

THE
INDUSTRIES OF SCOTLAND

THEIR
RISE, PROGRESS, AND PRESENT CONDITION.

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CALICO-PRINTING AND TURKEY-RED DYEING.

ANTIQUITY OF THE ART OF DYEING AND PAINTING CLOTH—ITS INTRODUCTION INTO EUROPE—PROGRESS OF THE ART IN BRITAIN—VARIOUS STYLES OF CALICO-PRINTING—CORDALE PRINTFIELD AND DALQUHURN DYEWORKS—DESCRIPTION OF THE PROCESSES OF CALICO-PRINTING AND TURKEY-RED DYEING.

EXCEPT when used for underclothing or linings, cotton cloth is generally ornamented with colours. The art of dyeing and painting cotton and linen fabrics was known to some of the Eastern nations from a very early date. The Egyptians practised dyeing in blue, purple, and scarlet, at least 1500 years before the Christian era; and Herodotus mentions that a tribe who lived on the borders of the Caspian were in the habit of painting with vegetable dye figures of animals on their garments, the impression being so strong that it could not be washed out. In Pliny's time a great advance had been made by the Egyptians in the art of dyeing and staining. Pliny thus describes the process, which bears some resemblance to the modern mode of dyeing by mordants:—"Garments are painted in Egypt in a wonderful manner, the white cloths being first smeared, not with colours, but with drugs which absorb colour. These applications do not appear upon the cloths; but when the cloths are immersed in a cauldron of hot dyeing liquor, they are taken out the moment after, painted. It is wonderful that, although the dyeing liquor is only of one colour, the garment is dyed by it of several colours, according to the different properties of the drugs which have been applied to different parts. Nor can this dye be washed out. Thus the vat, which would doubtless have confused all the colours if the cloth had been immersed in a painted state, produces a diversity of colours out of one, and at the same time fixes them immovably." It is here stated that the cloth was painted or smeared with the chemical substances, which shows that the production of patterns

by means of engraved blocks was not then known to the Egyptians.

The art of calico-printing—or rather painting—was not introduced into Europe until the seventeenth century. It had been brought from India, and was at first practised according to the rude method adopted by the inhabitants of that country. In Anderson's "History of Commerce," it is stated that calico-printing was begun in London in 1676; but a considerable time elapsed before the trade came prominently into notice. Towards the close of the seventeenth century a demand had sprung up in Britain for the cheap and gaudy prints of India, Persia, and China; and the result was that the woollen and silk manufactures began to suffer. An outcry was raised against the importation of printed calicoes, and at length the attention of Parliament was called to the matter. In 1700 an Act was passed prohibiting the importation and use of Eastern prints, under a penalty of L.200. Meantime the home calico-printing trade went on extending, and as it was not looked upon as interfering with the consumption of woollen and silk goods, it was allowed to be carried on without legislative interference. By the year 1712, however, it had become so important that Parliament recognised its existence by imposing an Excise duty of 3d. on every square yard of calico printed, stained, painted, or dyed; and as it appeared to bear the impost easily enough, the duty was doubled in 1714. Printed linens were subjected to half the rate levied on cotton. Notwithstanding the duty, printed fabrics were extensively used by the public, and again the cry was raised that the woollen and silk manufactures were in danger. In 1720 an Act of Parliament was passed which prohibited the using or wearing of printed or dyed calicoes, whether printed at home or abroad, and even of any printed goods of which cotton formed a part, excepting only calicoes dyed all blue. This law put an end to the printing of calicoes, and the printers were limited to the printing of linens. After the Act had been in force for sixteen years, the portion of it which forbade the use or wear of printed goods of a mixed kind containing cotton was repealed; and thenceforth cloth composed of linen warp and cotton weft was made and printed. It was estimated in 1750 that 50,000 pieces of this mixed fabric were printed annually. The cloth-printing trade was confined almost exclusively to the neighbourhood of London until the year 1738, when it was introduced into Scotland. Twenty-six years later it was begun in Lancashire, and after that time the London trade gradually declined, as the printers there could not maintain competition with those in the

districts where the cloth was manufactured. In 1774 the law which prohibited the printing of English made calicoes was repealed, and, by the aid of a series of wonderful inventions and improvements, the art of calico-printing flourished and increased, though the Excise duty was not removed until 1831.

As showing the progress of the trade, it may be mentioned that in 1796 the quantity of British calicoes and muslins which paid the print-duty was 28,621,797 yards; in 1829, it was 128,340,004 yards; and in 1857, the quantity of dyed and printed calicoes exported was 808,308,602 yards, the declared real value of which was L.13,921,428, while it was estimated that in the same year 135,000,000 yards were retained for home consumption. The quantity exported remained about the above figures till the time of the American war, when there was a falling off. In 1866 the trade had recovered to 897,825,547 yards of coloured calicoes, the declared value of which was L.22,095,216. The year 1867 showed a decrease of about 17,000,000 yards. There are no figures to indicate the quantity of cotton cloth printed and dyed in Scotland; but the fact that upwards of 12,000 persons are employed in the print and dye works shows the importance of this branch of industry.

