Vol. XVII. No. 8 AUGUST 1926

The Journal of the TEXTILE INSTITUTE

Official Journal for Communications (Transactions) released for Publication by the British Cotton Industry Research Association, British Research Association for the Woollen and Worsted Industries, Linen Industry Research Association, and British Silk Research Association.

THE TEXTILE INSTITUTE
ST. MARY'S PARSONAGE, MANCHESTER

THE

TEXTILE INSTITUTE

NOTICES: INSTITUTE MEETINGS

Annual Conference at Buxton, Wednesday, Thursday, and Friday, 20th, 21st and 22nd October 1926. Annual Mather Lecture; morning of Thursday, 21st October, by Sir William H. Bragg, K.B.E. Details of other arrangements will be sent direct to members.

Saturday 11th September	*Manchester*—3 p.m. Crompton Scheme Committee: Special Meeting at the Institute.
Tuesday 14th September	*Manchester*—2-45 p.m. Meeting of Publications Committee, at the Institute.
Wednesday 15th September	*Manchester*—2 p.m. Meeting of Selection (Diplomas) Committee, at the Institute.
Wednesday 22nd September	*Manchester*—2-45 p.m. Meeting of Council, at the Institute

FOUNDED in 1910, the Textile Institute, the headquarters of which are at St. Mary's Parsonage, Manchester (with Branch Office and Rooms at 38 Bloomsbury Square, London, W.C.1), is specially concerned with the advancement of Science and Technology in relation to the textile industries. The recently obtained Royal Charter of Incorporation will enable the Institute, in addition to its other powers, to hold examinations and to grant Diplomas and Certificates of competency to practice, teach, or profess Textile Technology.

Conferences and Lectures

The Institute organises meetings at which Papers and Lectures are contributed and discussed. General conferences are usually held in the Spring and Autumn of each year. Meetings are arranged for different areas by Section Committees, and are intended to stimulate and advance interest in technical and other problems.

The Annual Mather Lecture

Instituted in 1919 with a view to the advancement of the interest in Lectures delivered under the auspices of the Institute, this annual feature was also established in honour of the association of the name of the late Sir William Mather, President of the Institute for three years in succession, with the promotion of the Institute Foundation Fund for the raising of a sum of £50,000. The annual revenue from invested donations (donations amounting to over £12,000) has enabled the Council to embark on several important additional efforts.

The Journal of the Institute

Issued monthly, the Journal is now a well-recognised medium for publication of Communications of scientific and technical interest. The Journal is sent post-free to members, and the value of the publication is definitely expressed by the growing demand for copies from many countries apart from the ordinary membership list of the Institute.

Design and Structure of Textile Fabrics

Under the Lieutenant Crompton Memorial Prize Fund Scheme of the Institute, a sum of £100 is offered annually in prizes to advanced students at Technical Colleges and Schools for specimens of fabrics woven in the institutions and embracing a given number of groups of materials.

The Institute Premises

The headquarters at Manchester offer a well-appointed writing and reading room for use by members, with telephone and other facilities. Current textile publications are available. The rooms provide a convenient centre for interviewing purposes, and refreshments may be secured. The Branch premises in London at 38 Bloomsbury Square, W.C.1, have reading, writing, telephone, and other facilities.

Membership and Annual Subscription

The Institute's membership is representative of all branches of the Textile Industry. The Annual Membership Subscription is Two Guineas; Life Membership, one subscription of not less than Twenty Guineas; Junior Membership (under 25 years), One Guinea. The Council of the Institute cordially invites not only additions to membership, but the active interest and co-operation of all individuals elected.

J. D. ATHEY, *General Secretary.*

16 St. Mary's Parsonage
Manchester, *October 1925*

Form of Application—see opposite page

FORM OF APPLICATION FOR MEMBERSHIP OF THE TEXTILE INSTITUTE

I hereby make application to the Council of the Textile Institute for admission to........................Membership of the Institute. If elected, I undertake to observe and to be bound by the regulations (including the provision for three months' notice to terminate Membership) under the Charter and Bye-Laws of the Institute, and to endeavour to further the objects of the organisation.

Signature of Applicant (in full)..

Date ....

Business or Profession..

Address (for all communications)..

....

....

We, the undersigned, recommend the above-named applicant for election—

Proposer..*Member of the Textile Institute.*

Seconder..*Member of the Textile Institute.*

ANNUAL SUBSCRIPTION

The annual Membership subscription is Two Guineas, payable in advance; Junior Membership (under 25 years), One Guinea. The subscription covers post-free supply of the *Journal* of the Institute. Life Membership of the Institute may be secured by one subscription of not less than Twenty Guineas.

QUALIFICATIONS FOR MEMBERSHIP

Persons interested in promoting the welfare of the textile industry and/or occupying responsible positions in connection with the following, are eligible for membership, subject to the Rules and to election by the Council of the Institute—

(*a*) Production or Handling Textile Raw Material.

(*b*) Spinning, Weaving, Bleaching, Dyeing, Printing, Finishing, and any process embraced in the production of Textiles.

(*c*) Chemical and other industries which supply materials for the production of Textiles.

(*d*) Architecture and Engineering in their application to the Textile Industries.

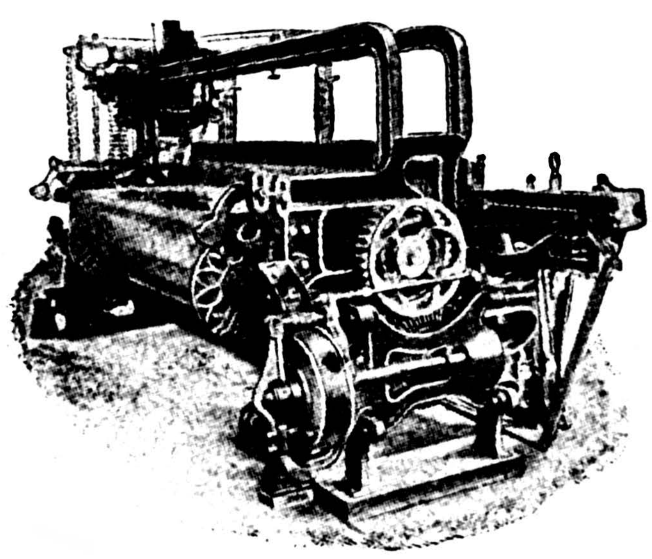
(*e*) Buying and Selling of Textiles.

(*f*) Testing, Consulting, and Journalistic Work, Patents and Trade Marks, and the Inspection of Factories and Workshops, in their application to the Textile Industry.

(*g*) Teaching of Science and Technology as applied to Textiles.

Students, Apprentices, and others under the age of 25 who are preparing themselves for responsible positions in any branch of the Textile Industry, may join as Junior Members.

Additional application forms for membership and any other information supplied by the General Secretary, J. D. Athey, 16 St. Mary's Parsonage, Manchester.



THE JOURNAL *of the* TEXTILE INSTITUTE

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THE TEXTILE INSTITUTE

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N.B.—Chairmen of all Standing Committees and, in the case of Section Committees, the Chairmen and Honorary Secretaries of such Committees, are entitled to attend all meetings of the Council, but not to vote thereat unless they have been duly elected members of Council.

The General Secretary
J. D. ATHEY, 16 St. Mary's Parsonage, Manchester

Honorary Solicitors—Messrs. KNOTT & CASTLE, 3 Norfolk Street, Manchester

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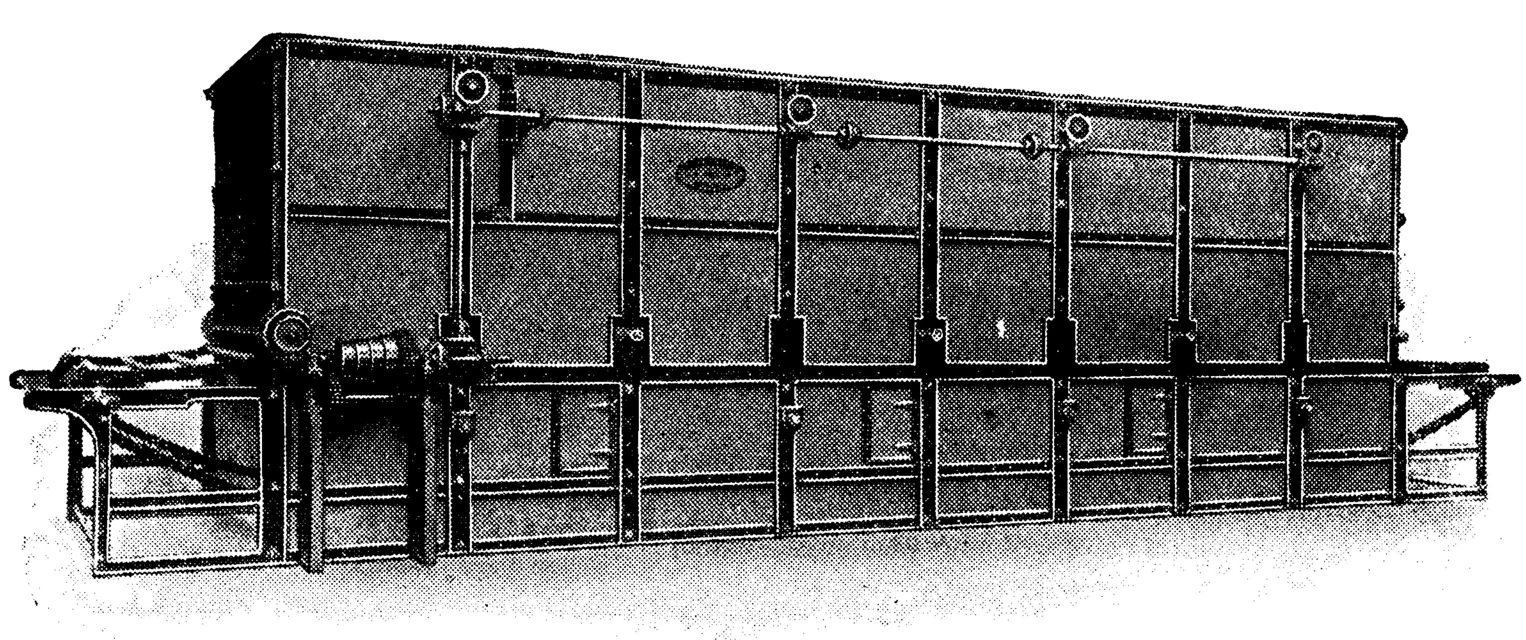

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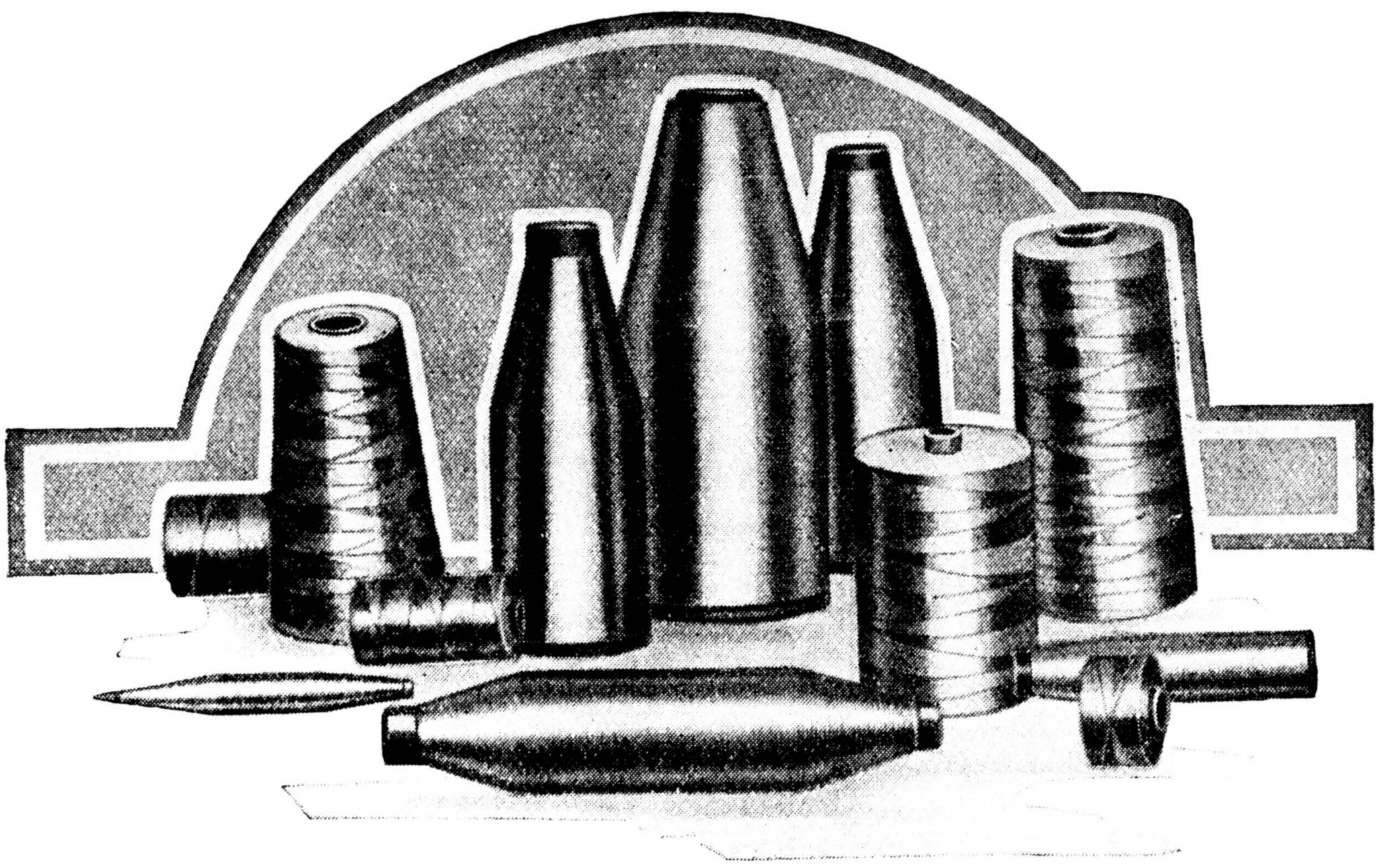

THE JOURNAL OF THE
TEXTILE INSTITUTE

Vol. XVII AUGUST 1926 No. 8

PROCEEDINGS

London Section

Exhibition at Institute's London Rooms, in Bloomsbury Square, of Fabrics woven in Bradford Technical College under Bradford Textile Society's Prize Scheme, 23rd and 24th June 1926.

The chief objects of this exhibition were, firstly to illustrate the type of work being conducted by the Bradford Textile Society and the Bradford Technical College to develop colour and design as applied to woven fabrics, and secondly to obtain from London buyers of textiles, suggestions and constructive criticism so as to stimulate this section of work to a higher standard of attainment. The fabrics displayed were the results of students' experiments, produced under the Bradford Textile Society's Prize Scheme, and not the results of work of designers with industrial and factory experience. Of the 280 fabrics displayed, of which no two were alike in design and colouring, fully 60% were produced by young men who had not been employed in a weaving factory, but who, over the age of 16 years, had left a secondary, grammar or public school, and entered upon a three year course of full-time study in cloth manufacture at the Bradford Technical College. The objects of the scheme were to encourage experiments in new combinations of materials, the production of new effects due to twist and unusual structure of yarn, and to foster improvements in colour, design, and structure. The possibilities of artificial silk were illustrated by combinations of viscose and "Celanese" artificial silk, and also by combinations of artificial silk with wool, cotton, and pure silk. More than 20 various combinations, including piece-dyed two-colour effects, in these materials were displayed. One cloth, which compared very favourably with the best French fabrics, had a soft, full handle and light weight (5 ozs. per yard, 54 in. wide). This cloth was much admired. The Exhibition was visited by Representatives of the Board of Trade, Board of Education, Department of Overseas Trade, F.B.I., Drapers' Chamber of Trade, the National Federation of Launderers, London University, The Incorporated Association of Retail Distributors, and various London wholesale, retail, and shipping houses. Criticism on the whole was distinctly favourable and considerably more encouragement was offered by trade buyers than at the 1925 Exhibition. Below are a few examples of actual trade criticism—

> In most cases these goods will appeal very much to the public.
>
> You have got on to the softer touch, and away from the hardness and brittleness of a few years ago.
>
> I like that clean slippery feel.
>
> You have improved wonderfully in the touch and softness of artificial silk.
>
> That is "Frenchy" in design.
>
> What we want is effect; wearing quality has very little value, and more weight is no good.
>
> I much prefer the botany cloths blended with artificial silk. The Botany cloths show no advance but here (artificial silk weft) and there is a novelty and it is definitely better for the market.

This is a distinct improvement on your last year's show.

One of your best cloths is that soft uncreasable spongecloth effect.

The construction of the cloths is excellent but the artistic side is weak.

This is the softest Bradford fabric I have ever handled.

It is lovely stuff but not a selling proposition in this country; there is nothing here I should feel like buying. From an educational point of view it is wonderful.

Bradford has done very much better lately; you are getting a softer handle. We have been hammering at you all the time about it.

Bradford has still got to learn a lot about handle; that goes a long way. The touch is everything.

People like all-wool cloths. If you say there is cotton in a cloth they won't have it. They don't understand what Botany really is, but the name goes a long way in selling.

Such Exhibitions without any prices being given would stimulate interest; the public are not educated to what is British.

The artificial silk introduced with wool gives the wool a much brighter appearance.

You would hardly credit these were Bradford goods.

I think you have nearly got the exact French thing; it is up to the tone, and the taste and the feel of to-day in women's dress.

The Bradford Textile Society is to be congratulated on inspiring the young men in the wool trade to produce such smart fabrics.

Professor E. Midgley, of Bradford Technical College, and Mr. Henry Binns, Hon. Secretary of Bradford Textile Society, were in attendance at the Exhibition and took note of the criticism offered.

VISIT TO HOSIERY MANUFACTURERS

On June 10th a party of members of the London Section of the Institute spent a very interesting and instructive afternoon in a visit to the works of Messrs. Dix, Watson & Co. Ltd., knitted goods manufacturers, of Alperton, Middlesex. After a hearty welcome by the Managing Director, the Works' Manager conducted the visitors on a tour through the factory. Opportunity was given to inspect each process from the winding of yarn to the finishing of the made-up garment. At the winding frames great interest was expressed at the variety of colours and of types of yarns employed. The jacquard machines, as used in connection with knitting, also attracted a good deal of attention and the visitors greatly admired the designs produced. They also noted with interest how many varied designs were produced by comparatively simple mechanism, some indeed so little complicated that the operator was able to memorise the design and subsequently adjust the machine during the knitting process so as to obtain the desired effect without further reference to his card. The visitors later passed through departments where seaming, buttonholing, teasing, calendering, and steam pressing were in progress and also viewed several specimens of made-up and finished garments. After the tour, the party was entertained to tea by the Directors of the firm, to whom a cordial expression of gratitude was tendered.

NOTES AND NOTICES

The Institute's Annual Conference

Postponed in consequence of the general strike, the Annual Conference of our Institute, originally fixed to take place at Buxton during Whit-week, is now being convened for the third week in October. It is hoped that the rearrangement of the fixture will not involve any material departure from the original programme. Sir William Bragg, K.B.E., has kindly accepted re-invitation to contribute the Annual Mather Lecture of the Institute and has engaged to attend at Buxton for the purpose on the morning of Thursday the 21st October. On the Friday morning (22nd) it is expected that the papers by Mr. J. A. Robertson, M.I.E.E., M.I.Mech.E. (on Centralised Electricity Production), and by Mr. Percy Bean, F.C.S., M.Ph.S. (on the subject of Sizing), will be contributed in accordance with the programme previously presented. Printed programme and attendance form are in course of preparation for posting to members. Meantime, members are urged to make note of the dates of the fixture—at Buxton, Wednesday, 20th October, to Friday, 22nd October, inclusive. The proceedings will commence on the Wednesday evening with a reception. After the Conference on the Thursday morning, it is hoped to arrange for a visit to works at Macclesfield as originally planned.

Section Meetings of the Institute

Arising out of a recent meeting of the Lancashire Section Committee of the Institute, at which the possibility of availability of a paper of interest to the knitting industry was mentioned, it was agreed that endeavour be made to provide for such a paper to be presented at a meeting at Leicester—to be held under joint auspices of the Institute and the Leicester Textile Society. It is now proposed to hold the meeting at Leicester during the period of the Exhibition of Textile Machinery, and the date contemplated is the 16th October (Friday). Mr. Frank Nasmith has kindly promised to provide accommodation for the holding of the meeting and members of the Institute will be given opportunity to inspect the exhibition. Further particulars will be issued later. The paper at Leicester will be contributed by Mr. Herman S. Bell, of Nottingham, who will deal with the subject of "Thread Take-up in the Seaming of Knitted Fabrics." Mr. John T. Stokes, the Hon. Secretary of the Leicester Textile Society, has notified acceptance of the proposal to promote the meeting under joint auspices.

Textile Institute Diplomas : Fellowships and Associateships

Since the publication, in our July issue, of the list of additional names of members elected to the Fellowships or Associateships of the Institute, the following elections have been completed—

FELLOWS

BARBER-LOMAX, Joshua Arthur (Bolton).
CHADWICK, Arthur (Rochdale).
HUEBNER, Julius (Cheadle Hulme).
KERFOOT, James (Sidcup).
PADGETT, Charles (Bradford).

ASSOCIATES

BUTTERWORTH, Ernest (Stockport).
CRESSWELL, Albert (Blackburn).
DEARNALEY, Alfred (Hadfield).
GEE, Percy Herbert (Huddersfield).
HEYWOOD, William (Bombay).
JONES, George (Blackburn).
LEES, Robert (Audenshaw, near Manchester)
POMFRET, Harry (Rishton, near Blackburn).
ROTH, Alfred Bernard (Rochdale).
ROTHWELL, Herbert Theaker (Huddersfield).
SMITH, John (Walkden, near Manchester).
SPENCER, Arnold Kingsley Norman (Bradford).
WRIGHT, Robert Harcourt (Gatley, near Stockport).
WYKES, Alfred Launcelot (Leicester).

Examination of Applicants for Associateship

Of the applications for the Associateship of the Institute now under consideration by the Selection Committee, in about a dozen cases the applicants have been offered the opportunity to present themselves for examination. The examination is intended to cover, in quite an elementary manner, the whole field of General Textile Technology—that is to say (quoting the terms of the notice to candidates) that questions may be asked "regarding the microscopic and other characteristics of the well-known textile fibres and also regarding preparation for and processes involved in the spinning, weaving, bleaching, dyeing, and finishing of textile materials generally. Yarn and fabric structure (the doubling of yarn and the construction of woven, knitted, twisted and felted fabrics) may be dealt with." The next examination of candidates is to take place at the Institute at Manchester on the afternoon of Wednesday, 15th September. There will be two or three candidates from the London district. A while ago, the Selection Committee contemplated the conduct of an examination in London, but, on account of the very limited number of candidates from the South of England, it was agreed that the next examination must take place at the Institute headquarters.

Collections of Woven Fabrics

The annual competition of the Lancashire Education Committee for collections of woven cotton fabrics produced by students at the various schools has been concluded. A Committee of the Textile Institute has carried out the work of adjudication, as in previous years, and in accordance with their recommendations the awards have been notified by the Director of Education as follows—Gold Medal and Prize of £10—Rennie Jackson, Nelson Technical School; Silver Medal and Prize of £10—Harold O. Croasdale, Colne Technical School; three Prizes of £10 each—James H. Nutter and Philip Weston, Burnley Technical School, and Ernest Greenwood, Colne Technical School; Prizes of £5 each—Herbert Maxwell, W. P. Richmond, and Herbert Thistleton, Nelson Technical School; and Alfred S. Taylor and Thomas Shackleton, Colne Technical School. The Adjudicating Committee, in their report regarding this year's competition, point out that it is obvious that students are sometimes handicapped owing to limitations in availability of suitable yarns. The problem is one for the schools concerned, it is suggested, but the Committee also suggests that where difficulty is experienced in this connection communication on the matter should be made to the Textile Institute.

COMMUNICATIONS*

To G. J. Fleming, Esq.

Dear Sir,—The Editor of the *Journal of the Textile Institute*, Manchester, has forwarded me a copy of your letter of the 6th April, with the request that I supply any information which might prove useful to you. I have read your letter with very great interest, and, as an old official of Africa, I can well appreciate the difficulties you are faced with.

In East Africa we found that the hairy type of sheep responded readily to crossing with Merino and Down Rams, and that at the third cross the hairy fibre has been removed from the fleece and a marketable wool produced. From a perusal of the enclosed report, you will see that somewhat similar problems present themselves in the Sierra of Peru, and the success, which has attended our endeavours, may well encourage you in your efforts to create a type of sheep which will yield a wool of commercial value.

The Peruvian Merino Ram (*vide* pages 9, 10, 13 of the report) might be a type of sire which would suit the conditions obtaining in your part of the Sudan; they

* Further letters in reply to that of Mr. G. J. Fleming which, with other replies, appeared in the July issue of this Journal (pages P116-P119), are printed above. It is hoped that other correspondence will be received on this topic.—Editor.

are extremely hardy and can be obtained for some two pounds each. Their wool yield is not a high one, but it is a fine wool of lofty handle and wonderfully light in, condition. Our last consignment of wool (1925) realised in Liverpool up to 17d. per pound for "selected native."

You will note that our annual rainfall averages 30 to 31 inches, and the general climate conditions are a brilliant hot sun by day and hard frost by night. If you would care to give the rams a trial in your district, I would be only too glad to assist at this end, in purchasing good hardy types for you. Please let me know if I can be of any further service.

(Signed) ROBT. J. STORDY, *Col.*
Director de la Granja Medelo de Puno.

Granja Escuela Oficial en Puno,
Chuquibambilla, Peru, *21st June* 1926.

To G. J. Fleming, Esq.

