

Flock Printing and Finishing

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THE finishing or printing of fabrics by coating directly with cut or ground fibres called flock, is practised on a large scale under the name "Flock Printing". Flock prints are produced by printing or coating textiles and other suitable materials with an adhesive and then applying cut fibres. In this manner patterns in relief or surfaces of velvet-like texture are obtained.

Flock prints in themselves are not novel and flock printing is not a new industry. Formerly, this was mainly done by spreading process in which minute and dyed particles of fibre dust (called flock), left in the weaving of textiles, were used for protection or improvement of the surfaces of the different fabrics. The fabrics to be finished were covered with a suitable layer of adhesive and flock then sifted into the still wet layer by spreading devices. The flock was held by the adhesive and the surplus subsequently brushed off after drying. By this process the fabric was given a felt like finish. By flock finishing or printing this way the flock was in most cases unevenly distributed and no firm flock adhesion was attained so that the felt like finish did not have the required resistance to wear and abrasion. After many years of experience cut fibre finishing and printing has again come into being, being a practical method for decoration and functional purposes. Many developments have taken place since last 20 years. The modern electrostatic flocking machine which is capable of producing velvety appearance on the articles flocked and different effects by using various types of flocks is the latest improvement in flock printing and finishing field. In the present article a review will be given of the whole flock printing and finishing process giving more stress on recent developments.

Flock and its preparation :—

In short, flock is a linear section of textile fibres that has been cut or ground from the staple or filament to form a quantity of minute strands. These strands may vary in length ranging from actual dust upto one quarter of an inch.

In general, there are three types of flocks available : precision cut-to-length, random cut and ground flocks. Precision cut-to-length flock is a flock that is cut to a predetermined length and held to length in the cutting within close micrometer tolerance. There are various cutting machines available for producing this type of flock. For example, a flock cutting machine, for making various lengths of flock, is being sold by Arno H. Wirth of Reutlingen.^{5,11} This machine, the model 60/1 will produce some 65 lbs. per hour of 1 m.m. flock, while 80/11 has an output of about 100 lbs. per hour. The cutting takes place at the rate of 340 strokes per minute. The blades in the machine may be changed in a few seconds and the builders advise firms interested in these cutters to include in their calculations a blade grinding machine. Normally machine cut staple of 0.5-3.5 mm. length advancing in steps of 0.5 mm. but should it be necessary, special models can be provided to cut other lengths. This firm also provides a special machine which separates these little pieces of clogged flock which inevitably occur in production and handling.

Random length flock is either cut or ground and then screened through regulated screen opening for the elimination of very short dust lengths and over long fibres. Ground flock is as the name implies. The staple is ground to flock state and then separated to length classi-

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fication by the screening method. Generally speaking a suede surface is produced with flocks of 0.3-0.5 mm. length, while a velour may be made with 0.8-1.0 mm. flock. A definite plush or fine velvet finish is created with the larger flocks of 1.2-1.5 mm.⁶

Popular flock materials include, cotton, wool, hair, bristle, silk, vegetable fibres and asbestos from natural fibres and rayons, nylon, cellophane and spun glass from manufactured filaments. Of these, viscose rayon, cotton, wool and animal hair comprise the major source of supply. Mica dust is also used in some cases as flocking material.

Rayon flock is used wherever a pile fabric surface is desired. Rayon is the most popular of the manufactured fibres and certainly the most versatile of all flock fibres. The brilliant richness of velvet and velour or the dull short pile effect of sueded leather can be had. It is available in closely controlled diameters (precision cut-to-length) and lends itself to any dyeing or treating specification that might be required. The popular lengths in rayon flock are $\frac{1}{2}$ mm., 1 m.m., 1/64, 1/32 and 1/16 inch. Cotton flock, unlike rayon, cannot be cut to precision lengths. After cutting or grinding, it is graded by screening and it is available in 30, 40 and 60 mesh. Cotton flock is generally made from either production waste clippings or linters. When applied, it produces a variegated finish and cotton flock finished surface resembles sueded leather or napped cloth. Wool flock, like cotton, is normally processed from manufactured waste material, and it cannot be cut with any degree of accuracy and is graded like cotton as 30, 40 and 60 mesh. Because of the stiff fibrous nature of wool, the flock finished surface is harsh and wire like in nature. Wool flock has to be treated in staple form to a considerable extent to remove the oils and greases common to it and also to remove foreign matter. It is least popular of all fibres,

but it produces a dull uneven finished surface of maximum wear resistance. Animal hair is usually ground into flock that is much coarser in nature than those previously described. After grinding or cutting, it is screened to general lengths ranging from 1/8 inch to 3/8 inch. Animal hair flock must be processed, as wool, to remove oils, greases or foreign matter¹⁸. Another type of material used for flock printing is metal dust which can be obtained in a wide variety of different sizes. Mica is also available in various particle sizes and colours and is particularly effective when used on dark fabrics as a contrast⁶.

