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WASC 2

WASC 20
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WASC 20:A

WASC 20:B

WASC 20:C

Description of the
Manufacture of Abel's
pulped and compressed
Cotton at Waltham
Abbey

Col. CW Youngusband
11-1873

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Description of the manufacture of Abel's pulped and compressed guncotton at Waltham Abbey. 13th November 1873.

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DESCRIPTION OF THE MANUFACTURE OF ABEL'S PULPED AND
COMPRESSED GUNCOTTON AT WALTHAM ABBEY

Description of the Manufacture of Abel's Pulped and
Compressed Guncotton at Waltham Abbey

The Raw Cotton

The raw cotton made use of is waste from the cotton mills, which, after having served for cleaning the machinery, is, with other waste, swept from the floors and sent to the bleachers to be cleaned. This process consists in boiling the material in strong alkali and lime, then wringing and drying it. After these operations, which are conducted very roughly, the cotton waste goes into the market for use in oiling machinery; the cleanest and best samples are secured by us for Guncotton manufacture. Its cost is about 40s/- per cwt.

The first operation after the cotton waste has been received at Waltham Abbey, is to pick it over by hand and take out any bands, strings, rags, or other foreign substances. It is then passed through a Teasing Machine for the purpose of being thoroughly opened out, and tearing asunder all knots and matted lumps, so that in a subsequent operation the acid may act freely on every part. It is then taken to a rag-cutting machine, through which it is drawn upon an endless leather band, and cut longitudinally and transversely into short lengths of about three inches, after which it is again passed through the Teasing Machine. The Teasing Machine is shewn on Plate I, Drawing A 2829, and the Rag-cutting machine on Plate II, Drawing 5156. The room containing these two machines is warmed by waste steam from the boiler-house, so as to assist in drying the cotton while it is being opened out, but a very complete and thorough drying is necessary before immersion in acid; therefore, after the cutting process is completed, it is spread in thin layers on an endless travelling band, by which it is conveyed into a drying closet in another apartment.

The drying closet (see Plate III, Drawing A 1026, Plate IV, Drawing A 6491, Plate V, Drawing A 1265, and Plate VI, Drawing A 1859) consists of eight endless canvas bands, supported on rollers and passing over double sheet-iron partitions about 20 feet in length and three feet in width; within which exhaust steam is admitted. The upper of the eight bands communicates with the teasing room, and on it the cotton is conveyed into the drying closet. Having traversed the whole length of the machine, it drops on to the next lower band which brings it back to the other end, where it again drops to the next band, and so on, until it is finally delivered into a receiving closet. By this system the upper and under surfaces of the cotton are alternately exposed to a current of hot-air circulating through the closet.

Conveniently placed outside the room is a fan with a tubulat heater containing a nest of air tubes. Steam is conducted into the case so as to surround the tubes, through which the heated air is driven by the fan direct into the drying closet. The air inside the closet is maintained at a temperature of 180° to 190°, and at this heat the cotton is exposed for about 25 minutes, during which the operation of passing through the closet lasts.

The dried cotton is now weighed into charges for the dipping troughs. These charges were, in the first instance, fixed at 1 lb. each, in accordance with Stowmarket practice, but for a short time past 1/4 lb. charges have been used, and are found quite manageable.

The cotton being thoroughly dry is now cooled. For this purpose it is packed into closed metal boxes, each box holding one charge, made with well fitting lids, so as to protect the cotton from contact with the air of the Cooling-room, in which it remains 24 hours before being dipped.

/The Acids

The Acids

The acids employed are a mixture of three parts by weight of Sulphuric Acid, specific gravity 1.84 with one part of nitric acid, specific gravity 1.52. Both acids are made specially for this manufacture by Mr. Barnes of Hackney, and are delivered twice weekly; the sulphuric acid in carboys of 105 lbs., and the nitric in bottles of 35 lbs. each, this being the proportion in which they are mixed.

The Gauge tank is placed upon a Stage at a higher level than the Mixer, which in its turn commands the Store tanks. The acids are raised to the Stage by means of a double lift so that while the full bottles ascend, the empty ones descend (see Plate VII, Drawing A 2860).

