicated by measuring the amount of water of condensation discharged, during a specified period, from the heater.

Further, in two specific instances, in each of which 15 % of size was applied to the yarn, the production of two sizing machines equipped with this system of hot air-drying, when sizing a warp containing 6000 warp threads of 28's T., was at the rate of about 810yds. per hour in one instance; and in the second instance, when sizing a warp containing 3600 warp threads, the rate of production was about 1120yds. per hour.

§ 324. Another method of adapting the principle of hot air-drying to slasher sizing machines is that illustrated in Fig. 185, which represents Zach's modification of an air-drying chamber as constructed by Messrs Robert Hall & Sons, Ltd., and through which the yarn is conducted in a series of nine zig-zag folds extending horizontally along the entire length of that chamber which, unlike that described in the three previous sections, is quite open inside, and not divided into a number of separate shallow compartments for the respective layers of yarn.

The present modification also differs essentially from the previous one, not only in the structural features of the drying chamber, but also in the methods both of heating the fresh air and of diffusing it throughout that chamber. Thus, instead of separating the drying chamber proper, which forms the upper portion of the chest, from the heating apparatus contained in the lower portion, they are both contained in what virtually constitutes an open chest, which is partially divided by means of a wooden diaphragm O extending horizontally from the forward end for one-half the length of the chest, as represented in the diagram.

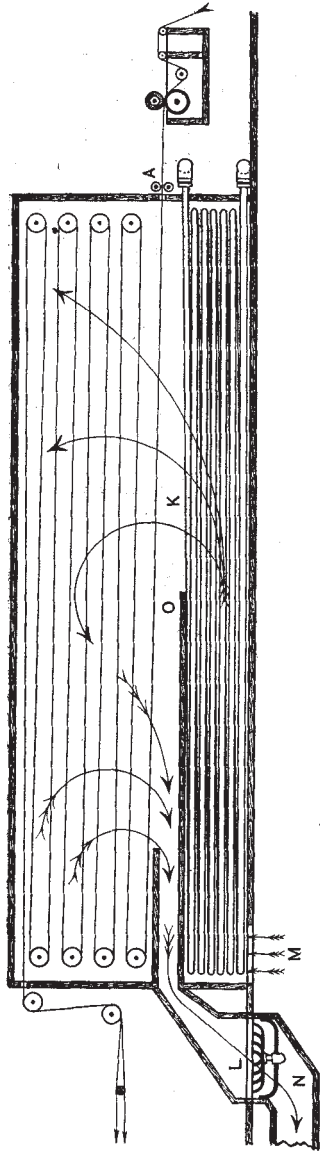


Fig. 185.—ZACH HOT AIR-DRYING CHAMBER.

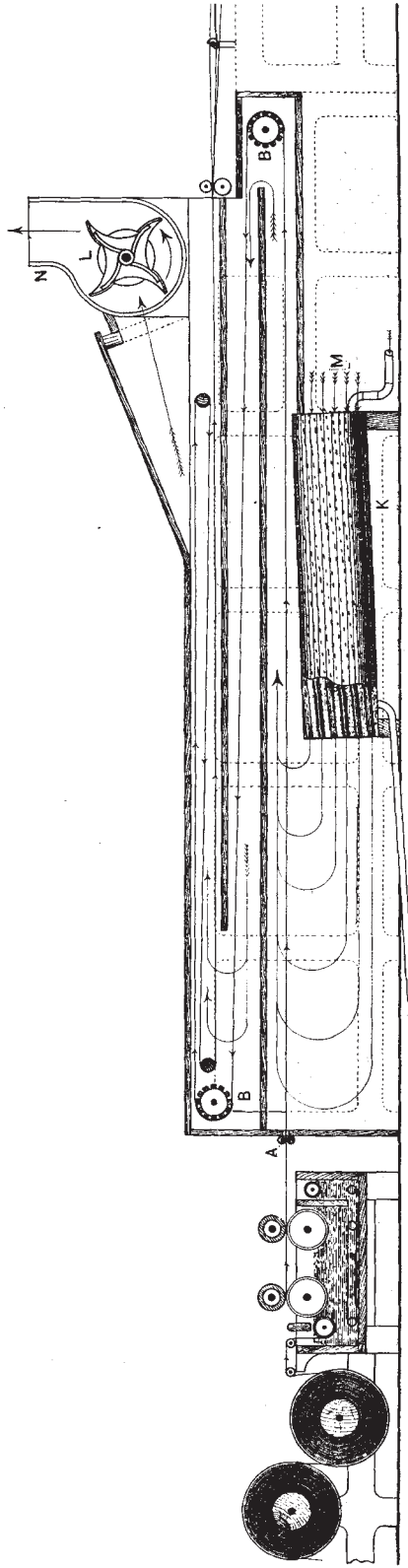


Fig. 186.—BULLOUGH & WHITEHEAD "COOL" AIR-DRYING CHAMBER.

The heating apparatus of this modification consists of several zig-zag coils of steam-piping extending the entire length and width of the chest. Each of these coils, which contains from 60 to 100ft., according to the dimensions of the chest, is constructed entirely from one continuous length of piping, without any joints, to prevent the risk of steam leaking within the drying chamber, and the several coils are heated, either separately or collectively, with high-pressure steam, for generating hot air.

This object is effected by directing a current of fresh air along a duct that terminates with a wide orifice M extending across the entire width of the chest, and opening into the base of the heating chamber, at the fore-end of it, where the current of fresh air enters and then passes between the coils of steam-piping K, whence it issues as a stream of hot and dry air, which is directed by means of the wooden diaphragm O, towards the centre of the drying chamber, in which it diffuses amongst the layers of yarn, from which it absorbs the moisture, and is, along with its charge of vapour, ultimately expelled from the drying chamber into the air outside the room.

The supply of fresh air to the *heating* chamber; its diffusion, after heating, throughout the *drying* chamber; and also its expulsion, after it has become saturated with vapour, from that chamber, are effected and controlled entirely by means of an exhaust fan L mounted in a duct N leading from a wide opening in the fore-end of the drying chamber, whence the duct passes downward and extends underneath the floor until it terminates with its orifice opening into the outer air.

Therefore, under the influence of the exhaust fan L, which creates a partial vacuum in the duct between this fan and the drying chamber, the large volume of air within the chamber moves slowly towards the opening in front, and passes along the duct, by which it ultimately escapes into the air. At the same time, the saturated air expelled from the drying chamber is replenished with fresh air which, under the influence of atmospheric pressure without, rushes through the fresh-air inlet M in the floor of the chest, whence it percolates between the coils of steam-pipes and enters the drying chamber as a stream of hot air, as described.

The foregoing method of expelling the saturated air from the

*lower* part of the drying chamber is contrary to the more general practice of removing the air from the *upper* part of the chamber, and constitutes one of the chief and distinctive features in the construction of this particular air-drying chamber which may also be substituted for the drying cylinders of ordinary sizing machines.

This departure from the usual method of removing saturated air from the drying chamber is based on the circumstance of the relative absorption of moisture from the damp yarn being greater in that part of the chamber where the stream of hot air first encounters the yarn, which, in the present case, is in the *lower* part; and that it is, therefore, obviously a more rational procedure to expel the air *immediately* from that part of the chamber, and thereby leave the upper layers of yarn exposed to a current of *hot and dry air only*, instead of causing the saturated air to ascend and pass through the yarn into the upper part of the chamber, and from thence to be expelled into the air outside.

§ 325. The principle of drying yarn by submitting it, immediately after it emerges from the size-box, to the influence of hot air having a very high temperature of, say, 212°F. = 100°C. (which is the boiling point of water) or thereabout, is strongly deprecated by some manufacturers, who submit that *hot* air-drying tends to bake the size, which forms a hard, dry and parched crust around the warp threads, and is, therefore, liable to crack and peel or rub off those threads during weaving.

Drying by means of *hot* air is also found to be unsuitable for drying worsted and other varieties of yarn that are usually sized with what is termed "animal size," prepared from various substances of animal origin, as distinguished from size prepared from vegetable substances. Under these circumstances, therefore, drying by means of *warm* or relatively *cool* air having a temperature of only about 80°F. (26.67°C.) is sometimes adopted in preference to hot air-drying; but the relative productiveness of a "cool" air-drying sizing machine is necessarily of smaller value than that of a hot air-drying machine.

From the foregoing considerations it is manifest, therefore, that the relative advantages of the alternative systems of hot and of relatively cool air-drying of yarn, during sizing, are determined chiefly by the particular character of warps to be treated, as regards the

staple and counts of yarn and the character of sizing materials employed; and also that one system of air-drying is preferable to an alternative system only in respect of different classes, and not of necessity in respect of the same class, of warps.

It is because the technical and special treatment required for the different classes of warps is not sufficiently understood by mechanical experts that these differ in their opinions respecting the theory of air-drying and its practical application to slasher sizing machines; and also that some advocate the use of relatively cool air at about 80° to 100°F. in preference to air having a much higher temperature.

§ 326. It is well known that hot and dry air possesses a high power of absorption, and also that its absorptive power increases considerably as the temperature rises, as explained in §§ 282 and 283. Hence, it is generally accepted that effectual air-drying of yarn may only be accomplished by submitting it to hot air having a very high temperature that cannot be too great provided it does not involve the risk of parching or scorching the yarn.

Such a procedure, however, would only be practicable provided the air within the drying chamber is of the normal atmospheric pressure of 14.7 lb. per sq. in.; but if the internal air-pressure is reduced sufficiently to create a partial vacuum within the drying chamber, it is established by actual experience that the process of drying may be accomplished effectually even with a considerably lower air-temperature.

This, of course, arises from the more rarefied condition of the air, which accelerates the process of drying more on the principle of "extraction," rather than by "absorption," of vapour, from the yarn, in a manner precisely analogous to the method which is adopted on a commercial scale for the purpose of drying timber by confining it within a large air-tight drying chamber from which some of the air is extracted to create a partial vacuum.

§ 327. One of several modifications of what are commonly described as "cool" air-drying chambers is that designed by Bullough & Whitehead, and illustrated in Figs. 186 and 187, which represent a longitudinal and a transverse section, respectively, of that air-drying chamber as constructed by Messrs Howard & Bullough, Ltd. In this modification the heating and drying compartments are not contained in separate divisions of the same chest, as



in that illustrated in Figs. 182 to 184; but, like those of the previous modification illustrated in Fig. 185, they form the lower and upper portions, respectively, of what virtually constitutes a single chamber.

In the present instance, however, the upper portion of the chamber extends forward for a considerable distance (equal to about one-third the total length of the entire structure) beyond the lower portion, and is also divided, by means of two wooden partitions or diaphragms that extend horizontally across the entire width, and for nearly the full length of the drying chamber, to form two shallow compartments, above

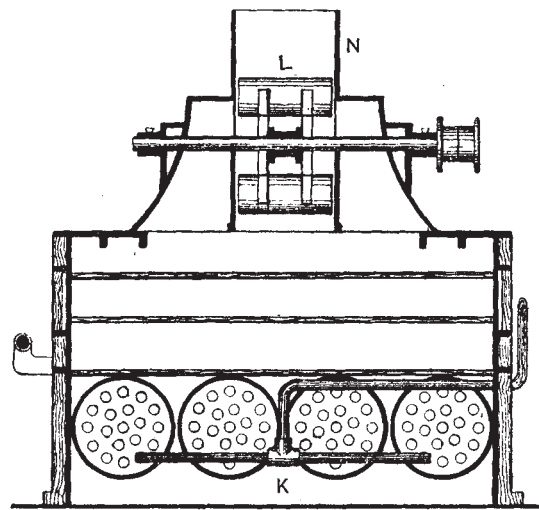


Fig. 187.

a lower and larger one, which also contains the heating apparatus.

In its progress through the drying chamber, the sheet of yarn passes forward and backward, in alternate succession, extending in a series of five zig-zag folds of peculiar disposition, whereby the fourth and fifth layers of threads

are folded between the second and third layers, as represented in Fig. 186. The fifth layer of yarn emerges finally through a narrow aperture, extending across the front of the drying chamber, whence it is conducted in the usual manner to be wound on to the weaver's beam.

The heating apparatus of this so-called "cool" air-drying chamber consists of four multitubular steam-chests K, similar in construction to the single steam-chest employed in conjunction with the hot air-drying chamber illustrated in Fig. 182, and described in §§ 321-323. In the present instance, however, steam is employed only at a very low pressure, whereas in both of the previous devices steam is employed at a very high pressure to generate *hot* air. Each of the

four steam-chests encloses a considerable number of air-tubes through which there is directed a current of fresh air which issues from the rear of those tubes as a volume of warm and dry air having a temperature ranging from 80° to 100° F. (26·27° to 37·78° C.).

On emerging from the air-tubes in the steam-chests the warm air passes immediately into the lower and rear portion of the drying chamber, through which it flows, following the same course as that of the yarn, and ascending gradually to the upper portion of the chamber, from the fore-end of which the saturated air is extracted by the action of an exhaust fan L and passed into a short flue or duct N leading into a ventilating trunk, whence it escapes into the atmosphere outside.

In the present drying chamber, as in all probability it is similar with those described previously, the volume of air extracted from the chamber, *at the commencement*, is slightly in excess of its renewal by fresh air, until, of course, the volume of the outgoing air is exactly counter-balanced by the inrush of fresh air. The momentary disparity between the outgoing and incoming volumes of air creates, within the drying chamber, a partial vacuum equivalent to a reduction of air-pressure of about 1½ lb. per sq. in., which is maintained so long as the exhaust fan L is in operation at full speed, thereby accelerating the drying of yarn, for reasons explained in § 326.

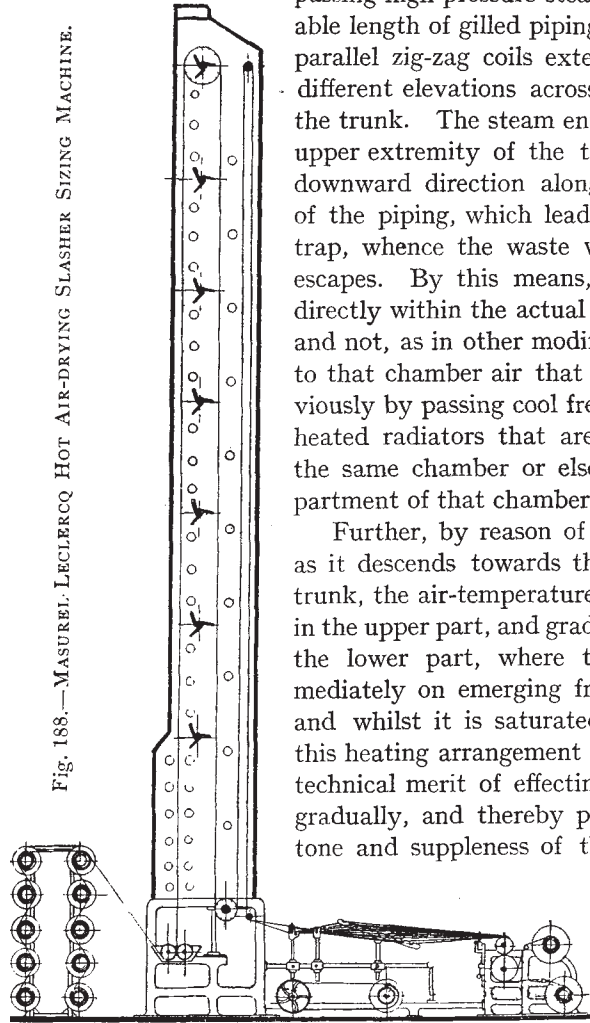
§ 328. Each of the three modifications of air-drying chambers described previously extends horizontally for the entire length of the chamber, and therefore occupies a comparatively large floor-space, although they have a relatively low elevation; whereas air-drying chambers of the vertical construction occupy a relatively small floor-space, but extend vertically, sometimes to a considerable height, ranging from 16½ ft. to 44½ ft., according to the particular class of warps for which they are specially constructed.