Special attention should be given to the storage of flock to ensure that it be kept in a dry place, for moisture is flock's worst enemy. Any dampness will cause balling and pilling, which is detrimental to good and even printing and finishing. Should the flock become damp it should be dried before use by spreading the material out in trays and drying with either the use of heat lamps or hot air. Other methods of avoiding the tendency of flock fibres to stick together include the treatment of flock with certain chemicals. In many cases, the flock is made electricity conductive by charging it with hygroscopic salts, such as of the ammonia group¹⁸. In this way the dipole appearances produced by influence effect are avoided. All flock fibres take on the same potential and repel each other. Recently, Henry Ewing¹⁴ in an invention seeks to surmount the difficulty by applying an aqueous dispersion of a fine powder to the fibres (viscose or cellulose acetate) which are then dried. The amount added is about 0.5-2.0%. Suitable materials are mentioned in the twenty-five claims which include precipitated silica, chalk, magnesia and talc. The treated flock is intended to be applied by the electrostatic method.

Some interesting figures issued by Hug A. G.⁹ show that for flocking of an area of one square yard, 40 to 50 gms. of

rayon flock will be consumed. This allows for waste, but it should be remembered that waste in flock printing is recoverable; and may be returned to the flock hopper for reuse. To print an area of same size with a pattern, considerably less flock will be required and a very dense pattern will usually only cover about one-tenth of total area.

Adhesives :

The quality of flock prints produced depends mainly on the use of an efficient adhesive. For applying flock any adhesive can be used that can be applied to backing surface in a liquid or semi-solid state, that will remain wet long enough for the application of the flock fibre to the entire prepared area, that will dry with good adhesion to the surface being coated, and that will at the same time maintain its fibre-retaining qualities¹⁸. However, for the best in finishing or printing results it is advisable to use adhesives specially designed for flock printing and finishing effects as they invariably have inherent qualities that are a requisite for maximum efficiency in flock printing and finishing. If proper selection of adhesive is not made then on washing or even dry-cleaning, the flock printed effects completely disappear or leave behind dismal stains that make the garments in which they are used unwearable. Therefore, flock printing or finishing manufacturers have now teamed their flocks and flock printing machinery with a range of adhesives, each of which is specifically suited to the purpose for which it is intended.

For the textile industry, the solvent and water dispersion rubber types of adhesives are most commonly employed. Other adhesives for textile purposes consist of special resins, as well as some types of varnishes, but they are rarely used. Whenever it is necessary to use an adhesive of a very flexible nature, rubber adhesive is generally used. The solvent type rubber adhesive is made

from reclaimed material and held in liquid or semi-solid state by use of petroleum solvents. Like the solvent rubber adhesives, the water dispersion rubber type is best suited for use where extreme flexibility is required. Held in dispersion by use of water as a vehicle, this adhesive has found widespread use in coating fabrics, where it is desirable to reduce the hazard of fire. The resin type, usually alkyd, is one whose drying time can be regulated to best suit production requirements. It is a sturdy adhesive, offering maximum in base adhesion to the surface being coated and in fibre adhesion. It is available in all standard colours to match the flock being used. Sometimes, many types of enamels, a few lacquers and some water soluble glues are also used as adhesives, but most of such adhesives have many disadvantages such as the tendency to skin over readily, getting dried immediately and becoming brittle on drying¹⁸. So they find limited use and are employed for coating rigid surfaces only. Based on these general principles, some most commonly employed adhesives will be briefly described.

Orafix *PF*, an auxiliary product suggested by Werdenberg²³ and marketed by CIBA, is based on a synthetic resin emulsion and permits the production of flock prints fast to washing, boiling and dry cleaning. This adhesive has marked elastic property, is non-inflammable and may be diluted with water. The addition of an Orema colour (which should match the colour of flock), while not necessary, does enhance the brightness and depth of shade of the flocking especially when applied to a dark background. The goods are printed or coated with the adhesive and flock immediately applied by any method. After drying, goods are cured for 5 mts. at 130–150°C. To get fully satisfactory results a heavy layer of Orafix *PF* should be applied.