The Gauge tank (see Plate VIII, Drawing A 1166) is divided by a partition in such a manner that one section will hold as many carboys of Sulphuric acid as the other holds bottles of Nitric acid; the exact proportion of the two acids is thus ensured, and as the acids are accurately weighed into each carboy and bottle no mistake can possibly occur either in the weight or number of carboys or bottles used. The gauge tank being full, the plug in both sections are withdrawn simultaneously and the two acids flow together through one common pipe into the mixing tank.

In the mixing tank the process of mixing is completed by the operation of an agitator perforated with holes, which stirs the acid backward and forwards. From this tank the mixed acid is lowered, on the withdrawal of a plug, into one of the Store tanks ready for use.

The Store tanks, six in number, are so arranged that any one of them can be filled from the mixer, and a supply drawn off from any one for dipping.

Dipping

Returning now to the dipping process:

The dipping troughs consist of 24 pans and four distributing tanks, one to each six pans. These pans are fitted into a cast iron trough about 40 feet in length, through which a constant stream of cold water flows. Each pan is thus surrounded with running water, so as to prevent the heating of the acid by the action of the cotton in the process of dipping. Acid from one of the Store tanks passes, as required, to the distributing tanks by opening a plug, and from thence it is ladled out into the dipping pans. The cotton brought from the Cooling-room in the closed boxes, in which it has been kept 24 hours, is taken upon waggons constructed for the purpose (see Plate IX, Drawing 1548 and Plate X, Drawing 1547) to a place partitioned off from the dipping troughs, and immediately behind them where it is emptied into tin spouts, and passed immediately through an aperture in the partition to the dippers. It is then raked out bit by bit from the spouts into the acid, care being taken to perform this process gradually, so that the acid may act immediately on the cotton as it is immersed. After a few minutes stirring in the acid the cotton is lifted out with a fork on to a grating where the excess of acid first strains out, and finally is squeezed out to the required extent by a powerful lever, the expressed acid running back into the pan. Fresh acid is transferred to the pan from the distributing tank after each charge has been dipped.

Cooling

The cotton is now placed in earthenware pots, and conveyed to a cooling-pit which contains water to the depth of about 10 inches, and through which a constant stream of cold water is flowing; the pots of cotton remain here digesting in acid

/for

for 24 hours. About 11¼ lbs. of mixed acid is taken up by each 1 lb. of cotton, so that the 1¼ lb. charges weigh now about 15¼ lbs.

The arrangement of the Dipping Troughs, and pipes, Supply tanks, Save all, etc., is shewn on Plate XI, Drawing A 2038; and Plate XII, Drawing A 979; and the tools used by the dippers on Plate XIII, Drawing A 2043.

Acid Wringing

On the following day the pots are taken to the Acid Extractors (see Plate XIV, Drawing A 1868, and Plate XV, Drawing A 1875) the contents of six pots are emptied into one centrifugal acid extractor. The waste acid wrung out passes by a pipe, in connection with each machine, to a tank, from which it is drawn into carboys. About 10 lbs. of spent acid is thus collected from each charge and is returned to the manufacturer.

Immersing

The wrung out Guncotton is now immersed in water, in order to remove the free acid which could not be expelled by the centrifugals. For this purpose machines (see Plate XVI, Drawing 1781) have been constructed in such a manner that the Guncotton when fed gradually through a hopper is plunged at once deep under water, and well agitated by means of a revolving drum. A good supply of fresh water is always kept up, while the acidulated water is allowed to flow off through a grating fine enough to retain the Guncotton.

Water Wringing and Soaking

The guncotton is next removed to a water extractor, where the water is wrung out; it is then thrown into a Soaking tank. These tanks are constructed to hold 110 charges: they are filled up with water covering the guncotton, and the soaking process is prolonged for a longer or shorter time, depending upon the progress made by a further advanced charges in passing through their subsequent operations. At this period, the more soaking and wringing the guncotton can get, the more time will afterwards be saved; a treble set of tanks has therefore been recently put up in which a reserve of guncotton is subjected to additional soaking. At the present time hot water instead of cold is being employed in some of the soaking tanks with marked success. Steam is conducted into the tanks and the water raised as nearly as possible to the boiling point. With the final wringing out the treatment of the guncotton on the acid side of the works is complete.