Dear Sir,—Reference is made to your letter of 6th April, addressed to the Secretary of the Textile Institute of Manchester, England, in regard to sheep improvement in Sudan. This letter, which was referred to Dr. L. J. Cole of the University of Wisconsin, has, in turn, been referred to this office for further attention. As the latitude of Sudan is considerably nearer the Equator than any portion of continental United States, the experience we have had with sheep in the United States may not apply directly to the belt you mention as the sheep country of Sudan. The Department of Agriculture has experimented with different types and breeds of sheep in the region of the Gulf of Mexico and the results of these experiments indicate that sheep of the fine wool type are better adapted to that region than breeds of the mutton type. The fine wool breeds, which we call the Rambouillet and the Delaine Merino, are produced successfully on the Edwards Plateau in the south-west part of the State of Texas, where the altitude is approximately 1,500 to 2,500 feet above sea level. That part of Texas is the farthest south of any of the territory of the United States where improved sheep are kept in large numbers, but in referring to the map you will notice that it is 15 to 20 degrees of latitude north of the latitude of central Sudan. In Texas it appears that the Rambouillet is somewhat more popular than Delaine Merino. This may be due to the fact that Rambouillets predominate in western United States and it is probably more convenient for the Texans to secure their breeding stock from the West than the East, where the Delaine Merinos are more numerous than Rambouillet. However, it is possible that the tendency of some Merinos to reproduce individuals with heavy folds may also influence the popularity toward Rambouillets, as Rambouillets are bred in large numbers in the West, where for several generations the breeders have endeavoured to establish strains that are free from excessive folding. Freedom from heavy folds and excessive wrinkles is considered quite an advantage, especially in a hot climate.

Dr. Cole in his letter to you of 16th June has given you some very good advice in regard to the various methods of crossing with the native sheep of Sudan as a means of testing the proportion of improved breeding that would be best suited to these conditions. We have no experimental evidence that sheep carrying some degree of inheritance of the sheep native to the southern part of this country would be any better adapted to that part of the country than pure bred Rambouillets or Delaine Merinos. Nevertheless in view of the fact that the southern part of this country is so much farther north than the sheep country of Sudan, it may be that our experience would not apply to your conditions. It appears that actual trial under the conditions of Sudan would be necessary in order to furnish definite information in regard to your problem.

(Signed) D. A. SPENCER,
Animal Husbandman in Charge Sheep and Goats Investigations.

Bureau of Animal Industry,
U.S. Dept. of Agriculture, Washington.
29th July 1926.

REVIEWS

Die Verwertung der Zellstoff-Ablaugen. By Dr. A. Schrohe; published by Otto Elsner Verlagsgesellschaft, Berlin (140 pp. and Index. 2 marks).

This book consists of abridgements of patent specifications filed since 1912, on the application of the waste liquors obtained during the manufacture of wood pulp. German, American, English, French, Austrian, Swedish, and Swiss patents are dealt with, the whole being classified in Section A, according to the particular uses for which the products are applied. These uses include the manufacture of alcohol, finishing materials, winding materials, fuels, manures, tanning materials, and others. In Section B the same patent specifications are arranged in the order of dates of application. The book is particularly useful to those inventors who are interested in securing patents on the subjects dealt with.

—W.H.

Technologie der Textilveredelung. By Dr. P. Heermann; published by Julius Springer, Berlin (632 pp. and index; 33 marks).

This book is a very useful treatise on bleaching, dyeing, and finishing of textiles. In the introduction figures for the world production of textiles are given which would be more useful if brought up to date. The first section deals with the textile fibres. An outline of the research work done in cellulose up to 1925, including the X-ray work of Herzog and others is given. The physical and chemical properties of cotton, kapok, vegetable silk, linen, hemp, jute, and ramie are dealt with, together with statistics of production. Wool, animal hairs such as camel hair, wild and cultivated silks, and also mussel or sea-silk are dealt with in a similar manner. The various forms of artificial silk are considered and figures for world production up to 1924 are given. A chapter is devoted to the consideration of the properties of water, its purification by filtration and chemical treatment by the most modern methods, with description of apparatus used and also the treatment of sewage of effluents from textile works. The chemicals used in the textile industry are then considered : acids, alkalis, salts, bleaching agents, mordants, tannins, and moth-proofing agents, soaps, oils, and finishing agents, as well as thickening agents used in printing, and finally dyestuffs, including mineral colours, natural dyestuffs, and all the artificial dyes applied in modern times. An account of the practical methods of mercerising yarns and fabrics is given, but some of the machinery illustrated is very out-of-date. The production of transparent, opalescent, and wool (philanising) effects is mentioned. A full account of all the processes used in the bleaching of cotton is given and mention is made of damages caused during bleaching. The bleaching of linen, hemp, jute, and ramie finds mention. A chapter is devoted to the scouring, bleaching, washing, carbonising, and milling or felting of wool; a sketch being given in proof of the scale theory of felting which the reviewer regards as obsolete. The degumming and bleaching of silk is described, as well as the boiling and bleaching of mixed goods. A section of the book is devoted to dyeing and deals with the theory of colour, colour harmony, and colour mixing according to Ostwald's theory, of which an account is given with diagrams. The various methods of dyeing are then described, including basic, acid, and mordant colours on animal fibres; and direct, basic, sulphide, mordant, and vat colours, as well as diazo colours, on cotton and artificial silk. Various types of apparatus are illustrated for dyeing and drying. The methods of weighting silk are considered as well as the after-treatment of dyed and weighted silk. The dyeing of leather, fur, feathers, horn, straw, wool, flowers, grasses, and paper are dealt with. A section is devoted to the printing of fabrics of wool, cotton, and silk; another to the finishing of cotton, linen, wool, and silk, in fabrics and also in yarn; another also to the waterproofing and rubbing of fabrics and to the fireproofing of fabrics. This book is invaluable to those engaged in the industries to which it refers.

—W.H.

GENERAL ITEMS AND REPORTS

"Dating of Patents" Committee

A Committee has been appointed by the Board of Trade to consider whether any, and, if so, what change is desirable in the practice of—

(*a*) Dating patents, applied for under Section 91 of the Patents Acts, as of the date of application in the foreign state; and

(*b*) Dating patents granted upon ordinary applications as of the date of application in the United Kingdom.

The main question which the Committee has to examine is whether this practice should be continued or whether patents granted upon applications made under Section 91 should bear some later date, such as the date of application in this country, or the date of grant of the patent, while still giving the applicant the priority as regards inventorship which must be given to him under international arrangements.

The Committee will be glad to receive suggestions or representations upon the matters covered by their terms of reference. In considering the questions involved, the Committee desires that due regard should be paid to all the interests involved, i.e., the interests of inventors, manufacturers, consumers, and the public generally. Communications should be addressed to the Secretary to the Committee, Mr. B. G. Crewe, The Patent Office, 25 Southampton Buildings, London, W.C.2.

British Association Meeting at Oxford ; 1926

The Hygroscopic Properties of Colloidal Fibres and their Relation to Technical Processes

Messrs. S. G. Barker, H. R. Hirst, and A. T. King, of the British Research Association for the Woollen and Worsted Industries, at a meeting of Section A of the British Association held on 10th August presented a paper under the above title in the course of which the theory of elasticity of colloidal fibres was developed, and it was shown that wool fibres possess the usual characteristics of colloids. Wool structure can apparently be represented by an elastic framework filled with a viscous medium. The effect of moisture absorption on the viscous phase was discussed, and it was stated that wool is a perfectly elastic material and makes a complete recovery from strain even up to its breaking point. The effect of moisture on thermal and electrical conductivity was discussed. In the former case it was shown that the increase in thermal conductivity of dry material for an increase of moisture content of 1% of the dry weight, ranges from 0·0000017 to 0·000002 for wool. The electrical conductivity is shown to increase with moisture content and it is noted that perfectly dry fibres are non-conducting.

Following an outline of the distinctive regain characteristics of wool as compared with other fibres, the relation between density and regain was discussed and an expression devised connecting apparent density with regain. Reference was made to the regain and swelling exhibited by wool with other liquids than water, especially with ethyl and methyl alcohols, and to the significance of this in arriving at the true density of wool by displacement methods, this value, 1·30, being obtained in benzene in which wool exhibits no regain or swelling. The variation of the true density and the apparent density in water, with regain was shown graphically A mathematical relation between the apparent specific volume, swelling and sorption (or liquid regain) in any liquid sorbed by wool was derived, which in the case of water, gave a calculated swelling in close agreement with the observed values. Reference was made incidentally to the analogous behaviour of gelatine.

The mechanism of the heat of wetting was discussed in relation to regain, swelling, and rate of evaporation, and the several theories of solid solution, liquid film compression, and surface area due to porosity were referred to. The evidence for porosity was discussed in detail and the conclusion was reached that the various phenomena are explained by assuming the keratin substance of wool to be of the type of structure observed in dried gelatin jellies, rather than to the surface area or due to any grosser heterogeneous structure such as would be involved in the individual cells of scales or cortex, or the easily observable pores found by Mark.

The swelling of wool fibres has been investigated by the authors, and the results of such swelling in air of various relative humidities and in water, alkalis, acids, and organic liquids recorded. The accompanying physical changes due to sorption of moisture which may be described as variation in plasticity or pliability, were shown to be of great importance in technical processes of the wool industry. The significance of the hygroscopic characteristics of wool fibres with regard to manufacturing processes was also described.

Investigation of the fading of worsted cloths dyed with typical dyes of different chemical constitution, exposed to sunlight and air in India and at home, shows that there is a relation between loss of colour and the amount of moisture in the atmosphere. The sensitiveness of wool to bacterial damage has also been investigated, and shown to reach a maximum at the point of extreme saturation with moisture. In this connection reference is made to the damage caused by uneven trade conditioning.

The Colour Users' Association

Addressing the seventh annual meeting of the above Association on Tuesday, 27th July, Mr. H. Sutcliffe Smith, the Chairman, said that he thought the work done by the Association during the past year had proved extremely useful to all colour users and he thanked the Council, the staff, and all members for their share in the work accomplished. He then proceeded to review the work of the various standing Committees of the Association, and, referring to the Dyestuffs Advisory Licensing Committee, thanked the representatives of the Colour Users' Association for their services on this important Committee. Some idea of the magnitude of the work involved might, he thought, be gathered from a consideration of the figures of the Board of Trade covering licenses granted during the five years 1921 to 1925. In 1921 licenses covering an importation of nearly 3,000,000 lb. of dyestuffs valued at over one million sterling had been granted, while in 1925 the poundage had increased to 3¼ million pounds, though for obvious reasons the value had dropped. He suggested that the importation of approximately 1,500 tons of dyewares in 1925 compared with a pre-war importation of 18,390 tons, indicated considerable progress on the part of British makers, but suggested that there still remained a wide field of enterprise which should have the very close consideration and immediate attention of dyestuffs makers. "Unless British makers," said Mr. Smith, "make the fullest use of the remaining period of the Dyestuffs (Import Regulation) Act and are able to meet the complete demands of British users, particularly in the better types of vat colours and the specialities now offered by foreign makers, they will be in a serious position when the British market is eventually exposed to open competition." Turning to the work of the Joint Technical Committee of the C.U.A., Mr. Smith said that in his opinion there was one particular question in regard to which the services of this Committee would be of great assistance. He was convinced that something should be done to reduce the number of brands of dyestuffs now on the market. Hundreds of dyestuffs were produced yearly, of which only a few pounds had been sold. This was wasteful and uneconomical and if users would concentrate on fewer types for which they could give larger orders, makers would have a chance to produce economically and quote lower prices. Mr. Smith, considering the requisitioning of reparation colour from Germany by the United Kingdom, pointed out that no colour had come into the country under this head and that of the stock of colour on hand at the end of last year only about 450 tons remained to be disposed of. Reparation colour, he said, was still being imported by France, Italy, and Belgium, but as such colours were now being sold on a commercial basis no undue advantage was being given to the consumers in those countries. Continuing, the Chairman again drew attention to the great developments in the chemical industries achieved since his previous address. More particularly had these developments taken place in Germany and they were characterised by consolidation of interest, research on wide lines, and production in big units. He was satisfied, however, that there was evidence of continuous progress in the British dyemaking industry, but he wished to emphasise the vital importance of fundamental research and to point out that there was also a wide field for research into the improvement of technical methods. The Dyestuffs Industry Development Committee, the British Dyestuffs Corporation, Ltd., and the Interessen Gemeinschaft with its distributing company in this country were then dealt with by Mr. Smith, who concluded his address with comments on the observations of the deputation from the Association to France, Italy, Belgium, and Germany to consider dyestuff prices in those countries, and said that a complete report from the deputation would shortly be ready.

34—THE BLEACHING OF WOOL WITH SULPHUR DIOXIDE

A SUMMARY OF THE LITERATURE

By E. F. H. Cook

(The British Research Association for the Woollen and Worsted Industries)

INTRODUCTION

If wool is treated with sulphur dioxide, washed with water, and subsequently reoxidised, it will be found to have undergone certain changes. The natural colouring matter of the wool which is insoluble in water has been reduced, and with the SO_2 forms a water-soluble, colourless leuco compound, which has to be washed out well if the bleach is to be fairly permanent. The process is called "sulphuring," and is the oldest and cheapest method of bleaching wool. It was already practised in the Middle Ages on very much the same principles as it is to-day, and no operation in bleaching has changed so little during the centuries. According to the form in which the SO_2 is applied, either in the form of gas or dissolved in water, one can distinguish between "gas bleaching" and "liquid bleaching," and of these two methods the former is more generally employed.

With regard to the results obtained with either method, it may be said that neither sulphur fumes nor the liquid give a really genuine bleach. The sulphur whites are all more or less unsatisfactory because they are not permanent. The oxygen of the air reoxidises them back to their original condition, an action which is greatly hastened by moisture, sunlight, and air. (It will be noted that the fact that the colour returns does not agree with the statement that the leuco compound must be or can be washed out. Raynes[24a] shows that dry wool forms a yellow compound with SO_2; this may explain the discrepancy.) The rough and harsh handle which the sulphur imparts to wool, and the smell of it, which is extremely difficult to eradicate from the goods, are further disadvantages of the sulphur bleach.

Many of the processes described involve the use of oxidising substances (e.g., permanganate) either before the SO_2 or after to remove the excess. There seems to be little evidence of advantage in these more elaborate methods.

TECHNICAL APPLICATION

The Gas Method

The wool is well scoured to free it from soap and grease, exposed to the gas for from 6-24 hours, according to requirements, then aired and rinsed, treated with oxidising agents if necessary, and again rinsed in water. The foregoing is a general outline of the process, but a number of good descriptions of the same will be found in current text-books, [7, 8, 9, 21, 25, 36, 37], which differ only slightly in details of mechanical equipment or length of exposure to the gas.

The bleaching action of sulphur dioxide on the wool is explained by Bottler[2] in the following way—A colourless compound forms between the colouring matter of the wool and the dioxide, and is removed by washing, as it is liable to undergo decomposition after a time, thus causing the wool to resume its natural colour. He attributes the harsh handle of wool not to sulphuring, but to rinsing in impure or hard water. Cooper[4] is of the opinion that the SO_2 in some cases decomposes the water present, liberating hydrogen, which in its turn reduces the coloured body.

According to Beech,[1] the gas method is not an effective process, as the colouring matter is not destroyed, but only enters into a chemical combination. Another defect, he states, is that the sulphur volatilises, settles upon the wool, and turns it yellow. To restore the suppleness of the wool, which sulphur bleaching leaves rather hard, the author recommends washing in weak soft soap or soda, care being taken that the alkaline treatment is not so strong as to neutralise the bleaching effect.

Hummel[12] considers that the bleaching action of sulphur dioxide is most probably due to its reducing action upon the natural yellow colouring matter of wool, or perhaps to the formation of a colourless compound with the latter. But the effect is not permanent. Frequent washing in alkaline solution tends to restore the yellow colour of the fibre, which is to be explained according to Hummel[12] in the following way—it either induces oxidation or the colourless bisulphite compound is decomposed and the original colouring matter is precipitated on the fibre.

Meister, Lucius & Brüning[20] point out the disadvantage of the sulphur bleach of only transforming the yellow of wool temporarily into a colourless body, and of acting destructively on many colours if all traces of sulphur dioxide are not removed, but they consider it to be cheaper and easier to operate than any of the oxidation methods. They further state that sulphur whites change their shades considerably in the subsequent processes of milling and steaming if Methyl Violets have been used for tinting.

Heermann[11] is of the opinion that on the whole the gas method is not supposed to be so thorough as the liquid process, but where the gas comes properly into contact with the fibres, it is more effective than the solution. He, too, advocates clean and if possible soft water, as unsuitable water gives wool a harsh handle. To prevent this harshness, he applies a weak soap bath before sulphuring, and adds soda or soap to the rinsing water to neutralise the acid, and at the same time remove the reaction products of the wool dyestuffs. This is especially important as bleaching has only converted the colouring matter into a leuco compound and not destroyed it.

In connection with the effect of sulphur dioxide on wool it is interesting to note Matthews'[17] observation, that besides giving the fibres a harder and rougher handle, it lessens their lustre. He, too, points out the difficulty of removing SO_2 from wool, but thorough washing with iron-free water, or in some cases weak baths of chloride of lime, sodium hypochlorite, potassium permanganate, or hydrogen peroxide should free the fibre from it and restore the pleasant handle. Of these oxidising agents he believes hydrogen peroxide to be the safest. It converts the SO_2 into sulphuric acid, which is easily removed by washing, and, further, there is no danger of an excess injuring the fibre. Chloride of lime, although it neutralises the injurious effect of sulphurous acid, and also increases the affinity of wool for many dyestuffs, gives injurious results if all the chemical is not subsequently removed. In another of his books Matthews[18] discusses the practical impossibility of removing every trace of sulphurous acid by washing, however thorough it may be, as the wool apparently combines chemically with it. Sulphurous acid, he states, holds the pigment in the fibre in a reduced state so that the bleach lacks permanency, and, further, the presence of sulphurous acid is liable to act injuriously on other colours with which the wool may subsequently come into contact.

Numerous secondary effects of the stoving process are discussed by Schofield,[30] who maintains that some SO_3 is formed at the same time, which combines with the moisture to form sulphuric acid in the fabric, and the concentration of this acid during drying may deteriorate the material.

Ristenpart and Herzfeld[27] allow sulphur dioxide to act on the wool overnight and longer, and especially point out that the goods must be moist, as the dry gas does not bleach. Matthews[18] makes a statement to the same effect, that the wool should be moist, not wet, as the gas only acts slowly on dry wool. He exposes the material to the gas for 10-20 hours. Walland[34] in his description of the gas bleaching method, advocates the presence of sufficient oxygen in the sulphur chamber, otherwise the sulphur dioxide is mixed with sulphur fumes, which condense in cool places and form yellow stains.

According to Bottler[3] the bleaching operation lasts from 6-8 hours, and if necessary is repeated two or three times. Treatment with a warm solution of soda and soap then follows, which removes the excess of acid and (he says) also the converted colouring matter. It also makes the wool supple and soft. This author further remarks that although the soda gives wool again rather a yellowish tinge, this can be removed by sulphuring and washing once more.

With reference to the use of potassium permanganate for oxidising purposes, Matthews[18] recommends great care not to employ an excess beyond that which is necessary for the reaction, otherwise a brown deposit of an oxide or hydrate of manganese will form on the wool. Subsequent treatment with sodium bisulphite, he states, again removes this deposit. Knecht, Rawson, and Loewenthal[15] counteract the small amount of yellow which remains in the wool after stoving, by blueing or tinting with a colour complementary to yellow. A similar method is recommended by Meister, Lucius & Brüning,[19] who pass the wool through a weak soap bath, which for special shades is tinted with suitable blue or violet colours. The bleached material must not be dried at too high a temperature.

Sulphur Stoves &c.

Much of the plant in use to-day is still very primitive. A chamber of four walls and a pan in the corner upon which the sulphur is burnt, constitute the whole equipment, and although newer stoves are better constructed, they still adhere closely to the old system. The most notable modification is that the sulphur is sometimes burnt in a separate compartment, the gas being led or driven by a fan into the bleaching chamber.

An example of this type of generator is the Clayton; the air and gas is continually circulated from the bleaching chamber through the burner and back to the chamber. In this manner a greater concentration of gas is obtainable, and the concentration is easily controlled.

Hummel[12] describes a stove of the above old style, and one in which the operation is made continuous for thinner materials. The latter is provided internally with a wooden frame, having rollers above and below. The roof is lined with lead and heated with steam pipes to prevent condensation. The stove is charged with sulphur dioxide by burning the sulphur inside or preferably outside, and leading it in underneath a false perforated floor. The cloth is introduced through a narrow slit in the wall, passes under and over the rollers and out again by the same opening. A similar stove is also described by Beech.[1] Further technical details of sulphur stoves are given by Paterson,[22] who holds that they require to be spacious, although not too roomy, in order to give free access to all parts of the yarn, so that full advantage may be taken of the sulphur consumed. If the chambers are built of brick, the walls must be lined with wood, as SO_2 so acts on the bricks and lime as to disintegrate them in time. He also recommends special attention to the heat of the ball used for igniting the sulphur, and the proper admission of air into the chamber. Zänker[37] describes a stove only differing from the above in that the gas is passed underneath the roof instead of the floor. According to the size of the chamber, two, three, or more sulphur pans are used, so that the sulphur does not sublimate, but burns completely. A vessel containing water should be placed inside the chamber to produce the necessary moisture. Bottler[3] recommends passing wool fabrics &c., which are to be bleached, slowly through the sulphur stoves instead of hanging them up, and describes a stove with ventilation holes, which open and close automatically with the varying pressure. By covering the sulphur pans with a lead-coated shield and a piece of felt, sulphur is prevented from settling on the goods.

A good illustration of a continuous sulphur stove is given by Reiser.[25] It really consists of four chambers—(1) containing the sulphur pan, (2) a chamber where the sulphur fumes are distributed and pass through an opening into (3), the actual sulphur chamber, at each side of which are continuously rotating rollers, and (4) a ventilator. In some sulphur stoves the motion of the goods is not a horizontal but a vertical one, and in the latter case the fumes rise to the top and are distributed more easily.

It may be noted that when a continuous fabric is to be treated the method of passage over rollers offers advantages. If also one of the methods of recirculating the chamber gases through the burner be used, thus obtaining a high concentration of gas, then the time necessary for treatment may be very brief.

Matthews,[17] in his detailed account of various forms of bleaching chambers emphasises the necessity of providing suitable means of ventilation and heating coils to prevent drops of condensed acid forming on the roof. The presence of metals in these rooms should be avoided, as acid vapours forming therein will rapidly attack them, and the products dropping on the wool will cause stains. He further describes a convenient apparatus devised by Shaw for bleaching wool materials with compressed sulphurous acid gas in an airtight vessel, where it is supported on a perforated beam. It consists of a cylinder containing the liquid sulphurous acid which is connected to an expanding chamber. This in turn is connected with a cylinder through which a perforated pipe leads up through the material to be bleached. The air having been exhausted from the expanding chamber, sulphurous acid is admitted until a pressure of about one atmosphere is attained. Shaw also describes this same apparatus in his patent (1901).[32]

In some old patent specifications the gas method of bleaching wool &c. is described as follows by Dale and Dale (1866).[5] The fabrics are placed in an airtight vessel into which sulphurous acid produced by burning sulphur in air or by heating sulphuric acid and charcoal, is introduced either alone or mixed with steam. Piece goods may be wound on a perforated pipe, and the sulphurous acid forced through them, either alone or mixed with steam, or water may be supersaturated with sulphurous acid and used instead of the gas. Sachs (1876)[28] patented the following procedure. Wool after washing with a weak solution of chlorine is treated with a solution of potassium permanganate, and then subjected to the action of sulphur vapours in a closed chamber. The materials are then washed with a weak alkaline solution. In some cases a small quantity of magnesium sulphate is added to the permanganate solution. A patent taken out by Margotin (1909)[16] describes an apparatus and means of preventing alteration in the fibre, or the production of yellow stains, due to the action of the air, and also to avoid the escape of SO_2 into the atmosphere. In addition to the usual closed vessel this comprises—(1) The driving of SO_2 out of the vessel into water or an absorbent solution of soda or lime by compressed air; and (2) prior treatment with a solution of potassium permanganate, hydrogen, or other suitable peroxide, to prevent any harmful action by the compressed air.

The Liquid Process of Bleaching

For this purpose aqueous sulphurous acid or sodium bisulphite solution are usually employed, and bleaching by means of the liquid method is considered to be as powerful as bleaching with sulphur dioxide gas. The goods are worked and steeped in a bath containing bisulphite of soda, sulphuric or hydrochloric acid, and *iron-free* water, treated with oxidising agents and tinted with alkali violet or some other colour. If the whites are required to withstand milling, the use of indigo in the bleaching bath or afterwards is advisable. In a paper on bleaching with sulphurous acid or bisulphite of soda (*J. Soc. Dyers and Cols.*),[38] the suitability of both agents for the purpose are compared, and the bisulphite of soda is considered to be more suitable, as it dissolves the brown shade of manganese oxide from the fibre more easily.

The whites obtained with the liquid method are not more permanent than those produced by sulphur dioxide, but a better clearance of the sulphur smell is possible (*Text. Rec.*).[39] Matthews,[17] however, is of the opinion that although the whiteness produced by the liquid process is of the same degree as that obtained with the stoving method, it is more permanent, and when dry the wool is free from the smell of sulphur. The writer assumes that this greater permanency of the white is probably due to the better penetration of the bleaching agent into the core of the fibre.

Liquid bleaching is not any more perfect than gas bleaching, according to Beech,[1] as the colour is liable to return on washing with soap or alkalis. It is, however, free from the defect of producing yellow stains. Paterson[22] considers the wet process to be the best theoretically, but the bleaching action seems to take longer than by the gas method. Zänker[37] and Murphy[21] both state that the liquid bleaching method is generally preferred to the SO_2 method, especially for piece goods, as a better control during the process is possible. Meister, Lucius & Brüning[19] find that the shades are not as pure as those obtained by bleaching in sulphur chambers.