Texcol *D* or Watex for producing flock printed effects and Texcol *U* for applica-

tion when all-over flocking is desired are being supplied by Hug and Co.⁶ These adhesives maintain their flexibility through out the life of the fabrics, while they also retain the flock which has been applied to them.

Ewing and Blackmore¹⁵ have described adhesives which are made from rubber like copolymer of butadiene with acrylonitrile and marketed under the name Hycar O. R. 15 and 25. This adhesive is used for cellulose acetate, which will remain hard at 100°C and be sufficiently flexible.

Heberlein and Co. A. G., in a patent¹⁹ describe an adhesive which is a solvent for cellulose and may be thickened (for printing) with cellulose. The following solvents (as solutions) are mentioned: Zinc chloride, calcium thio-cyanate, benzyl trimethylammonium hydroxide, sodium zincate and unripened viscose. After applying the flock the solvent is destroyed by washing the material in dilute sulphuric acid.

Polymerised esters of acrylic acid are used as adhesives with rayon flock by Steinberg²¹, in order to produce a surface of velvet like texture by electrostatic means.

A new thermoplastic adhesive has been marketed by British Celanese Ltd.¹⁶, which contains two plasticizers of different volatilities as a means of bonding fibre flock to a base fabric. By evaporation of the more volatile plasticizer, after applying the flock, sticky coating becomes non-sticky but flexible. For example, cotton fabric is coated with an acetone solution of polyvinyl acetate, dimethyl phthalate and tricresyl phosphate, dried at below 50°C, and then covered with flock and heated at above 120°C. The fabric may be given a first coating of polyvinyl chloride to prevent penetration by the polyvinyl acetate solution.

Application of adhesives:

For application of adhesive to areas or surfaces that are to be flock printed, dip, brush, spray, silk screen, roller coat or doctor blade method is employed¹⁸. The dipping of the fabric in adhesive for film application is the simplest and one of the most economical methods for all over flock finishing on both sides of the fabric. Here the fabric is passed through a vat containing the adhesive and then wiped off from both sides to retain the appropriate amount of adhesive only. Brushing is a slower method than dip or spray method and definitely for piece work applications. Care is necessary to ensure the elimination of brush marks and to apply an adhesive film that is reasonably even in thickness. This is used when small lengths of fabrics are to be printed or finished with flock. The conventional paint spray-gun is used in conjunction with a paint spray booth for the evacuation of excess adhesive and solvent fumes. Production requirements, of course, control the size of the gun to be used for this purpose. Silk screen is the most popular method of all other methods of applying adhesive to fabrics. It is particularly suited where pattern and design are desired. The silk screen method of application makes use of rubber blade, called a squeegee, which when drawn over the screen spreads the adhesive in an even film through the openings of the screen. The method is just like screen printing as far as the use of screen is concerned for the application of adhesives on the surface of the material. The roller coat method of adhesive film application is confined to the preparing of production quantities of continuous lengths of the fabric for overall and pattern effects. The usual operation of this method is seen in roller printing machines. One roller rotates with its lower portion in an adhesive filler reservoir or tray. This roll transfers the adhesive to a second rotating roll which is set in, in relation to first. There is a doctor blade which controls the thickness

of the adhesive film and removes the adhesive from unwanted portions of the design. The regulated adhesive film is transferred to the backing material as the material is drawn along in contact with it. If the roller is plain then we get all over flock finishing effect and when roller is engraved with particular design we get flock printing effect.

In the application of adhesive to the fabrics, the adhesive consumption varies according to three factors as firstly, adhesive quality, secondly, adsorption capacity of the material to which it is being applied, and thirdly, the method of application—doctor blade, roller etc. It is stated by Hug A. G.⁶, the amount of adhesive required for coating an area of one square yard for all over flocking will take from 65—120 gms.