A hot air-drying chamber of the vertical form, designed by Masurel-Leclercq, and constructed by Messrs Knowles & Co., is illustrated in Figs. 188 to 192, which represent various modifications of this chamber adapted for drying different classes of warps.

This chamber consists of one, or more than one, wide trunk or duct extending vertically for any practicable height, immediately above the size-box, and terminating each with a small outlet or chimney, whence the vapour from the sized yarn escapes by *natural* ventilation into the atmosphere.

The method of heating the chamber constitutes a distinctive feature in the construction of this modification, and is effected by passing high-pressure steam through a considerable length of gilled piping disposed in a series of parallel zig-zag coils extending horizontally at different elevations across the entire width of the trunk. The steam enters the piping in the upper extremity of the trunk, and passes in a downward direction along the successive coils of the piping, which leads, finally, to a steam-trap, whence the waste water of condensation escapes. By this means, hot air is generated directly within the actual drying chamber itself, and not, as in other modifications, by supplying to that chamber air that has been heated previously by passing cool fresh air through steam-heated radiators that are contained either in the same chamber or else in a separate compartment of that chamber.

Fig. 188.—MASUREL-LECLERCQ HOT AIR-DRYING SLASHER SIZING MACHINE.



Further, by reason of the steam condensing as it descends towards the lower part of the trunk, the air-temperature is therefore greatest in the upper part, and gradually declines towards the lower part, where the yarn enters immediately on emerging from the sizing rollers, and whilst it is saturated with size. Hence, this heating arrangement possesses not only the technical merit of effecting the drying of yarn gradually, and thereby preserving the mellow tone and suppleness of the warp threads, but

it also conduces to economy by promoting natural ventilation within the trunks, whereby the vapour is expelled

from them without the aid of exhaust fans for that purpose.

In addition to the gilled steam-piping, there are also mounted at

regular intervals apart, vertically, several wide-vaned fans, of special design, extending horizontally across the entire width of the trunk for the purpose of accelerating the process of drying the yarn by fanning the hot air between the warp threads, which are thereby vibrated as they pass upward and downward in the form of sheets of threads extending vertically from the summit to the base of the trunk, as represented in Fig. 188.

§ 329. The vertical form of drying chamber, extending for a considerable height, in conjunction with the particular method of heating just described, is the chief factor that conduces to a degree of efficiency which, it is claimed by the makers of this chamber, will produce results that are in many respects greatly superior to those obtained by any form of horizontal air-drying chamber.

This claim is based chiefly on the easy flow of vapour by natural ventilation within the trunks, *and its immediate and direct discharge from them*, because of their vertical position, which also permits of a *long interval or span of yarn between the sizing rollers and the first of the several guide rollers* over which the threads are conducted after leaving the sizing rollers.

The hot air, with its charge of vapour, rises naturally within the trunks, whence it escapes through small chimneys directly and without coming into contact with the folds of yarn that may be contained in adjacent trunks of the same drying chamber. As the air ascends, it meets successive lengths of steam-piping, which is hotter as it approaches the summit, where the live steam first enters the piping and then descends towards a steam-trap at the base. By this ingenious arrangement, therefore, the temperature of the air increases as it ascends within the trunks, whereby its power to absorb moisture from the yarn, and also its capacity to retain it as vapour in suspension, are constantly increasing, thereby preventing the vapour from condensing within the trunks and remoistening the yarn.

§ 330. The long interval or stretch of warp threads between the sizing rollers and the first guide-roller with which the yarn comes into contact, after being saturated with size, permits of a relatively longer time for the threads to dry sufficiently to prevent the risk of these clinging to, and depositing size on, the surface of the guide-roller which, like other guide-rollers around which the yarn is con-

ducted, is mounted in ball bearings to reduce, to the least possible degree, the tensile strain upon the warp threads.

This object is also still further effected by the vertical disposition of the folds or relays of warp threads, whereby the descending sheets of threads exactly counterbalance the ascending sheets of yarn. Under these conditions, therefore, the tension upon the warp threads is not appreciably increased by increasing either the length or the number of folds or relays of yarn that are exposed within the drying chamber at the same time. Hence, the warp threads retain their roundness, fulness, strength, and elasticity, and being of a more supple character, they are therefore less liable to breakages when subjected to sudden strains or shocks during weaving, and the cloth produced is said to be of a much superior character of texture.

§ 331. In contrast with the foregoing advantages, it is urged by the makers of this particular form of hot air-drying chamber that warp-drying by any of the several modifications of horizontal air-drying chambers is neither so effective nor so economical, because of the vapour being expelled from those chambers by the aid of a forced draught induced by means of an exhaust fan, which is mounted in a common outlet formed at one end of the chamber only, albeit the sheet of warp threads extends in a series of horizontal folds that lie in different horizontal planes throughout the entire length and width of the drying chamber, which consists either of one large and open compartment, or else of several shallow compartments, as described and illustrated previously.

These circumstances are held by the advocates of the vertical form of drying chamber to constitute serious obstacles to the efficiency of horizontal chambers, not only by impeding the process of drying the yarn, and thereby curtailing the productiveness of the machine by causing the stream of hot air to flow along the same course as the warp yarn continuously, but also because, in consequence of the air becoming gradually cooler as it passes through the chamber, the air loses both its power of absorbing moisture and of retaining the vapour in suspension, as explained in §§ 282-3, with the result that the vapour condenses before it is expelled from the drying chamber, and is, therefore, again partially reabsorbed by the yarn.

This circumstance is, indeed, not only freely admitted by the makers of the horizontal hot air-drying chamber described in §§ 321-3

and illustrated in Figs. 181 to 184, but the makers of that modification actually adduce this result as a highly commendable and desirable feature which enhances the merit of their system of air-drying, by leaving the yarn slightly moistened, and therefore in a much better condition for weaving, than when the yarn is dried more thoroughly.

It is also urged as an objection against both cylinder-drying machines, and also the horizontal form of hot air-drying chambers, that by subjecting the warp threads, immediately after they emerge from the sizing rollers, and whilst they are completely saturated with size, to the influence of a very high initial temperature, the process of drying is effected so suddenly that the size forms a hard, crisp, and brittle film or sheath around the threads without properly binding together and consolidating the fibres composing them, with the result that the size rubs off the warp threads when passing through the comb during beaming, and also through the healds and reed during weaving, when the benefits accruing from sizing are most urgently needed.

In the vertical form of chamber just described, however, both the cold fresh air and the saturated warp threads enter the drying chamber concurrently at the base, and ascend together in the trunks, whilst the air-temperature is gradually increasing, and thereby effecting a progressive and gradual process of drying, which is said to have the effect of fixing the size more securely upon the threads, so that it is less liable to rub off and become wasted during the operations of beaming and weaving.

§ 332. With regard to the interval or stretch of warp yarn extending between the sizing rollers and the first guide-roller with which the yarn makes its first contact, after being saturated with size, that interval may be of any practicable length, or there may be any number of folds or relays of yarn exposed at the same time within a vertical drying chamber, without materially affecting the degree of tensile strain upon the warp threads, for reasons stated in § 330.

In a horizontal chamber, however, the length of span between the sizing rollers and first guide-roller is necessarily restricted because of the sagging or drooping of warp threads between those rollers, which subjects the threads to a degree of tension which is proportionate to the length of span.

Also, unlike the vertical form of drying chamber, each fold or relay of yarn which extends horizontally imposes additional effort,



and therefore tension, upon the threads when passing through the chamber, because the horizontal folds of yarn do not counterbalance each other as do vertical folds. Under these circumstances, therefore, it is necessary not only to restrict the span of yarn, especially between the sizing rollers and first guide-roller, but also the number of folds in horizontal chambers, and consequently to submit the yarn to heat of a high initial temperature to dry the threads sufficiently before they pass around the first guide-roller.

As stated in § 328, this form of drying chamber is constructed with a variety of modifications, each of which is adapted suitably to the special requirements of the particular class of warps for which it is intended. For example, the height of the trunk may be constructed to any dimension according to the length of warp traverse required; also two or more trunks may be employed in combination to permit of a greater number of folds or relays of yarn within the drying chamber, and thus keep it exposed to the hot air for a relatively longer period, with the object of accelerating the progress of yarn through the machine, and thereby increasing its productiveness. The trunks may also be employed in conjunction with only one or more than one size-box to permit of single, double, or treble sizing as required; or the size-boxes may be employed for sizing the same or different counts or colours of yarn from one, or more than one, set of back beams, simultaneously, without the risk of threads of one colour becoming tinged with other colours.

§ 333. One of these modifications, which is specially adapted for woollen yarn of fine counts, consists of a single trunk of extra width from front to back, and of considerable height, erected above only one size-box. The trunk is furnished with one short vertical zigzag row, and two long vertical rows of gilled steam-pipes, and also with seven wide-vented fans mounted about 4ft. 6in. apart, as represented in Fig. 188.

In this modification, the warp threads emerge from the sizing rollers whence they pass immediately between several steam-pipes that are placed with a close parallel disposition in the lower part of the trunk. From this lower range of steam-pipes the warp threads continue their upward course to the top of the trunk, where they pass over a ribbed or lattice guide-roller and descend to the bottom of the trunk, whereby the first two folds or relays of yarn extend on both sides of the first row of steam-pipes and the seven fans referred to previously.



If, on arriving at the bottom of the trunk, the warp threads are dried sufficiently, they pass underneath another lattice guide-roller, whence they are conducted to be wound immediately on to the weaver's beam. But if, from any circumstance arising from the state of the weather, yarn of coarser counts, a greater number of warp threads, or a greater percentage of size applied to them, it is necessary, in order to ensure its thorough drying, to pass the yarn for a second time up and down the trunk, that course may be adopted by conducting the yarn underneath the bottom lattice guide-roller, then over a plain guide-roller at the top of the trunk, and downward again to be passed under a plain guide-roller at the bottom of the trunk, and thence on to the weaver's beam or beams, in the manner represented in Fig. 188. By adopting this course, the yarn is exposed for a second time to the drying influence of an additional long row of steam-pipes, whereby the drying of the yarn is greatly accelerated and the relative productiveness of the machine thereby considerably increased.

§ 334. Other adaptations of this particular form of hot air-drying chamber are illustrated in Figs. 189 to 191, which represent modifications of this chamber which are employed specially for sizing and drying three distinctly different classes of warps. In each of these examples, the drying chambers consist of two trunks in combination, erected above two separate size-boxes, whereby they are adapted to any of the following requirements—namely: (*a*) For single sizing only, as represented in Fig. 189; (*b*) for double sizing—that is, sizing and drying the same warp threads twice in succession and in the same machine, as represented in Fig. 190; (*c*) for sizing two separate and distinct warps, composed either of the same or different counts or colours of yarn, and to be wound on to separate weavers' beams simultaneously, as represented in Fig. 191; and (*d*) for sizing warps composed of two or more different colours of yarn, and of which the warp threads are

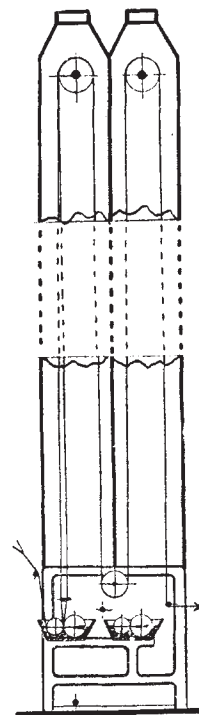


Fig. 189.

combined into one sheet only when they reach the top of the drying chamber, and they are dried sufficiently to prevent the risk of threads of one colour becoming tinged with other colours, and which is also

represented in Fig. 191.

§ 335. A third modification of this drying chamber is illustrated in Fig. 192, which represents three trunks in combination, erected above two size-boxes, whereby it is adapted for yarn of coarser counts and for the heavier grades of sizing, without curtailing production, as the additional trunk permits of the exposure of the warp threads to the hot air for a considerably longer period, to ensure thorough drying.

When two or more trunks are employed in combination, they virtually constitute a single drying chamber consisting of a corresponding number of vertical compartments that are separated from each other by means of sheet-metal partitions. Each trunk or compartment, therefore, forms a separate flue or duct that may be employed quite independently of the others, as they are each equipped with fans and a separate system of steam-piping, whereby the heating of the several trunks, and therefore their drying power, may be controlled independently and regulated suitably to the character of the warp, grade, and character of sizing, and the rate of production required. Also each

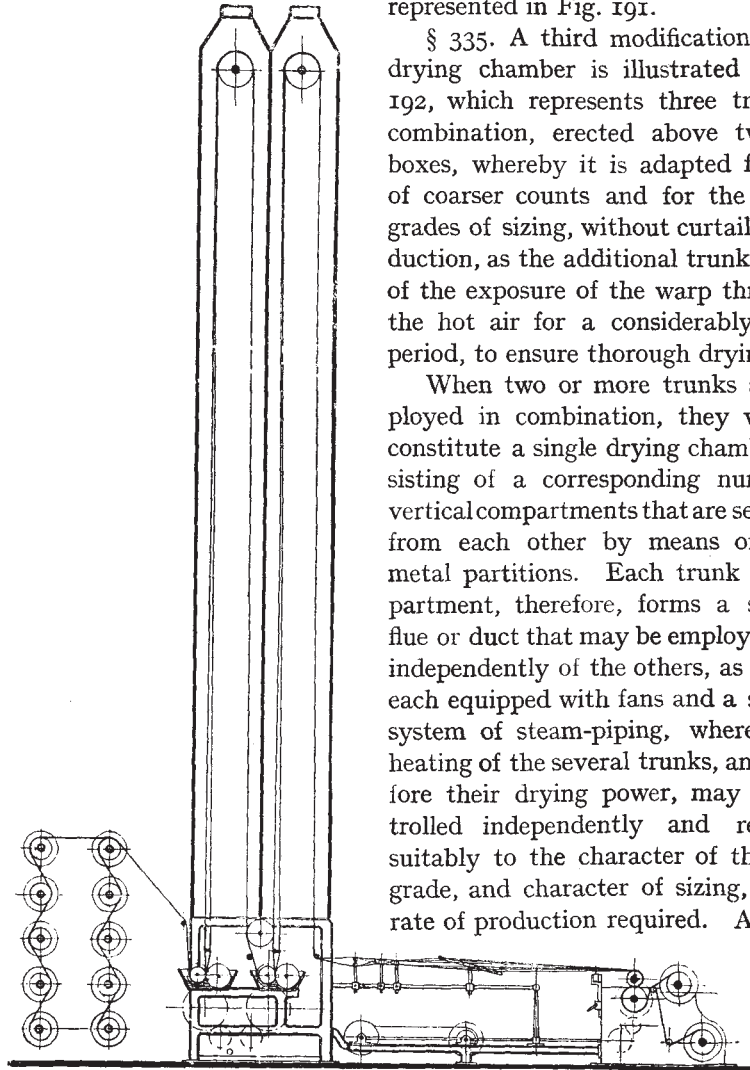


Fig. 190.

trunk is surmounted by a separate small chimney outlet provided with a damper or baffle-plate which opens or closes automatically on starting or stopping the machine, and may be adjusted as desired to regulate the discharging of vapour from the trunks, and thereby control the rate of condensation of the steam consumed in drying the yarn.