Details of the bisulphite process are given by Matthews[17] as follows—The material is steeped for 6-10 hours in a sodium bisulphite bath of about 2° Tw., and subsequently in a bath of sulphuric acid at 1° Tw., which renders the bleaching complete. The whole process lasts from 6-24 hours. Treatment with chloride of lime or other oxidising agents removes the last traces of sulphurous acid. The writer points out the necessity of thorough scouring and hydro-extracting before bleaching, as cloth, if too wet, will not take up the bleaching liquor properly, and if too dry the bleaching is uneven. Bottler[2] advocates a solution containing sodium bisulphite and hydrochloric acid, the operation being equivalent to bleaching in a solution of common salt saturated with sulphur dioxide. Beech[1], too, recommends a weak hydrochloric acid bath after steeping in a bisulphite solution for one hour, as this liberates sulphur dioxide, which in a nascent condition is more powerful than if it were already free.

With regard to the strength of the solutions to be used, Hummel[12] is of the opinion that bleaching is more effective by leaving the wool in a sodium bisulphite solution of 20° Bé for 10-15 hours, and then immediately treating with sulphuric acid of 4° Bé, than by bleaching in dilute solutions. Zänker[37] uses three baths. A preliminary bath containing potassium permanganate and soda, a bath 2-3% of sulphurous acid or sodium bisulphite of 3°-5° Tw., and a second bisulphite bath or an almost boiling solution of oxalic acid. In an anonymous paper on sulphur bleaching (*Text. Rec.*),[39] it is suggested that by giving the acid bath separately the method is far more effective than by combining it with the bisulphite bath, as then the acid liberates sulphurous acid within the fibres themselves. A recent patent by Griesheim-Elektron claims the use of sodium bisulphite of 0·5 to 1·0 B for 2 to 5 minutes.

According to an earlier patent by Smith (1875),[33] wool is subjected to the successive action of warm oxidising baths, followed by washing with alkaline sulphites and warm or cold liquors of bisulphites or sulphurous acid. After being subjected to the action of dissolving agents or oxidisers, the goods are sufficiently bleached to receive any dye. Sahlström and Parr,[29] in their patent (1892), treat wool successively with a solution of permanganate of potash, air, liquid, or gaseous sulphurous acid, water, and a current of oxygen or ozonised oxygen. Jardine and Nelson,[14] in a more recent specification (1914), bleach textile fibres under pressure with magnesium or sodium bisulphite, the liberated gases being removed in order to prevent deterioration of the fibre by the liberated sulphur dioxide.

Many other accounts of the bisulphite method which only vary in a few details are to be found in current literature by Matthews,[18] Hummel,[12] Knecht, Rawson and Loewenthal,[15] Paterson,[22] Meister, Lucius and Brüning,[19, 20] Walland,[34] Heermann,[11] Bottler,[3] Ganswindt,[9] Schreiber,[31] E. P. Paterson,[24] &c.

Sulphurous acid can also be substituted by sodium hydrosulphite, and Matthews,[17] Bottler,[2] Knecht, Rawson and Loewenthal,[15] Dommergue,[6] *Text. Rec.*,[39] and patent specification Imray,[13] have described processes of this kind. Small quantities of finely ground indigo, thin milk of lime until alkaline, and acetic acid are usually added to the hydrosulphite vat. The indigo is converted into indigo white, and absorbed by the fibres in this condition, the blue colour being regained on exposure to air. Knecht, Rawson and Loewenthal[15] immerse the goods in the above vat for 12-24 hours, while Matthews[17] considers soaking for 6-8 hours in a hydrosulphite solution at about 2° Tw. sufficient. Dommergue[6] points out the necessity of washing and rinsing the wool out of contact with air during the process, otherwise heating takes place and the material is damaged. He further suggests that if the pieces are marked, they should be passed through a bath of dilute hydrochloric acid.

The use of hydrosulphite of soda in conjunction with barium chloride for the purpose of bleaching wool is described by Graham and Cope in their patent.[10] The goods are bleached by immersing in a solution obtained by treating sodium bisulphite with zinc powder, decanting, and adding barium chloride paste to the liquid, and then washed in potassium permanganate.

Bottler[3] and Zänker[37] give details of the method of bleaching with hydrosulphurous acid as follows—The wool is treated for 12-24 hours in a bath of dilute hyposulphite (3°-4° Bé) and acetic acid, exposed to air, washed and dried.

Wirth (1876)[35] has patented the following procedure—The wool is passed through a bath of indigo, and is then placed in a vat containing hydrosulphite and some acetic acid, air being excluded. The indigo is reduced to indigo white, which on exposure to air becomes permanently blue, neutralising the yellow of the wool. The bath may then be used for a second operation with addition of a further quantity of hydrosulphite. The fibre is taken out and hydrochloric acid added until sulphurous acid gas is given off from the sulphites present. The fibre is replaced and bleaching completed by the sulphurous acid. After-treatment with acetic acid finishes the process. Wirth suggests the use of neutral hyposulphite for bleaching wool of a very yellow colour.

INVESTIGATIONS ON THE CHEMISTRY OF THE PROCESS

On the subject of fixation of sulphur dioxide by wool, during the bleaching process, some interesting investigations have been made by Reychler,[26] from the results of which he concludes that the amount of gas fixed by wool depends partly upon (*a*) chemical combination, but (*b*) mainly upon absorption (solution) of the gas by the fibre.

The following is the method which Reychler[26] used for this determination—The material was placed in a dry atmosphere of sulphurous acid, mixed in various proportions with air. C and c respectively denote the number of molecules of SO_2 per kilogram of wool and per litre of gas. In the case of fat-free wool containing 11·4% of water, the relationship between C and c is given by the equation $C=0{\cdot}88+44{\cdot}7c$, provided c is greater than about 0·005 molecules per litre. When the concentration of sulphur dioxide is smaller than this, the amount absorbed is less than that required by the equation, and the difference between the two quantities increases as the concentration diminishes. This shows that the quantity combined increases first with the concentration, but attains a maximum, represented by 0·88 molecules of sulphur dioxide per kilogram of wool.

Some figures obtained by Raynes[24a] agree fairly well with those of Reychler, but he can find no proof of the presence of a chemical compound in measurable amounts.

Paterson,[23] in his paper dealing with the affinity of wool for SO_2, writes that sulphur dioxide is retained so strongly by wool that drying stoved yarns at 160°-212° F. will not remove it. Yarns wound on bobbins were found to retain SO_2 after 12 years on the inside where it is not exposed. When he exposed sulphured yarns to strong direct sunlight for 10 days, he found that nearly two-thirds of the adsorbed SO_2 changed into sulphuric acid. A sample of ordinary sulphured yarn after heating for four hours to 160° F. to expel the excess of sulphur dioxide, was steeped for 12 hours in cold water and gave up 0·56% sulphur dioxide, but if exposed to sunshine will yield to the water only 0·17%, the rest being in the form of sulphuric acid.

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35—THE BLEACHING OF WOOL WITH SULPHUR DIOXIDE AND SULPHUROUS ACID AND A NOTE ON THE PRESENCE OF A CARBONYL GROUP IN WOOL

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THEORETICAL CONSIDERATIONS

SUMMARY AND CONCLUSIONS

The bleaching of wool by sulphurous acid has previously been attributed to (*a*) the conversion of the colouring matter into a soluble substance, (*b*) reduction to a colourless compound, (*c*) combination to form a colourless compound.

It is shown in the present communication that at least two distinct components of wool combine with sulphur dioxide. The one of these, apparently itself colourless, gives a lemon-yellow product, which may be prepared from nearly dry wool, and is only produced when a high concentration of sulphur dioxide is used; this substance is very unstable, being completely decomposed in a vacuum. This yellow body and this reaction do not seem to be connected with the bleaching effect. It may be suggested that some colourless amino-compound of the wool is converted by combination with sulphur dioxide (possibly only in the presence of a trace of water) into a coloured quinonoid salt, just as colourless amino-derivatives of triphenyl carbinol are transformed into coloured compounds by interaction with acids.

The other component of wool which combines with sulphur dioxide does so only in the presence of appreciable quantities of water, and is possibly a coloured carbonyl compound which gives a colourless additive product

$$>C\begin{matrix}\diagup OH \\ \diagdown O{\cdot}SO{\cdot}OH\end{matrix}$$

This substance is relatively stable in a vacuum, but is very slowly decomposed on exposure to light and air, the wool being then debleached; it is slowly decomposed by prolonged washing with water, and very quickly by alkalis.

The bleaching of wool with sulphur dioxide in the presence of moisture does not depend to any appreciable extent on the reduction of any component by the addition of hydrogen and simultaneous formation of sulphuric acid.

The presence of carbonyl compounds in wool seems to be established by the behaviour of the material towards hydroxylamine and semicarbazide, but from the fact that wool bleached with hydrogen peroxide still reacts with hydroxylamine, it would seem that there are both coloured and colourless carbonyl-compounds in the fibre.

From a very comprehensive survey of the literature dealing with the bleaching of wool by sulphur dioxide and sulphurous acid,* it is clear that

* As facilities were not available in Nottingham for a thorough search of the literature, the British Research Association for the Woollen and Worsted Industries kindly placed at the author's disposal an epitome by Miss Cook of some forty papers and text-books on the subject; the author wishes to express his gratitude for this assistance.

very little is known about the chemical changes which occur in these operations. Some writers (Bottler, "Modern Bleaching Agents and Detergents") suggest that the natural colouring matter of the wool, which is insoluble in water, is converted into a soluble substance, which is removed when the material is subsequently washed. According to Cooper ("Textile Chemistry"), this conversion is due to reduction, involving the simultaneous oxidation of the sulphurous acid, but Hummel ("The Dyeing of Textile Fabrics") suggests that the sulphurous acid combines with the colouring matter to form a colourless product.

From a theoretical point of view, no other suggestions of importance have been made, and any further reference to the original papers or text-books would therefore be of little value; the matters there dealt with concern rather the non-permanency of the sulphur bleach, the relative merits of the dry (gas bleaching) and wet (liquid bleaching) processes, the effect of the treatment on the properties of the wool, and other questions of practical importance, which throw no light on the chemistry of the process.

The first experiments which were made had for their object to ascertain whether any component of wool does or does not combine with sulphur dioxide. For this purpose unbleached wool, dried at 100° C., was treated with dry sulphur dioxide in the absence of air; instead of being bleached, the wool turned a distinct lemon yellow colour, which persisted even after prolonged action. A similar development of colour also occurred when the wool was treated with a sufficiently concentrated solution of sulphurous acid. As it is difficult to conceive that such an intense coloration could be produced by simple adsorption, it must be concluded that chemical combination occurs between the sulphur dioxide and some component of the wool. The yellow compound so formed, however, is most unstable, since, when the coloured wool is placed under highly reduced pressure it regains its original (unbleached) appearance; the same result occurs when pure nitrogen, hydrogen, oxygen, or carbon dioxide is passed over the yellow material, and also when the latter is treated with a sufficient quantity of air-free water. It appears therefore that the yellow additive compound dissociates or decomposes even at ordinary temperatures. It may also be inferred that the yellow compound is not formed from that colouring matter which is rendered colourless in sulphur bleaching; because, whereas both wet and dry wool give the yellow product, the former only is bleached when the sulphur dioxide is subsequently removed under reduced pressure. In other words, the disappearance of the lemon yellow colour is not necessarily accompanied by the bleaching of the wool; whether the latter is bleached or not depends on some other change which has taken place previously, during the actual development of the yellow colour. In order to try and obtain further evidence of chemical combination, very careful experiments were made on the absorption of sulphur dioxide by wool both in the "dry" condition and in the presence of known quantities of water. For this purpose it was necessary to devise an apparatus consisting entirely of glass, because it was found that rubber stoppers and connections absorbed appreciable quantities of sulphur dioxide.

The wool which was employed was first extracted with ether in a Soxhlet apparatus, then thoroughly washed with water at 50° C., extracted with pure alcohol, and dried at 103° C. in a conditioning oven.* For those experiments in which moist wool was used, a known weight of the dried materials was then exposed to moist air or damped with water; from the gain in weight the percentage of moisture in the product could be ascertained. The absorption experiments were carried out under atmospheric pressure, pure dry sulphur dioxide being used; most of the gas was absorbed during the first ten hours, but not until about twenty-four hours had elapsed was absorption practically complete.

From the results of four concordant experiments it was found that one gram of "dry" wool at 17° and 760 mm. pressure absorbs 55 c.c. of sulphur dioxide. The presence of a small quantity of added water did not make any appreciable difference to the result, but when the wool carries 75-100% of its own weight of added water, the volume of gas absorbed, calculated for one gram of "dry" wool, increased to 90 to 102 c.c From the average value thus obtained in all the experiments it was found that the increased absorption which occurs in the case of the wet wool corresponds very closely with that which should be observed if the additional volume of gas is merely dissolved in the water present. Thus one gram of "dry" wool, plus 0·75 gram of water, absorbs 89 c.c. of sulphur dioxide. But 0·75 gram of water at 17° and 760 will dissolve 35 c.c. of the gas; subtracting this volume from the total, the absorption due to the wool is 54 c.c., a volume almost identical with that obtained with "dry" wool and with wool containing not more than about 2% of additional moisture.

As it is highly probable that the weight of the sulphur dioxide which acts chemically on the coloured components of wool is very small compared with that of the wool, it was not very likely that any conclusions could be drawn from the final results of such absorption values, since even the "dry" wool would contain water sufficient to catalyse chemical action; for this reason the *rate* of absorption was also studied, and at the commencement of each experiment readings were taken at intervals of fifteen seconds, the absorption values being then plotted in the form of curves. It was hoped that in this way some evidence of chemical combination might be forthcoming, but this was not the case; the regular parabolic curves which were obtained showed no initial irregularities such as might be taken to indicate a rapid chemical combination.

Reychler (*J. Chim. Phys.*, 1910, 8, 3) exposed wool containing 11% of water to mixtures of sulphur dioxide and air of varying and known concentrations, and suggested that his results afforded some indication of chemical combination to a maximum extent of 0·88 mol. of sulphur dioxide per kilogram of wool. The author's observations do not substantiate Reychler's suggestions in this respect, although the experimental absorption values are not discordant. Thus the total maximum absorption, chemical and physical, which Reychler observed was 64 c.c. per gram, compared with about 60 c.c. found by the author. The difference between these

* I am informed by the Director of the British Research Association for the Woollen and Worsted Industries that work which has been carried out and is still in progress shows that commercially "dry" wool may still contain from 1% to 2% of moisture. The commercial method of determining "regain" involves heating the wool in air to a standard temperature above 100° C. The Bradford Conditioning House uses a temperature of about 115° C. (235°-240° F.).

If wool be heated however in dry air (dried by passage over the usual drying agents) there is a further loss of from ½% to 2%.

In the present paper the samples were heated to 103° C and may therefore be assumed to have contained up to 2% of moisture.

I am unable to continue this work at present but the action of SO_2 upon chemically dry wool might repay study at other hands.

figures is probably due to differences in the methods of scouring the wool and to differences in the original samples themselves; it is quite conceivable that wools from different sources would show different absorption values.

In spite of the negative, quantitative results described above, qualitative experiments showed distinctly that the bleaching of wool with sulphurous acid involves the chemical combination of the acid with some component of the material. When moist wool, bleached with sulphur dioxide, is subsequently washed well with several portions of distilled water and then left in a vacuum over caustic potash during a period of about two weeks, it undergoes no visible change; but when it is then treated with dilute sulphuric acid it is partially debleached, and a distinct smell of sulphur dioxide can be detected. It may be concluded therefore that one factor in the bleaching of wool with sulphur dioxide is a combination of a coloured component of the material with the gas, or more probably with sulphurous acid; if the latter merely combined with some colourless amino-acid or other basic substance to form a sulphite, the decomposition of such a salt would not be accompanied by a debleaching effect. It seems probable therefore that the coloured substance which combines with the sulphurous acid is quinonoid in constitution, or at any rate a carbonyl compound (see later p. T383); the additive product, moreover, contrary to what seems to be assumed by some writers, is obviously only sparingly soluble in cold water.

Attempts were next made to find out whether, in addition to the fixation of sulphurous acid, there was any reduction of a coloured substance to a leuco compound; if such a change occurred, sulphuric acid must also be produced, $H_2SO_3+H_2O=H_2SO_4+2H$, and its presence, after bleaching, if established, would lend strong support to the view that a leuco-compound is formed.

Since sulphur dioxide is oxidised by atmospheric oxygen, and is appreciably decomposed by light, giving sulphur, sulphuric acid, and certain thionic acids, these experiments were very troublesome; but apparatus was devised in which wool, which had been previously extracted with alcohol and ether and then well washed with a dilute solution of sodium carbonate until free from sulphates, was treated with pure sulphur dioxide in glass vessels coated with black enamel. The occluded oxygen in the wool and the atmospheric oxygen in the apparatus were removed by filling the whole system with pure hydrogen and then exhausting, these operations being repeated six times before admitting the sulphur dioxide; the hydrogen was freed from oxygen by passing it through three wash bottles containing an alkaline solution of pyrogallol.

After displacing the hydrogen by pure sulphur dioxide and leaving the wool in contact with the gas for about twenty hours, the sulphur dioxide was removed as far as possible by prolonged evacuation; an air-free 4% solution of sodium carbonate was then admitted into the apparatus to extract from the wool any sulphuric acid which had been produced, and the extract was run into excess of dilute air-free hydrochloric acid; the acid solution was then evaporated almost to dryness under reduced pressure. All these operations were carried out in the closed glass apparatus in absence of oxygen and of light.

The concentrated acid solution was next diluted and filtered (in the air) in order to free it from traces of sulphur, produced by the interaction of sodium sulphite and sodium sulphide, the latter of which is formed by the action of sodium carbonate on the wool; the filtered solution was then treated with barium chloride solution, and the weight of the precipitated barium sulphate determined.

Four very concordant experiments gave an average of 0·023 gram of sulphuric acid when the weight of the wool, containing 13 per cent. of water, was 50 grams; or 0·053 gram of sulphuric acid per 100 grams of "dry" wool. Further experiments showed, however, that it is very doubtful whether even the small quantity of sulphuric acid which was found in the experiments just described had any connection whatever with the bleaching of some coloured substance, because if this acid had been produced as the result of the formation of some leuco-compound, a repetition of the experiment with the same sample of wool, now bleached and left in the air-free apparatus, should give a much smaller quantity of the acid or none at all. A second treatment was therefore carried out exactly as before, except that no hydrogen was used, because there was no air in the apparatus; the quantity of sulphuric acid obtained in this second treatment was practically the same as in the first, and in fact the same wool, treated ten times with sulphur dioxide in the total absence of oxygen, gave each time approximately the same amount of sulphuric acid as in the first experiment. An obvious explanation of these results would be, of course, that oxygen gained admission during the experiment, owing to defective apparatus or that the sulphuric acid was contained in the reagents which were used; several blank experiments were therefore carried out, using a little concentrated solution of sodium carbonate in the place of the wool, all other conditions remaining unchanged; not a trace of sulphuric acid was produced in any case. No satisfactory explanation of this formation of sulphuric acid can be advanced, but the conclusion seems to be justifiable that the bleaching of wool with sulphur dioxide does not involve the addition of hydrogen to a coloured substance. This conclusion is confirmed by the fact that when unbleached wool is well padded with finely divided magnesium and then placed in dilute acid until all the magnesium has dissolved, no bleaching effect whatever is observed; wool left during 24 hours at ordinary temperatures in a solution of formalin appears to be bleached to a slight extent, but under all conditions which we tried the action of formalin is far less than that of sulphur dioxide.

The Presence of a Carbonyl Group in Wool

Up to this stage the experiments seemed to show that the bleaching effect of sulphur dioxide was caused by the addition of sulphurous acid to some coloured component of the wool. Since direct combination with sodium hydrogen sulphite is a property of the carbonyl grouping, it seemed probable that, as already suggested by Gebhard (*Jour. Soc. Chem. Ind.*, 1914), some ketonic compound in the wool is converted into a colourless additive product—

$$>C\begin{cases}OH \\ O.SO.OH\end{cases}$$

This view would explain several facts observed by the author, namely, that the presence of small quantities of alkali improve the quality of the bleaching obtained with sulphur dioxide; that when bleached wool is treated with dilute alkalis or soap, it almost immediately reverts to its original colour, even in the complete absence of air; and when bleached wool is boiled with water, debleaching occurs with evolution of sulphur dioxide. On the other hand, it would be contrary to the author's observation that bleaching with a concentrated solution of sodium hydrogen sulphite is less effective than with sulphurous acid, since the former, apparently, combines with ketonic compounds more readily than the latter.

In order, then, to obtain some evidence as to the presence of the carbonyl grouping, unbleached wool was heated under a reflux apparatus during four hours with an alcoholic solution of hydroxylamine. At the end of that time the wool was removed, pressed, and thoroughly washed with warm distilled water, dilute acetic acid, and again with water. The treated wool and a sample of the original material were then dried at 100° in the same oven, and the percentage of nitrogen determined in each by the Kjeldahl method. The results were as follows—

		Original Wool		Treated Wool		Average Difference
Nitrogen%	...	17·72	...	18·0	...	0·3
	...	17·61	...	17·95	...	

A second series of experiments with a different sample of wool, carried out exactly as before, gave the following results—Nitrogen%, average difference, 0·185.

The increased percentage of nitrogen in the treated material is no doubt very small, but seems to be too large to be due to experimental error. If it were assumed that the carbonyl compound in the wool has a molecular weight of 200 (a purely arbitrary number), the above increase in the percentage of nitrogen would correspond with that required for about 4% of such a compound.

That the increased nitrogen content of the wool is due to a reaction with hydroxylamine having taken place, and not merely to an adsorption, seems to be proved by the following facts—The treated wool gives with an aqueous or alcoholic solution of ferric chloride a deep violet colour, and it does so even when it has been soaked in warm dilute hydrochloric acid for a prolonged period and then washed with water; only after it has been heated with concentrated hydrochloric acid does it cease to give a coloration with ferric chloride, but at the same time the fibre is very much disintegrated.

As the presumed formation of an oxime indicated the presence of a carbonyl compound in wool, an experiment was next made to ascertain whether the carbonyl compound was or was not contributory to the colour of the raw material. For this purpose a sample of pure unbleached wool was treated with a neutral 2-volume solution of hydrogen peroxide during two days, and was then thoroughly washed; this bleached material was then treated exactly as before with an alcoholic solution of hydroxylamine, and subsequently washed well with a alcohol, water and dilute acetic acid. When treated with ferric chloride, this wool gave a violet coloration, which, so far as could be ascertained, was of exactly the same shade as that produced by the oximated wool, which had not been treated with hydrogen peroxide. It must be concluded, then, that the colouring matter in wool which is oxidised by hydrogen peroxide is not the carbonyl compound which reacts with hydroxylamine.

If the interaction of wool and hydroxylamine is the normal change which occurs in the case of a carbonyl compound $>CO+NH_2{\cdot}OH \longrightarrow C{=}N{\cdot}OH + H_2O$, the treatment of wool with semi-carbazide should give a semicarbazone $>C{=}NH{\cdot}NH{\cdot}CO{\cdot}NH_2$, and the increase in the percentage of nitrogen should be approximately three times as great as in the case of hydroxylamine. Two samples of unbleached wool were divided into two parts;

one part of each was steeped in a warm alcoholic solution of semi-carbazide during about 24 hours, and was then squeezed out and thoroughly washed with alcohol, warm water, dilute acetic acid, and water again, successively. The treated samples were then dried in the same oven as the untreated samples, and all four were analysed—

	Untreated Wool		Treated Wool		Difference
Sample A—Nitrogen %	18·20	...	19·1	...	0·9
	18·20	...			
Sample B—	18·12	...	18·87	...	0·8
	18·03	...			

These results afford a very satisfactory confirmation of those obtained with hydroxylamine, and seem to show conclusively that one or more of the components of wool is a carbonyl compound.

The author is greatly indebted to Prof. Kipping, F.R.S., of University College, Nottingham, for the constant interest which he has taken in this work.

36—THE SULPHUR CONTENT OF WOOL
PART I.—INHERENT VARIATIONS ACCORDING TO THE TYPE OF WOOL

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SUMMARY

The sulphur content of a number of different wools has been determined. A review of the methods available for the determination of sulphur is given, and of these the Carius method is regarded as the most suitable for a substance of the nature of wool, and this method has been used throughout the present work. A modified method for the determination of moisture content, suitable for small samples, is described, and it is shown that regains determined by this method of thorough drying are somewhat higher than those obtained by use of the commercial conditioning oven. Incidentally, it is shown that if a kempy wool, e.g. a Blackface wool, be separated into two grades, say, fine non-kempy and coarse kempy, the regains of the two fractions are the same. It is shown that there is an inherent variation in the sulphur content, according to the type of wool. Generally speaking, finer qualities show a higher sulphur content than coarser qualities. There are also definite variations between different wools of the same quality and breed, and in pedigree flocks the sulphur content varies with different animals. Variations occur in different parts of the same fleece, particularly in coarser varieties, and in the same animal there are indications of variation of sulphur content in different shearings. Kempy wools show a lower sulphur content than non-kempy wools. The lowest value so far obtained is with a sample of coarse Turkey mohair. The sulphur content in relation to a number of factors is under investigation.

INTRODUCTION

The principal constituent of wool is keratin, which belongs to the class of proteins known as scleroproteins. Its composition and properties have been dealt with in a previous paper (Barritt, *J. Text. Inst.*, 1926, **17**, T111). Keratin undoubtedly varies somewhat in composition according to its source, and its sulphur content appears to be particularly sensitive in this respect.