Application of flock :—

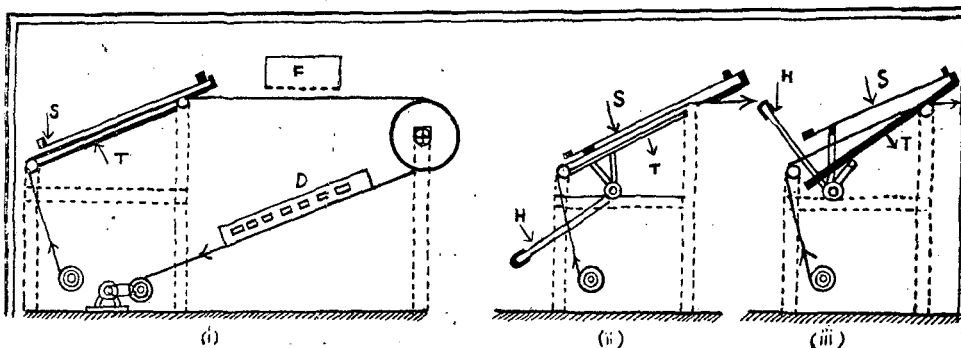
There are three methods of applying flock to the adhesive prepared surfaces of continuous lengths of cloth. They are the spray method, the beater bar method and the modern electrostatic method.¹⁸ Fibre spray gun is used which is specially designed for this purpose exactly on the same principles as the spray gun with the exception that it has been made to handle the dry fibre. Every precaution should be taken that the air used in flock application is moisture free. Mechanical beater bar methods or electrically operated hexagonal beater bar methods of evolving flock printing and finishing are essentially the same and they are considered a substitute of one another. As the flock is shifted on the fabric to be printed or finished, it is agitated by bringing the reverse of the adhesive prepared side in contact with a revolving hexagonal or octagonal bar. The method causes the flock fibres on the adhesive coated side to dance so that fibres set themselves vertically in the adhesive. But both these methods of spray and beater bar are rarely used now, as they give results which are far from satisfactory.

Electrostatic method of applying flock is latest development which perhaps originated simultaneously in Germany, Switzerland and America. The principle of this method⁴ is that the tiny particles of fibres are charged with a high voltage, while the surface to be flocked is earthed. The difference in potential between flocks and the base materials is used to propel the flocks into the previously glued surface. During this process the electric force aligns the individual flocks which enter the adhesive layer at right angles and are in that way attracted to the base material at one end of their short length. As the fibres are closely arranged and held in the adhesive firmly at one end, the resistance to rubbing is greatly improved. This method gives a smooth even pile surface which will be fast to most rigorous processing. Based on this principle many of the machinery manufacturers have built electrostatic printing and finishing equipment. In all such equipment, the essential principal is same as described above, but they only differ in design and other minor mechanical details.

Text-O-Stat, Switzerland has put on the market W.L.C. flock printing equipment^{5, 9}, which is being used to a great extent at many places. The W.L.C. electrostat, built for hard work and even for operation over very lengthy periods, is available in any voltage, operating on a.c. supply. Instead of utilising valves, it operates on selenium rectifiers and nepolin condensers which the makers say they have found to give the utmost safety when producing high tension direct current, which is infinitely variable between 25 and 50 K.V. with the operating power at only 100 watts. All the vulnerable parts carrying the high tension current are immersed in oil, and proof against any outside influence. A vibrating sieve for applying the flock fibre is supplied with each W.L.C. electrostat. The W.L.C. mobile flock printing carriage is designed for use with long silk screen printing tables or with Text-O-Stat flock printing

machine. The carriage runs on rails which are fitted to the table, and is traversed by hand after the adhesive has been applied through silk screens. The fibre is flocked in one operation and surplus flock is electrostatically cleared from the fabric and automatically returned into the flock container. By means of adjustable partitions the width of the flock printing carriage may be adjusted to accommodate any normal width of cloth up to about 63 inches. The builders of this equipment maintain that theirs is the only machinery capable of producing a perfect fit-up to a design without there being any evidence of a join between screens. The cloth to be printed is mounted on roller placed beneath one end of the machine. The fabric is then taken through two vulcanised rubber rollers which have a variable control guide regulator, automatic electric stop motion and solenoid operated braking. The cloth to be printed is brought up to the printing table and an automatic control system ensures that the cloth is only taken up after the adhesive has been applied, either through the screen by a squeegee or if the effect is to be all over by means of a doctor blade. As the printing screen is raised, so the

printing table is simultaneously lowered and the cloth, carrying the adhesive is taken under the electrostat for flocking. With each movement of the cloth the operator applies more adhesive to the screen on the inclined printing table at the front of the machine. After flock printing of a pattern has been completed the loose flock is removed by vibration and returned for further use to hopper. The cloth is then taken through a special drying chamber beneath the machine, where special *infra red* heaters polymerise the adhesive but leave the fabric untouched. As there is no visible light transmission there is subsequently less danger of damaging the fabric ground shade. Should the fabric for any reason, be stopped from travelling through the machine, screens automatically come between the *infra red* units and cloth in the drying chamber, thereby protecting the cloth from excessive heating. The production rate of normal 8 hour shifts is in excess of 1,000 yds., but this will of course, vary according to the skill of operatives. A control panel is conveniently situated at the front of the machine. Two operatives are required, one to apply the adhesive and another for the flock.