§ 336. The form of beam creel which is usually, though not necessarily, employed with these drying chambers, is that in which the back beams are disposed in two, or more than two, vertical rows, with the axes of the several beams in each row placed in the same vertical plane and with not more than five beams in each row, with the object of keeping the highest beam within convenient reaching distance by the attendant when he is recovering and piecing missing or broken warp threads, as described in § 185.

The vertical form of beam creel occupies relatively less floor space than the more prevalent form of creel in which the back beams are mounted with a zigzag or alternate disposition in two horizontal rows having two slightly different elevations. There may also be employed a duplex rotary beam creel constructed to support two distinct sets of back beams, as indicated in Fig. 192, thereby enabling a new set of back beams to be creeled without loss of time, and in readiness to be

placed in position by simply revolving the creel on its axis immediately the previous set of beams is depleted. The hauling of the back beams in and out of the creel is performed mechanically by means of an overhead winch erected immediately above the creel.

§ 337. Another departure from usual practice is also made by placing the dividing rods all in the same inclined plane, as represented in the diagrams, whereby the several sheets of threads from the respective back beams are more effectually and completely separated

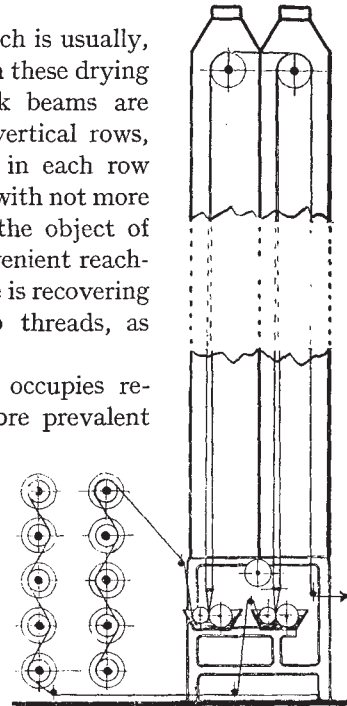


Fig. 191.

from each other, and the recovering and piecing of broken threads thereby effected more readily. The headstocks are constructed with two separate and distinct winding-on devices, which permit either of two similar or else different warps being sized, and wound upon separate weavers' beams, simultaneously, by the same machine.

The machines are also provided, if required, with a special form of length indicator and cut-marking motion, which operates automatically without the use of change-wheels, and produces cut-marks at the required intervals apart, by simply moving an adjustable cursor, which slides on a graduated scale, opposite the particular number which denotes the cut-lengths in yards required, and then securing it in position.

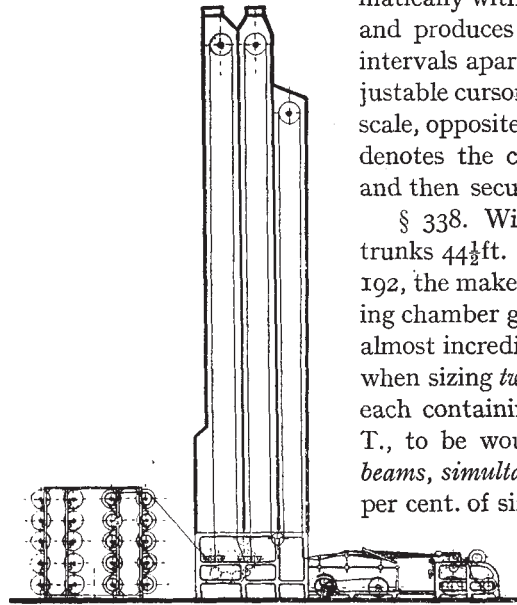


Fig. 192.

§ 338. With a combination of three trunks  $44\frac{1}{2}$  ft. high, as represented in Fig. 192, the makers of this form of hot air-drying chamber guarantee a production at the almost incredible rate of 4250 yds. per hour, when sizing *two* cotton warps *in duplicate*, each containing 1600 warp threads of 24's T., to be wound on *two separate weavers' beams, simultaneously*, 63 in. wide, with 10 per cent. of size, and a working steam-pressure of 105 lb. per sq in. in the first range of steam-pipes.

Indeed, a record of tests published by the makers re-

veals the fact that this enormous rate of production was actually attained even when sizing cotton warps containing 2500 warp threads of 30's T., as specified in the last item in the accompanying instructive Table of Particulars, which also records many interesting data relating to no fewer than twenty-four different tests, with both cotton and woollen warps of various counts of yarn and numbers of warp threads, and which were conducted with the several modifications of this particular construction of hot air-drying slasher sizing machine when winding the warps both on to one weaver's beam only, and also on to two separate weavers' beams, simultaneously.



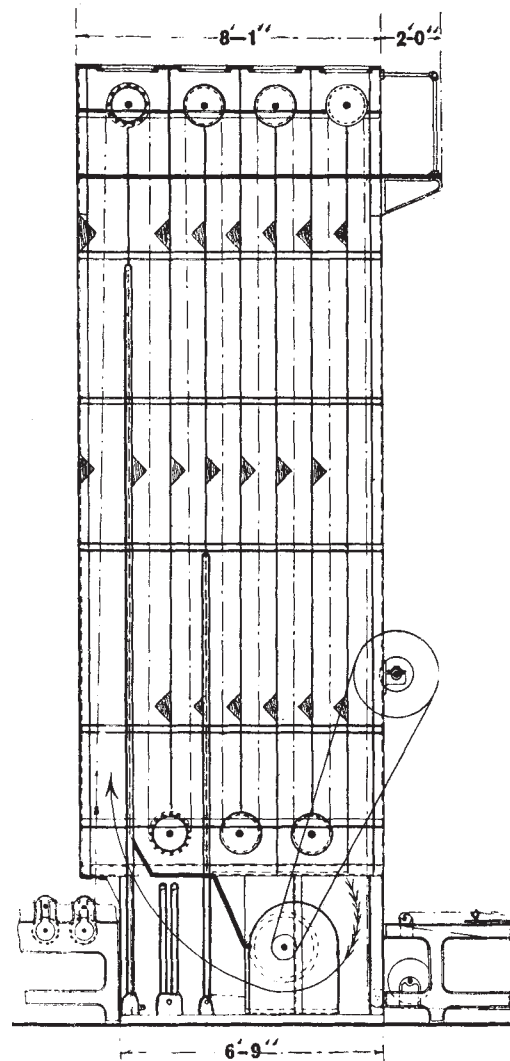


Fig. 193 —MARR HOT AIR-DRYING CHAMBER.

§ 340. Another, and a later, example of the vertical type of hot air-drying chamber is that represented by a side sectional and a front (or rear) elevation in Figs. 193 and 194 respectively, which illustrate Marr's modification of a vertical chamber that differs in several respects from that described in §§ 328 to 338 and illustrated in Figs. 188 to 192, both in the construction of the chamber itself and also in the methods of heating and drying that are adopted.

The present modification, which is constructed by Messrs Vincent, Roberts and Marr, consists of only one large vertical chest, about 25ft. 6in. in height, erected immediately above a lower chamber, forming the base, and in which the heating and drying apparatus are contained. This chest is divided into any desired *even* number of separate vertical compartments, each about 12in. deep from front to back, and extending across the entire width of the

chest, in which respect, therefore, this air-drying chamber bears a very close similarity to that described in §§ 321-3 and represented in Figs 182 to 184, if that chamber were placed on end vertically, instead of horizontally.

In their progress through the sizing machine, the warp threads are conducted upward from the last pair of sizing rollers, whence they pass through a very narrow aperture extending across the base of the first of several compartments along which the warp is conducted, first upward and then downward, in alternate succession, until it emerges from the base of the last compartment and is passed under a guide-roller near the floor, whence it is conducted in the usual manner to be wound finally on to the weaver's beam.

As the yarn passes along the several compartments, it is submitted to the drying influence of a stream of hot and dry air which flows continuously along these compartments

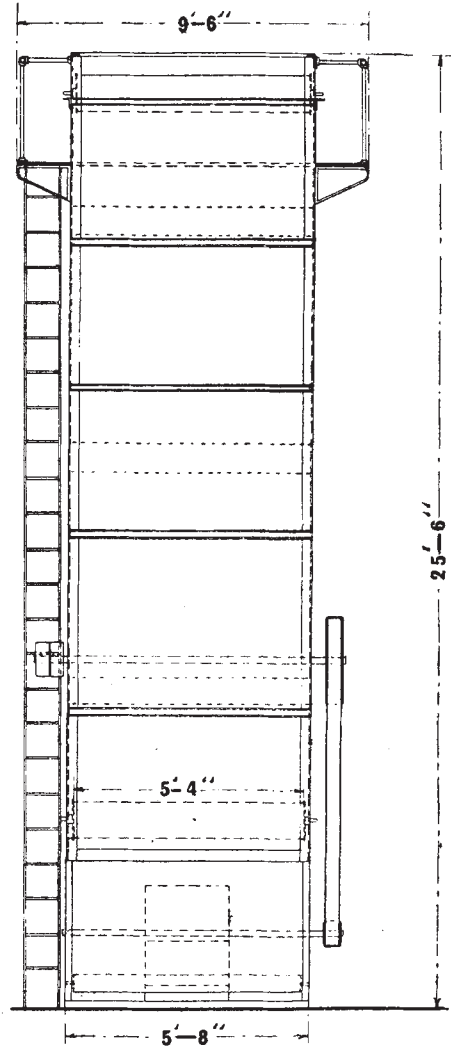


Fig. 194.



in the same direction as that in which the yarn travels, but with a very much greater velocity, which is in the ratio of about 1 to 10, so as to remove the vapour quickly away from the warp threads, and also to bring in a fresh supply of hot and dry air to react upon them. As the yarn is conducted through the drying chamber, it passes around a number of guide-rollers that are mounted at the extreme opposite ends of the chamber, and by which the threads are deflected from one compartment to another.

The first two of these guide-rollers, following immediately after the size-box, are formed with a ribbed or fluted surface to prevent the risk of the newly-sized threads adhering to, and depositing size upon the rollers, and all the guide-rollers are mounted in ball bearings, in which they revolve quite freely, simply by the surface contact with the warp threads, and without imposing appreciable tensile strain upon them.

The casing of the drying chamber should be covered externally with thin sheets or felt boards of non-conducting material about one-eighth of an inch thick, the better to insulate the chamber and thereby prevent the radiation of heat from it, and also to protect the upper part of the structure, which projects through the roof, and is therefore exposed to the destructive influence of the atmosphere. The chamber is also covered in at the top, and may, if required, be provided either with sliding or hinged trap-doors, or else adjustable louvres, placed above each pair of compartments for the purpose of controlling the escape of vapour from them as required under different atmospheric and other conditions.

Instead of employing fans, as in the previous chambers, to agitate the air within the compartments, this object is accomplished by a much more simple and economical method by fixing, at regular intervals apart, on the partitions, and also on the forward and rear ends of the drying chamber, a number of inclined baffles extending horizontally across the entire width of the chamber. The function of these baffles, which constitute a specially distinctive feature of this modification, is to contract the air-passages at those points, and thus cause frequent and temporary resistance to the free and regular flow of the air-current, thereby impelling the air against and between the warp threads, and producing an erratic movement and commotion of the air, which causes the threads to vibrate

slightly and separate from each other, and thus accelerate the process of drying the yarn.

§ 341. It is, however, more particularly in the method of heating the drying chamber, and also that of directing the stream of air, through the several compartments, that this particular modification marks such a distinct departure from any previous example of air-drying chamber. Thus, the hot air is generated by means of two or more steam-heated radiators contained in a separate compartment situated underneath the rear part of the drying chamber, and operating in conjunction with one or more than one air-propeller fan of the "multivane" type contained in another compartment underneath the fore part of the chamber, whereby a continuous stream of hot air is *circulated* through the several compartments in succession, whence the moist air is extracted and again conducted to the radiators, where it is redried and reheated, and from which it again proceeds to circulate through the drying chamber and back again to the radiators, and so on continuously, instead of being expelled entirely from the chamber as in the air-drying systems described previously.

As the hot air circulates through the drying chamber, and thereby becomes charged with vapour absorbed from the moist yarn, only a comparatively small proportion of the entire volume of that air is allowed to escape with its moisture into the atmosphere, whilst the greater volume of air, which still retains a considerable amount of heat, is again utilized for drying the yarn, thereby effecting considerable economy in steam consumption, and also retaining a sufficient amount of moisture in the air to leave the warp yarn in good condition for weaving; whereas in some air-drying chambers, the entire volume of air, after passing only once through the chamber, is expelled into the atmosphere, from which that air is replenished with an entirely fresh supply of cold air, which must be heated to the required temperature before it is allowed to enter the drying chamber, thereby involving a much greater consumption of steam.

Although, under normal atmospheric conditions, and other circumstances, practically the same stream of air circulates continually through the drying chamber, in the manner just described, and with but little replenishing with cool fresh air, that chamber is, nevertheless, provided with air trunks and valves to permit of the entire

current of air or any portion of it being discharged directly into the atmosphere, whence a fresh supply of cool air may be abstracted and passed through the heating chamber before it is allowed to combine with the air already in circulation. Also, instead of allowing the saturated air to escape from the louvred or other openings at the top of the drying chamber, that air may be expelled at a point immediately above the size-box, and thereby assist in removing the vapour that arises therefrom.

§ 342. The radiators employed for generating the stream of hot air each consist of a continuous length of steam-piping arranged in such a manner as virtually to constitute a number of vertical pipes with a close parallel disposition, to form a zigzag coil of piping extending across the entire width of the drying chamber. These radiators, of which any convenient number may be employed, are all contained in an isolated chamber which opens directly into the base of the first or rearmost of the vertical compartments into which the drying chamber is divided.