Sulphur may be regarded as the most characteristic constituent of wool substance, and its presence distinguishes wool and hair from certain other proteins. It was therefore felt that a careful investigation of the sulphur content of different types of wool might afford valuable information both from the scientific and commercial standpoints. According to the literature the sulphur content of wool and similar materials (i.e., keratin substances) appears to vary between the limits of 0·7% and 5% (Bourquelot, *Pharm. Journ*, III. 19, 1035), but it must be remarked that many of the determinations of sulphur recorded have been indirect, being estimated from the yield of cystin obtained on hydrolysis of the keratin by acids. Such results are very questionable, since the method depends on all the sulphur being obtained as cystin, and in addition it is probable that much of the cystin obtained was far from pure, the preparation of pure cystin in quantitative amount from a keratin being a very difficult operation.

Previous work on the subject of the sulphur content of wool has been summarised by Trotman and Bell (*J.S.C.I.*, 1926, **45**, 12T). They were unable to confirm the varying percentages of sulphur found by different workers, and concluded that the sulphur content of wool varies within quite narrow limits. Their published results given for three wools are—

	Max.		Min.		Mean	
Leicester wether	3·41	...	3·00	...	3·29%	Average 3·22%
Leicester hog ...	3·26	...	3·02	...	3·17%	
Black face ...	3·32	...	2·90	...	3·20%	

and they also give the percentage of sulphur in a low grade web as 3·24%. Their conclusion is as follows—"Consideration of the above results indicates that there is very little variation in the percentage of sulphur in purified wool, and that 3·4% is probably the maximum value."

It is not clear from the above table whether the maxima and minima, e.g., in the case of the Leicester wether, viz., 3·41% and 3·00% refer to sulphur determinations on the same fleece, or to determinations on different fleeces. In the event of the first supposition being correct, the results suggest that the method used, viz., the "Denis-Benedict" method, is not sufficiently accurate for the determinations of sulphur in a substance of the nature of wool, and if the second supposition be correct the variations are far from being insignificant.

Possible variations in the sulphur content of wools, assuming no inherent variability, may be caused to some extent by—

(1) The mode of preparing the samples.

(2) Neglect of variable regain under different conditions.

(3) Influences to which the fleece may have been subjected prior to shearing.

Under this heading are the possible effect of dips, especially sulphur dips, on the sulphur content, and the effect of weather.

Some sorption of sulphur may possibly occur with sulphur dips, but this is unlikely to cause actual addition of sulphur to any appreciable extent, since the fleece is very short when dipped.

Regarding the effect of weather, Bergen (*Textilberichte*, 1925, **6**, 745, *J.S.C.I.*, 1926, **45**, B 312) has pointed out that wool exposed to light becomes acid, due to conversion of some of the sulphur present into sulphuric acid. It is probable that the main portion of the fleece will be protected from this action, and that the total sulphur will only be very slightly affected.

It is intended to go further into this question, which, however, is outside the scope of the present paper, the values given in which refer only to the total sulphur content.

Also the normal sulphur content of wool cannot be safely ascertained from any processed wools, and *wools that have been scoured, crabbed, &c., will be separately examined.

While it is essential to remove dirt and wool fat, both of which are liable to contain sulphur, it is preferable to avoid soap or alkali in the scouring, and to use solvents free from sulphur. Further, wool has the power to absorb both sulphur dioxide and hydrogen sulphide, and undue contact with laboratory fumes must be avoided. Any variation in the moisture content will naturally give different values for the sulphur content. It is unfortunate that in much of the work published on the composition and properties of wool, the moisture content of the material used has not been

* In this connection it may be noted that blending of wools will tend to average out any variation, and that analyses of tops or cloth or web can be of little value in investigating inherent variations.

accurately specified. In the present paper it is shown that the sulphur content of wool is variable, and the variability is inherent, i.e., the sulphur content of one type of wool may, and in general does, differ from the sulphur content of another wool.

Methods of Determination of the Sulphur Contents of Wool

In any method involving the determination of sulphur in wool it is essential to know the moisture content of the wool at the time of weighing out the sample to be used. In the present work this was achieved by bottling samples for sulphur analysis, and at the same time bottling a sample for the determination of the moisture content of the wool (see below), the wool being previously stored in the humidity room, which was kept at a definite relative humidity. It was thought preferable to adopt this method rather than use a dried-out sample for the determination of the sulphur content for two reasons—

(1) Wool possesses the property of picking up moisture very rapidly, and is therefore difficult to work with in a dry condition; and

(2) To guard against the possibility that wool on drying out may lose volatile sulphur compounds, though this from experiments carried out appears to be improbable.

Almost all methods used for the determination of sulphur in organic compounds involve the oxidation of the sulphur to sulphuric acid and subsequent precipitation as barium sulphate. In the precipitation of barium sulphate from a solution containing free or combined sulphuric acid it is desirable to have no tervalent metals present, and it is found that when the amount even of a bivalent metal becomes relatively large in comparison with the amount of sulphuric acid present, the error arising from occlusion is likely to be large. On similar grounds the presence of nitric or chloric acids is undesirable.

In practice methods of determining sulphur may be divided into two groups—

(*a*) Dry or fusion methods.

(*b*) Wet methods.

An outline of these is given below.

Fusion Methods for the Determination of Sulphur

Liebig's Method.—A mixture of 8 parts of potassium hydroxide and 1 part of potassiumn nitrate is melted in a silver crucible with the addition of a little water. After cooling the substance is added and the contents of the crucible cautiously heated, and the mixture frequently stirred by means of a silver wire until the organic substance is completely decomposed. The melt is allowed to cool, extracted with water, acidified with hydrochloric acid, and the sulphuric acid precipitated and estimated as barium sulphate.

Warunis (*Chem. Ztg.*, 1910, **34**, 1285; *J. Amer. Chem. Soc.*, 1911, A, 1244) employs a method somewhat similar to the Liebig method. In a silver crucible 0·2 to 0·4 grams of the substance is mixed intimately with a mixture of 10 grams finely powdered potassium hydroxide and 5 grams sodium peroxide. The crucible is gently heated and the melt kept liquid for some time. The cooled melt is extracted with water, acidified with hydrochloric acid, a little bromine added, and the liquid boiled to expel bromine and the sulphuric acid estimated as barium sulphate.

Latshaw (*J. Assoc. Official Agr. Chem.*, 1921, **5**, 136-8; *J. Amer. Chem. Soc.*, 1922, A. **16**, 576, 3349; and *J. Amer. Chem. Soc.*, 1923, A. **17**, 2923) has determined the sulphur content of seeds and feeding stuffs, and has made comparative tests on three methods—

(*a*) The Parr peroxide bomb method, in which the substance is burnt in a bomb with sodium peroxide.

(*b*) A method employing magnesium nitrate as an oxidising agent.

(*c*) The official method in which the substance is fused with a mixture of sodium carbonate and sodium peroxide, in a nickel crucible over a sulphur free flame.

All three methods gave satisfactory results, and Latshaw recommends the use of the magnesium nitrate method owing to its ease of manipulation and accuracy. Trotman and Bell (*supra*), working on wool, were unable to obtain satisfactory results employing the magnesium nitrate method.

Kaye and Sharp (*India Rubber J.*, **44**, p.1189; *J. Amer. Chem. Soc.*, 1913, A., p. 1106) use the following method for the determination of sulphur in rubber, and suggest the extension of the method to organic substances in general. A suitable amount of the finely divided sample is weighed into a porcelain crucible, and mixed intimately with eight times its weight of pure zinc oxide and four times its weight of potassium nitrate. The mixture is covered with a thin layer of zinc oxide and gently heated. When the mixture reacts the flame is removed till the action has subsided. The crucible lid is then removed, and the contents strongly heated for about five minutes. The whole is allowed to cool, the melt extracted with hot dilute hydrochloric acid, the crucible and lid removed from the heater, the contents of which are filtered and sulphuric acid estimated as barium sulphate.

Abderhalden and Funk (*Z. Physiol. Chem.*, **58**, 331; *J. Amer. Chem. Soc.*, 1909, A., 2009) have used the sodium peroxide method for the determination of sulphur in urine. The urine is evaporated down with sodium carbonate and lactose, and this residue mixed with sodium peroxide and fused.

Barlow (*J. Landw*, 1903, **51**, 289-313; and *J. Chem. Soc.*, 1904, **85**, A. ii., 82) uses a combustion method for estimation of sulphur in organic substances. The substance is heated in a combustion tube, first in a current of carbon dioxide and then in oxygen, the gases being passed over heated soda quartz (prepared by mixing sand with 3 to 4 grams sodium carbonate dissolved in water and drying) in the front part of the tube, the end of which is drawn out and turned down to dip into a beaker of water. At the end of the combustion the soda ash, asbestos, &c., are emptied into a dish into which the tube is rinsed with water and dilute hydrochloric acid. The liquor is evaporated to dryness, heated at 110° C., and the residue extracted with dilute hydrochloric acid. The sulphuric acid is precipitated as barium sulphate in the usual manner. The method is stated to give very exact results.

Feigl and Schorr (*Z. Anal. Chem.*, 1923, **23**, 10-29; *J. Chem. Soc.*, 1923, A ii., 784) heat the substance with twice its weight of a mixture of equal parts of sodium carbonate and potassium permanganate under a layer of the same mixture in an iron crucible for one hour at a low red heat. The mass is extracted with aqueous alcohol and the sulphur estimated as barium sulphate.

Schreiber (*J. Amer. Chem. Soc.*, 1910, **32**, 977-85) uses a method involving oxidation by magnesium nitrate. The material is mixed in a nickel crucible with a solution containing sodium nitrate and sodium hydroxide (use for a 1 gram. sample 10 ccs. of a solution containing 100 grams of sodium nitrate and 150 grams sodium hydroxide per 500 ccs. of solution), 5 grams of crystallised magnesium nitrate are added, the mass well mixed and carefully evaporated to dryness, and eventually strongly heated. The mass is dissolved out with dilute hydrochloric acid, the solution filtered and precipitated with barium chloride. The method is said to agree to within 0·1% with the peroxide and the combustion method of Barlow (*supra*).

Hutin (*Ann. Chim. Analyt.*, 1915, **20**, 214; *J. Soc. Chem. Ind.*, 1915, p. 1105) uses a modified Schreiber method for the estimation of sulphur in rubber. The sample is decomposed by an excess of nitric acid, the liquid evaporated to a syrup, made alkaline with sodium hydroxide and mixed with calcined magnesia to form a stiff paste, which is carefully dried and ignited cautiously. After ignition the residue is dissolved in hydrochloric acid and the sulphur precipitated as barium sulphate.

Stevens (*Analyst*, 1918, **43**, 377) also uses a modified Schreiber method for the estimation of sulphur in rubber. The sample is digested with nitric acid and a little potassium chlorate. The mixture is refluxed for a few hours, evaporated to dryness, and mixed with pure magnesium nitrate. The mixture is carefully heated, and unburnt carbon is destroyed by digestion with nitric acid and potassium chlorate and excess nitric acid removed. The residue is treated with strong hydrochloric acid, evaporated to dryness, and sulphuric acid precipitated as barium sulphate.

The Denis-Benedict Method (Benedict, *J. Biol. Chem.*, 1909, VI., 363; and Denis, *J. Biol. Chem.*, 1910, VIII., 401).—The method was introduced by Benedict for the estimation of sulphur in urine, the urine being evaporated down with a suitable amount of a solution containing copper nitrate and sodium or potassium chlorate, and subsequently ignited. Denis modified the method by using a solution containing copper nitrate, sodium chloride and ammonium nitrate. The residue is dissolved in dilute hydrochloric acid, and the sulphate estimated as barium sulphate.

Trotman and Bell (*supra*), in estimating the sulphur in wool modify the method as follows—The wool is warmed with a little sodium hydroxide solution till it has just dissolved. A few drops of bromine are added, and after a few minutes the solution is neutralised with nitric acid, the Benedict-Denis reagent added, and the estimation continued as described above.

Halvesson (*J. Amer. Chem. Soc.*, 1919, **41**, 1494) has modified the Denis-Benedict method for the estimation of sulphur in fæces, foods, &c. The sample is heated in a Kjeldahl flask with water, and afterwards with nitric acid till the solution is clear. At this stage the residue is treated exactly as in the Denis-Benedict method.

Methods not Involving the Fusion or Ignition of the Substance

White (*Proc. S. Dak. Acad. Sci.*, 1919, **3**, 43; and *J. Amer. Chem. Soc.*, 1920, A **14**, 1760) estimates the sulphur in wool by digesting the wool with a mixture of sodium hydroxide and lead acetate. The mixture is acidified with acetic acid, and the precipitated lead sulphide is collected. The lead sulphide is decomposed and the lead finally estimated as chromate.

Osborne (*J. Amer. Chem. Soc.*, 1902, **21**, 140) has worked upon the method and has shown that in general the results obtained by the White method are too low, a result to be expected.

Gill and Grindley (*J. Amer. Chem. Soc.*, 1909, **31**, 52), for the determination of sulphur in urine, reject the sodium peroxide fusion method of Folin

(*J. Biol. Chem.*, **1**, 157), and employ a method involving oxidation with fuming nitric acid and potassium nitrate, the oxidation being carried out in a Kjeldahl flask. They arrive at the conclusion that in general fusion methods are incorrect, the fused residue often evolving hydrogen sulphide when acidified. Other workers have used as additions to nitric acid for oxidation, potassium chlorate, bromine perchloric acid, &c., and for details of these methods reference may be made to the paper of Trotman and Bell (*supra*).

The Carius Method.—This method is well known, and is in general use for the determination of many elements, other than carbon, hydrogen, and nitrogen, present in organic compounds. The method is simple, and consists in heating the substance under pressure in sealed tubes with nitric acid, when oxidation ensues. It has been subjected to many modifications, almost all of which have been designed to eliminate the use of sealed tubes.

Advantages of the Carius Method

The method avoids the addition of many salts used in other methods, and therefore avoids the risk of the contamination of the barium sulphate precipitate. It is easily controlled, and after the sealing of the tubes and the initial gradual heating to the desired temperature it requires no attention. At no stage of the process is there a risk of contamination of sulphur from gas burners, as exists in all processes where metal crucibles have to be heated for lengthy periods. The only disadvantage of the Carius process (apart from the labour involved in making sealed tubes) is the fact that the glass is liable to be attacked with formation of silicates with subsequent contamination of the barium sulphate precipitate by silica.

Rupp (*Chem. Ztg.*, **32**, 984; *J. Amer. Chem. Soc.*, 1909, A, p. 296) advocates the addition of barium nitrate to the Carius tube. The barium sulphate formed contaminated with more or less barium nitrate* is washed out off the tube into a beaker, boiled up with water, and collected on a filter.

Anelli (*Gazzetta*, 1911, **41**, I. 334; *J. Amer. Chem. Soc.*, 1911, A. 1379) showed that in the ordinary Carius estimation silica is found with the barium sulphate, this leading to high results. The use of barium nitrate in the Carius tube is advocated.

In the determinations given below, no addition of barium nitrate was made to the Carius tube, but the amount of silica in the barium sulphate was estimated and found to be only ·08%, and therefore the sulphur content of wools in the work described is influenced to less than 1 part in 1,200 by this factor.

PREPARATION OF THE WOOL

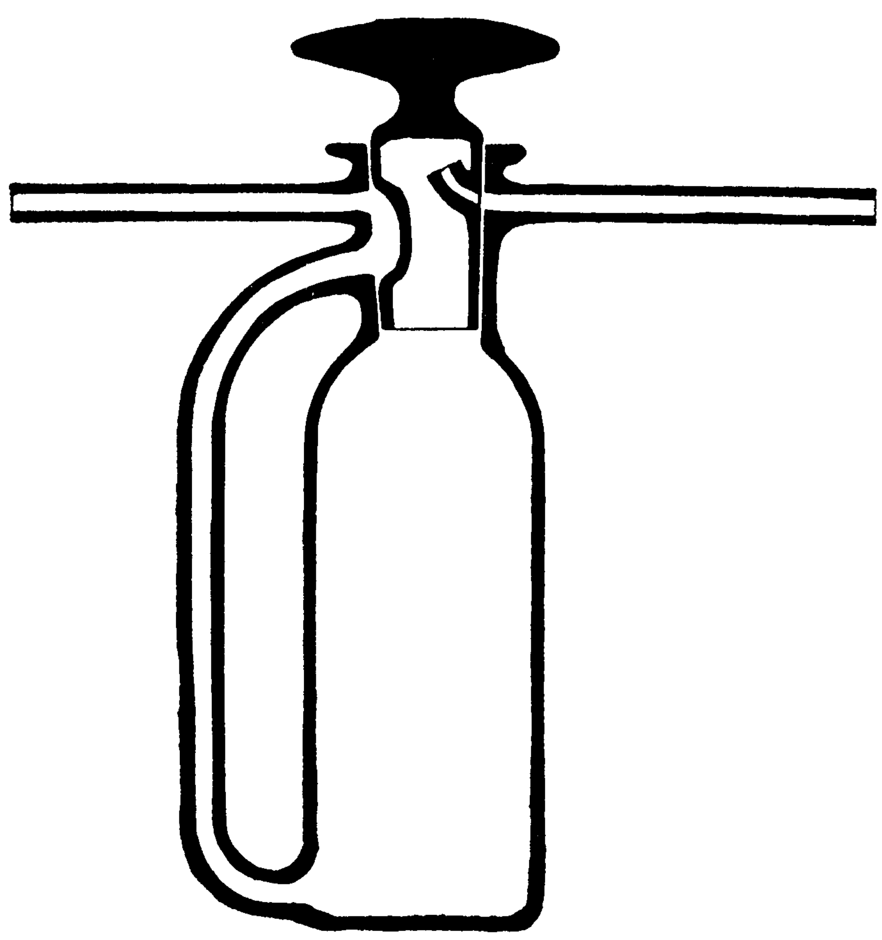
The wool was treated with sulphur-free benzene, worked about for some time, and the hard fatty portions which are sometimes present opened out as much as possible. It was withdrawn from the benzene, well squeezed out, and allowed to dry in warm air. The wool was now hand-sorted to remove the greater portion of foreign matter, a somewhat tedious process but essential to ensure complete removal of all vegetable and other foreign matter from the wool. The sorted wool was now extracted two or three times with pure benzene to remove all remaining grease, and then allowed to dry as before. At this stage it was again hand-sorted, and finally was given a scour in very dilute saponin solution, well washed off in distilled water, and left to dry in warm air. The samples were transferred to the humidity room and

* Evaporation to dryness with hydrochloric acid, to remove nitric acid, appears desirable at this stage.

kept in wire cages for a few days to condition equally. The above method of purification was adopted so as to ensure as little change as possible in the natural condition of the wool.

Method Used for Determination of Moisture Content

In estimating the sulphur content of wool it is essential to know the moisture content of the wool at the time it is taken for the sulphur determination. All sulphur determinations were carried out in duplicate, and a moisture content determination made at the same time. Two samples of wool (about 0·5 grams of wool per sample) were weighed out in small weighing



bottles for the determination of the sulphur, and at the same time a third weighed sample was taken in the special bottle described below.

The special bottle* (see diagram) used for this determination was designed so that with one position of the tap a current of air could be drawn through the wool, entering at the bottom of the bottle, and on turning the tap through 90° the bottle was completely closed. The use of a bottle of this type capable of giving accurate values for moisture content with quantities of wool down to 1 gram was necessary owing to the fact that many of the samples were small—too small, in fact, for use in an ordinary conditioning oven, which requires at least 20 grams of wool.

The bottle containing the weighed wool sample was placed in an electrically heated oven kept at 104° to 106° C., and a current of dry air, dried by means of the usual drying agents (sulphuric acid and calcium chloride) was passed through. After 1½ to 2 hours the tap was closed and the bottle transferred to a desiccator for half an hour and then weighed. The bottle was reheated for half an hour and its weight taken. This was repeated until the weight was constant, and in almost all cases two reheatings were sufficient, and in many cases only one reheating was found to be necessary.

Discrepancy in Dry Weight from Above Method and Conditioning Oven

In checking this method for the determination of moisture content against the method used in commercial practice, i.e., drying out wool in a conditioning oven at about 235° F., it was shown quite conclusively that the percentage regain as determined by the bottle method came out higher

* This bottle was supplied by Messrs. Standley, Belcher & Mason.

than that found with the conditioning oven, the difference being about 1%, for example, 15% in place of 14%. Passing undried air through the bottle gave a regain intermediate between the values obtained with the conditioning oven, and the dry air bottle method.

A fuller investigation will be made in the Physics Department of the Association.

In this paper the regains refer to the dry weight obtained in a current of dry air at 104°-106° C., and not to that from the ordinary conditioning oven.

REGAIN OF KEMP

It is interesting to note the equal regain shown by kempy and non-kempy portions of the same fleece, both with Blackface wool and Turkey mohair. The black face was separated by hand sorting into three fractions, which may be called

(*a*) Fine non-kempy fibres.
(*b*) Coarse kempy fibres.
(*c*) Kemps.†

All three fractions were placed in the humidity room, and samples from (*a*) and (*b*) were bottled simultaneously both for sulphur and for regain determinations. The regain of (*a*) and (*b*) were almost identical, being—

Fine non-kempy fibres ...	15·66%
Coarse kempy fibres ...	15·62%

and on the evidence of these determinations the kempy fraction was assumed to have a regain of 15·62%.

In the case of mohair the regains are as follows—

Fine mohair	15·64%
Coarse mohair	15·68%

Details of the Sulphur Determination

About 3 ccs. of fuming nitric acid (s.g.=1·53) were transferred by means of a long funnel and pipette to the bottom of a Carius tube, and wool transferred by means of forceps and pushed down the tube to within about 6 inches of the bottom by means of a glass rod. The tube was sealed in the usual manner, and estimations were carried out in duplicate for each wool. The tubes were heated together in the Carius furnace, and in a period of about 1½ hours the tubes were raised to 200° C. and maintained at this temperature for eight hours. Each tube was allowed to cool overnight and opened by softening the tip with a Bunsen flame, a slight pressure being found in the tube. After withdrawing from the furnace and cutting off the ends, the tubes were gently warmed to drive off dissolved gases, and the contents were washed out into beakers, evaporated to dryness (on steam) with the addition of hydrochloric acid, this being repeated to remove all traces of nitric acid, which is detrimental to the sulphate estimation. About 100 ccs. of hot distilled water were added, and the contents filtered off to remove any traces of glass introduced when opening the tubes. The liquid, about 400 ccs. in volume, was acidified with dilute hydrochloric acid, heated to boiling and precipitated by the slow addition of 50 ccs. of boiling N/20 barium chloride. After keeping hot for some hours and allowing to stand overnight, the barium sulphate was collected and estimated on a weighed Gooch crucible in the usual way.

† The reason a regain determination was not carried out on "(*c*)" was that only about 0·5 gram of the sample was available, a very large amount of Blackface having to be sorted to obtain this amount.

It should be especially noted that to ensure complete breaking up of the wool it is essential that the temperature of the tubes be not less than 200° C., and further that only a short length, at the most one inch of the tube, project beyond the iron containing tube. In one or two cases when these conditions were not observed, on opening the tubes a smell of oxy-butyric acid was observed, and when washed out the contents of the tube formed a yellow solution, and usually a low result for sulphur content was obtained. Results from any wool showing a difference in sulphur content in two determinations of above 1 part in 100 were rejected and the analyses repeated.

The sulphur content of between 40 and 50 wools has been determined, the following table showing some of the typical results. The lowest value found for sulphur content is that for coarse mohair, the value being 3·03%. The highest value found is that of 4·13% for a wool from a Welsh mountain sheep, this being one of a series of nine wools examined.

It is proposed in a subsequent paper to deal with the qualities of wools, in relation to their sulphur content, but it may at once be remarked that the lowest values of sulphur content are found with coarse wools (*cf.* following table).

Table of Typical Results

Type of Wool.	%'s of Sulphur found I.	II.	Regain	%'s of Sulphur on Dry Weight	Remarks
Australian merino, 100's	3·25	3·21	16·44	3·76	
Lamb's wool merino ...	3·20	3·19	16·76	3·73	
Lincoln (white)	2·67	2·68	15·89	3·10	Two samples from different fleeces, one fleece very yellow, other fairly white.
Lincoln (yellow)... ...	2·77	2·79	15·95	3·26	
Turkey mohair (fine) ...	2·89	2·92	15·64	3·36	The mohair was separated by hand sorting into two fractions.
Turkey mohair (coarse)	2·62	2·63	15·68	3·03	
Fine Ripon fleece ...	2·85	2·87	16·74	3·34	
Peruvian (1924) ...	3·23	3·21	16·47	3·75	Samples from the same sheep, clipped one year apart.
Peruvian (1925) ...	3·30	3·27	16·19	3·82	
Monte Video (Romney)	3·22	3·19	17·44	3·76	
Blackface: Fine ...	3·29	3·31	15·66	3·82	Blackface was hand sorted into three fractions. The regain of the kempy fraction was taken as 15·62, i.e., equal to the regain of the coarse fraction.
Blackface: Coarse ...	2·88	2·88	15·62	3·33	
Blackface: Kempy ...	2·80	—	(15·62)	3·24	
Welsh mountain P. 64 ...	3·35	3·34	18·65	3·97	Two typical analyses from a series of analyses made on Welsh mountain sheep; the S's are the first clip and the P's the second clip.
Welsh mountain S. 71 ...	3·20	3·21	18·28	3·79	
Cape merino (Kaffrarian)	3·45	3·41	16·47	4·00	
Cape merino (Le Grange)	3·37	3·40	16·32	3·94	

A striking example of how sulphur content varies in different parts of the same fleece is to be found in the case of the black face wool. The wool was separated by hand sorting into three fractions and the sulphur content of each fraction determined.