(i) This gives, in schematic form, the basic arrangement of the Text-O-Stat Flock Printing machine. The cloth is taken from a roll under the screen (S) and over table (T). From here it passes beneath the Flocking device (F) and is then

conveyed downward under *infra-red* drying unit (D), finally being taken-up in a collecting roll.

(ii) Shown here is the lever arrangement for disengaging the table (T) and screen (S) from the cloth. All control is by means of handle (H).

- (iii) The table (T) and screen (S) have been disengaged from the cloth. Handle (H) is lifted upwards and two arms move in such a manner that while one lowers the table other simultaneously lifts the screen (S).

A major feature of Text-O-Stat flocking machine is the synchronisation of the timing between printing and drying. Thus the danger of smearing the adhesive and flock printed pattern is virtually eradicated. It is also possible on this machine to combine colour and flock printing. The adhesive is applied through a screen nearest the operative, while colour may be applied through second screen.

Arno H. Wirth of Reutlingen, Germany, have developed in collaboration with another firm Canillo Reisinger—an electrostat unit, of which four models are available^{1,4}. For flock printing fabrics up to about 6½ feet wide, the industrial model I 1100 is offered. The unit is connected to an a.c. single phase supply and is rated at 40--80 K.V. on an 2.2m.A. current. The high tension voltage is conducted to the grid electrodes through a special heavily insulated cable. Printing is practicable on this machine at speed of 4--6 yds. per minute or higher. The controlling factor is usually the drying capacity, which is effected by radio frequency heating, as this heats from the adhesives interior and dries thoroughly. As soon as adhesive is firmly set the cloth is given a thorough beating or brushing to remove surplus flock, while a suction unit carries it back into the machine. The AWR flock printing carriage⁵ is designed to produce velvet effects by the electrostatic process and works on the same principle, as Text-O-Stat flock printing carriage. The whole flock printing unit is compactly designed and operates on the same principle as conventional screen printing machine being an addition to an ordinary silk screen table.

After many years of experimentation a Swiss Firm, Hug A.G. of Wildeg, has developed an electrostatic flocking equipment^{2,6}. The flock printing units made by Hug produce a direct current of 20,000--150,000 volts or more from a normal a.c. mains supply. The high tension current is connected to two pole plates, one of which is earthed and other heavily insulated. The flocking takes place by electrostatic means as in other machines. The total unit includes cloth unwinding, adhesive coating, flocking, drying, embossing and winding up of the treated fabrics. The machine may be used for flocking fabrics from 39 to 78 inches wide. Another type of flocking machine that is being made by Hug is intended for handling belts, ribbons, tapes etc. and have maximum working width of 11.8 inches.

New electrostatic generators and flock desposition units have been introduced by Spraytex (Manchester) Ltd., and are claimed to have marked advantages.¹² Spraytex have devoted their attention to electrostatic flocking equipment, which in some instances, can readily be adopted to a firms existing methods, thus reducing initial outlay. The electrostatic generators are housed inside metal cases and no valves or coils are used in their construction. They are entirely mechanical and it is said that they can be regarded as trouble free. The flock desposition unit is built of non-conductive material with a wire grid inside connected to the generator. The flock is fed into top of the unit and by a rotary action which can be either manually or mechanically applied, the fibres are passed across the grid, so becoming electrostatically charged and deposited on the material (Coated with an adhesive) passing under the grid. The flock desposition unit may be stationary or may be fitted with wheels to travel along a screen printing table. This is useful for widths above 2 feet 6 inches. Another method of applying the flock used by Spraytex is the tray-technique, in which use is made of a re-

ctangular tray of the size required, standing upon four insulators: The charge is taken from generator to the tray upon which fibres are placed and these become electrostatically charged. Articles, previously coated with an adhesive are then placed above the tray and are covered with flock in a matter of few seconds.

The Eloflock process and layout of the plant of Eloflock G.m.c.H., Köhn-Niehl are also described.²⁰ This is also based on electrostatic deposition of fibres in order to obtain plush like surface and particularly this is used in manufacture of uniform or patterned nap material made of 300 m.m. wide perlon net. The process involves four stages: Coating with the adhesive, application of fibre flocks, drying of the adhesive and removal of excess flocks. The production potential of the Eloflock machine is 5 meters per minute.