One row of steam-piping, forming a separate radiator, extends upward into the drying chamber for a distance of about three-quarters of the height of that chamber, and occupies a position midway between the first two folds or layers of warp threads following after the size-box. This row of steam-piping is succeeded by two or more rows of shorter vertical length, which do not extend into the drying chamber; whilst an additional supplementary row of steam-piping extends upward for a distance of about two-fifths the height of the chamber, and occupies a position midway between the third and the fourth folds of yarn for the purpose of accelerating the process of drying during cold and damp weather, or in other circumstances, when the process of drying proceeds tardily, and additional heating power is required. This air-drying chamber also may be substituted in place of the cylinders of ordinary slasher sizing machines.

§ 343. From the results of two actual tests conducted on sizing machines equipped with this hot air-drying chamber, the following authentic data were obtained:

*Test No. 1.*—When sizing 2240 warp threads of 34's T.  
Production = 2400yds. per hour.  
Steam consumption = 200lb., or 20gals. water, per hour.

Steam pressure = 70 lb. per sq. in.

Air temperature in first compartment (over size-box) of drying chamber ranged from 114° to 124° F. (45·56° to 51·11° C.).

*Test No. 2.*—When sizing 2814 warp threads of 12's T.

Production = 1074 yds. per hour.

Steam consumption = 472 lb., or 47·2 gals. water, per hour.

Steam pressure ranged from 71 to 77 lb. (Av. 74 lb.) per sq. in.

Air temperature in first compartment of drying chamber ranged from 158° to 166° F. (Av. 162·5° F.) = 70° to 74·45° C. (Av. 72·5° C.).

Air temperature in last compartment of drying chamber ranged from 123° to 131° F. (Av. 125·37° F.) = 50·56° to 55° C. (Av. 51·87° C.).

§ 344. Another different type of hot air-drying chamber, and one which constitutes quite a distinct variation from any of the foregoing examples, not only in the construction of the chamber itself, but also in the methods of heating it and of effecting the process of drying the yarn, is that illustrated in Fig. 195, which represents a longitudinal section of a German type of sizing machine invented by Sucker, about 1869, and for which a British patent was granted in 1889. Since this date, the machine has undergone several important modifications and improvements, and as constructed by Gebrüder Sucker, Grünberg, it is regarded as a hot air-drying machine of a very high standard of efficiency, and is now adopted by a few Lancashire manufacturers, in whose mills a number of machines of this type are in successful operation.

The principal feature which distinguishes this type of hot air-drying chamber from those described previously consists of the employment of three, five, seven, nine, or eleven large skeleton cylinders or swifts (according to the production desired), each having a diameter of about 2 ft. 6 in., and extending across the entire width of the chamber, in which they are enclosed, but easily accessible through small doors erected in the sides of the drying chamber, and within each of which swifts there is mounted a four-vaned fan.

During one part of their progress through the drying chamber the warp threads are conducted under and over these successive skeleton swifts, that are mounted with an alternate or zigzag disposition in two horizontal rows or tiers, and enclosed in a separate compartment situated between a lower one which constitutes the heating chamber, in the base, and a supplementary drying compartment

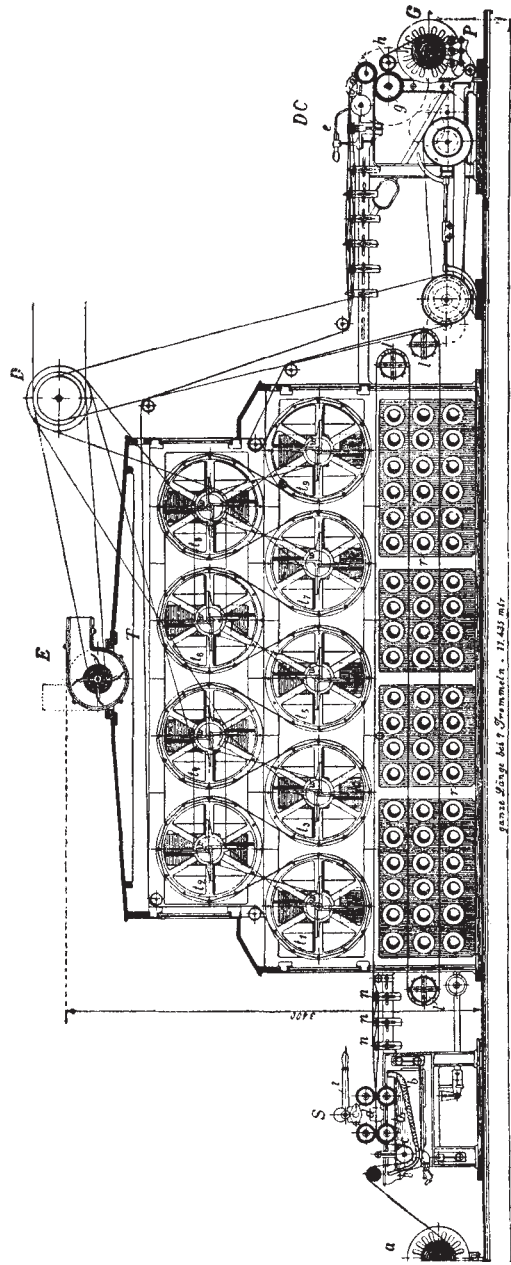


Fig. 195.—SUCKER HOT AIR-DRYING SLASHER SIZING MACHINE.

situated in the upper part of a large chest of considerable dimensions and constructed with a number of glazed panels through which the yarn in the drying chamber is always exposed to view.

The cylinder fans are driven positively, and revolve with a high velocity which is considerably greater than that of the cylinders, but in the same direction as these, with the object of driving the hot air with considerable force between the sheet of warp threads, and thereby accelerating the process of drying the yarn. Also, by causing the fans to revolve in the same direction as the skeleton swifts, it ensures that in the event of warp threads breaking, these will be carried along safely until they emerge from the drying chamber, when they can be recovered and pieced by the attendant.

Before the yarn is conducted around the skeleton swifts, however, it is first submitted to a preliminary process of drying by passing it forward and backward in three zigzag folds extending horizontally for the entire length of the lower division of the chest, which also contains the heating apparatus, consisting of an enormous and continuous length of gilled steam-piping arranged in three parallel and zigzag rows extending throughout the entire length and width of the heating chamber, and heated with high-pressure steam up to 100 lb. or more, per square inch.

Thus, immediately after leaving the last pair of sizing rollers, the warp threads are conducted forward over the top of the third or uppermost row of steam-pipes, then backward between the third and second rows, and again forward between the second and first rows of pipes, whence they are conducted upward and passed under and over the skeleton swifts in the lower and upper tiers in alternate succession, with a zigzag formation, and from the last or rearmost of which swifts the yarn is again directed upward and conducted along the upper supplementary drying compartment, from the front of which it emerges through a narrow aperture, whence it is deflected downward to pass under and over the dividing rods, and finally to be wound on to the weavers' beam or beams, as indicated in the diagram.

Whilst the yarn is passing between the rows of steam-piping contained in the heating compartment, and when it is therefore extended in three long spans between the guide-rollers, the warp threads are supported at several intervals to prevent them from sagging or drooping,

and thereby coming into contact with, and becoming scorched or burnt by, the steam-piping. Also, the larger guide-rollers, around which the yarn is conducted, are mounted in ball bearings to reduce frictional resistance and thus minimise the degree of tensile strain upon the warp threads.

The fans in the skeleton swifts of the *lower row* communicate at both ends of the fans, and by means of ducts, with the heating compartment in the lower part of the chest, whereby these lower fans draw only a current of *hot air* from that compartment, and deliver it with considerable force between the warp threads in the manner and for the purpose stated previously; whereas the fans in the *upper row* of swifts, which do not communicate with the heating compartment, draw in from the sizing-room a current of cool air which passes through louvred openings formed in the sides of the drying chamber, and thence to those fans.

By adopting this unusual procedure the yarn is submitted to currents of *hot air* and *cool air* in alternate succession, which, it is claimed by the makers, has the effect of imparting to the warp threads that peculiarly soft and mellow tone which is much appreciated, and also of preserving their original property of elasticity so essential to good weaving. The warp threads are also relieved of undue tensile strain, which would otherwise be imparted by the effort of turning the skeleton swifts, by mounting these in ball bearings that are lubricated in a special manner, whereby frictional resistance in those bearings is practically nil. In addition to this refinement, the skeleton swifts contained in the lower row are driven *negatively* from the long side-shaft which, through the medium of frictional driving-gear, transmits motion to those swifts in such a manner that the degree of tensile strain upon the warp threads may be regulated to any desired tension.


Also the removal of saturated air from the drying chamber is effected by means of an exhaust fan mounted in an outlet formed in the roof of the chamber, whence the moist air is discharged into a vertical form of ventilating trunk, and finally expelled into the atmosphere in the usual manner.

In machines of more recent construction, of which that illustrated in Fig. 195 is an example, the three lattice guide-rollers around which the warp threads are deflected and then conducted



backward and forward between the three rows of steam-pipes contained in the lower part of the drying chamber, as represented in the diagram, are each mounted immediately *outside* the ends of that chamber, with the object of displaying the yarn more effectually to observation by the attendant.

The size-box constitutes a special feature distinctive of this particular type of sizing machine, and is constructed of thick sheet copper to constitute a size-box of the cavity or jacketed type, of which another example is described in § 194, and illustrated in Fig. 79. Instead, however, of utilizing the cavity as a steam-jacket for heating the size, as in the previous example, it is, in the present machine, converted into a water-jacket which is heated by injecting steam through a perforated pipe passing through the water. Provision is also made whereby the size may, if it is desired, be heated by the usual method of injecting steam into it directly through a perforated pipe fixed *inside* the copper size-box, as described in §§ 190-1.

Also, the rear part of the size-box, containing the copper immersion-roller, is deeper in that part, whence the base of that box is inclined, at an angle of 12 degrees, towards the front of the box, thus , which is, therefore, very shallow in that part, thereby reducing its relative capacity to about one-half the usual volume of size. For reasons stated previously in § 191, however, the constructing of wide and shallow size-boxes of relatively smaller capacity is considered, by some practical sizers who advocate the use of deep and narrow size-boxes of relatively larger capacity, to conduce to uneven sizing of the yarn.

By a simple adaptation of levers furnished with adjustable weights, provision is also made whereby the degree of compression, exerted by the heavy squeezing or finishing rollers, may be regulated suitably to the requirements of different warps, according to the number of warp threads, counts and character of the yarn, grade of sizing and percentage of size required on the finished warp.

Also, when sizing warps with the heavier grades of sizing, the productiveness of the machine is maintained by a special arrangement whereby the yarn, as it leaves the last skeleton swift, is conducted backward, immediately *above* the rows of steam-piping, for the entire length of the drying chamber, and then forward again *between* the rows of steam-piping, thereby ensuring the effective

drying of the yarn without diminishing the speed of the machine, which would involve a proportionate loss of production.

The driving gear of this machine consists of a combination both of cone-drum and change-wheel gearing which permits of differential driving with a speed variation in the ratio of 1 to 6, with an actual yarn-speed of 5 to 30 yards per minute, according to varying conditions and requirements. Also, by means of slow-speed driving gear, the working speed of the machine is reduced to one-tenth of the normal full speed.

A special form of cut-marking and measuring motion enables the warps to be subdivided into unit-lengths ranging from 5 to 150 yards, in length-units of only 2in. each, and without employing change-wheels. A length-indicator also registers the number of cut-lengths of warp produced.

It is claimed by the makers of this type of air-drying sizing machine that when sizing dyed yarn the colours retain their original hue, purity and brilliance of tone; that it is superior to Scotch dressing or sizing, for linen warps; that when sizing light cotton warps containing from 400 to 800 warp threads of 32's T., and heavy cotton warps containing up to 6000 warp threads of 16's to 20's T., there was recorded, under actual tests, 25 per cent. more elasticity than is obtainable by any other type of hot air-drying sizing machine. Also, if required, the air-drying chamber only, of this machine, may be adapted to operate in conjunction with the headstock and sizing apparatus of any other type of slasher sizing machine of modern construction.

## CHAPTER IX

### LOOMING

#### I. DRAWING-IN. 2. TWISTING-IN. 3. TYING-IN.

§ 345. AFTER a warp is wound finally on to the weaver's beam, the warp threads require to be passed, in a prescribed order according to a prearranged plan termed the "draft," first through the respective eyes of the shedding harness, consisting either of a set of healds or else a jacquard mounting, whence they are passed usually in pairs, or else in groups of three or four threads uniformly, between successive dents of a reed, ready for weaving. The function of placing the warp threads through the shedding harness and reed of the loom is accomplished by an operation termed "looming," which is usually performed manually, by seniors of either sex, although it may be accomplished by various types of automatic mechanical appliances, and may be effected by any one of three optional methods, namely: (1) Drawing-in; (2) twisting-in; and (3) tying-in, which is sometimes adopted as an alternative method to twisting-in, and is usually performed mechanically. In some instances, however, warps that are produced from very thick folded yarn, as employed in some net leno and other fabrics containing "corded" warp threads; warps produced from yarn composed of artificial silk, glazed or polished; and other yarn which is of a wiry and refractory character, are sometimes tied-in by hand.

#### I. DRAWING-IN

The operation of drawing-in consists of drawing the warp threads separately first through the shedding harness, and then, usually in pairs, between the dents of the reed, and is the only method of looming by which warp threads may be passed for the first time through any new harness and reed. Drawing-in is also essential whenever the threads of a new warp require to be passed through the shedding

harness with a different order of drafting from that of the previous warp, even if the same harness and reed are employed, and also if both warps are identical as regards the counts of yarn and number of warp threads.

If, however, the same order of drafting is to be adopted for the new warp as that of the previous warp, and provided the "setting" or counts of the harness and reed is the same in both cases, and also that the counts of yarn and number of warp threads in both the preceding and succeeding warps are the same, or even approximately similar, it is usual, under these circumstances, to adopt the manual twisting-in method of looming, which is both easier and cheaper than manual drawing-in, although the operation of looming may be effected much more expeditiously and economically either by mechanical drawing-in, twisting-in, or else tying-in, whenever circumstances are favourable to either of those operations being performed automatically.

If warp threads are required to be passed through the eyes of a jacquard harness, any operation of looming must necessarily be performed at the loom itself, as it would be quite impracticable to remove the jacquard machine with its harness mounting away from the loom for that purpose. If, however, warp threads are to be drawn through a heald harness, it is usual to adopt the more expedient practice of performing that operation in a separate looming department, where the threads of new warps may be passed through duplicate sets of healds and reeds, without the necessity of waiting until the previous warps are finished in the looms, and of keeping these stopped whilst the new warp threads are being drawn through the same healds and reeds that were employed for the previous warp.

§ 346. If the operation of drawing-in is performed in the looming department, the warp beam and healds are suspended in a vertical stand which is adapted suitably for the purpose of supporting the warp beam in an elevated position, to permit of the warp threads drooping immediately behind the healds which are secured firmly in the same relative positions that they will occupy when they are gaited up in the loom, and as represented in Fig. 196. The warp threads are then ready for the operation of drawing-in, which requires to be performed with great care to avoid what are termed

“ misdrafts,” that would cause wrong interlacings of warp and weft, and thus produce faults in the cloth, during weaving.