	% of Sulphur
Fine non-kempy wool	3·82
Coarse kempy fibres	3·33
Kemps	3·24

A similar result was obtained with Turkey mohair, the sulphur contents of fine and coarse fractions from the same sample being 3·36 and 3·03 respectively. The extreme values found in the 20 Australian pedigree wools examined were 3·46% and 4·11%, the mean value being 3·78%. The Welsh wools examined show variations between 3·75% and 4·13% in sulphur content, the mean value being 3·94%. It is of interest to note that the average sulphur content of the Welsh wools from the first shearing is 3·83%, whereas from the second shearing the value is 4·03%. Too much stress cannot be laid upon these figures owing to the comparatively small number of samples worked upon, but it is intended to follow up this question by examining samples of wool from the same sheep over a period of years; in addition the sulphur content in relation to a number of other factors is being investigated.

37—THE MICROSCOPICAL EXAMINATION OF DAMAGED COTTON HAIRS BY THE CONGO RED TEST AND THE SWELLING TEST OF FLEMING AND THAYSEN

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INTRODUCTION

During the course of investigations of the fine structure of the cotton hair, Miss G. G. Clegg, working in this laboratory, observed that hairs which had been swollen in sodium hydroxide and then stained in Congo Red did not become uniformly coloured, but took up the stain more intensely at points where the cuticle had become loosened or totally detached, and that this staining afforded a ready means of detecting damage to the cuticle. A method based upon these observations has now been worked out, and the present paper describes its application in determining microscopically the visible signs of damage in a Sakel cotton resulting from treatment in various ways, e.g., by heat, by mechanical means, by the action of a fungus, or by the action of acid. The method is shown to be capable of detecting even the slightest mechanical damage, and reveals in characteristic form the effect of heat or the attack of a fungus, though it is doubtful whether in all cases the last two effects could be distinguished one from the other. The changes brought about in cotton hairs by treatment in the cold with sulphuric acid of varying concentration are shown to be of a different nature from the other forms of damage investigated.

For the present work one cotton, a good quality Sakel, was used throughout, being examined in the undamaged state and after infliction of damage in varying degree under controlled conditions in the laboratory.

The only method which has so far been developed to reveal modifications of hair structure due to attack by micro-organisms and the probable resulting amount of deterioration ("tendering") is the swelling test of Fleming and Thaysen[6]. The conclusions of these workers have met with some adverse criticism, chiefly from Denham[3] and Burns[1], so the opportunity was taken to apply both the Congo Red test and the swelling test to similarly treated samples of the same cotton, and to compare the results. As an outcome, no general statement can be made about the performances of the two tests; their relative efficiencies vary according to the material on which they are used, and each case must be considered separately, bearing in mind the type and degree of damage that is being investigated.

THE METHOD OF APPLYING THE CONGO RED TEST AND THE RESULTS TO BE OBTAINED THEREFROM

About 0·1 gram of the cotton was placed in a filter flask of water, and as much air as possible withdrawn by means of the filter pump. This ensured that the cotton was thoroughly wetted out. It was then gently squeezed to remove most of the water, placed in 25 ccs. of an 11%* solution

* The use of solutions of exactly the right concentration is a matter of some importance. All solutions were made up more concentrated than actually required, and were then adjusted to the correct specific gravity, as obtained from the tables in the *Chemists' Year Book*. The percentages refer to grams per 100 grams of solution.

of sodium hydroxide, shaken thoroughly, and allowed to stand for five minutes. After washing rapidly in water, it was placed in a saturated (=about 2%) solution of Congo Red, and shaken at intervals for six minutes, when it was removed and washed by shaking up in water, the latter being changed until it no longer became pink. With as little delay as possible the cotton was placed in 18% sodium hydroxide, teased out, and a few hairs mounted in the same liquid for examination under the microscope. To prevent any of the sodium hydroxide escaping, the coverglass was sealed down with the cement recommended by Langeron[5]. The examination was made with $\frac{2}{3}$ in. objective and a $\times 10$ eyepiece, the iris diaphragm of the substage condenser being left wide open so as to fill the back lens of the objective with light.

A normal undamaged cotton hair, on being placed in 11% sodium hydroxide, swells nearly to its full extent, as described by Calvert and Summers[2], and its irregular cross section changes to an ellipse. The cuticle, however, remains intact and, later, takes up the Congo Red to a slight extent only, becoming coloured a faint pink. Finally the 18% sodium hydroxide swells the cellulose of the hair still further, and in places actually bursts the cuticle, thus exposing to view a strip of white cellulose. The colour contrast between the pink and the white is by no means great, but can be seen in several hairs in Fig. 1. Where cotton has been damaged by mechanical means, the cuticle is cut or at least weakened at the point of damage. On application of the Congo Red test, the cellulose is exposed or may even protrude, and becomes deeply stained, giving the appearance of a bruise upon the hair. If the cotton has been damaged by exposure to heat, sulphuric acid, or the attack of a fungus, the appearance is different, and in each case more or less characteristic, as described in detail below.

An outstanding difficulty in the detailed examination of any cotton was encountered, namely, the large variation amongst the individual hairs. For the purpose in hand it was only necessary to consider one character, this being the amount of secondary cellulose laid down in the hair wall, for the variation in this was one of the only causes so far investigated of the difference in behaviour of cotton hairs in a swelling solution.[2] In most commercial cottons there were a certain number of fuzz hairs, which though short in length were extremely thick-walled. The lint hairs themselves varied considerably in this respect, ranging from hairs of large cellulose development down to thin-walled hairs almost devoid of thickening. If the cotton under examination by the Congo Red test contained any hairs with abnormal cellulose development, particularly fuzz hairs, the swelling in the weaker (11%) sodium hydroxide was generally sufficient to rupture the cuticle. In this case the cellulose bulged out, and during the treatment with Congo Red became deeply stained. Since the cuticle usually split in a line running spirally round the hair, the red band which appeared after the application of the Congo Red test followed this course (Fig. 2), and an examination with a high power objective showed the torn edge of the cuticle flanking this band. These spiral bands had previously been observed in hairs under somewhat similar treatment by other workers, notably Denham,[4] but their real character had not been described. Their occurrence did not necessarily indicate damage, but simply the presence of hairs with an extreme development of cellulose. When using the test to examine a cotton containing hairs of this type, it was found advisable to reduce the concentration of the sodium hydroxide in the preliminary swelling from 11% to 9%.

This gave a preparation consisting of hairs all stained faintly pink and free from spiral bands. On the other hand, if the cotton contained any hairs with less than the normal development of cellulose, these hairs took up the Congo Red evenly, but to a greater extent than normal ones. In extreme cases where the hair was immature in development and the wall very thin, deep red staining took place throughout, and the ribbon shape with convolutions was retained. Since nearly all cottons were found to contain a certain number of abnormal hairs, the appearance which these displayed after being treated by the Congo Red test had to be noted in order to avoid interpreting them as signs of damage.

The technique is simple to carry out if the cotton to be examined is at the most slightly damaged, for the hairs become entangled during the first swelling and can be transferred from one solution to another by means of a glass rod. But in a badly damaged sample the hairs are easily broken into small pieces, which become dispersed when the solutions are shaken, and are usually left behind during transfer from one liquid to another. However, in these circumstances loss can be avoided by filtering through glass-wool.

Material

In order to avoid the complications raised by the presence of so many types of hair, search was made for a cotton as free as possible from very thick- or thin-walled hairs. The cottons available for use were examined by the Congo Red test, and the one which appeared most satisfactory in this respect was a Sakel, grown in 1923 on the Egyptian State Domains Seed Farm, and forwarded to this laboratory as a representative sample. The total quantity available was about one pound, from which an experimental sample was collected by taking small bunches and drawing from each of these in turn a few groups of twenty or thirty hairs. To divide up these groups the whole of the experimental sample was then thoroughly mixed and test samples finally obtained by drawing small groups of hairs from different parts of the whole. Except in one or two cases where it is specially stated, this material was used throughout, and appears in all the illustrations.

Description of Results Obtained

"*Damage-free Cotton.*"—This description was reserved for cotton which after treatment by the test showed no sign of damage. A cotton which fulfilled this condition was obtained from some specially chosen bolls of Punjab-American-285F. All the hairs were stained pink, and deep red staining was completely absent except at the end of each hair where this had been torn from the seed, and where naturally mechanical damage had taken place, giving the Congo Red immediate access to the cellulose. Any ruptures of the cuticle due to the final swelling in 18% sodium hydroxide showed as faint white stripes on the pink of the outside. Damage done during teasing out on the microscope slide was easily recognised by the absence of any red staining of the exposed cellulose (Fig. 5).

"*Commercial Undamaged.*"—Under this heading were included cottons that had been ginned and baled, as in ordinary commercial practice. In the case of the Sakel, most of the hairs were pink (Fig. 1), but a few showed bruises, and hairs which tapered at the end usually appeared as shown in Fig. 3. An occasional thick-walled hair showed broad spiral bands as in Fig. 2.

Mechanically Damaged Cotton.—This term was applied to two samples of the Sakel which had been subjected to mechanical damage in a mortar. Fig. 4 shows small bruises upon a hair that had been slightly damaged by being tapped gently with the pestle, and in Fig. 6 can be seen more extensive bruises. Fig. 7 shows the result of grinding up with great force; the bruises were so large and numerous as to cover almost the entire surface of the hairs, so that these appeared deeply stained and very ragged after the application of the test.

Heat Damaged Cotton.—This had been exposed to a temperature of 110° C. in an electrically heated thermostatic oven. It was found that the manner of exposure influenced the final result. If the sample was left between sheets of filter paper in a closed Petri dish for as long as six days the only sign of damage was the appearance of simple spiral bands in occasional hairs (Fig. 18). If, however, the cotton was freely suspended in a loop of asbestos string, 24 hours exposure was sufficient to produce spiral bands, either simple or multiple, in about 20% of the hairs. The regularity of the bands and the number of hairs possessing them increased with the time of exposure, until after a fortnight in the oven all the hairs were covered with multiple spirals. To obtain higher temperatures a small gas-heated oven was used, the cotton being again suspended in a loop of asbestos string. After four hours at about 150° C. it had become yellowish, and the Congo Red test showed that some of the hairs were covered with fine multiple-spiral bands, which displayed very clearly the points of reversal of the spiral (Fig. 19). Others, which were also spirally marked though less distinctly, were not swollen to the rod shape, but remained as ribbons with a corrugated outline (Fig. 20). Pronounced singeing was caused by exposure to a temperature of 190° C. for a similar period, and in such cases the hairs became stained red throughout, but again could not be swollen to the rod shape, remaining as ribbons with a corrugated outline and deep cracks. In some cases the cuticle could be seen as a wrinkled yellow ribbon wound spirally round the hair (Fig. 21). To test the effect of steam heat, the cotton was pushed about half way down a test tube, which was then plugged with bacteriological cotton wool, and the whole exposed to 15 lbs. per sq. in. steam pressure in an autoclave for 15 minutes. No sign of damage could be detected by means of the test, the hairs being free from any red staining.

Cotton Damaged by the Attack of a Fungus.—This cotton had been sterilised, inoculated with the spores of a fungus, and incubated at 25° C., some sterilised distilled water being added. The first fungus employed was a strain of *Aspergillus niger*, one of the commonest infections of raw cotton. The test showed evidence of damage to all the hairs, which in some places were stained evenly red (Fig. 16) and in others were covered with multiple spiral bands, similar to those produced by a temperature of 150° C. Cracks and abrasions, however, were totally absent. The second fungus, which still awaits identification, was employed on account of its great capacity for attacking the cotton hair and penetrating the central canal, or lumen. In this case the hairs were stained red throughout, broken up into short lengths, and covered with cracks and abrasions (Fig. 17).

Cotton Damaged by Sulphuric Acid.—The breaking loads of single hairs of Egyptian cotton after treatment with different concentrations of sulphuric acid in the cold had been determined by Vincent[9], so in order to find out to what extent the Congo Red test could indicate a decrease in strength due to the action of sulphuric acid, this author's method of treatment was followed. The cotton was first wetted out under the filter pump, and then placed in about 200 ccs. of the acid solution; the whole was thoroughly shaken and allowed to stand for 48 hours. The cotton was then washed thoroughly in water and dried slowly in air. It was found that concentrations of acid up to 30% (=grams per 100 ccs. of solution) produced no effect that could be readily detected by the Congo Red test, but hairs that had been treated with 40% acid were covered with irregular red streaks and patches, quite different in appearance from the regular spiral bands produced by heat, or the swollen bruises found in cases of damage by mechanical means. In addition, the hairs were not fully swollen to the rod shape, but remained corrugated. These effects became more marked as the concentration of the acid was still further increased (Fig. 8).

THE SWELLING TEST OF FLEMING AND THAYSEN

The original microscopical test for damage to the cotton hair, developed by Fleming and Thaysen[6], the pioneer workers in this field, was based upon experiments by Balls with the viscose process of Cross and Bevan. Their method was employed to estimate only the damage caused by micro-organisms, this term being used to denote bacteria and the streptothrices, which are intermediate between the true bacteria and the fungi, resembling sometimes one, sometimes the other, according to conditions. The cotton to be tested was swollen in a mixture of carbon disulphide and 15% sodium hydroxide, and examined under a low magnification, the damaged hairs being counted against the undamaged ones, and the count expressed as a percentage. In the present investigation some difficulty was experienced in carrying out the counts, but through the courtesy of Dr. Thaysen a visit was paid to the laboratory at Holton Heath and the points of misunderstanding were cleared up. For example, it must be noted that for the purpose of the count that portion of a hair in the field of the microscope at any one time was reckoned as one unit, so that a single complete hair figured in the count as several units, some of which might be classified as damaged and others as undamaged. It would appear that Burns[1] also misunderstood this method of making the count, and was thus led to criticise the test.

In the course of the work now described it was found that on placing a cotton hair in a mixture of 15% sodium hydroxide and carbon disulphide, the cellulose immediately expanded, inwardly to fill up the central canal, and outwardly to stretch the cuticle to its elastic limit. The reaction was complete in two or three minutes, and no further change occurred until, after about half an hour, the stress imposed by the expanding cellulose became sufficient to burst the cuticle. The line of rupture was a spiral one round the hair, so that the cuticle became rolled back upon itself to form a tightly stretched cord, which moulded the cellulose into a shape resembling either a chain of beads (Fig. 11) or a corkscrew (Fig. 13). The stages illustrated were only reached after swelling for about an hour, though the time required varied according to the type of hair and the amount of shaking applied. Further extension of the time of swelling caused the cellulose to dissolve at the edges, so that the general outline of the hair grew faint and ragged. If the test was applied to a hair with a cuticle that had been split or loosened, the cellulose, being no longer restricted at this point, expanded very rapidly and soon began to dissolve. The appearance presented by such a hair depended naturally on the length of time that it had been in the swelling mixture; if the time was short, say less than half an hour, the undamaged portions of the hair were still free from beads, whilst an irregular bead was formed at the point of injury to the cuticle. A longer period of swelling resulted in the cellulose at this point going into solution and producing a break in the hair. Thus, slight mechanical damage, such as the Congo Red test had shown to be present in commercial cottons, was not easily recognisable as such under the conditions of the swelling test, but nevertheless its effect was present. Severe mechanical damage, on the other hand, as produced by grinding in a mortar, not only tore the cuticle but also lacerated the cellulose, leaving cracks which were plainly visible after swelling for, say, 20 minutes (Fig. 10). Longer exposure to the swelling mixture proved to be inadvisable, for many of the hairs began to dissolve, so that little could be learnt as to their condition; this was found to hold good for damage due to any of the causes investigated; indeed, an unduly prolonged period of swelling gave misleading results, the more badly damaged hairs dissolving and leaving only the less damaged ones to come up for examination.

The samples of the Sakel cotton referred to above (page 144) that had been attacked by fungi in pure culture, were also submitted to the swelling test. The hairs that had been exposed to the action of *Aspergillus niger* swelled evenly and without forming beads, but displayed spiral striations (Fig. 15) obviously corresponding to the multiple spiral bands produced in the same cotton by the Congo Red test. It seemed doubtful whether, in the absence of beading, these hairs should be classed as damaged, or, in the absence of any obvious surface injury, as undamaged. Dr. Thaysen expressed the opinion that no hair-portion should be counted as damaged unless it displayed definite cracks or abrasions. This sample therefore passed the swelling test as undamaged. In the second sample, that had been exposed to the lumen-invading fungus, surface damage was widespread (Fig. 14), very few hair-portions being fit to be counted as good. It was noted, however, that the injuries of some of the hairs resembled those produced by grinding almost to the point of being indistinguishable (Figs. 10 and 12), so that it would seem advisable to use the swelling test only on cottons known to be free from mechanical damage unless very slight.

The samples of the Sakel cotton that had been treated with sulphuric acid behaved in much the same way as those that had been exposed to heat, in that they formed no beads but expanded evenly, displaying numerous fine cracks; since these were very regular, and all at right angles to the axis of the hair (Fig. 9), they were easily recognisable and not likely to be confused with the injuries caused by micro-organisms.

There has in the past been some controversy as to the mode of attack of micro-organisms upon the cotton hair and its effect upon the test. Thaysen and Bunker[7,8], working upon raw cotton exposed to the attack of bacteria and streptothrices, stated that in their experience the attack always commenced at the outside of the hair wall and proceeded inwards, and that cases of lumen attack were exceedingly rare. Denham[3], on the other hand, found that, in material from a variety of sources, central canal invasion was very common, especially by fungi, and this was confirmed by Burns[1]. During the examination of a large number of samples of yarn and grey cloth for mildew damage, the writer saw many cases of isolated hairs which, though spun into the yarn, were penetrated from end to end of their central canals by hyphæ, without any trace of fungus appearing on the outside of the hair or elsewhere in the yarn. It was concluded that these hairs had become infected either in the cotton field or in the bale, and had been separated from other hairs simultaneously attacked and also from fungus adhering to the outside by the redistribution which occurs in cotton spinning; for where raw cotton, yarn, or cloth had been exposed to the action of micro-organisms either under trade conditions or as a pure culture in the laboratory, the writer found that an invasion of the lumen was invariably accompanied by an attack upon the hair wall from outside, though the application of swelling or staining reagents in preparing a specimen for examination was often enough to remove the organism adhering to the outside, and so lead to the faulty conclusion that an internal attack alone had taken place. From the work carried out with pure cultures in this laboratory, it was clear that the habit of invading the lumen in the early stages of attack was a characteristic of certain fungi only, a notable case being the species mentioned above; and it was doubtful whether even this fungus could penetrate directly the wall of an undamaged hair. It was probable that the attack, whether external only or simultaneously internal and external, was not localised but distributed, so that the wall underwent a general degradation, in the later stages of which penetration occurred. Up to the present no test has been available which could detect the earlier stages of damage and so throw light on the mode of attack at its commencement, but in this connection it is hoped that the Congo Red test will be of assistance in future research.

THE SCOPE OF THE CONGO RED TEST

Burns[1] rightly pointed out that the percentage of damage as determined by the swelling test was no measure of the decrease in spinning value of a cotton, for the latter depends on the amount of waste due to fly and the strength of the yarn produced. Actually, the figure obtained by use of the swelling test was the percentage of hair-portions that had reached a certain stage of damage. As this stage appeared to be an advanced one, it was probable that these hair-portions would be eliminated during spinning as "card fly," leaving the remaining hairs or parts of hairs to form the yarn. About these the swelling test furnished no information, though in practice all might be undamaged, and so give good yarn, or all might be damaged and so give weak yarn. Here the Congo Red test could yield useful information, and its quantitative application might be brought about by counting first the number of units displaying signs of slight damage, namely spiral bands, secondly the number stained evenly red but without cracks, and lastly the number with cracks, i.e., those which would be condemned under the conditions of the swelling test. However, the values obtained from such a determination could only be rendered useful by their correlation with the results of spinning tests as indicated by Burns[1]. Further, as this author pointed out, in any such form of test, the number of hairs which could conveniently be examined under the microscope was comparatively small, and could only be considered to represent a sample of strictly limited dimensions. Burns himself, by increasing the number of hairs examined, rendered his test samples large enough to be representative of quantities suitable for spinning tests.

It should be emphasised that the swelling test and Congo Red test have not yet been studied with respect to their relation to the spinning values of cotton before and after damage. But in research work where it is desired to study, say, the relative attacking power of an organism, some method of estimating the attack is necessary. For this purpose the swelling test appeared to be satisfactory, and the Congo Red test, being more sensitive to slight damage, might profitably be developed quantitatively along similar lines. For example, in the cases of damage by heat, fungus, or mechanical means, different stages of damage could be recognised from the appearance of the hairs as indicated in Table I. By applying Fleming and Thaysen's method of examining hairs by units, the percentage of units in any stage could be found and used as an index of damage, but far more meaning would be attached to such determinations if they could be correlated with the breaking loads of single hairs and the spinning value of the cotton.

Table I.

Appearances produced by the Congo Red Test in Cotton Hairs in different stages of degradation.

Degree of Damage	Appearance of hairs: Attacked by a Fungus	Exposed to Heat	Damaged by Mechanical Means	Treated with Sulphuric Acid
No damage	Stained pink ...	Stained pink ...	Stained pink ...	Stained pink
Slight damage	Narrow multiple red spiral bands ...	Broad simple red spiral bands ...	Surface bruises ...	—
Moderate damage	Stained evenly red...	Narrow multiple red spiral bands ...	Deep cuts ...	Irregular red patches
Severe damage	Stained red and cracked ...	Stained red and cuticle singed ...	—	—

As shown by the descriptions and illustrations of the damage caused by different means, it was seen that the test had the power of distinguishing one form of damage from another, but it was obvious that this would not hold good under all circumstances. Mechanical damage was unmistakable, and could not be confused with that due to heat or the action of a fungus; the last two, however, possessed points of similarity, but where a fungus was the cause, there always remained some trace of the organism itself, and there was no sign of the broad spiral bands or the singed cuticle which were found respectively in the first and last stages of heat damage. In this way they could be differentiated if the material were examined undisturbed, but if the damaged hairs had been mixed with undamaged ones, as would occur in sampling, and a preparation finally produced showing only a few of the former, it might not always be possible to make a decision. Further work remains to be done on cotton treated with sulphuric acid; at present it can only be said that the effect of treatment in the cold followed by washing can be recognised if the damage is severe; the result of treatment with warm acid, or of allowing the acid to dry on the cotton, has not yet been investigated by the Congo Red test.

The writer wishes to acknowledge the kindness of Dr. A. C. Thaysen, of the Bacteriological Laboratory, Royal Naval Cordite Factory, the author of the swelling test. In a series of consultations on both the swelling test and the Congo Red test, Dr. Thaysen and Mr. H. J. Bunker have contributed materially towards an accurate valuation of the performance of both tests,

and have suggested several modifications of technique which have been included in the description given above of the working of the Congo Red test.

The photographs are the work of Mr. H. Gunnery, who has given valued assistance throughout the research.

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EXPLANATION OF PLATES

The hairs were photographed with a Zeiss 16 mm. apochromatic objective and a Zeiss 15 × compensating ocular (K 12), the magnification being 330 diameters; those shown in Figs. 9 to 15 had been treated by the swelling test, and the remainder by the Congo Red test.

Fig. 1—Congo Red test; normal hair, undamaged.
Fig. 2—Congo Red test; thick-walled hair, undamaged.
Fig. 3—Congo Red test; tapering end, undamaged.
Fig. 4—Congo Red test; slight mechanical damage.
Fig. 5—Congo Red test; damaged during teasing out.
Fig. 6—Congo Red test; mechanical damage.
Fig. 7—Congo Red test; severe mechanical damage.
Fig. 8—Congo Red test; damaged by sulphuric acid.
Fig. 9—Swelling test; damaged by heat.
Fig. 10—Swelling test; severe mechanical damage.
Fig. 11—Swelling test; undamaged hair.
Fig. 12—Swelling test; damaged by lumen-invading fungus.
Fig. 13—Swelling test; undamaged hair.
Fig. 14—Swelling test; damaged by lumen-invading fungus.
Fig. 15—Swelling test; damaged by *Aspergillus niger*.
Fig. 16—Congo Red test; damaged by *Aspergillus niger*.
Fig. 17—Congo Red test; damaged by lumen-invading fungus.
Figs. 18 to 21—Congo Red test; damaged by heat.

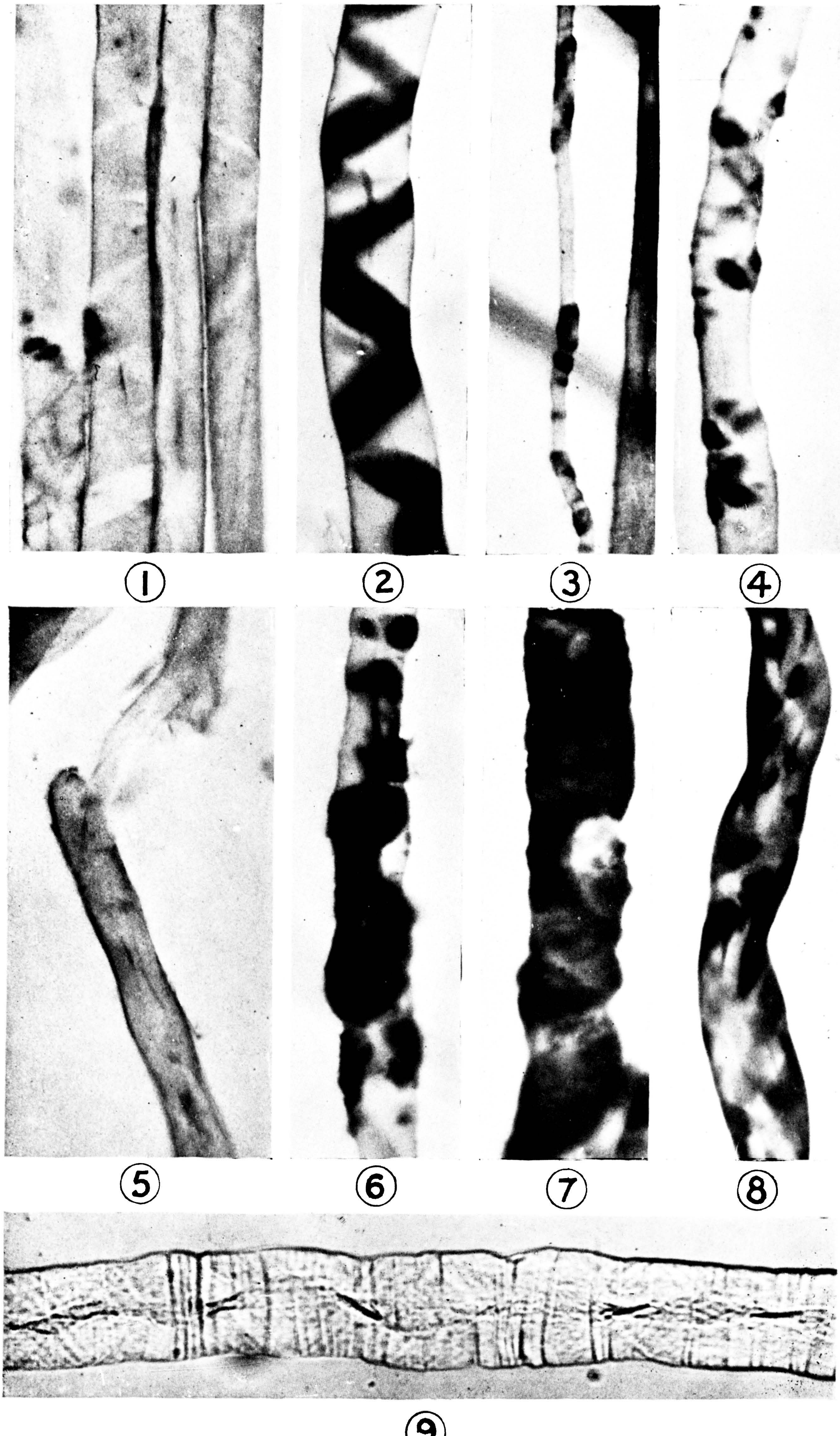

PLATE I.