Böhmler has produced electrostatic machine "Velvetine" which eliminates the use of valves and transformers and operates on the principle of tape generator.¹³ The machine is easy to operate and can be used to produce velvet, velour and suede effects.

Burridge and Hirst¹⁷ of Dunlop Rubber Co., claim for an apparatus for making a pile fabric by the electrostatic deposition of fibres on an adhesive backing and which is said to deposit more fibres per unit area than similar type of apparatus. The electrodes are spaced vertically, the backing material is passed along in contact with the upper electrode and fibres are brought between the electrodes on a conveyor belt. Means are provided for vibrating the backing so that loose fibres are removed.

Schwartz and Gross²² have developed a low humidity method of flock printing a textile fabric. Due to low humidity the balling and clogging of flock is eliminated to a great extent. The fabric is passed between two closely spaced elec-

trodes to which an alternating current of between 30,000 and 45,000 volts is applied for 3 out of 4 seconds. The upper electrode is foraminous to allow the flock to fall through it. A glass plate lies in the air gap directly under the fabric, its objects being to prevent the development of a heavy discharge between the plates. "Treeing" or clumping of the fibres is prevented by switching off the field for one second out of four, by agitating the above electrode and by slowly passing a woollen belt under the fabric near the glass plate.

Recently, the modern development in flock printing field is to combine colour and flock printing. Should the popularity of flock printed styles fade, the machines need not stand idle for they can just as easily be used for ordinary screen printing of colours. It has been indicated earlier under W.L.C. flock printing process, how the same equipment can be utilized for combined colour and flock printing.

To meet the need for a machine smaller than the large and expensive machines, yet with a greater production than usual screen printing units, Reisinger Apparatebau, Vienna 8, have introduced a small screen and flock printing machine type KSM and KFM.⁷ The machine is suitable for ribbon in addition to normal broad cloths. As an indication of the size of the machine, the drying chamber is only 79 inches long and from 59 to 79 inches wide depending upon fabric width. Nevertheless, the production potential of machine for single colour work is equal to that of large size machines. Special advantages of new machine are its low cost and versatility for cloths up to 39 to 55 inches wide. It can be used in three different ways, firstly as a screen printing unit up to six colours, secondly, as a flock printing unit and thirdly, as a combined flock and colour printing. The machine is built with either one or two printing units requiring the services of one or two

operatives respectively. The production of one unit with one colour is between 220 and 275 yds. per hour. Multicolour work is proportionately slower. The plant includes printing unit, screen magazine, washing unit, gumming arrangement, ironer, dryer, take-up, ribbon attachment and flocking attachment. This machine can be utilised for colour and flock printing of ribbons also.

It is possible to permit effective combination of colour, lacquer, gold and silver screen printing in conjunction with flock printing in Melostat type C—Multicolour made by Fritz Hoffer, Olten, Switzerland.¹⁰ This unit makes possible multicolour screen or flock printing in one single process and is very simple in operation. Even unskilled operators are able to work the machine without any trouble once they have been shown how. The machine is operated entirely from a central control panel: by depressing a foot pedal, the pattern or design can be repeated automatically and with absolute precision. The electrostatic unit consists of selenium rectifiers and nepolin condensers. The automatic guard against overloading, which operates on a thermic and magnetic basis, a voltage meter, acoustic signalling lights, special supports for the sets of rectifiers and short circuit-proof system are further features of this mechanism.

Normally, the flock printed and finished goods are utilised for greeting cards, sportswear, dress and curtain materials, drawer interiors, camera case linings, suede leather articles etc. But that fashion still continues to smile on flock printed effects is due to considerable around improvements that have been effected in recent years in equipment, adhesives and flock itself. Now, flock prints are being used to produce various types of novel and decorative effects on fabrics. They are being featured in a wide variety of pattern, in a range of colours and on many types of cloth, ranging from say sheer nylon plain or slubbed weaves to

really coat weight gros-grains and also the intermediate weight fabrics including taffetas, satins, jacquarded structures, fancy ribbed and carded cloths. Another interesting innovation is production of flock printed rayon nets in dainty patterns, such as butterflies, stylised flowers and leaves, which look remarkably like lace, at a fraction of cost.

“Flock-prints, intelligently used, can ring the changes in cloth styles in a remarkable way”.³

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