The actual drawing-in of the warp threads is, therefore, usually performed by a senior of either sex who sits *in front* of the harness and is assisted by a boy or girl, described as a “reacher-in,” who sits *behind* the harness on the same side as that on which the sheet of warp threads droop. But the procedure varies amongst operatives in different weaving mills, chiefly according to personal preference, and also, in some measure, according to the particular character of the work as regards both the type of shedding harness and the class of fabrics to be woven.

Under ordinary circumstances, however, it is usual to commence drawing-in on the *left-hand side* of the harness when facing it, although this practice is quite optional and is not governed by any technical consideration. The reacher, with the right hand, then proceeds to select the warp threads from a bunch held in the left hand, and delivers them in consecutive rotation to a reed-hook which is inserted through successive eyes of the harness by the drawer-in, who draws the warp-threads forward through those eyes in a prescribed order indicated by the drafting plan.

§ 347. In the task of selecting warp threads to deliver them in their proper rotation to the reed-hook of the drawer-in, the reacher

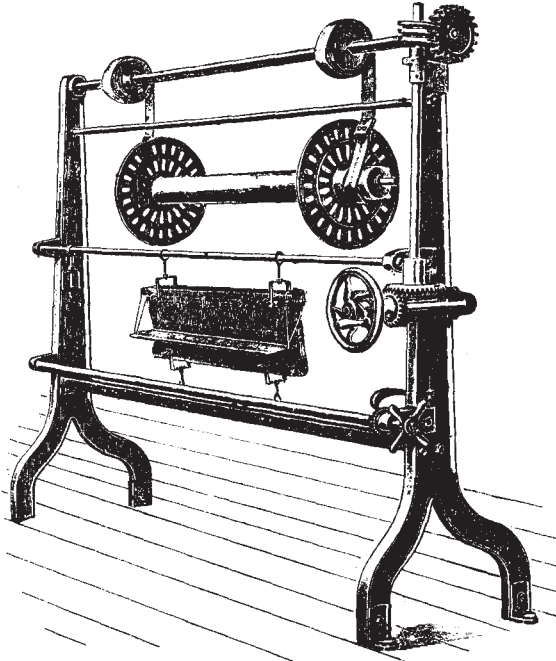



Fig. 196.

is assisted by what is known as a "lease," of which there are several different forms, according to the purpose which they are intended to serve. Thus, there is the imperfect form of lease termed the "slasher's lease," which is obtained by inserting the short dents or teeth of a slasher's half-reed or comb between the warp threads of slasher-sized or other beamed warps, for the purpose of retaining those threads in their proper relative positions, as described in § 182.

A slasher's or comb lease, however, does not constitute a perfect division of warp threads into uniform groups, and is liable, therefore, to cause the warp threads to be somewhat crossed after being drawn in, so that they tend to pull and strain at the lease-rods and to break during weaving, and thereby impede production. For these reasons this form of lease is adopted only when there are no means of obtaining an "end-and-end" or "looming" lease, which is the only perfect form of lease, inasmuch as it disposes the warp threads alternately into an odd and an even series, constituting two distinct sheets of threads that cross each other, thus , in such a manner that they may be selected from the lease only in their proper rotation, and without the risk of being crossed excepting by culpable negligence on the part of the reacher-in.

§ 348. When warp threads are drawn through a heald harness with a perfectly regular and simple order of drafting, such as that employed for plain, twill, and other simple weaves, an expert drawer-in usually employs a double hook, consisting of two separate reed hooks of different lengths inserted in the same handle, about half an inch apart, and parallel with each other, whereby two warp threads may be drawn through separate heald eyes simultaneously, and thus increase the speed of drawing-in.

After the warp threads are drawn through the harness eyes, they require to be passed through the reed, usually with two threads in each dent. If the work is of a simple character, that function is usually performed concurrently with the operation of drawing-in the warp threads through the healds, and is accomplished by fixing the reed in a flat horizontal position, immediately in front of the healds, and about an inch lower than the heald eyes, as in Fig. 196.

Thus, as successive pairs of warp threads are drawn forward through their respective heald eyes, the drawer-in passes them immediately under a special form of a broad and thin hook, usually

made of boxwood, and inserted from *above*, between successive dents of the reed, but withdrawn from *below*, thereby drawing the warp threads also through the reed.

When drawing-in warp threads for what is described as "fancy," as distinguished from "plain," weaving, however, and as exemplified in such weaves as require an irregular scheme of drafting, it is a common practice first to draw these threads separately through their respective harness eyes until all the threads are drawn in, and afterwards pass them between the dents of the reed in a manner similar to that just described.

A more approved method of procedure, however, when drawing-in warp threads with an irregular scheme of drafting through the eyes of a heald harness is, first to draw all the warp threads through their respective heald eyes only, with the warp beam elevated so that the warp threads droop immediately behind the healds, as in the two methods described previously. After all the warp threads have been passed through the harness eyes in this manner, the warp beam is placed on the floor, and the reed is then fixed immediately above, and resting upon, the upper heald-staves, in a reclining position, thus  $\diagup$ , and preferably with a broad strip of white paper placed immediately below it, whereby the divisions of the reed are revealed more distinctly to the vision of the drawer-in.

The *reacher in*, who remains at the back of the healds, on the beam side, then performs the duty, *temporarily*, of *drawing-in*, and proceeds to draw the threads through the reed by means of a short and broad metal denting or reed-hook, which is served with warp threads by the *drawer-in*, who remains on the same side in front of the healds and assumes, *temporarily*, the part of a *reacher-in*. When the operation of drawing-in a warp is completed, the warp beam, healds and reed are all taken together to be fixed in the loom and "gaited-up" ready for weaving.

§ 349. Although the operation of drawing-in does not demand, on the part of either the drawer-in or the reacher-in, any mental or strenuous physical effort or special technical ability, it is, nevertheless, a most tedious and monotonous occupation, requiring dexterity combined with diligence. It also imposes a strain upon the vision in selecting the warp threads, harness eyes, and dents of the reed in their proper order to prevent the risk of misdrafts; for should these



occur, it will be necessary to withdraw all the misplaced warp threads, and then redraw them in their proper positions; otherwise the misdrafts would be liable to cause more or less conspicuous defects in the cloth.

Indeed, it is asserted that drawers-in, more than any other class of textile workers, suffer more frequently from the distressing effects of eye-strain; especially if they are employed constantly in drawing-in coloured warp threads; or engaged upon healds and reeds of fine counts; or if the lighting is inadequate; each of which conditions has a very injurious effect upon the eye-sight, with the result that the work becomes still more difficult, and the risk of misdrafts consequently increases.

Therefore, with the object of facilitating the operation of drawing-in, both by relieving the drawer-in of excessive visual strain and also by expediting the work, there have been devised numerous mechanical appliances, of which there are but very few, however, that have met with any measure of appreciation or that have been adopted extensively.

These mechanical devices assume quite a variety of different forms, ranging from simple hand-tools that are designed merely to facilitate or expedite the work of drawing-in, to elaborate machines of the most ingenious conception and intricate construction, and which are capable of performing the function of drawing-in warp threads through both the heald-harness eyes and dents of the reed simultaneously and automatically with the greatest precision, at the almost incredible rate of 260 warp threads and 130 dents per minute.

But whatever special merit these devices may possess economically as auxiliary aids, their functions are of such a subsidiary character, both from a technical and a commercial aspect, that it is proposed only briefly to describe the cardinal features of several of the more typical examples of these devices, which, from some special merit they possess, have succeeded in establishing themselves with some measure of appreciation in their respective spheres of usefulness.

§ 350. One of these devices, described as a "sleying" or "denting" hook, is a simple and ingenious hand tool that costs only 5s., and is specially adapted for "denting" of a simple and regular character (although it is employed also in some sections of the

“fancy” weaving trade), for the purpose of passing the warp threads between the dents of the reed, concurrently with their being drawn through the harness eyes.

This device is illustrated in Fig. 197, which represents several views of an improved form of a German invention, patented in 1906, and which consists essentially of a long, flat, steel hooked blade A—

either curved, as in the original invention, represented at A<sup>1</sup>, or else straight, as in Smith’s modification, patented four years subsequently—and a forked spring clamp B fixed to a small wooden handle. The spring clamp grasps the base of the hooked blade, freely but firmly, and in such a manner that by a simple downward and upward movement of the blade, when this is inserted between the dents of the reed, the blade is thereby propelled

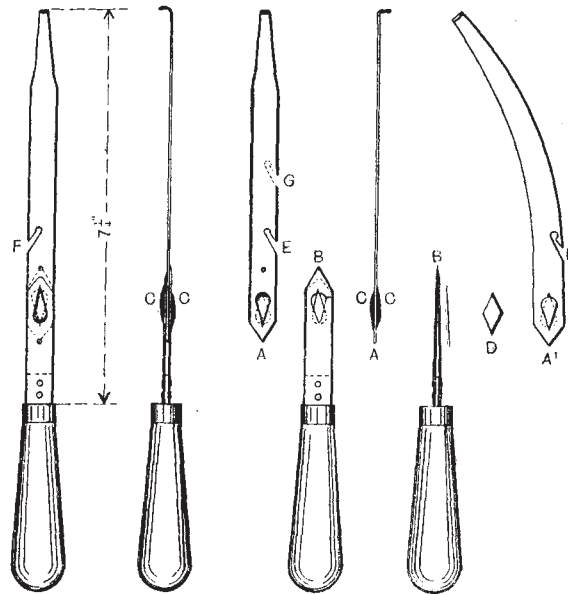


Fig. 197.

along the successive dents which are selected in their proper rotation, mechanically, and entirely unaided by the vision of the drawer-in.

The special object of forming this denting hook with a straight instead of a curved form of blade is to prevent the free end of that blade—which is bent over at right-angles for about an eighth of an inch, thus  $\perp$ —from hooking or catching on to the heald-twine during the operation of drawing-in.

Another modification, of a very trivial character and of no real advantage whatever, to the user, was patented by Johnson in 1911, and is effected by slightly varying the shape of the two *reversed*

metal studs or buttons C that project a little on each side, near the base of the hooked blade, and which enter holes of exactly the same size and shape formed in the forks of the spring clamp to retain that blade in position, with a firm and yet a yielding grasp.

This modification is effected simply by forming those studs with *both ends pointed* to form diamond-shaped studs, as represented at D, instead of forming them with *one end pointed* and *one end rounded*, as in the original conception, and which are, indeed, preferable to the diamond-shape of studs, by reason of their greater circumference.

A still further modification of this denting hook, and one which is the conception of an ingenious drawer-in who adopted it for his own special and personal benefit, is effected by constructing, in the blade A, an additional slit or hook, placed about an inch or more further from the first hook, as indicated at G by dotted lines, so that in the rare event of one or both of the warp threads, that are to pass through the same dent of the reed, being missed by the first hook E, the blade may be returned through the *same* dent before it has selected and entered the next one, whereby the missing thread or threads may be passed under the second hook F and drawn through the correct dent of the reed. Although this particular modification has not been patented, yet, like those noticed previously, it emphasizes the ease and readiness with which an original invention of real merit may be seized upon and modified in trivial and quite unimportant details of construction, unless an inventor is cautious enough to protect himself against such risk by a clear and comprehensive statement of claims embracing minor modifications.

§ 351. When this form of denting hook is employed, the blade is inserted from below the reed, through the first dent to be filled, on the extreme left, with the hooked edge *facing* the drawer-in, who holds the handle constantly by the *left* hand and draws the warp threads through the heald eyes by means of the usual form of double drawing-in hook held by the *right* hand. Then as each successive pair of warp threads is drawn through the heald eyes, they are passed at once on to the "denting" hook, which is pulled downward to pass those threads through the reed, and then returned immediately for the next pair of warp threads, and so on, until the operation of drawing-in is completed.

Therefore, by selecting the dents of the reed mechanically in the

manner described, the use of this device relieves the drawers-in entirely of the visual effort of selecting the dents by the usual method, whereby they are at liberty to concentrate their attention entirely to the healds, without requiring to do more than just glance at the reed occasionally for reassurance that the work is progressing satisfactorily; and for plain work, this device is highly commended.

It is affirmed, by users of this device, that it increases their efficiency as much as 10 to 25 %, according to their previous capabilities and the particular class of work on which they are engaged.

Many other mechanical appliances of various types have been conceived with the object of facilitating the operation of drawing-in warp threads either through the eyes of a heald harness only, or else between the dents of a reed after all those threads have been passed through the heald eyes. These devices, however, do not operate automatically, but serve only to select, by mechanical means, either the heald eyes or else the dents of the reed in consecutive rotation, and require to be operated, intermittently, by an attendant, who also delivers the warp threads to the drawing-in hook by hand, in the usual manner. Machines of this character, therefore, have a very limited productive capacity, and are of so little practical utility in a properly-organized weaving mill that they have not received the general approval of British manufacturers.

#### AUTOMATIC WARP DRAWING-IN MACHINE

§ 352. It has been stated previously, in § 349, that the entire operation of drawing-in warp threads through both the heald harness and the reed, simultaneously, is sometimes performed quite automatically by means of a special type of machine designed for that purpose. This machine is operated under the personal supervision of a senior attendant of either sex, with junior assistants to perform minor duties incidental to the use of the machine, which selects the warp threads separately and delivers them in consecutive rotation to a hook which draws them through the heald eyes and between successive dents of the reed simultaneously by a single operation, and with unerring precision, at the enormous rate of 250 to 260 threads per minute.

In addition to this, the machine may also be adapted for drawing

the warp threads through three banks or rows of drop-wires, that are sometimes employed in conjunction with certain types of automatic warp-stop devices as applied to some power-looms.

The automatic warp drawing-in machine referred to is that invented by Field, Hathaway & Lee, as illustrated in Fig. 198, and introduced into this country from America in 1909 by the agency of Weaving Appliances Limited. The advent of this machine constituted an important development with far-reaching influence in promoting the welfare of the weaving industry, by solving in a con-

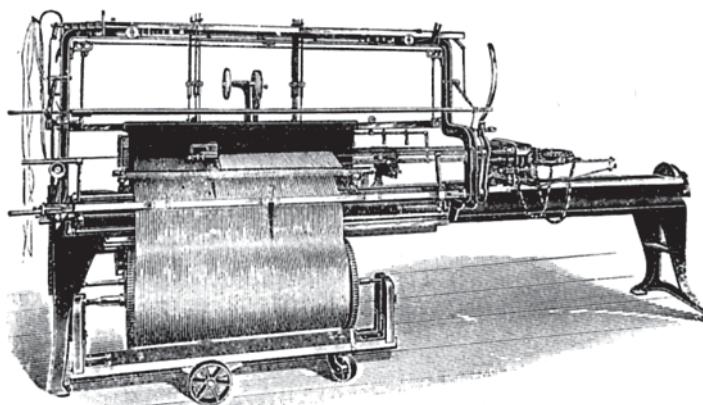


Fig. 198.—AUTOMATIC WARP DRAWING-IN MACHINE.

clusive and thoroughly practical manner the erstwhile difficult problem of drawing-in warp threads through both the shedding harness and reed simultaneously by a single operation performed mechanically and automatically, and in a manner that confidence in the efficiency and reliability of that machine, for the particular sphere of work for which it is expressly adapted, is quite established.