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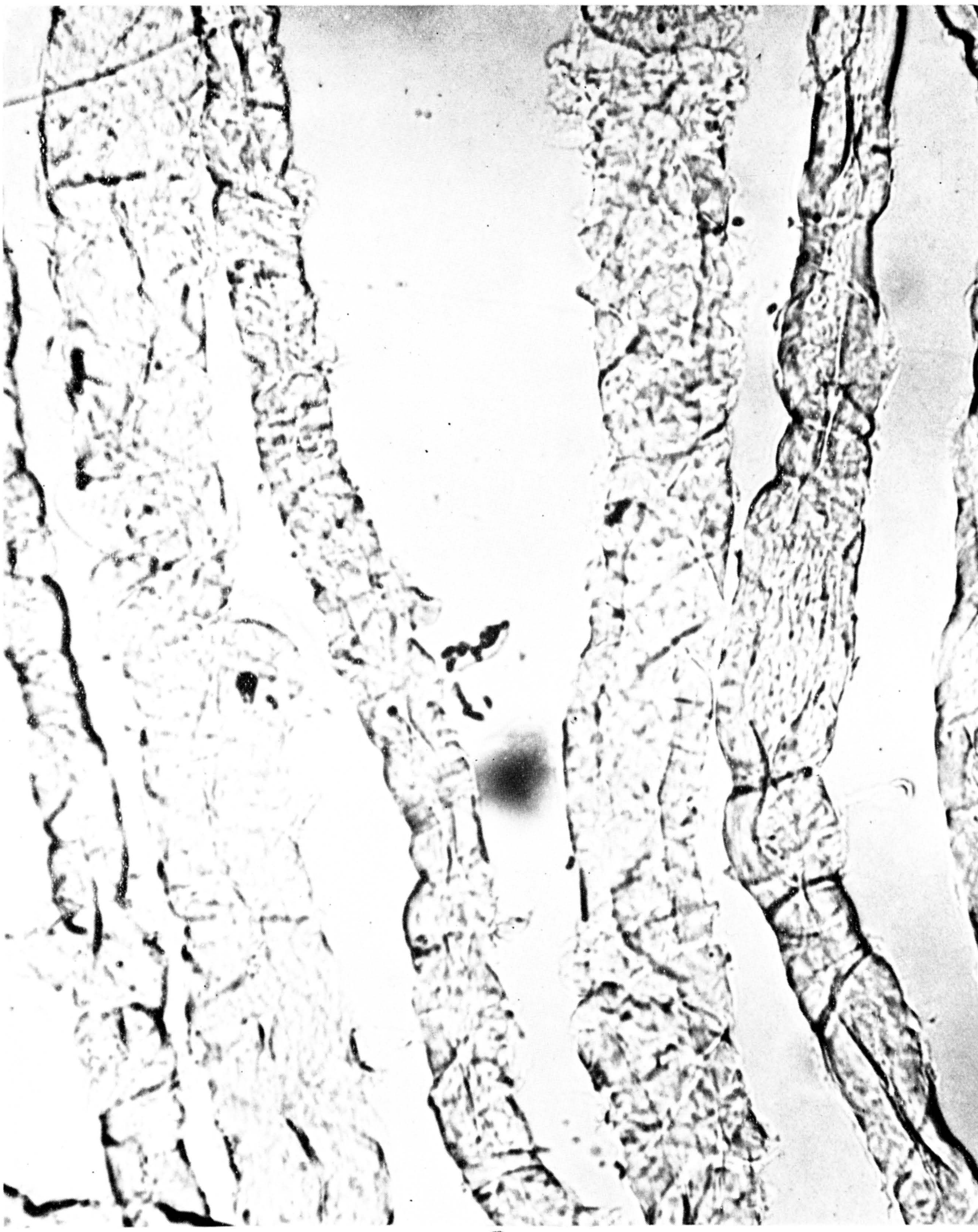

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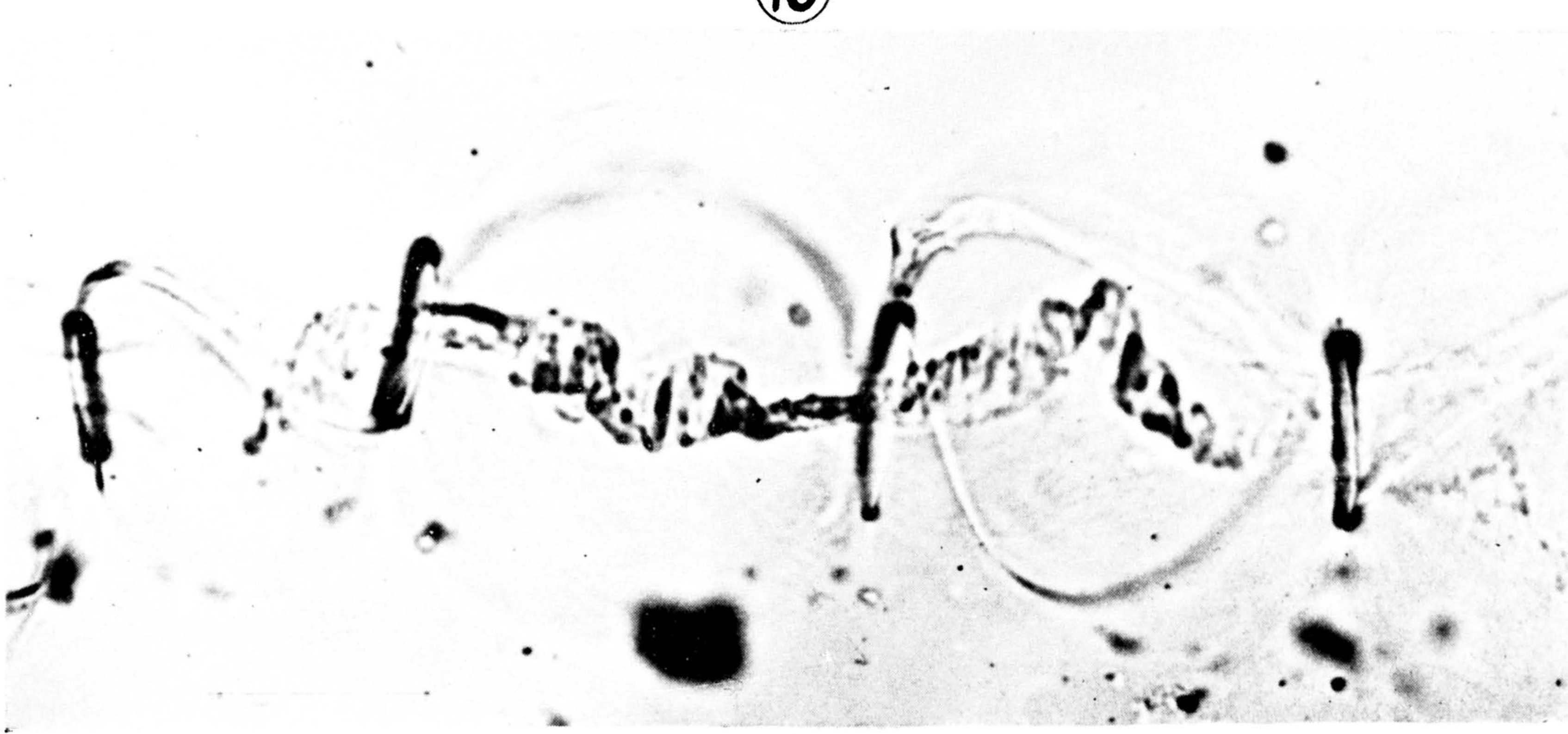

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Plate II.

(12)

(13)

Plate III.

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(17)

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(21)

PLATE IV.

38—THE BREAKDOWN OF FLAX FIBRE STRANDS DURING THE PREPARING PROCESSES

By J. A. MATTHEW, M.Sc. (Lond.), A.R.C.S., F.Inst.P.
(York Street Flax Spinning Company, Ltd.)

A considerable amount of work has been done on the breakdown of flax fibre strands during the preparing processes for wet spun yarn, using the sorting machine and methods described in an earlier publication.* Previous work had shown that during the progress of the fibre from spreadboard to rove, extensive changes in the dimensions of the fibre strands take place, both in length and cross section, but there were not sufficient data to determine which particular features were most important, and therefore of most interest to measure.

The object of this work was twofold—

(1) To investigate the relative importance of length and of cross section or fineness of fibre strand and of the fibre distribution, as regards the spinning quality of the fibre.

(2) To study in detail the manner in which the breakdown occured, and to determine whether the breakdown was a feature of the fibre or of the machinery, and if the latter, what factors were operative.

The answer to (1) would then indicate the lines along which to work to bring about improvement in the behaviour of fibre in spinning, whilst the answer to (2) would possibly indicate some means of bringing about the desired change. In consequence the paper has been divided into two parts dealing respectively with the above heads.

PART I.

A detailed study was made of the change in fibre dimensions, both length and cross section, at each stage of the preparing process from the spreadboard to the rove, which in future will be referred to as the "system," following the ordinary trade practice. All samples tested were representative of the ordinary mill practice unless otherwise stated, that is the fibre was being worked in the way considered most suitable for its class. The samples were designated by the lea of the yarn to which the rove was to be spun, and only fibres for wet spun yarns were dealt with.

The method adopted was to take a sample of sliver leaving the spreadboard, doubler, first drawing and so on, and of the rove. These were then tested on the sorting machine, group selections being made at 2-inch intervals; determinations were made of the mean cross section of fibre strand in each selected group and the average cross section of the total sample, as well as the percentage distributions by weight and by number, weight mean length of fibre in sample, and true arithmetic mean length of fibre. From these results the progress of the breakdown of the fibre strands during the passage of the fibre over the various machines comprising a system was studied. This was repeated on 14 different systems each working its usual class of fibre, so as to cover a wide range of sorts, for example Courtrai and Irish flaxes for several leas of line yarn, Russian flax for line yarn, Courtrai and Irish tows for yarns of different leas, and Courtrai and Irish rescutched tows for combed tow yarns.

* J. A. Matthew and G. F. New, *J. Text. Inst.*, 1925, **16**, T197–T208.

The results for one system are given in full and the various methods of presenting them are discussed, but for the other systems only such results are given as appear necessary to demonstrate differences found in behaviour. These are tabulated and shown graphically as far as possible.

DETAILED STUDY OF BREAKDOWN THROUGHOUT A LINE SYSTEM

Flax used—Courtrai long line sorted for 50's lea warp yarn.

Experimental Method

The experimental method was to select groups of fibres at 2 inch intervals, a certain number being counted and weighed and the remainder weighed separately. The number counted was increased as the group length decreased, as the total number of fibres in the group increases. From the two weights added together, the weight distribution curve and mean lengths were calculated as already described.* From the ratio of the two weights and the number counted, the total number of fibres in each selected group was obtained by proportion, and calculations of cross section made as follows—

In any selected group

Let N_0=number of fibres counted.

w=weight of counted fibres.

w_1=weight of uncounted fibres.

$W=w+w_1$=total weight of fibres in grams.

Then N=total number of fibres.

$$=\frac{W}{w}N_0$$

Let L inches=mean group length of fibres.

Then if d=density of fibre,

a=mean area of cross section of fibre strands in group in sq. cms. (subsequently called the "mean group cross section") we have—$a\ d\ NL\ 2{\cdot}54=W$

$$\therefore a=\frac{W}{2{\cdot}54\ NLd}$$

Now in order to obtain the absolute cross sectional area, we must know the density of the fibre. This was not determined in each case, but a general value of 1·50 has been adopted in the following work. The density of different sorts of flax will vary slightly from this figure, but the differences are small; comparisons between different sorts will therefore be affected to this extent, but comparisons at different stages of the process where the same sort of flax is concerned, will not be affected by the value taken for the density.

$$\therefore a={\cdot}263\frac{W}{NL}\text{ sq. cms.}$$

To obtain the mean cross section of all the fibres of different lengths in the sample, a weighted mean was obtained in the following way—

Let a_1=mean cross section of all fibres in the sample (subsequently called the "average cross section"),

$$\text{Then } a_1=\frac{\xi Na}{\xi N}=\frac{{\cdot}263\,\xi\frac{W}{L}}{\xi N}\text{ sq. cms.}$$

* *Loc. cit.*

In considering the first system in detail, the results for the percentage of fibre of each length by weight and by number, the mean group cross section and weight mean length, true mean length, and average cross section of the fibres in the whole sample, in each of the slivers leaving the successive stages of the preparing system from the spreadboard to the roving are presented in various ways in diagrams 1–6.

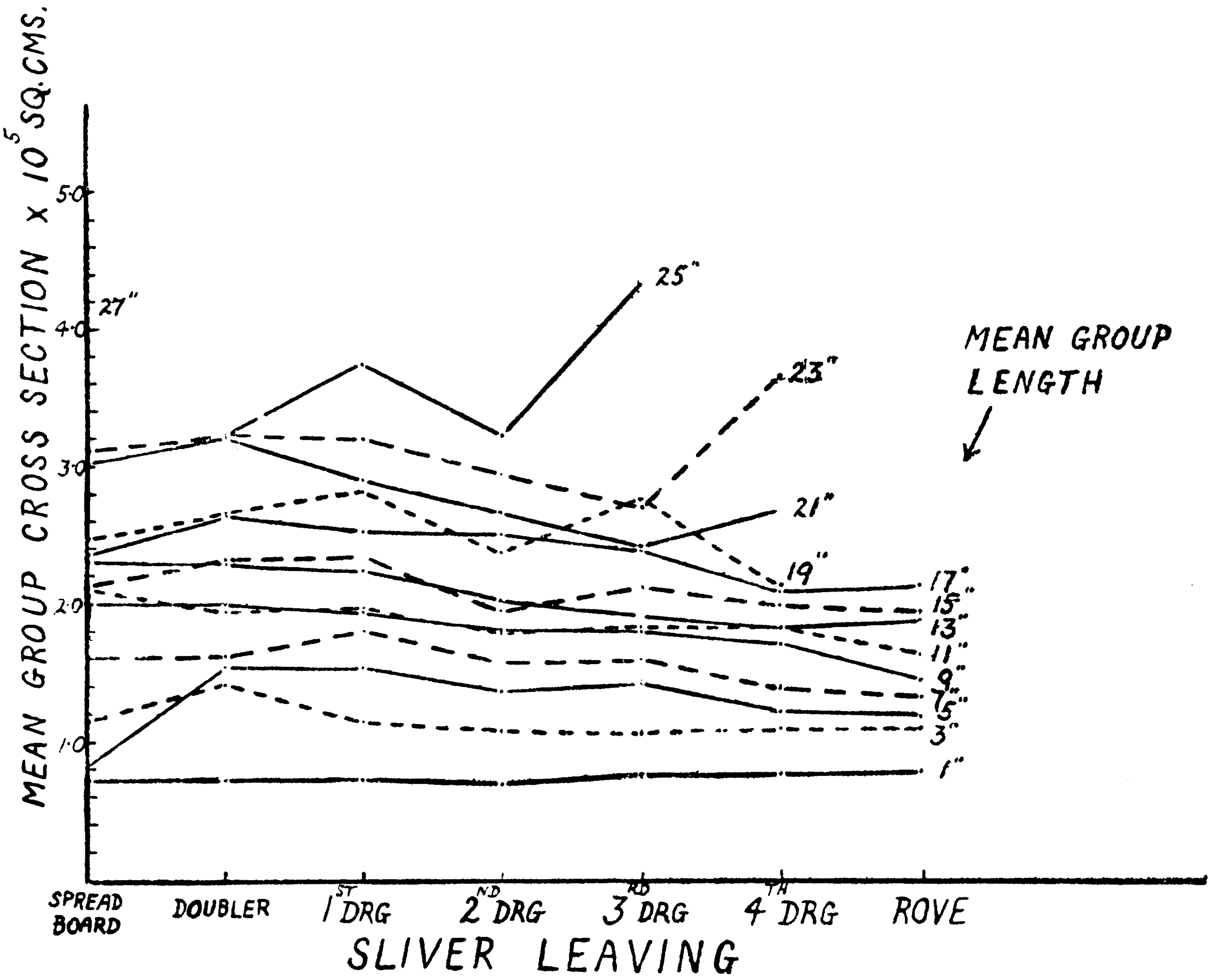

DIAGRAM 1.

Discussion of Results

In diagram 1 the mean area of cross section of fibres in each group is shown at the various stages of the system. It may be noted that the fibre of 1 inch mean group length, subsequently referred to as 1-inch fibre, does not appear to alter appreciably in cross section throughout the system, whilst other lengths up to 21 inches all show a progressive decrease in cross section. The results for fibres of 19 inches and over are more erratic than the majority, no doubt because of the small number present. On the whole the cross sections lie in the order of length of fibre : there are more exceptions to this in the spreadboard sliver than elsewhere, probably because sampling errors would be much greater in this case, as the number of doublings is so small at this stage.

Diagram 2 represents the same results in another way, as here the mean group cross section is plotted against the mean length of the group for slivers from the doubler, the second drawing, and the roving. The other stages are omitted to save confusion. The curves lie in the same order as the stages occupy in the system, but they all tend to join at the 1-inch length, showing that the fibre of each length progressively decreases in cross section, but the change in the case of the 1-inch fibre is very small. Also the graphs show clearly that the fibre strands are coarser as the length increases.

In diagram 3b, the changes in weight mean length, true mean length, and average area of cross section are shown after each stage in the preparing. It will be seen that each operation causes a decided decrease both in length and cross section of fibre; in this case the mean length and average cross section have been reduced to approximately one-half and two-thirds respectively. The true mean length is approximately one-half of the value of the weight mean length, but the ratio is not constant throughout; for the purposes of such comparisons as these, however, it does not matter which value is considered, and in this paper the weight mean length is generally adopted.

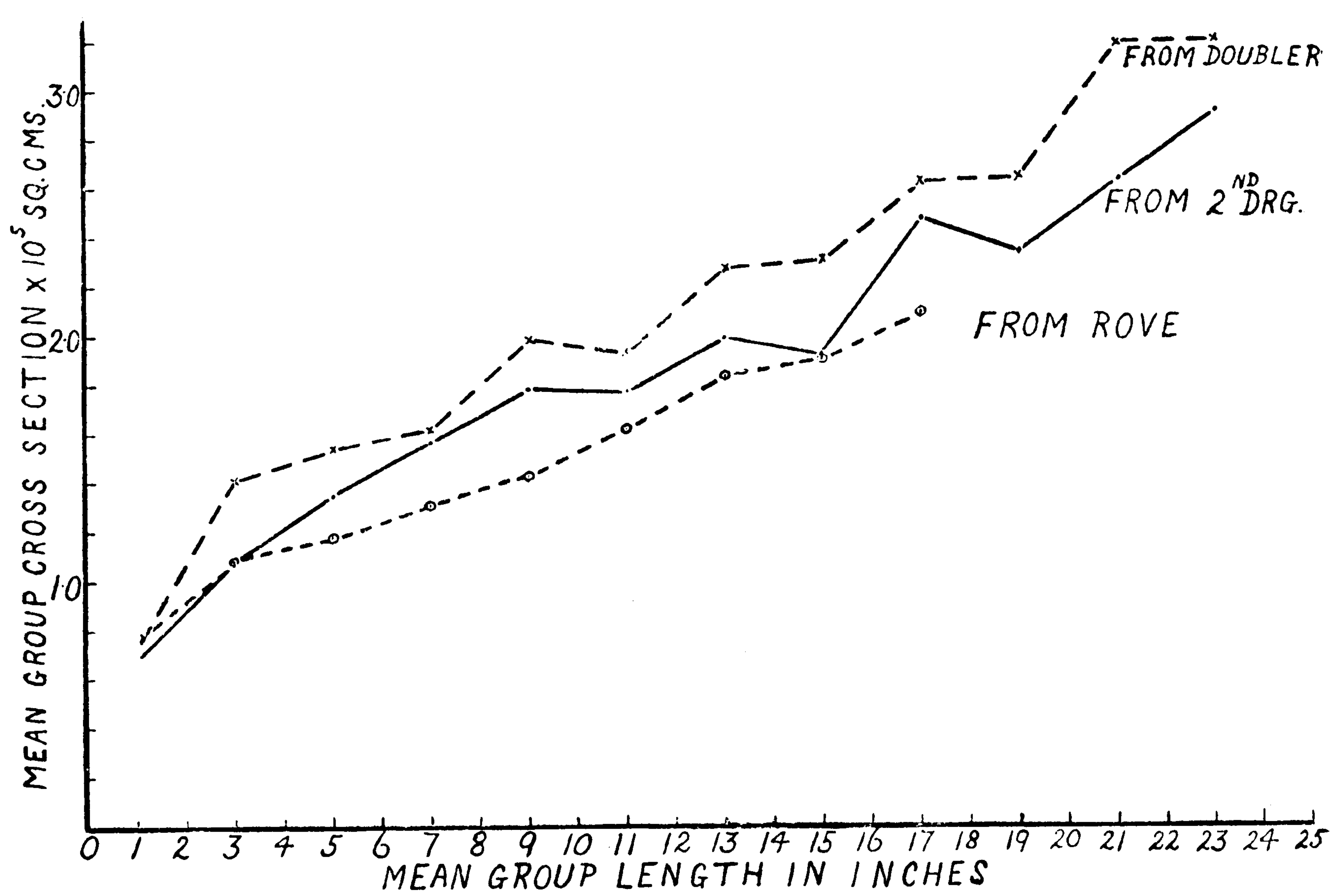

DIAGRAM 2.

In diagram 3a, the average cross section of the fibre in the sample is plotted against the mean length of the fibre after each stage in the preparing; the graph therefore represents the rate of change of cross section with change of length. The experimental results are marked by the crosses on the right of the figure. To decide the type of smooth curve to be drawn throughthese points, we must consider the extreme point on the curve. Obviously there must be some finite limiting value, for example, the cross section of the ultimate fibre; it was shown above, however, that the cross section of the 1-inch fibre shows remarkably little change during the preparing, so it appeared that this was the limit of fineness to which the flax fibre strands can be broken down by an indefinite amount of preparing on machinery of the present type. For the curve shown in diagram 3a, therefore, the cross section of the 1 inch fibre was also plotted and this point connected with the crosses on the right by a smooth curve as shown. In some later cases it was found that the mean group cross section of the 1-inch fibre may tend to fall and then to rise again to its original value; in these cases the fall and rise was always found to be gradual, so it was concluded to be a real effect and not an irregularity due to sampling, and could be explained as due to a transverse breakage of short lengths from long coarse fibres. In such cases the minimum value of mean group cross section found for the 1-inch fibre throughout the system was regarded as the limiting value to be taken for diagrams such as 3a.