In both the chemical and mechanical departments of calico-printing and Turkey-red dyeing, many important inventions and improvements have been effected in Scotland, one of the most valuable being the invention, in 1785, of cylinder-printing by Mr Bell, of Glasgow, which worked a revolution in the trade. There are five general styles in calico-printing, namely—1. The fast-colour or chintz style, in which the mordants are applied to the white cloth, and the colours of the design are afterwards developed in the dye-bath. 2. Where the whole surface receives a uniform tint from one colouring matter, and figures of other colours are afterwards brought up by chemical discharges and reactions. 3. Where the white surface is impressed with figures in a resist paste, and is afterwards subjected to a general dye. 4. Steam-colours, in which a mixture of the mordants and dye-extracts is applied to the cloth, and the chemical combination is effected by the agency of steam. 5. Spirit-colours, consisting of mixtures of dye-extracts with nitro-muriate of tin. The latter are brilliant but fugitive.

The following account of the Cordale Printfield and Dalquhurn Dyeworks—two extensive establishments situated on the banks of the Leven near the village of Renton, Dumbartonshire, and belonging to Messrs William Stirling & Sons, Glasgow—will convey an idea of the processes of calico-printing and Turkey-red dyeing:—

As already explained, there are various styles of calico-printing, and sometimes two or more of these are carried on in one printfield; but at Cordale (which is one of the most extensive works of the kind in the country) Turkey-red printing only is practised. The cloth, after being dyed red at the Dalquhurn works, is taken to Cordale and figured with other colours by certain chemical processes. In order, then, to trace the successive operations, it is necessary that the Dalquhurn Dyeworks should be first described. In the beginning of last century an extensive bleach-field was formed at Dalquhurn, which in 1791 was acquired by Messrs Stirling, and used for bleaching the cloth printed at Cordale. In 1828 the firm extended the premises, began to dye Turkey-red, and founded their present celebrity in that branch of trade. The grounds pertaining to the works extend to about seventy acres, of which ten are covered by buildings.

The cloth and yarn dyed and printed by Messrs Stirling & Sons are made chiefly in Glasgow and Manchester. The cloth is sent in as it comes from the looms, and the first process to which it is subjected is a partial bleaching. From 2000 to 3000 pieces, averaging about twenty-five yards in length, are formed into a continuous web by being sewed together by a steam sewing-machine. This web is led on to a washing-machine of peculiar construction, which removes the simpler impurities. The washing-machine consists of a trough surmounted by a framework. In the bottom of the trough is a roller extending from end to end, and there is a similar roller in the framework above. A web of cloth is fed in at each end of the rollers, and after winding spirally round the upper and lower rollers the ends are brought out in the centre. When the machine is set in motion the cloth, which before it enters is compressed into the form of a rope, is drawn round by the rollers; and from the time it enters the machine until it comes out, every part of it has been a dozen times immersed in the trough, and as often wrung nearly dry by compression between the upper leading roller and one which bears against it. Each washing-machine disposes of about 800 pieces, or 24,000 yards, in an hour, consuming in that time about 24,000 gallons of water. As the cloth comes from the washing-machine it is deposited in a large iron boiler, technically called a "kier." When the boiler is full the cover is fixed on, and high-pressure steam is admitted. Water impregnated with a certain proportion of caustic soda is then injected in a boiling state, and by a system of pipes and taps is drawn downward through the cloth. This operation is continued for about eight hours, when the cover is removed, and the end of the

web attached to the washing-machine, which draws the cloth out of the kier, and washes it. From the washing-machine the cloth passes to the souring cistern, where it is steeped in a weak solution of sulphuric acid, and afterwards washed in pure water. The cloth is then dried, when it is ready for the first stages of the dyeing process. Before the cloth reaches the dye-bath it is subjected to no fewer than twenty-six operations after those which have been described. It is passed through a variety of dung and oil liquors, exposed on the grass, dried in stoves, and so on, several of these operations being repeated three or four times, and the whole extending over several days.