The general arrangement in plan and section of this part of the guncotton works is shewn on Plate XVII, Drawing A 621, and Plate XVIII, Drawing A 625; the boilers, on Plate XIX, Drawing 1460, Engine for driving the machinery on this side, Plate XX, Drawing A 986, and details of Shafting on Plate XXI, Drawing 1425.

Beating

The Guncotton is now passed to the other side of the works to be cut up in the Beater or Rag-Engines. The general arrangement of this part of the works is shewn on Plate XXII, Drawing A 2205; the general arrangement of the Boilers on Plate XXIII, Drawing 1444; and the Pressure Main on Plate XXIV, Drawing 1544.

The Beating Machines (see Plate XXV, Drawing 1428 and Plate XXVI, Drawing 1435) are similar in construction to those employed for cutting up rags into pulp in paper manufacture; this operation occupies about 4 hours, after which time the guncotton is found to have been reduced to a finely divided pulped condition.

/Pipes

Pipes are so arranged that the pulp may be conveyed from any one of the Beaters to any one of the Poachers which are erected on a lower level in the same building.

Poaching

The Poachers (see Plate XXVII, Drawing A 2864) are large iron pans, 18 feet long, 9 feet wide, and 4 feet deep, each having a capacity equal to eight beaters. In them the complete washing of the guncotton is effected. The guncotton is now in a very finely divided state and therefore in the most favourable condition possible for the action of the water in removing all trace of free acid, as well as the resinous matters and other impurities locked up in the fibres of the cotton. This, and the preceding operation of beating constitute the principal improvements originated by Mr. Abel, and substituted by him for the long continued washing of skein cotton in running water, which formed part of Baron Von Lenk's process.

A great deal of difficulty has been experienced and much time spent in perfecting the poaching operation. In principle it is similar to that of paper washing; but guncotton pulp having a much higher specific gravity than paper pulp, the revolving drums required considerable modification before an effectual stirring of the material was achieved; they now act very successfully.

After being washed in the poachers for 24 hours, the water is completely drained from the pulp, fresh water is admitted, and the washing is continued until the tests show that perfect purity has been attained.

The washing being now completed a dose of alkali is added as a precaution against the possible liberation of acid. The alkali dose consists of 500 gallons of lime water, 3 lbs. of Whitening stirred up in a bucket of water, and 6 lb. of Soda caustic dissolved in boiling water. This is added to 880 charges of $\frac{1}{4}$ lb. each. The lime mixers are shewn on Plate XXVIII, Drawing 1445. The pulp is now drawn up into the "Stuff Chest" preparatory to pressing. The "Stuff Chest" (see Plate XXIX, Drawing 1449; Plate XXX, Drawing 1450; Plate XXXI, Drawing 1447) is a cylindrical iron Chest 12 feet in diameter and 4 feet deep, constructed to hold exactly the contents of one poacher. Connected with it are pipes leading to a Wrought iron Vacuum Vessel, Plate XXXII, Drawing 1471; this vessel is in its turn connected with a vacuum pump, by means of which the vacuum vessel is exhausted, and by this arrangement the Stuff Chest itself is exhausted whenever it is required to fill it with guncotton pulp from one of the poachers. An agitator continually revolving within the Stuff Chest, maintains the pulp in the same uniform state of suspension it was in when being stirred up in the poachers. Complete Drawings of the Vacuum Pump are shewn on Plates XXXIII, Drawing A658; Plate XXXIV, Drawing A 636; Plate XXXV, Drawing A 981 and Plate XXXVI, Drawing A 659.

Pressing

2 / From the Stuff Chest, charges, equal to about $20\frac{1}{2}$ lbs. of guncotton, are drawn down in gauge tanks, and from them run into 36 moulds, the pulp being continually stirred to prevent settling. The Vacuum Vessel is here again employed to draw off the water from the pulp; fine wire gauze strainers being used to retain the pulp in the moulds. Details of the Moulding Machines are shewn on Plate XXXVII, Drawing A 1596; Plate XXXVIII, Drawing A 187; Plate XXXIX, Drawing A 2042; Plate XL, Drawing A 1091; and Plate XLI, Drawing 1094. The moulds of guncotton are next transferred by means of a Carriage running on rails (see Plate XXXVII, and Plate XLII, Drawing A 1636, to an 11" Hydraulic Press, in which sufficient water is expressed, and the pulp sufficiently consolidated to reduce the length of cylinder of Guncotton from 9" to about 5". The 11" press with moulds, pistons, etc. is shewn on Plate XLIII, Drawing 4231; Plate XLIV,

/Drawing

Drawing 4232; and Plate XLV, Drawing 1599.