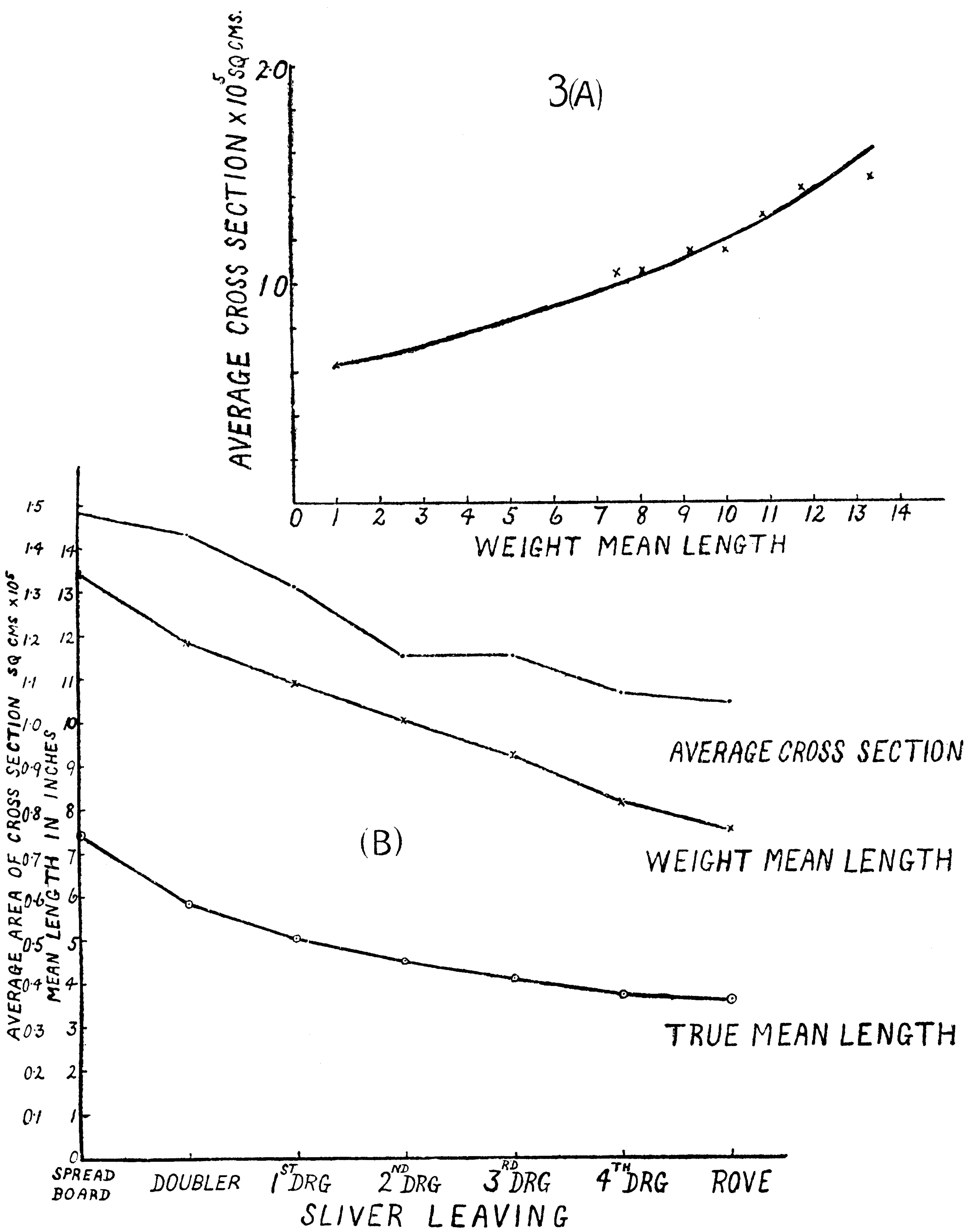

Diagram 3.

Diagram 4 shows how the fibre length distribution curves (estimated as percentage of total weight) vary with the amount of preparing. Alternate stages are omitted to save confusion of the diagram. It will be seen that there is a progressive moving of the curves to the short length side of the diagram, accompanied by an increase in the height of the curve. That is, each drawing causes a reduction in the percentage weight of long fibres and of course, a corresponding increase in the percentage of shorter fibres, and the fibre becomes more and more uniform in length. With this type of graph it is confusing to plot too many curves on the same diagram, so in order to show graphically the results at all stages, diagram 5 was prepared, and it is preferable in many ways for the purpose of studying results over a whole system. This diagram (5) shows the percentage by weight of each individual group at the successive stages of the system. Up to a mean group length of 7 inches all the groups show an increase in percentage, the 3-inch and 5-inch groups increasing rather more rapidly than the others. The 9-inch group increases up to leaving the first drawing and then remains fairly constant, the 11-inch group shows a slight rise followed by a fall, the 13-inch group remains constant to the first drawing and then falls, whilst all the longer groups may be said to show a progressive decrease in percentage throughout the system.

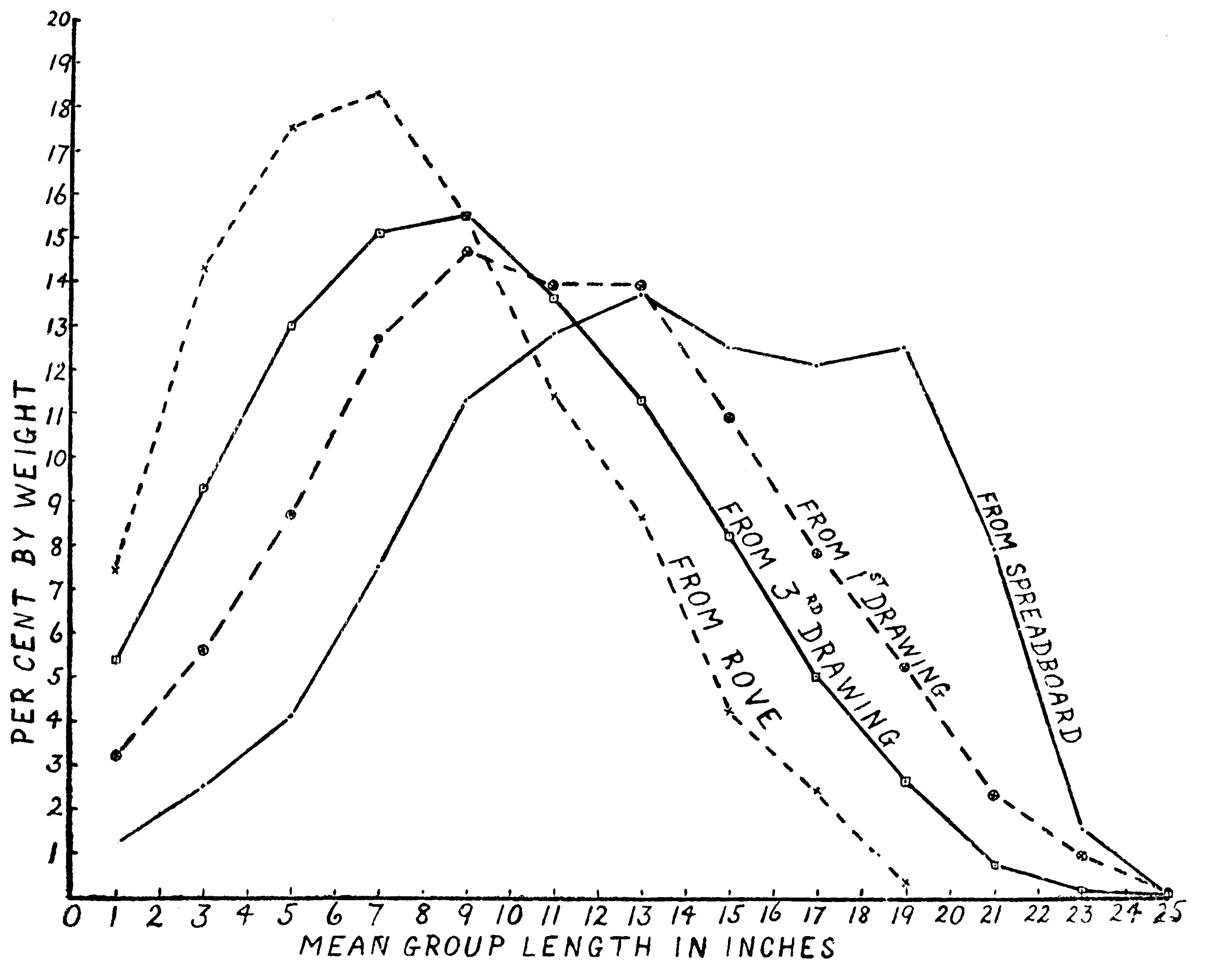

DIAGRAM 4.

Diagram 6 shows in a similar way the results for percentage by number (that is, the number of fibres in each group as a percentage of the total number of fibres in the sample) of each individual group at the successive stages of the system. For a mean group length of 7 inches and over, each group shows a gradual decrease in percentage number as the roving is approached. A length of 5 inches appears to be a sort of transition stage, as the results vary around a constant figure, but both the 1-inch and 3-inch groups show very pronounced increases, both being much greater than for any other single group. The rate of increase in these two groups are characteristically different, because whereas the 1-inch group gives a very rapid rise on leaving the doubler, followed by a continuously decreasing rate of increase, finally approaching a constant value after the fourth drawing, the 3-inch group shows a fairly rapid and uniform rate of increase throughout.

This last diagram appeared to be very interesting and suggests an explanation of the method of breakdown. It was shown in diagrams 1 and 2 that the fibre in each length group is reduced in cross section after each drawing.

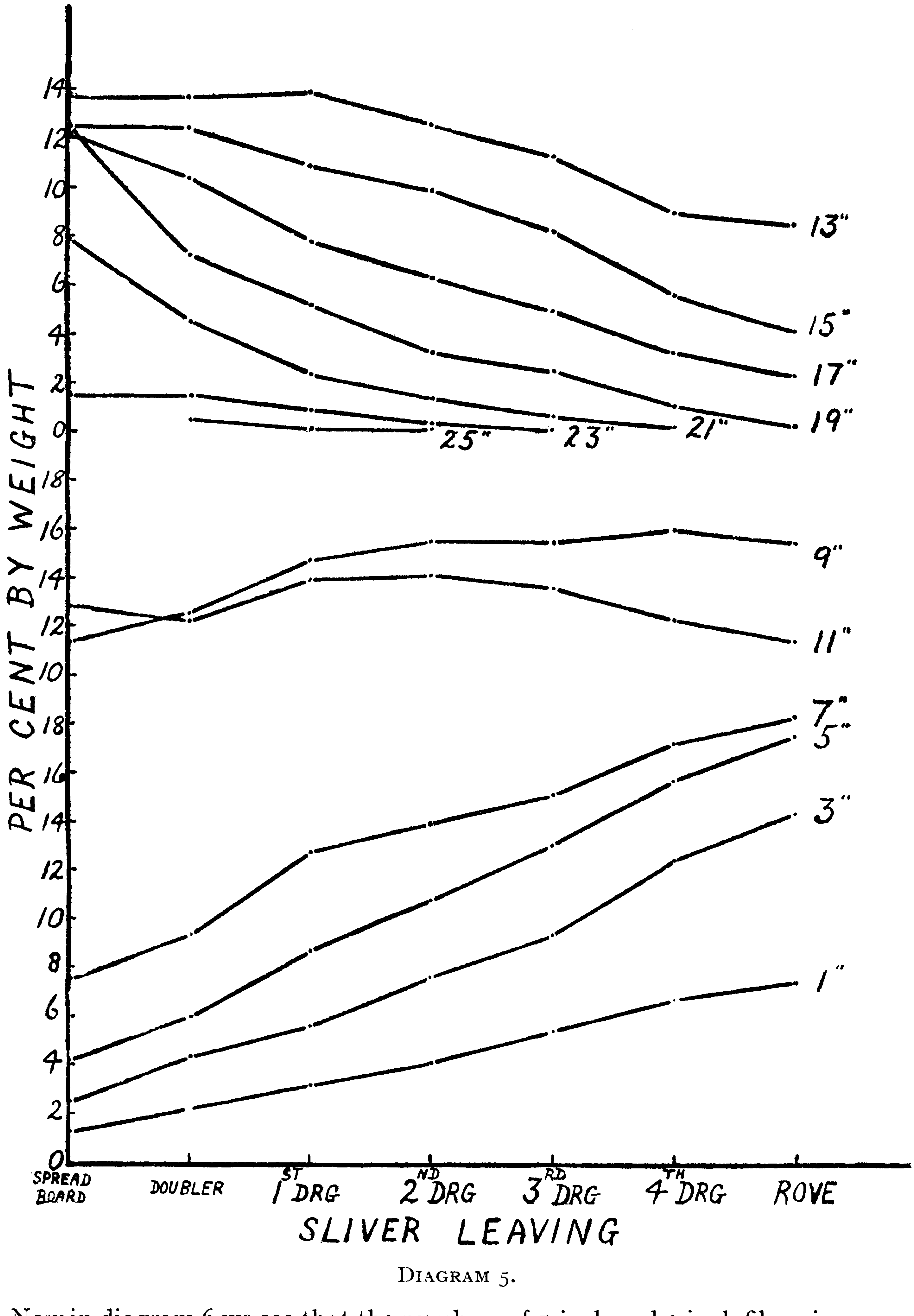

DIAGRAM 5.

Now in diagram 6 we see that the numbers of 1-inch and 3-inch fibres increase at a much greater rate than the number of long fibres decrease. Therefore the conclusion is that a good proportion of these 1-inch and 3-inch fibres are produced from the long fibres without causing any reduction in their effective length, that is that they are short pieces stripped or peeled off the sides. The initial rapid rise in percentage number of 1-inch fibre also suggested that they might be produced by the first few drawings pulling or breaking off short lengths as the ends of the fibres might be expected to be

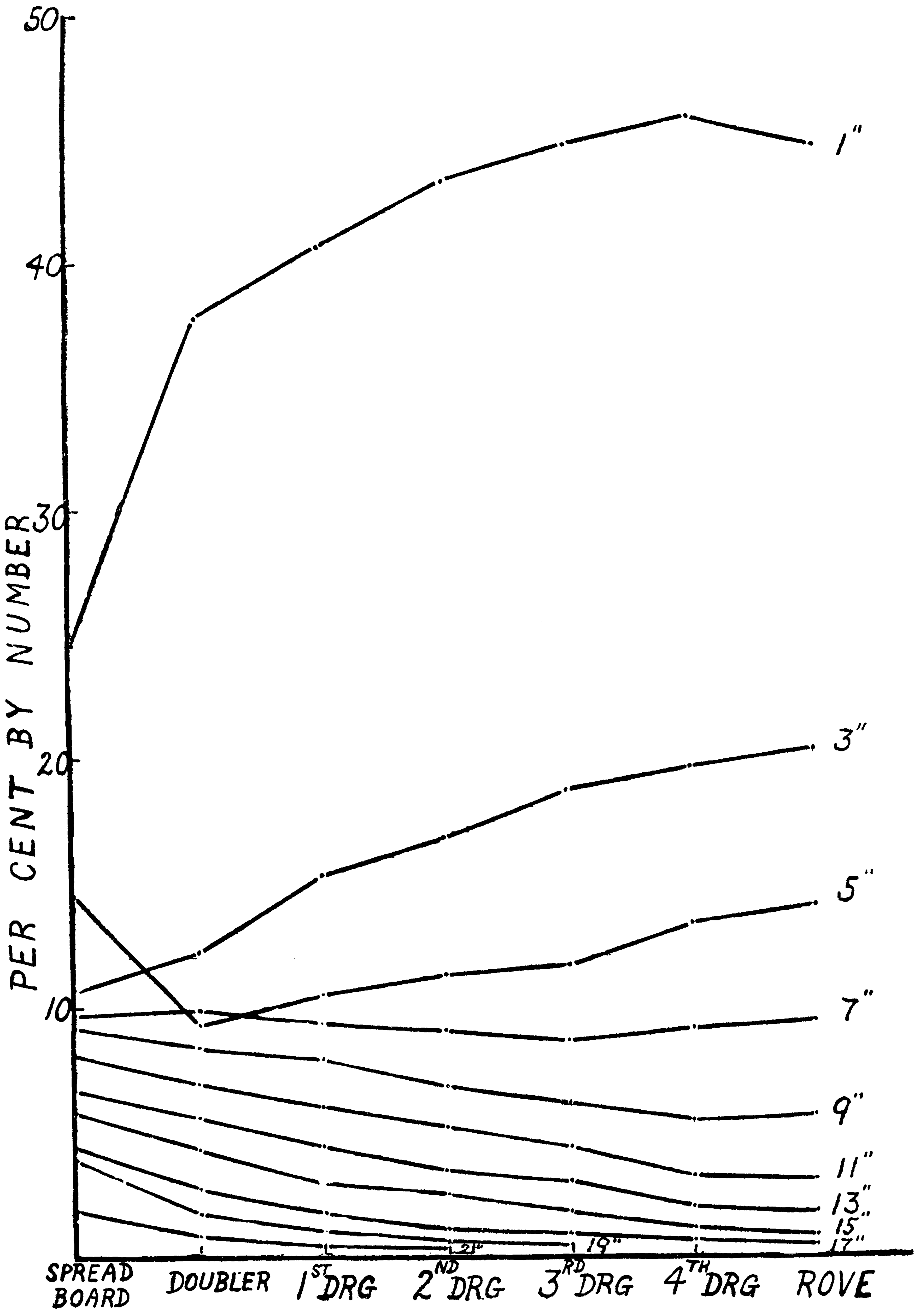

DIAGRAM 6.

fine and weak. An attempt to trace such an effect has been made by including cut line in the following measurements, as then weak ends should be mostly removed by cutting.

Conclusions

From this detailed study of the fibre dimensions after each stage of the preparing system, the following conclusions and suggestions may be drawn. That with this Courtrai long line fibre—

(1) The average length and the average cross section of the fibre is reduced continuously during its passage over each of the various drawing frames.

(2) The mean group cross section of each length of fibre is reduced by each successive drawing, but the cross section of the shortest fibre (1 inch) remains practically unaltered throughout the system.

(3) When the average cross section is plotted against weight mean length, after successive drawings, a smooth curve is obtained which passes through a point which represents the cross section of the 1-inch fibre, which is regarded as the limiting fineness to which the fibre can be broken down by this preparing process.

(4) The fibres from the successive stages not only become shorter on the average, but the variation in length becomes smaller and smaller.

(5) A study of the changes in percentage number of fibres, in conjunction with the previous conclusions, suggests that the 1-inch and 3-inch fibres may be very largely produced by a peeling off of side branches from the long fibres, and there is also a suggestion that some 1-inch fibre may be produced in the earlier stages as a pulling off of weak ends from the fibre strands.

FLAX LINE SYSTEMS: VARIOUS KINDS AND QUALITIES

In order to see how far these results might be typical, and to investigate the suggestions mentioned above, a number of other line systems were examined in the same way, as follows—

(1) Courtrai cut line for 180's lea yarn.
(2) Courtrai long line for 160's lea yarn.
(3) Courtrai long line sorted for 50's yarn, as already described, given five extra drawings on doubler and an additional drawing on the first drawing frame, a suitable number of doublings being given every time to keep the weight of sliver correct.
(4) Irish tipples for 70's lea weft yarn.
(5) Irish tipples for 35's lea warp yarn.
(6) Russian tipples for 60's lea weft yarn.

Nos. (1) and (2) were not carried out on the same sort of flax which would have been necessary in order to obtain an exact and direct comparison on the effect of cutting the flax line. As the same sort of flax as used in the 180's cut line was not available at the time, the nearest available sort was taken and there would be a difference of about three grades between the two sorts. Comparison of No. (3) with the 50's described above in full gives the effect of extra preparing. (4) and (5) were intended to compare different sorts of Irish flax, whilst (6) permits of comparison between Courtrai, Irish, and Russian flaxes.

The results are too numerous to give in full for each system, as was done in the first case, so only those dealing with the various points under discussion will be presented. The figures are shown graphically in diagrams 7—11, which also show for direct comparison the results given above for 50's Courtrai. It is not intended to discuss the results system by system, but to compare the various sorts of flax and systems from the various standpoints raised by the discussion on the results of the system given in the previous section.

Discussion of Results

The *change in mean length* of the fibre is shown on the left of diagram 7, in which the ordinate scales are moved to keep the various curves distinct. The bottom two curves show the reduction in length at successive stages of Courtrai flax, Cut line, and Long line of somewhat similar sorts. The Cut line is a good deal shorter than the Long line on leaving the spreadboard, but this difference is eliminated after passing over the doubler, and then throughout the rest of the system the differences are small, with the Long line

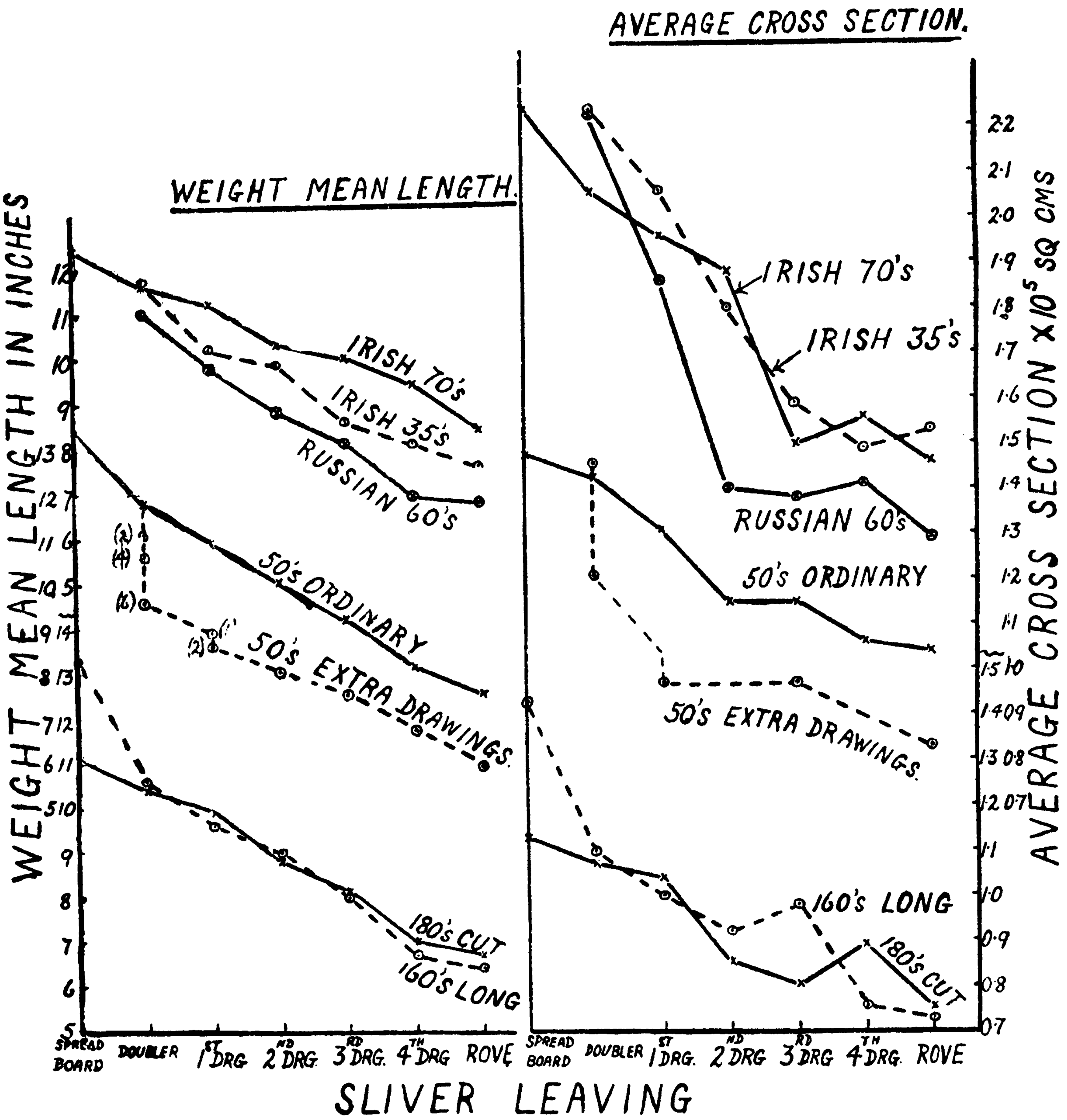

DIAGRAM 7.

ending up slightly shorter than the Cut line. Over the whole system, therefore, the Long line showed a greater amount of breakdown than the Cut line.

The middle pair of curves shows the effect of extra preparing on Courtrai Long line (sorted) for 50's warp yarn. The same kind of flax fibre was used in both cases, the extra preparing given was five times over the doubler and once extra over the first drawing, in all cases the doublings being arranged to keep the weight of sliver normal. The changes of length after two, four, and six times over the doubler are shown one below the other, similarly after one and two times over the first drawing. From then on the normal preparing was followed. It will be seen that there is still a decided decrease in length after each drawing, although on leaving the first drawing the rate of decrease is not quite so great as in the ordinary system. The total reduction in length of fibre is rather greater for the 160's than for the 50's Long line Courtrai.

The top pair of curves shows Irish flaxes, a 70's weft and a 35's warp. In both cases a continuous decrease is shown, and in both cases this reduction is less than for Courtrai line, especially in the case of the 70's Irish, which

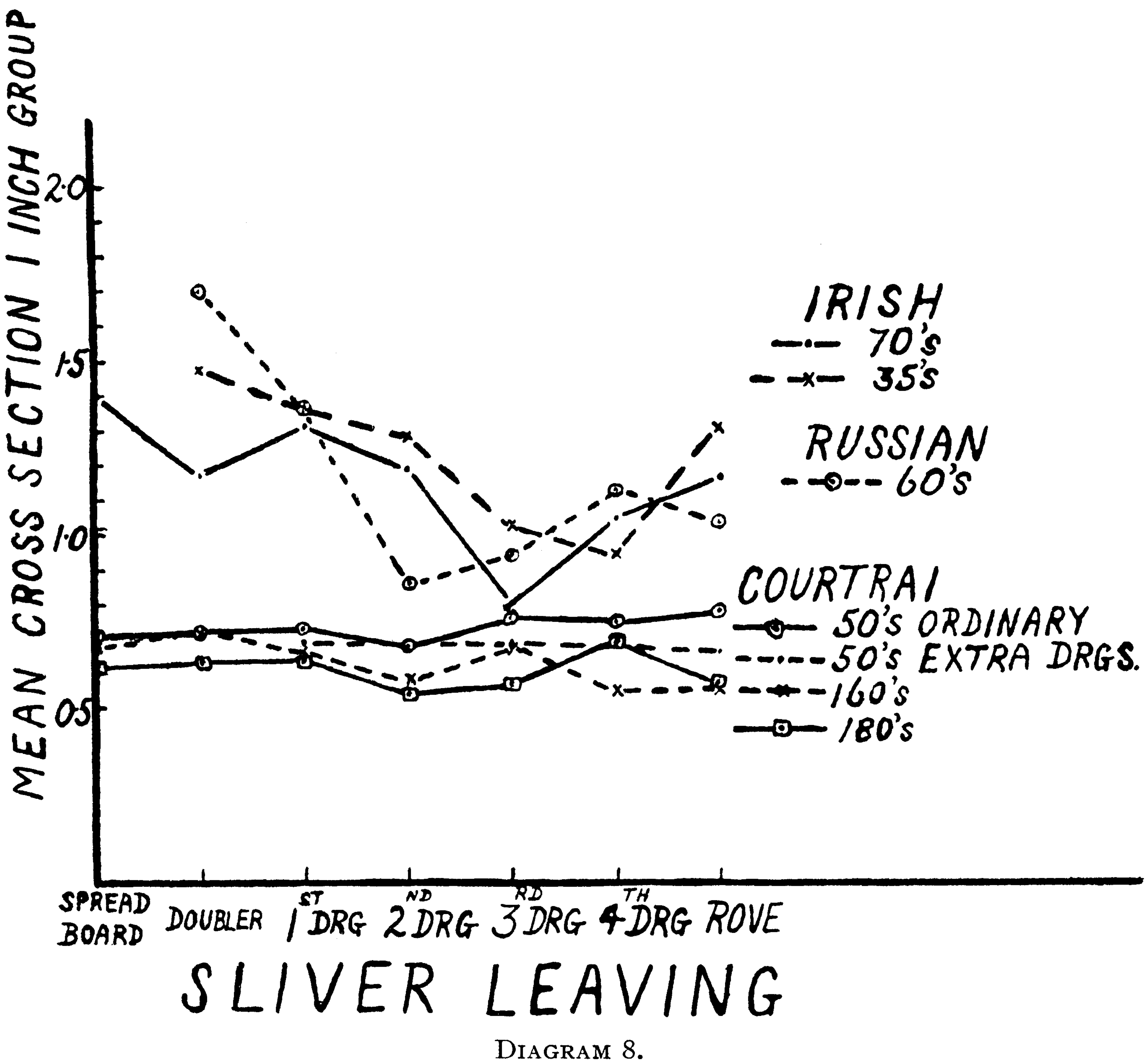

DIAGRAM 8.

is approximately the same as for the 180's Courtrai Cut line. The Russian flax is compared on the same scale as the Irish; the fibre appears to be shorter to start with and remains shorter throughout the system, the rate of breakdown being about the same as for the 35's Irish. The length of fibre in the rove is shorter than for Irish or Courtrai of the same lea.