The art of dyeing Turkey-red was introduced into England in the end of last century by M. Borelle, a Frenchman, who established himself in Manchester, and received a reward from Government for the disclosure of the secret. A year or two afterwards, another Frenchman—M. Papillon—went to Glasgow, and, in company with Mr George Macintosh, began to practise the art. The method followed by M. Papillon was more successful than that adopted by M. Borelle at Manchester, and Glasgow became famous for dyeing Turkey-red. Up-till 1810, however, the colour could be imparted only to thread and yarn. In that year, M. Kœchlin, of Mulhausen, in Alsace, discovered a mode of giving the colour to cloth; and a year afterwards invented one of the most beautiful and interesting processes in calico-printing, namely, the mode of discharging the colour from the dyed cloth according to any pattern desired, and inserting designs in other colours. This is the system practised at Messrs Stirling's dye and print works.

The art of the dyer and calico-printer is based on the proper understanding and use of "mordants." The term "mordant" is applied to certain substances with which the cloth to be dyed must be impregnated, otherwise the colouring matters would not adhere to the cloth, but would be removed by washing. Thus the red colour given to cotton by madder would not be fixed unless the cloth were previously steeped in a solution of salt of alumina. The cloth has the property of decomposing the salt, and of combining with and retaining a portion of alumina. The red colouring principle of the madder has an affinity for the alumina and combines with it. The consequence is, that the alumina, being firmly retained by the cloth, and the colouring matter by the alumina, the dye becomes "fast"—that is, it cannot be removed by water, even when soap is added, though water alone is sufficient to remove the red colouring matter from the cloth if the alum mordant has not

been previously applied. After the cloth has been subjected to the thirty preparatory operations referred to above, it is steeped for a night in the alum mordant. It is then washed and wrung, but not dried. Through all the operations up to this point the cloth is retained in the long webs into which it was formed for the first washing, and in that shape is passed through tubes from one part of the premises to the other. The various departments are distinct from each other in order to ensure perfect work in each; and in its progress the cloth travels many miles through tubes, over pulleys, and round cylinders; and inexperienced persons are apt to wonder that after so many washings, boilings, and squeezings there is any strength left in it. Preparatory to being placed in the dye-bath, the cloth is separated into lengths of two or three pieces, several of these subdivisions going into each bath. The baths are fitted with automatic reels, or open revolving frames, round which the cloth is loosely wound, so that it hangs in loops down into the dye. Constant motion is necessary in order to ensure equality of colour, and the cloth is kept revolving round the reels so long as it remains in the bath. The cloth is put in when the dye stuff is cold, and the heat is brought up slowly by means of steam-pipes. In two or three hours the liquid is made to boil, and the ebullition is kept up for about fifteen minutes, when the cloth is withdrawn and washed and cleared several times with soap and soda in copper boilers.

Madder, when used with an iron mordant, produces a purple colour, with alum it produces red, and with alum and iron in certain proportions, it produces chocolate or black. In the production of Turkey-red the madder is mixed with bullock's blood, of which about 130,000 gallons are used annually at the Dalquhurn Works. Yarn is dyed by a hand process, and the operatives engaged in that department have a most unhealthy and disagreeable occupation. They have to stand over the cisterns of scalding, steaming liquor, and keep the yarn in constant motion by shifting and turning about the rods on which it is hung. Self-acting machines for superseding hand labour are being tried. The yarn is subjected to preliminary processes similar to those which the cloth undergoes; but as it cannot be formed into a continuous line, special appliances are required for dealing with it. Machines for washing, liquoring, and wringing the yarn have been devised and constructed at the works.

The establishment contains a fine collection of machines, and the organisation of the place throughout exhibits a variety of labour-saving arrangements and appliances which will not fail to arrest the

attention and excite the admiration of visitors. There are from 900 to 1000 persons employed in the works, about two-thirds being women, of whom a considerable proportion are Irish. A more healthy-looking class of women than those employed in bleaching is not to be found, though the labour in the winter time is somewhat trying.

The machinery is driven by 26 steam-engines, the aggregate force of which is about 180 horse power nominal. Steam for these is generated in 14 boilers, and the quantity of coal consumed in the works is from 25,000 to 30,000 tons a-year. About 600,000 pieces, or 18,450,000 yards of cloth, and from about 600,000 lb. to 800,000 lb. of yarn are dyed annually, and, when extensions at present in progress are completed, that quantity will be much increased. The wages paid annually by the firm amount to about L.40,000. L.50,000 worth of madder and L.20,000 worth of olive oil are used every year. It would be impossible to have such an establishment in a locality where there was not an abundance of pure water; for the quantity consumed at Dalquhurn would be sufficient to supply every man, woman, and child in the city of Edinburgh with ten gallons a-day.