The 5-inch cylinders are then removed to a second and more powerful press having a 24" ram in which each disc of guncotton is reduced to about 2 inches in thickness. The pressure to which each cake is subjected in the last press is about 6 tons per inch, and the density of the compressed guncotton is about equal to that of Gunpowder. The 24 inch press is shewn on Plate XLVI, Drawing 4234. Certain modifications have recently been made in this press, which will be easily understood on reference to the Drawing. As originally constructed, each of the 4 moulds (which it will be seen are 15" in length) was extended to take three cakes from the 11" press, superposed, the middle cake being separated from the upper and lower cake by a steel disc. As now modified, the moulds are reduced in length to 5½ inches, and the pistons to 7".0 so that travel of the ram is reduced from 15" to 7"; the actual travel in working, allowing steel dies to rest upon the head of the pistons, is 3".0.

The presses are worked by a 10-inch Accumulator designed to give a maximum pressure of 1000 lbs. on the square inch. It is loaded with circular segments of iron, 4 inches in thickness, fitting one over the other, so as to be easily removable, and thus the total weight can be varied between eight and eighteen tons, producing a pressure on each disc in the 24-inch press from 3.1 to 6.1 on each square inch of cake.

The accumulator is filled by means of two sets of 3-throw hydraulic pumps shewn in detail on Plate XLVIII, Drawing 1784.

Drilling

A proportion of the discs are drilled with one or two holes, as may be required, for the reception of the detonating fuze, to serve as primers. The Drilling Machine is shewn on Plate XLIX, Drawing A 2041; and Plate L, Drawing 1639.

On removal from the second press the discs contain from 12 to 15 per cent of water, and in this state are unflammable, or with difficulty inflammable, when held in a gas flame. The additional precaution is however, at present observed of soaking the discs for several minutes in water, so that before being sent into Store they may contain about 30 per cent of water.

Manufacture at Waltham Abbey has up to the present time been confined to the cylindrical disc, 3 inches in diameter, 2 inches in thickness, weighing when dry, that is with its normal 2 per cent of moisture, 9 oz.

Waltham Abbey
13th November, 1873

Signed: C.W. Younghusband, Colonel, R.A.

List of plates mentioned in Abel's Pulped and Compressed Guncotton at Waltham Abbey

Subject	Drawing	Plate No
The teasing machine	A 2829	I
Rag cutting machine	5156	II
Drying Closet	A 1026	III
"	A 6491	IV
"	A 1265	V
"	A1859	VI
Gauge tank, mixer and store tank	A 2860	VII
Gauge tank	A1166	VIII
Wagons for carrying cotton	1548	IX
"	1547	X
Dipping Troughs, pipes, supply tanks etc	A 2038	XI
"	A 979	XII
Tools used by the dippers	A 2043	XIII
Acid extractors	A 1868	XIV
"	A 1875	XV
Immersing machine	1781	XVI
Water wringing and soaking - plan and section	A 621	XVII
"	A 625	XVIII
Boilers	1460	XIX
Engine for driving machinery	A 986	XX
Shafting	1425	XXI
Beating - General arrangement	A 2205	XXII
Boiler arrangement	1444	XXIII
Pressure Main	1544	XXIV
Beating machine	1428	XXV
"	1435	XXVI
Poachers	A 2864	XXVII
Lime mixers	1445	XXVIII
Stuff chest	1449	XXIX
"	1450	XXX
"	1447	XXXI
Vacuum Vessel	1471	XXXII
Vacuum Pump	A 658	XXXIII
"	A636	XXXIV
"	A 981	XXXV
"	A 659	XXXVI
Moulding Machine	A 1596	XXXVII
"	A 3187	XXXVIII
"	A 2042	XXXIX
"	A 1091	XL
"	1094	XLI
Carriage on rails	A 1596	XXXVII
"	A 1636	XLII
11" Press	4231	XLIII
"	4232	XLIV
"	1599	XLV
24" Press	4234	XLVI
3-throw hydraulic pump	1784	XLVIII
Drilling machine	A 2041	XLIX
"	1639	L