This machine is a triumph of mechanical invention, and in the ingenuity displayed in the construction and combination of the numerous and intricate parts composing it, all of which operate in perfect harmony and perform their respective and sometimes very delicate functions with considerable dexterity, it is probably not surpassed by any other machine incidental to the weaving branch of the textile industry.

Nevertheless, when in operation, drawing-in warp threads even at the rate of 250 to 260 per minute, the working parts of the machine operate harmoniously and with such rhythmical sequence, precision, and rapidity, that the performance appears to be almost of quite a commonplace character.

Since the special function of this machine, however, is essentially one affecting only considerations of an economic rather than those of a technical character in the general routine of manufacturing, and not one that involves any modification whatsoever in its effect either upon the character of the yarn or the disposition of the warp threads—such as, for example, those produced during the operations of winding, warping, and sizing—it will serve the present purpose to give a brief but concise description only of the cardinal features and operation of the machine, as follows:

§ 353. The chief groups of mechanism constituting this machine are classified under five distinct divisions—namely: (1) THE DRAWING HOOK OR NEEDLE DRIVE; (2) THE REED OPENER; (3) THE HARNESS EYE SELECTOR; (4) THE WARP THREAD SELECTOR; (5) THE DRAWING HOOK OR NEEDLE STRIPPER.

1. THE NEEDLE DRIVE comprises the drawing-in hook, termed the needle, and all other mechanism incidental to the operating and guiding of that hook between the dents of the reed and through the heald eyes, and it constitutes the leading group of mechanism in relation to which all other working parts of the machine are adjusted and timed to act in unison.

2. THE REED OPENER consists of a thin circular disc formed with a spiral edge or rim, by means of which successive dents of the reed are selected and opened out sufficiently to ensure the proper entering by the drawing hook for any number of successive thrusts, according to the number of separate warp threads to be inserted in each dent.

3. THE HARNESS EYE SELECTOR constitutes a most ingenious feature of the machine, and performs one of the most delicate of its many functions by selecting from the respective healds, successive eyes, and presenting them with their apertures directly facing the drawing hook, which may draw one or more than one warp thread in succession, but not two or more warp threads simultaneously, through each heald eye, as required.



4. THE WARP THREAD SELECTOR is another very ingenious device, which selects the warp threads separately and delivers them in consecutive rotation to the hook of the needle, which immediately draws the respective threads through the particular heald eye and dent of the reed penetrated by that needle.

5. THE DRAWING HOOK STRIPPER consists of a device for the purpose of removing the warp threads from the drawing hook, by striking those threads downward immediately in front of the reed, to remove them out of the path of that hook as this emerges through the dents of the reed, and thereby prevent the risk of the threads being again caught up by it during the forward thrusts to receive successive warp threads.

§ 354. Any method of power transmission, or direct driving by means of an electrical motor, may be employed to operate these machines, which are constructed with different capacities ranging from two to eight staves of healds only, or else up to six healds in conjunction with one, two, or three rows of warp-stop drop-wires.

These machines, however, are restricted to drafting plans of a simple and uniform character, such as the plain, twill, V-pointed or herring-bone, broken or skip, and other similar schemes of drafting plans. They are not adapted for drawing-in warp threads with an intricate and irregular scheme of drafting, such as sometimes becomes necessary in certain branches of "fancy" weaving; albeit they are capable of drawing-in any prescribed number of separate warp threads through each heald eye and dent of the reed, either uniformly or at specified intervals apart, to produce corded or ribbed effects in cloth.

They are also capable of dropping or casting-out surplus heald eyes, if it is required to employ a set of healds for a reed of coarser counts than that for which they were knitted. Thus, if, for example, it is required to employ, with a 56's reed, a set of any number of healds that have been knitted for a 64's reed, the machine would drop or leave empty eight out of every sixty-four eyes, or one in eight, by drawing warp threads through seven eyes, and missing one on each heald stave, uniformly.

The functions of selecting the particular number of warp threads to be inserted in the respective heald eyes and dents of the reed, and also that of leaving heald eyes empty, in a prescribed order, are



governed by means of automatic selecting mechanism controlled by perforated metal pattern cards, in a manner analogous to the controlling of a multiple shuttle-box motion of a check-loom.

The machines may be constructed for any practicable width of reed-space or any counts of yarn; and with an expert operator one machine is capable of drawing-in an aggregate of 70,000 warp threads through 30 different sets of healds and reeds during a working day of ten hours, at a net average rate of 120 threads per minute, including all necessary stoppages for the rectifying of errors and the replacing of harnesses and warps.

## 2. TWISTING-IN

§ 355. As stated previously in § 345, the operation of "twisting" is an alternative method of "looming" whereby the threads of a new warp are united, *separately*, by means of a peculiar twisting, to the corresponding remnant threads of a previous warp whilst these threads are still retained in the shedding harness and reed. It is therefore restricted to new warps that are to be controlled by the same harness and with precisely the same scheme of drafting as were employed for the previous warp, which must also correspond, approximately, with the new warp, both in the character and counts of yarn from which they are produced. Otherwise, the twistings by which the threads of the respective warps are united will tend to untwist and break down immediately on being subjected to tensile strain when "straining up" the warp in the loom, in order to draw forward the piecings of the warp threads and pass them quite clear through both the harness eyes and the dents of the reed before commencing to weave the cloth.

The circumstances under which the twistings, by which the warp threads are united, are more liable to untwist and break down are specified as follows: (a) If the respective warps are produced from yarn of different counts; (b) if one warp is produced from normal yarn and the other from mercerized, glazed or polished yarn; (c) if one warp is produced from single yarn and the other from folded yarn; (d) if either one or both warps are produced from artificial silk (which is usually tied-in by hand); and (e) if both warps are

produced from folded yarn in which the doubling-twist runs in reverse directions, respectively.

§ 356. Although the function of twisting, like that of drawing-in, is at the present time usually effected by hand, and performed by seniors of either sex, it is now actually accomplished, with a great measure of practical success, by means of an automatic mechanical device, described briefly in § 358.

As a manual operation, the function of twisting, like that of drawing-in, does not demand, on the part of the twister, either physical exertion or special technical ability. It is, nevertheless, a most wearisome and monotonous task, amounting almost to drudgery, which is totally devoid of any interest whatsoever, and for which manual dexterity, combined with patient diligence and care, is the only qualification required to ensure proficiency both in speed and avoiding the risk of missing and crossing the warp threads.

The operation of twisting, like that of drawing-in, may be performed optionally either at the loom itself or else in the looming department, if the warp is to be governed by a heald harness; but if it is to be controlled by a jacquard harness, the operation of twisting must then be performed at the loom.

§ 357. The usual method of procedure when preparing to twist a warp to be controlled by a heald harness is to support, in opposite ends of a suitable frame or stand, as represented in Fig. 199, both the new warp beam and the heald harness and reed containing the remnant threads of the old warp, with the warp beam and healds placed about 4ft. apart, to provide sufficient space for the twister, who sits between the two series of warp threads, usually with the healds on the left-hand side, and the warp beam on the right. In this case, the twister performs the actual twisting by means of the thumb and index finger of the left hand, although there is no technical reason why a twister may not, at the commencement, reverse these conditions, and twist with the thumb and first finger of the right hand, a course which is, on very rare occasions, sometimes adopted in actual practice. Indeed, ability to employ either hand for twisting would be a great advantage in the event of a twister being disabled because of some trivial injury to the hand usually employed, and which would otherwise involve loss of work and wages.

When the healds and warp beam are fixed properly in position,

the twister then gathers from each warp a small group of about 100 to 200 threads, more or less, according to the counts of yarn, and ties the end of each group into a knot, after which both groups of threads are inserted together through what is termed a "twister's hook," consisting of a wire ring about 2in. diameter, and formed with a narrow neck or loop about 1½in. long, to the extreme end of which there is brazed a curved piece of steel formed with a ground cutting

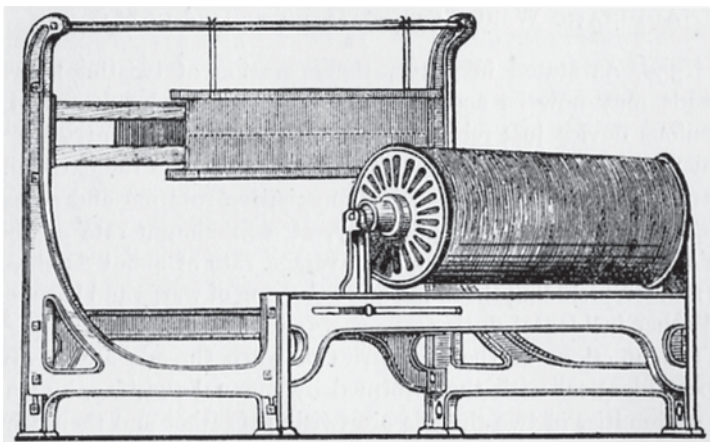


Fig. 199.

or breaking edge, against which the warp threads are severed as they are selected in succession for twisting together.

The twister's hook or ring is attached (with the break-edge downward) to a cord which is tied around the waist, and it serves to retain the respective groups of warp threads in an extended form to enable them to be selected readily by the twister, who, being guided by the "looming lease" formed at the end of the previous warp and at the beginning of the new warp, selects the corresponding threads from each group in consecutive rotation, and severs them simultaneously against the lower edge of the steel cutter under which the warp threads are sharply deflected. Then, finally, by an adroit rolling movement of the thumb and index finger of the left hand, the extremities of both warp threads are deftly twisted together, first by twisting the ends without their overlapping each other, and then turning them backward, whilst still rolling and twisting them, upon

the new warp thread, so that the severed extremities of the two threads *will point away* from the harness eyes and dents of the reed, and thereby avoid the risk of these obstructing the free passage of the twistings when drawing the warp threads forward *en masse* to bring those piecings well in advance of the reed before commencing to weave.

#### AUTOMATIC WARP LEASING AND TWISTING-IN MACHINE

§ 358. As stated in § 356, the operation of twisting-in warp threads may now be accomplished automatically by means of an ingenious device just recently introduced into this country by the agency of Messrs Cook & Co. This machine selects the extremities of two series of warp threads in consecutive rotation and actually *twists* them together, automatically, at a maximum rate of about 110 threads per minute, or a net average rate of about 85 threads per minute, including the fixing and removing of warps and harnesses, and other incidental duties.

The junctions of the two series of warp threads are in every respect identical with those formed by manual twisting, by which the extremities of two threads are twisted together and then, whilst the twisting still continues, they are turned downward and twisted upon the *new warp thread* with the severed ends lying away from the harness and reed so that these will not impede the free passage of the twistings, when drawing forward the warp threads, through the harness eyes and between the dents of the reed, ready for weaving.

It is claimed by the makers of this machine that it will twist together with equal success not only threads of the same kind of staple as cotton, linen, wool, mohair, silk and artificial silk of any counts of either single or folded yarn, but also that it will twist together two series of threads composed of different kinds of staple, respectively, as cotton to linen, and cotton to worsted threads.

The successful operation of this twisting-in machine is, however, dependent entirely upon the correct formation of an "end-and-end" looming lease in both series of warp threads that are to be twisted together. Therefore, since there are no means provided in slasher sizing machines for the forming of such leases, and with the

object of adapting slasher-sized warps to the conditions imposed by this twisting-in machine, the same inventor has conceived an automatic warp-leasing machine which is capable of separating an expanded sheet of warp threads into odd and even series respectively, to constitute a perfect "end-and-end" looming lease, with absolute precision, at a net average rate of 200 threads per minute, irrespective of the counts of yarn, and density of warp threads.

This object is accomplished by passing two leasing-bands or cords transversely across the sheet of warp threads in such a manner that the respective bands pass under and over consecutive warp threads in alternate succession and in a contrary manner, whereby the "lease" or division of those threads is retained until the warp beam is placed in the twisting-in machine, when the temporary leasing-cords are replaced by thin iron rods. The thread-selecting mechanism is so sensitive and adapted so ingeniously to its special function that, if it fails, during the first attempt, to obtain a warp thread, it will make repeated attempts until that thread is secured; after which the work proceeds normally and without the slightest discrepancy.

The operating of one twisting-in machine in conjunction with two or three leasing devices, and the performing of all duties incidental to the use of these machines, requires the services of a senior attendant of either sex, who prepares the warps both for the leasing and twisting-in machines, and also passes the twistings of the warp threads through the harness eyes and reed; and a junior assistant, of either sex, who attends both to the twisting and the leasing machines.

### 3. AUTOMATIC WARP-TYING MACHINE

§ 359. Another type of automatic machine, conceived with the object of superseding the usual method of warp twisting, is that invented by H. D. Colman, as illustrated in Fig. 200, and known as the Barber warp-tying machine, that was first used in America, in August 1904, and introduced in 1906 into this country, where it has received the approval of many British manufacturers, who have adopted it successfully in many of their weaving mills.

The special function of this ingenious device is to join the extreme

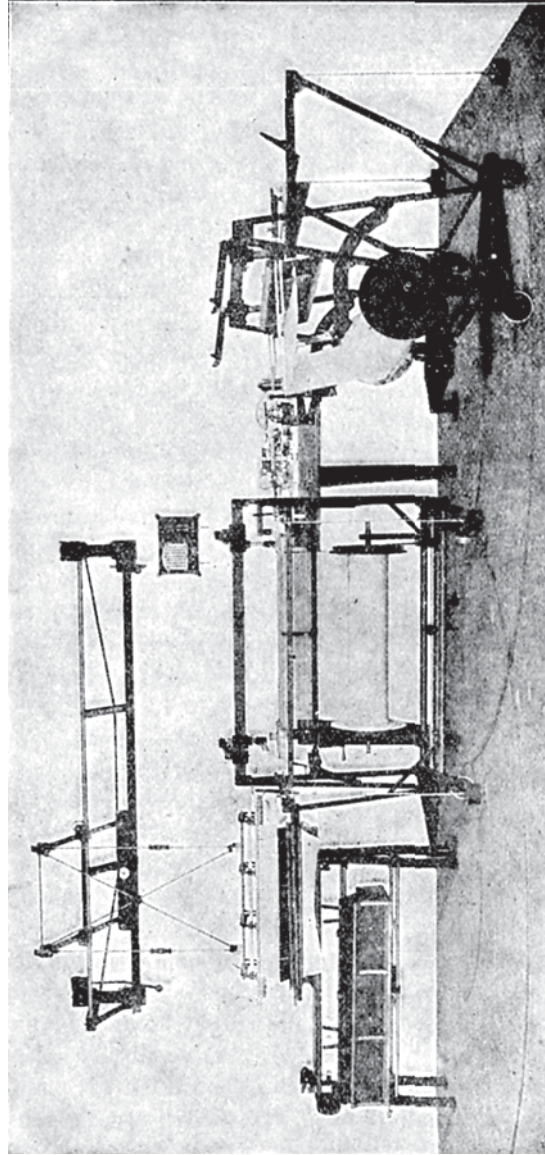


Fig. 200.—AUTOMATIC WARP-TYING MACHINE.



ends of two corresponding series of warp threads by tying them together by means of knots, instead of twisting them. This tying-in machine also is a triumph of mechanical invention, and, as such, of real merit not only in its conception and in the ingenious combination of intricate mechanism, but also in the subtle manner in which the various parts of the machine perform their numerous and sometimes very delicate functions, with a perfectly rhythmical sequence and almost infallible accuracy and precision, at the rate of about 250 to 260, and sometimes even 270, warp threads per minute.