All the yarn and more than one-half of the cloth dyed at Dalquhurn are exported in a plain red state. The remainder of the cloth is taken to the Cordale Printworks to be printed. As already stated, the style of printing practised is that whereby cloth, after being dyed of a uniform tint, has designs in other colours worked into it by a system of chemical discharges and reactions. If a paste composed of certain proportions of oxalic acid, tartaric acid, lime juice, pipe-clay, and gum (the two latter being used merely to give consistency to the mixture), be applied to a piece of Turkey-red cloth, and the cloth be afterwards dipped in a solution of chloride of lime, it will be found that all the parts covered by the paste have become white. The discharge paste of itself produces no effect on the colour, and may be removed by washing in pure water, and the chloride of lime in like manner may be applied without affecting the dye; but when both are brought to act together, the colour at once gives way. Again, if it be desired to erase the red ground according to any particular pattern, and insert, say yellow, in the cleared spaces, all that is necessary is to mix in the discharge paste a mordant that will seize yellow dye; and after the discharging is completed, immerse the cloth in the yellow bath. Thus, a design printed on red cloth with a paste composed of lime juice, tartaric acid, nitrate of lead, pipe-clay, and gum, comes out white after immersion in the chloride of

lime solution; and on being plunged immediately afterwards into a bath of bi-chromate of potash, comes out yellow, the red meantime remaining unaffected, except where the paste was applied. A knowledge of these facts is necessary to enable one to understand what to the uninitiated are most mysterious and wonderful operations.

The tedious process of painting designs on calico by hand was superseded by the use of blocks about the time the art was introduced into Europe. In block-printing a section of the design is cut upon a piece of sycamore, and, after being coated with paste or colouring matter, is laid upon the cloth and struck smartly. As the blocks most commonly used are only ten inches long by five broad, a great number of applications are necessary in order to print a single piece of cloth. The block has been superseded by the cylinder, except in special cases—such as at the establishment under notice, where, owing to the peculiar nature of the work, blocks are still used to some extent. The blocks are made on the premises by a staff of designers and engravers. As most of the goods are for the Indian market, the colours are somewhat “loud” and the designs peculiar. The dress-pieces made for people of the Hindoo religion have a broad border of peacocks round the skirt, the upper part bearing a spotted or diaper pattern. The ground-work of all is Turkey-red, but the birds and other designs are produced in blue, yellow, and green. The Mahometans consider it sinful to try to imitate nature too closely; and though peacocks figure in the designs prepared for ladies of that faith, they are drawn in the rudest fashion and worked out in mosaic. None of the designs of these Indian garments would find admirers in this country; and as the artists are bound down by certain conventional rules, they have no scope for the creation of original patterns. In cloth for turbans there is the same limitation in variety. The dress pieces are short, being only from $1\frac{1}{2}$ to 8 yards in length; and owing to that and other technical causes, it would be unprofitable to print them on a cylinder machine, so they are done by the block method. As has been already explained, what is printed on the cloth is not the complete colour, but a substance to discharge the red and absorb another colour. This substance is applied in the form of paste, which has no resemblance to the ultimate colour.

The cloth having been calendered and wound round a roller, is taken to the printers, who work in pairs, one standing at each end of a table. At one end of the table the cloth passes up from beneath, and as each space the size of the table is printed, it is drawn down at the other end and brought into contact with a drying

cloth are laid evenly one over the other, wound upon a roller, and taken to the press-room—a large apartment occupied by a range of hydraulic presses. The roller is fixed in a framework behind one of the presses, and the end of the cloth brought forward between the upper and lower plates. Suppose, for instance, the pattern is to consist of a series of circular spots of red on a white ground. In order to produce this two plates of lead have to be prepared. The surface of the plates is cut away, leaving a series of lozenge-like eminences. The lozenges of the upper plate must fall exactly upon those of the lower. A number of channels are cut on the back of the plates, which communicate by holes with the sunk part of the engraved side. The cloth is spread over the lower plate, and the latter is pressed against the upper plate with a force of hundreds of tons. The result is that the cloth is tightly compressed between the raised parts of the plates. A stream of bleaching liquid is then allowed to run along the channels in the plates, and is forced into contact with the cloth except at the points where it is compressed. The liquid discharges and carries off the red dye, and, on opening the press in a few minutes after the liquid has been let in, it is found that a handkerchief with red spots on a white ground has been produced. The process is capable of being applied to an endless variety of patterns. Thus the ground might be made yellow, green, or any other colour, as easily as white. Six presses, worked by as many men, are capable of producing upwards of 4000 handkerchiefs in a day of ten hours. In some cases blank spaces are produced, into which flowers, &c., are printed by another process from an engraved copper plate, and some very pretty work is produced in that way.

The Cordale Printworks cover five acres of ground, and give employment to about 500 persons—men, women, and children—so that in their two establishments Messrs Stirling employ nearly 1500 workpeople. Machine-printers earn from 30s. to 50s. a-week; small-block printers, 25s. to 30s.; large-block printers, 30s. to 40s.; boys, 4s. to 7s. The machinery at Cordale is driven by two water-wheels and an engine of 50 horse power.