This tying-in machine selects, in consecutive rotation, the corresponding threads of the old and the new warps; ties them together by means of winders' or spoolers' knots; trims the knots by cutting off the surplus waste ends to leave them very short; and finally expels the waste material by means of an air-suction or extraction tube, along which it is conveyed and ultimately deposited into a waste-box fixed at one end of the machine.

The thread-selecting devices, which consist of two sharply-pointed spear-like hooks, are so cleverly conceived and adapted for their particular function, that although they are virtually incapable of seizing more than one thread each from either of the two warps at the same time, yet they are capable of selecting threads of slightly different counts of yarn. Also, if the thread selectors meet with certain defects in the warp yarn—as, for example, slubbings or other abnormally thick places, neps, snarls, hard particles of size or other impedimenta—whereby either of the two selectors are prevented from securing the warp threads easily and readily during their first attempt, they will make up to five successive efforts to obtain the same warp thread, and if they still fail to secure it, the machine will stop automatically, and cannot again be restarted until the obstructive thread is rectified by the operator.

The mechanism by which the ends of two corresponding warp threads are actually tied together, and the superfluous yarn cut away from the knots, to leave short tail-ends, is identically the same as the Barber mechanical knotter, and ties precisely the same form of knot. In fact, it is interesting in this connection to note that this ingenious device was conceived originally as an integral unit of the warp-tying machine, and afterwards perfected independently as a separate and distinct device adapted specially as an automatic



mechanical knotter for the use of winders and warpers, as described in § 124.

One model of this machine is operated by means of a  $\frac{1}{2}$  H.P. electric motor attached permanently to the machine and adapted for direct driving, which is recommended as the most efficient method of power transmission. The machine is also supplied with several auxiliary appliances, comprising two beam-trucks, a harness-loading frame and a small overhead traveller or runway for transporting the healds and reed, containing the remnant threads of the previous warp, into their proper position in the machine ready for the operation of tying-in, thereby saving both time and physical exertion on the part of the operator.

§ 360. The use of this model of a warp-tying machine is virtually, though not of absolute necessity, restricted to grey and mono-coloured warps, and is, therefore, not so well adapted for tying-in multi-coloured warps in which the different colours of warp threads are arranged in *narrow* stripes, although the machine is quite suitable for warp patterns consisting of *broad* stripes, whereby the risk of broken patterns is minimized. There has also been designed a smaller and transportable model of this machine adapted specially for use in the weaving-shed, where it may be placed behind the looms and employed for tying-in warp threads that are governed by means of jacquard harnesses, so that its utility is no longer confined, as formerly, to heald harnesses only. This small model is also provided with a hand-driving wheel to be turned by the operator, although it could be adapted for electric driving also.

The relative productive capacity of a warp-tying machine varies chiefly according to the character, quality and counts of warp yarn, the number of warp threads per inch, the average number of warp threads contained on the weavers' beams, the proficiency of the operator, and many other variable factors. But one machine for 800, 1000 and 1200 looms is considered a reasonable proportion, according to whether the cloth produced is of coarse, medium or fine quality.

In a specific instance, one machine tied 115,600 warp threads during a working day of ten hours, at a net average rate of 193 knots per minute, which represents a net working efficiency of 77% of the maximum rate of 250 knots per minute.

In another instance, one machine, working at the rate of 250 knots per minute, tied five warps, containing 2500 threads each, of about 28's T., or an aggregate of 12,500 warp threads, in one hour, at a net average rate of 208 threads per minute, thereby yielding a net working efficiency of 83%.

One tying-in machine requires the services of a senior skilled operator, and a junior assistant to help in the loading and unloading of the warp beams, to recover and piece missing and broken warp threads that have escaped previous detection during the operation of tying-in; and to perform such other incidental duties as may arise during the progress of the work. When the operation of tying-in is completed, the warp beam, harness and reed are then quite ready for conveying immediately to the loom, without any further preparation whatever, to be gaited-up ready for weaving.

#### DATA RELATING TO MANUAL LOOMING

§ 361. *Character of Labour.*—As stated previously, in § 345, the manual operation of looming, by means either of drawing-in or of twisting-in, is variously performed by seniors of either sex, and also that a drawer-in is assisted by a junior reacher-in of either sex.

§ 362. *Production.*—The amount of work which is capable of being performed in a specified time by drawers-in and twisters varies within a very wide range according to many different and variable circumstances; and even with those who are engaged on exactly the same character of warps, it would be quite futile to compare the relative productive capacity of different operatives engaged in either of the optional methods of looming.

Also, the difficulty of such a task would be still greater from the circumstance that, with purely manual work of that character, everything depends upon the human faculty, and such attributes as personal ability, dexterity and special aptitude for the work, qualifications that are in no way assisted either by mechanical agency or any other external influence.

An expert drawer-in engaged on "plain" work has attained a rate of 3000 warp threads per hour, with a net average rate for the week of about 2000 threads per hour. A general net average rate for drawing-in, however, is about 1500 warp threads per hour.

An expert twister-in, engaged on "plain" work, has attained a rate of 2000 warp threads per hour, with a net average rate for the week of 1700 threads per hour. A general net average rate for twisting-in, however, is about 1500 warp threads per hour.

§ 363. *Rate of Wages.*—The rate of payment for both drawing-in and twisting-in varies not only in different localities, but also even in the same district, chiefly according to the different classes of fabrics that are manufactured, and many other circumstances. If, however, the work is of a regular and not of an exceptional character, it is the invariable custom to pay on the principle of piece-work rates of wages, in accordance with some recognized fixed rate of payment based on a specified sum for 1000 warp threads, with certain allowances above and below the standard basis according to such variable factors as the counts of reed, counts of warp yarn, number of heald staves, number of warp beams, plain or multi-coloured warps, and an infinite variety of other items that are too numerous to specify, but, of course, with a different basis for each of the optional methods of looming.

It is proposed, therefore, to specify the rates of wages paid for both drawing-in and twisting-in "grey" (natural colour) cotton warps, according to three of the principal standard lists for "plain" work only, and which are more generally adopted for those alternative methods of looming, viz.:

#### 1. BLACKBURN AND DISTRICT STANDARD LISTS.

(A) DRAWING-IN.—*Basis* (not including reaching-in): 5½d. per 1000 threads for reeds up to 80's counts (= 80 threads per in.); plus ¼d. per 1000 threads for each 10 or fraction of 10 counts of the reed up to 100's counts; finer than which, the same rate is paid for each 20 or fraction of 20 counts of the reed (= 20 threads per in.), irrespective of the counts of yarn.

For drawing-in of an exceptional character, a time-rate of 8d. per hour is paid.

Reachers' wages range from 10s. to 14s. per week, according to age, sex and ability.

(B) TWISTING-IN.—*Basis*: 4d. per 1000 warp threads for yarn ranging from 26's to 80's T.; plus ¼d. per 1000 threads for yarn coarser than 26's T.; and also for each 10 or fraction of 10 counts finer than 80's and up to 100's T.; finer than which, a sum of 5d. per 1000 threads is paid, irrespective of the counts of reed. But if the reed contains only one warp thread in each dent, uniformly, a sum of ¼d. per 1000 threads is to be paid in excess of the above rates.

For twisting-in of an exceptional character, a time rate of 6d. per hour is paid.

## 2. NELSON AND DISTRICT STANDARD LISTS.

(A) DRAWING-IN.—*Basis* (including reaching-in):  $6\frac{1}{2}$ d. per 1000 threads for reeds up to 80's (= 80 threads per in.); plus  $\frac{1}{4}$ d. per 1000 threads for each 20 or fraction of 20 counts of the reed (= 20 threads per in.), irrespective of the counts of yarn.

For drawing-in of an exceptional character, drawers-in are to be paid a time rate equivalent to their average earnings.

(B) TWISTING-IN.—*Basis*: 4d. per 1000 warp threads for yarn ranging from 21's to 60's T.; plus  $\frac{1}{4}$ d. per 1000 threads for each 10 or fraction of 10 counts finer than 60's and up to 100's T.; finer than which, the sum of  $4\frac{3}{4}$ d. per 1000 threads is paid, irrespective of the counts of reed. For counts of yarn coarser than 21's and down to 15's T. a sum of  $4\frac{1}{2}$ d.; and for 14's down to 12's T., a sum of 5d. per 1000 threads is to be paid for both single and folded yarn. But all yarn coarser than 12's must be drawn-in and not twisted-in.

Also, if the reed contains only one warp thread in each dent, uniformly, a sum of  $\frac{1}{4}$ d. per 1000 threads is to be paid in excess of the above rates.

For twisting-in of an exceptional character, twisters are to be paid a time rate equivalent to their average earnings.

## 3. COLNE AND DISTRICT STANDARD LISTS.

(A) DRAWING-IN.—*Basis* (not including reaching-in):  $6\frac{1}{2}$ d.; but including reaching-in, 8d. per 1000 warp threads, irrespective of counts.

(B) TWISTING-IN.—*Basis*:  $4\frac{1}{4}$ d. per 1000 warp threads for yarn of counts finer than 15's T.; coarser than which, and down to 10's T., a sum of 5d. per 1000 threads is to be paid.

§ 364. *Weekly Earnings*.—(A) DRAWING-IN.—The amount of wages earned by drawers-in varies within a wide range according to their proficiency, more especially as they are dependent almost entirely on their own individual effort and ability. Hence, their wages range from about 20s. to 46s., and sometimes more, with a general average sum of about 32s. per week, after paying the reacher-in.

§ 365. (B) TWISTING-IN.—Twisters, even to a greater extent than drawers-in, are wholly dependent upon their own individual resources, as they do not employ even a hand-tool of any kind, nor have they any other assistance in their monotonous occupation (like drawers-in with their reachers-in), but perform their task quite alone. Also, as twisting-in requires even a lesser degree of skill than that required for drawing-in, twisters are therefore paid a lower rate of wages, which range from about 15s. to 30s., with a general average of about 24s. per week.

§ 366. *Gaiting*.—“Gaiting,” or getting ready, is a term signifying the final preparation of a loom and its numerous appurtenances ready for weaving, and includes the proper adjusting of the warp beam, shedding harness, lease-rods, reed, temples and all incidental accessories, in order to prepare the loom in good working condition before leaving it in charge of the weaver.

In the case of a new loom, gaiting also includes the setting and timing of all the working parts to operate in unison, as well as the equipment of the loom with picking and check-straps, pickers, heald-straps and cords, ropes or chains for the weight-levers of the warp-tension (letting-off) device, and such other incidental parts as are necessary to establish the loom as efficiently as possible and in thorough working order, thereby concluding the final stage in the preliminary operations of weaving.

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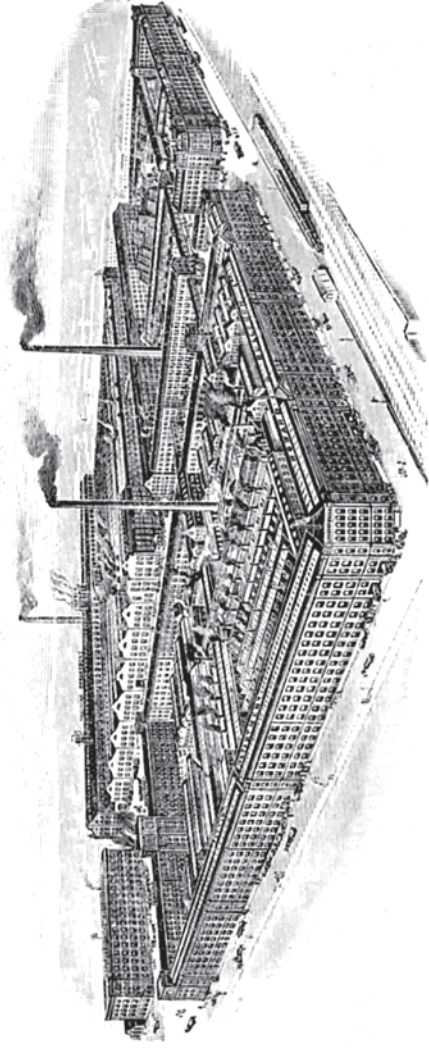
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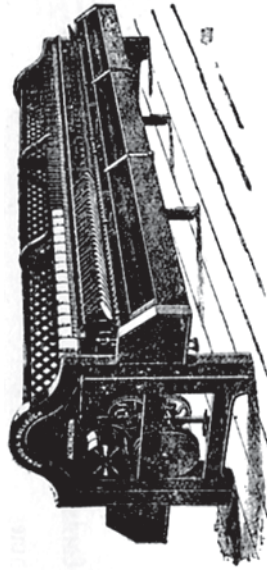
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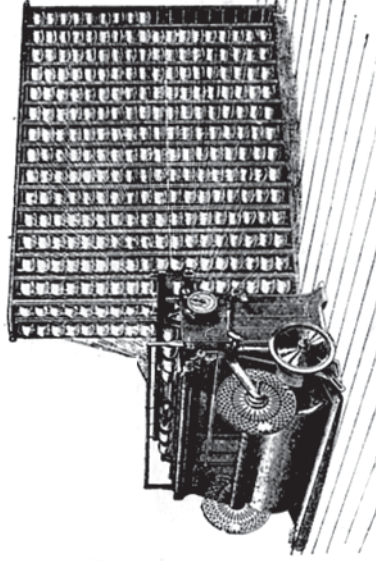
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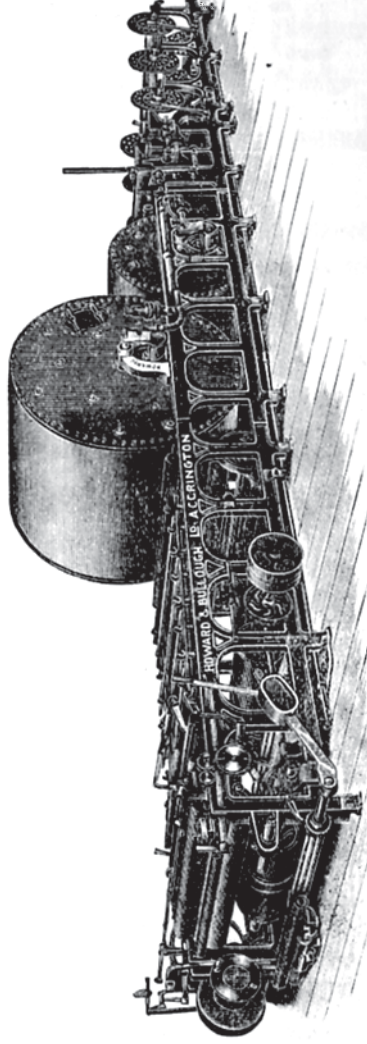
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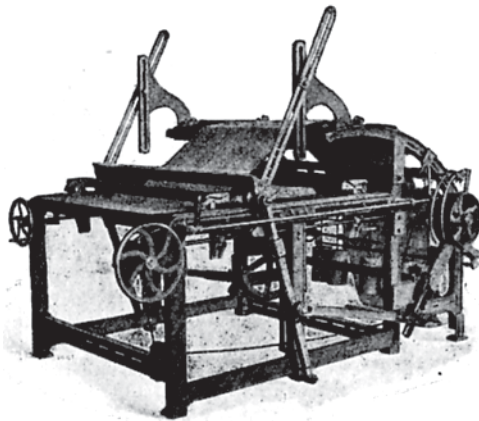
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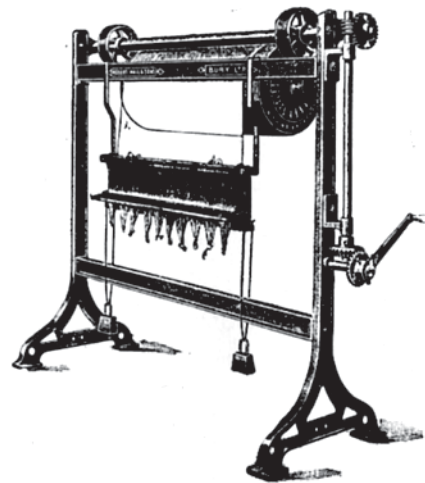
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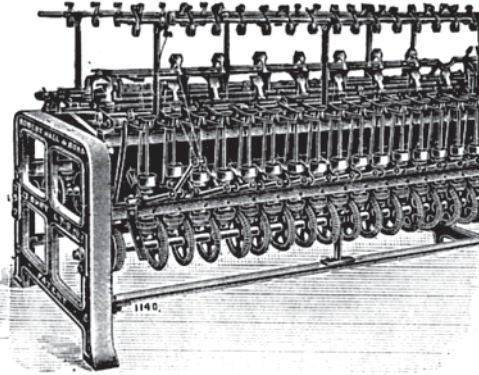
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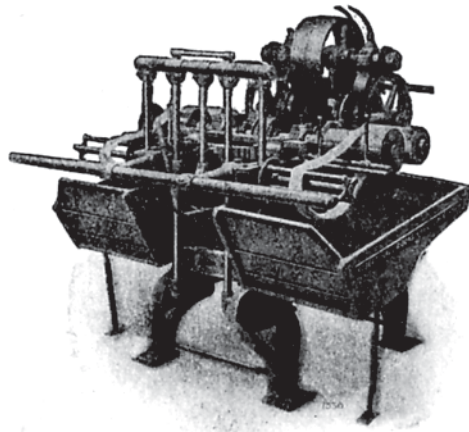
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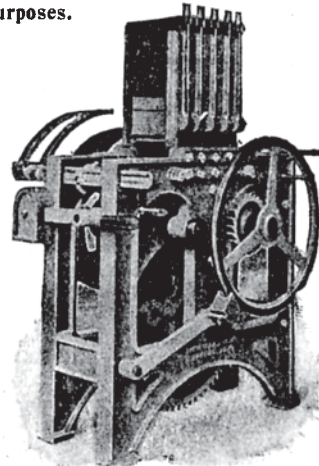
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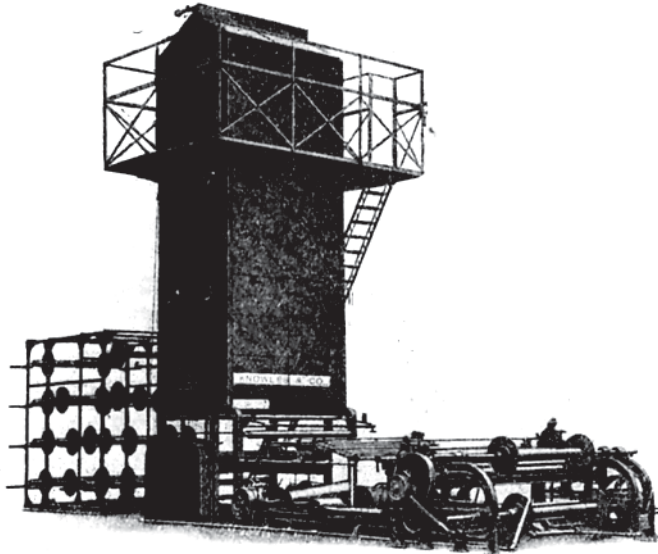
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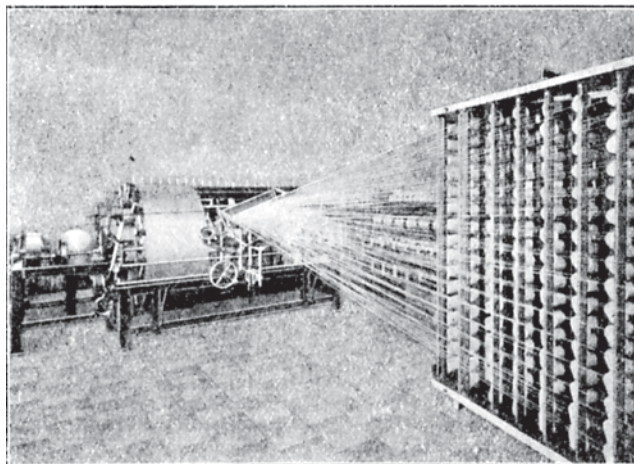
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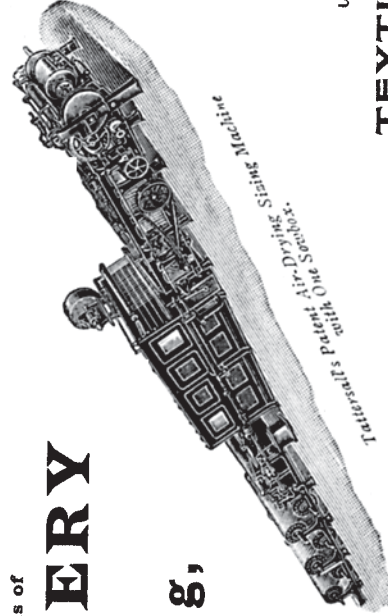
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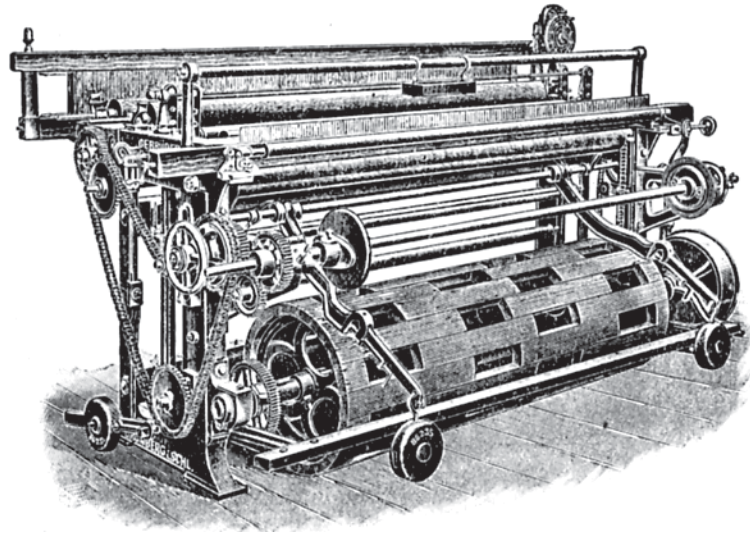
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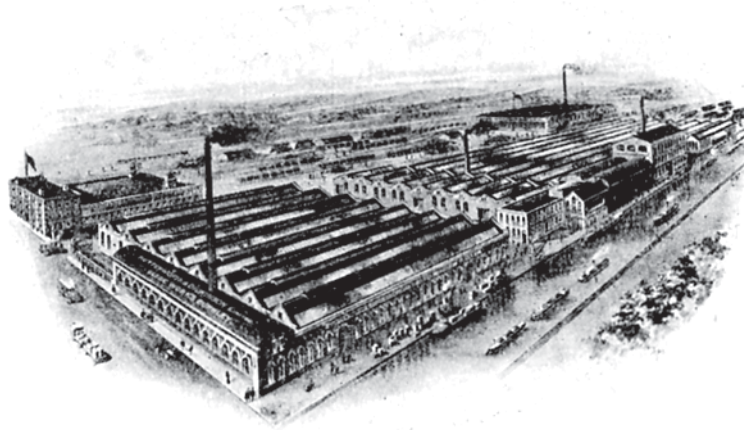
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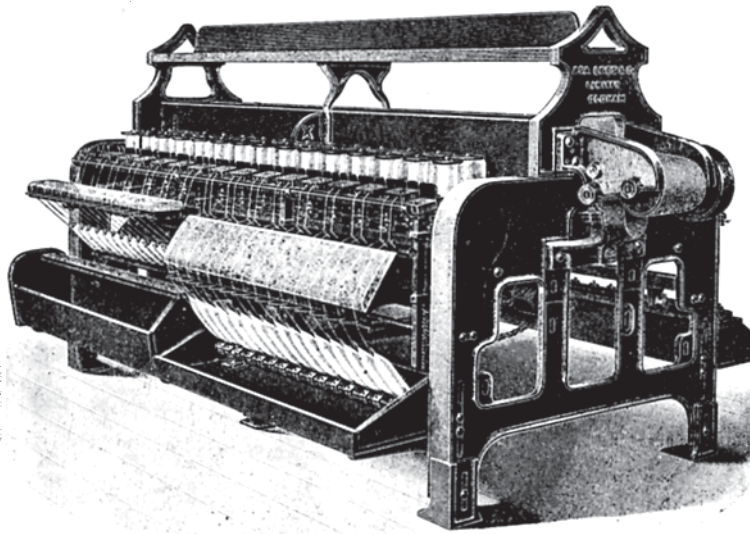
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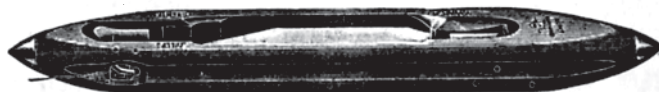
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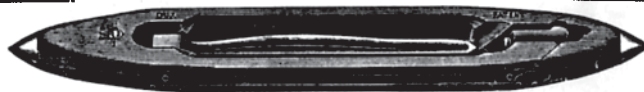
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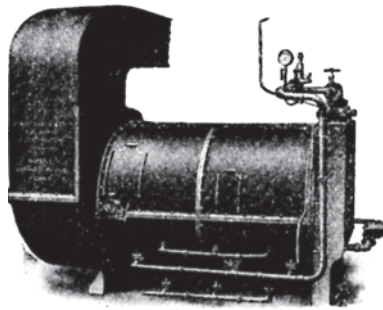
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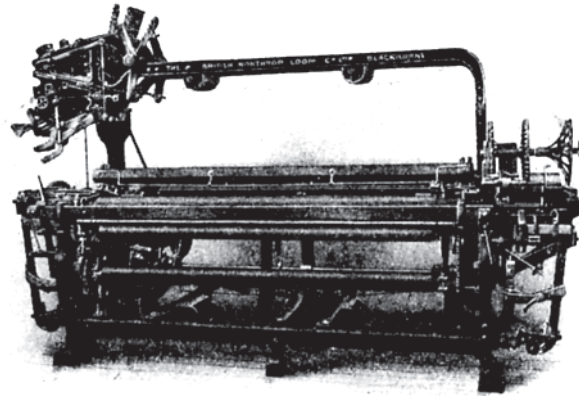
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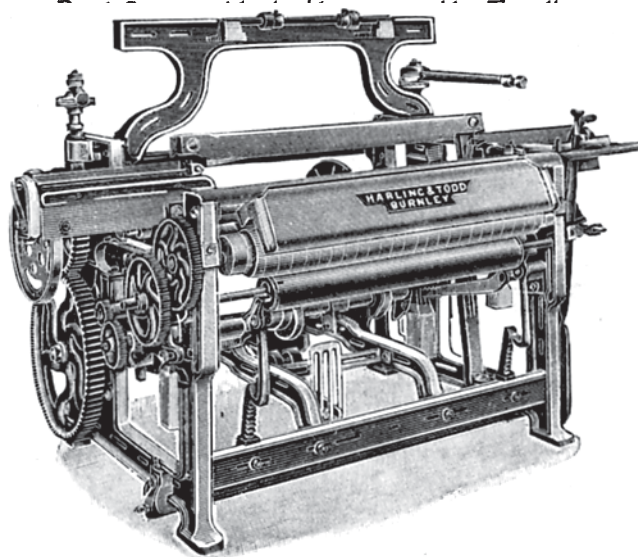
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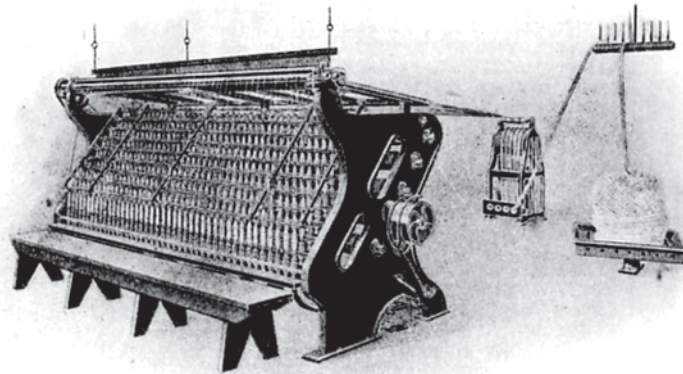
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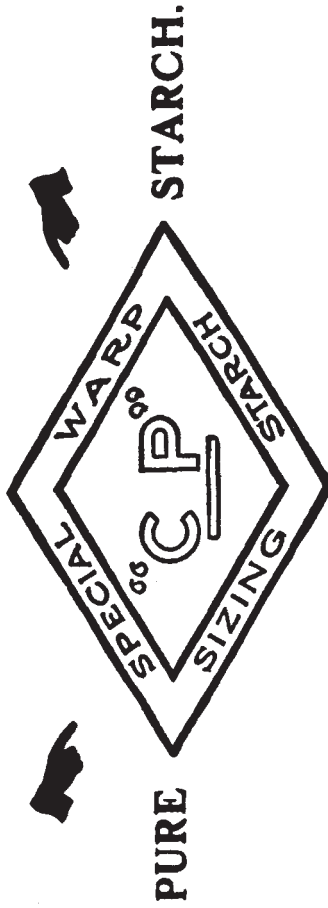
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**HARRY NISBET, M. Tex. Inst.**

*Weaving and Designing Master, Municipal Technical School, Bolton.*  
*Author of "Preliminary Operations of Weaving"; also, "Theory of Sizing."*

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