The *change in average cross section* of the fibre is shown on the right of diagram 7. The four Courtrai curves are relatively almost the same as those for mean length. The 160's Long line shows a greater total reduction in average cross section than the 180's Cut line, and although the 160's is coarser on leaving the spreadboard, it is very slightly finer on leaving the roving. There is also an indication that over the last few drawing frames, the rate of reduction in cross section becomes smaller than in the early part of the system. This feature is more pronounced with the 50's Courtrai which was given the extra preparing; in this case, after leaving the first drawing frame, the rate of decrease of average cross section becomes very small.

This feature is again very marked in both the Irish flaxes, and in the Russian flax. In these cases it can be said that the change in cross section after the third drawing is negligible compared with the total reduction. There was very little difference in cross section between the 70's and 35's Irish after the first drawing and both were much coarser than the 50's Courtrai.

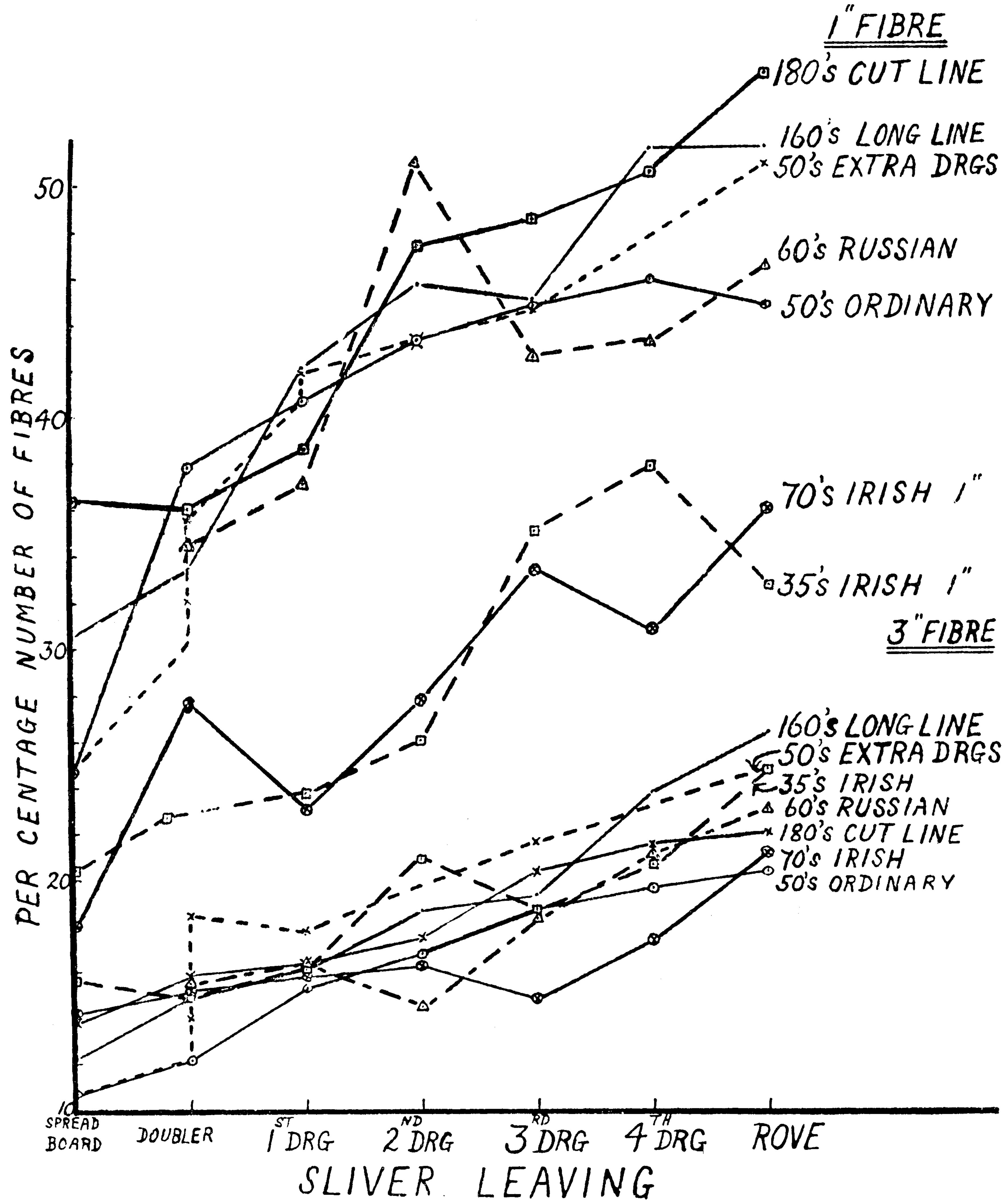

DIAGRAM 9.

The 60's Russian flax started with about the same cross section as the 35's Irish, and ended up considerably finer, but still much greater than the 50's Courtrai. The initial rate of change of cross section was much higher in Russian than in Irish.

The change in mean group cross section of the 1-*inch fibre* throughout the system for each of these flaxes is shown in diagram 8. In the system dealt with in full, it was remarked that the cross section of this fibre appeared to remain practically unaltered. This is very substantially confirmed in the case of Courtrai flaxes, for which it will be seen that the variations are very small. The case of the 50's Courtrai with extra preparing is very interesting in this connection, as the minimum mean group cross section of 1-inch fibre in this case is practically the same as in the ordinary system, in spite of the six extra drawings. This appears to indicate that this dimension is purely a factor depending on the flax fibre.

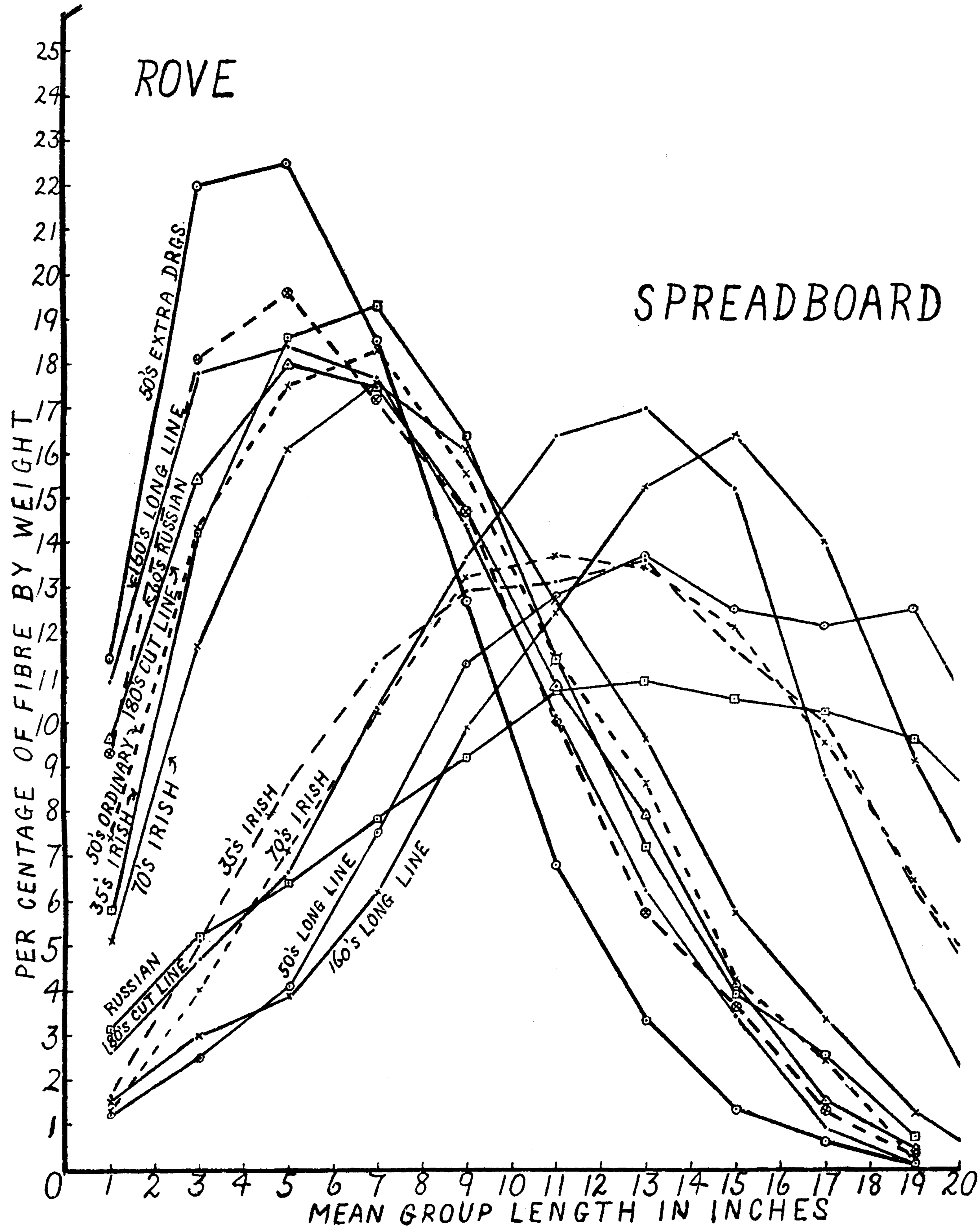

DIAGRAM 10.

With the Irish and Russian flax fibre, the mean group cross section of 1-inch fibre undergoes considerably greater changes than that of Courtrai flax. In each case the cross section shows a gradual decrease followed by a gradual rise.* This means that during the first few drawings the 1-inch fibre produced is finer in cross section than that in the original flax, but afterwards the 1-inch fibre produced is of greater cross section and so increases the mean.

* The differences shown are much greater than the probable error in the measurement.

This appears to indicate that some breakage of long fibres, which have been shown to have greater cross section, takes place. This is also consistent with the behaviours shown on diagram 7, in all cases a continuous decrease in mean length, but with Irish and Russian the decrease in average cross section almost ceases after the third drawing, whereas with the Courtrai flaxes it is still decided, although somewhat less. It would be expected that this behaviour, that is, whether the fibre strands become broken off to give short coarse pieces, or continue to the end of the preparing to give only short fine pieces, would be intimately connected with the tensile strength of the fibre strands, but no measurements on this point have yet been made.

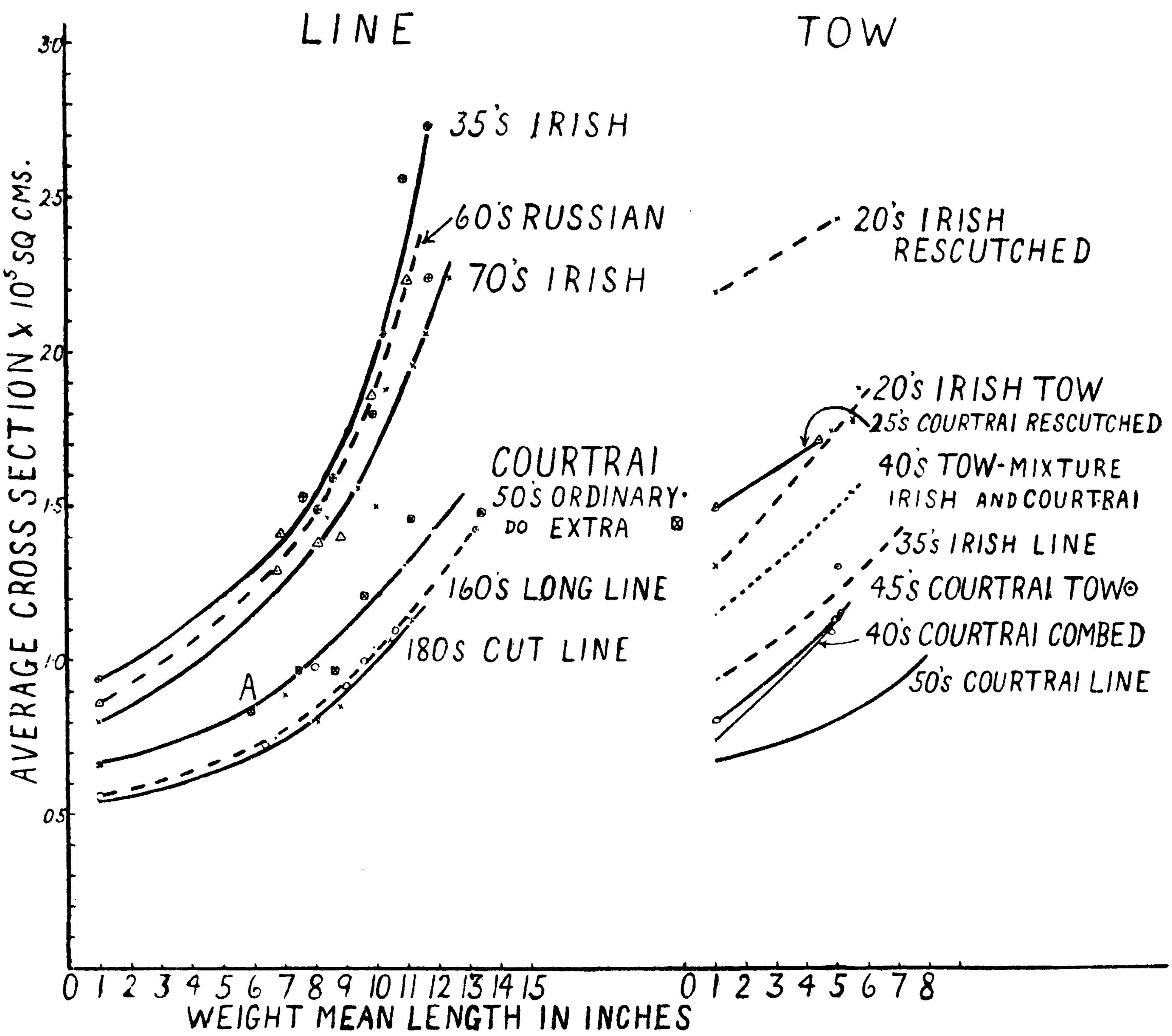

DIAGRAM 11.

The change in percentage of total number for 1-inch and 3-inch fibre at each stage of the system is shown in diagram 9. There appeared to be no real difference in any case in the general behaviour as regards fibres longer than 3 inches in length, so they are not shown. This type of diagram was shown to be of possible interest as affording a means of elucidating the method of production of the short length fibres, particularly that of 1-inch mean group length. It was seen in the case of 50's Courtrai Long line (also again reproduced on this diagram) that the percentage number of 1-inch fibre showed a very rapid rise at first and then gradually decreased. It was thought this was consistent with an explanation of weak ends being pulled off in the drawing, and this has been investigated by testing a system employing Cut line, in which a large portion of these weak ends should presumably have been removed before being used. It will be seen that this system, 180's, gave an entirely different type of curve, the percentage of 1-inch fibre showing only a very small change until the second drawing, after which the increase was fairly continuous. This flax was of a considerably finer sort than that used in the 50's, so the measurements were repeated on 160's Long line, thus employing a flax which, although of a different sort from that in the 180's, did not differ so much as that of the 50's Courtrai. With the 160's Long line, as in the 50's, the percentage of 1-inch fibre increased at once and continued fairly rapidly throughout the system. The results, therefore, appear to show a decided difference in behaviour between Long line and Cut line, and therefore provide some evidence of the correctness of the explanation that at least some of the 1-inch fibre is produced by being pulled off the ends of the strands.

The curves for the Courtrai flaxes lie close together, broadly speaking in order of the lea of yarn, the finer the yarn the greater the percentage number of 1-inch fibres. The Irish flaxes give very similar results to each other, but very different from the Courtrai, containing 10–20% fewer of these short lengths, both in the original and in the rove. The Russian flax appears to resemble Courtrai in respect of the number of 1-inch fibres present.

In regard to the percentage number of 3-inch fibres, the differences between the different sorts of flax found with 1-inch fibres do not appear to exist in such a marked manner. A range of 5% at any stage covers all the various sorts. The differences between the various kinds of flax do not show out distinctly, so they must be less important as regards the production of 3-inch fibre than other factors, such as particulars of the preparing systems, &c.

Fibre length weight distribution curves for the roves and the slivers leaving the spreadboard (below 20 inch length) are shown in diagram 10. The curves for normal roves are seen to be very similar in type, rising steeply to a maximum and then falling away fairly steeply. There does not appear to be any striking difference in the maximum value for the percentage weight. If the position of the peak, that is the mean group length at which the maximum percentage occurs, can be regarded as any criterion, there appears to be two classes; the first has a majority of fibres of 5 inches in length and includes the finer Courtrai flaxes and the Russian, whilst the second, including the Irish and coarser Courtrai flaxes, has a majority of fibres of 7 inches in length. It cannot be said at present whether this has any decided significance; in the meantime it should not be stressed unduly, because it has been found that the position of this peak may vary as much as 2 inches in repetitions on the same sample, as previously described.* It may be remarked, however, that these two groups, when differentiated in this manner, show a decided difference in the percentage weight of fibre of 1 inch length; the Irish flaxes contain only one-half as much as the finer Courtrai and Russian flaxes.

The rove curve for the 50's Courtrai with the extra preparing, is of the same type as that of the finer Courtrai flaxes, but is again quite distinct, because it has a much higher maximum percentage value and a noticeably less amount of the longer fibres, whilst the amount of 1-inch fibre is not greatly increased. That is to say, the extra preparing mainly produces fibres of 3 and 5-inch lengths, and produces a rove with less variation in length than is the case in, say, 160's rove. Generally these results are of a similar character to those found from consideration of the percentage number,

* *Loc. cit.*

except for a change in the order as regards the amount of 1-inch fibre; this is brought about because the weight of fibre takes into account the cross section of the fibre, as well as the number.

The curves for distribution of fibre lengths in the spreadboard slivers show considerable differences. The effect of cutting is clearly evident as a shift of the whole curve towards the shorter lengths. There is a noticeable difference in the curves for 50's and 160's Long line Courtrai, the latter having a sharper peak, denoting greater uniformity in the fibre lengths. The curves show very clearly that on leaving the spreadboard, the percentage weight of 1-inch fibre is the same in the Irish and Courtrai Long line, so the considerable difference found in the roves is a characteristic of the different behaviour of these flaxes on the preparing machinery. In this respect the Russian flax resembles a Cut line, containing twice as much 1-inch fibre as in Long line, but in the roves the amounts are about the same as for the Courtrai Long line, so that the Russian flax and the Courtrai Cut line flax do not make so much in the course of the preparing.

The change of average cross section with weight mean length in these cases is shown in diagram 11, the value of average cross section marked at the 1-inch group length being the minimum mean group length found throughout the system. A few considerable irregularities occur, but the smooth curves shown appear to represent the experimental results very fairly. It will be seen that a family of similar curves are obtained, and that the curves for Courtrai flaxes lie in a group well below the group for Irish flaxes, which also contains the Russian flax. The curves for Irish and Russian flaxes appear rather different from those for Courtrai flax, having a steeper slope, denoting that the rate of decrease of cross section with decrease in length is more rapid with these flaxes than with Courtrai. This of course was also indicated by the results shown on diagram 7, but not in so direct a manner.

In each group, the coarser the yarn to which the fibre was to be spun, the higher is the curve in the series.

The 50's Courtrai with extra preparing is of interest in this connection, as the extra drawings had the effect of decreasing the length considerably more than was the case in the ordinary system; the mean length of fibre in the rove of the normal system was 7·5 inches, but with the extra preparing this was reduced to 5·9 inches. This latter case, therefore, gives a point (A) on the curve which considerably reduces the gap from 7·5 inches to 1 inch which was filled in by inspection, assuming the value of the cross section for 1-inch fibre to be the correct limiting value. The new point A appears to lie fairly well on this filled-in portion of the curve, and so tends to justify the above assumption.

SUMMARY OF CONCLUSIONS FROM LINE FLAXES

Although the extent of the above work is very small compared with what would be necessary in order to make an absolutely detailed study of all the various practices, yet the samples selected cover a wide field, and the general behaviours examined are so similar and the results so concordant, that it may be said that they form, if not conclusive, at all events very strong evidence that the following conclusions may be drawn.

(1) With all the line flaxes examined, the mean length of fibre is decreased by each drawing operation, and with Courtrai flax the progressive decrease was found to continue for six extra drawings which were given. The rate

of breakdown in length varies slightly according to the nature and quality of the flax, but with Courtrai Long lines it was found that the finer the lea, the greater was the breakdown. The fibres have longer mean lengths in Irish than in Courtrai roves, which in turn are longer than Russian for approximately the same lea. Cut lines show a less rapid decrease in mean length than Long line of about the same quality.

(2) The average cross section of Irish flax did not show any great difference between the different sorts of 70's weft and 35's warp, but there was more difference between 50's and 160's Courtrai Long line, the 50's being coarser than the 160's. In roves, Irish fibre had the greater average cross sectional area, Russian flax was only a little less, and Courtrai flax was again a good deal finer than Russian. The rate of decrease of cross section shows more marked differences according to the nature of the flax than the breakdown in length. All the results tend to show that in the later half of the system, the rate of change of cross section becomes smaller; with Courtrai flaxes the difference is noticeable but not very large, but with Irish and Russian flaxes, the rate becomes so small as to be almost negligible.

(3) With Courtrai flaxes the mean group cross section of 1-inch fibre shows practically no change throughout the system, or even with a lot of extra preparing. Both Irish and Russian flaxes show a decided decrease followed by a gradual rise. The results are taken to justify the conclusion that the minimum value of mean group cross section of 1-inch fibre is a limit of fineness to which the flax fibre strands could be broken down by normal preparing machinery by an indefinite number of drawings.

(4) Consideration of the rate of change of percentage number of 1-inch fibre is shown to be of interest. The Courtrai flaxes contain decreasing amounts as the yarn lea behomes heavier, Russian contains approximately the same amount (by number) as Courtrai, but Irish flax appears to contain about 15% less than either Courtrai or Russian. A characteristic difference is shown between Cut line and Long line; whilst the former shows a very small increase in number of 1-inch fibre for the first few drawings, the latter shows a rapid and continuous increase right from the spreadboard. This seems to show that the more rapid rate of change of mean length found with Long line is due to the pulling off of short weak ends or some similar effect in the early stages of the preparing, since in Cut line such ends would be removed by cutting.

(5) No general distinction can be made between Courtrai and Irish flax roves as regards the type of the weight-length distribution curves. Russian flax gives the same type as a fine Courtrai, whilst Irish and coarser Courtrai have the same type. Extra preparing alters the type of the curve, to that of a much finer number, and in addition, raises the maximum height and reduces the amount of long fibre considerably, while the amount of 1-inch fibre is increased. The weight-length distribution curves for the slivers leaving the spreadboard show very considerable differences for the different sorts of flaxes, but as already stated, the effect of the normal preparing system appears to be to eliminate these differences very largely by the time the rove is made. Comparison of distribution curves for roves would hardly be expected therefore to offer much data in regard to the possible behaviour on spinning; distribution curves on spreadboard slivers might be more useful in this connection, in conjunction with other measurements.

(6) It was shown that the mean group cross section of fibre of each mean group length (except 1 inch) shows a gradual decrease throughout the system, which appears to indicate that the shorter length fibres produced during the preparing are mainly fine pieces stripped off the sides of the longer coarser strands.

(7) If curves be drawn showing the relation between average cross section and weight mean length, taking the minimum mean cross section of 1-inch fibre as a limiting condition, smooth curves are obtained of a very similar character for all the different line flaxes, only differing in position. Courtrai flaxes give curves close together in one group, whilst Irish and Russian flaxes give another distinct group lying much higher up. In each group the curves lie in order of the lea of the yarn to which the fibre was to be spun, in accordance with usual mill practice.

(8) The fibre dimensions and the nature of the changes which take place during preparing are shown to be quite different in Courtrai and Irish line flax. Taking the rove state for comparison, Courtrai flax is slightly shorter than Irish (7·5 inches against 7·6–8·4 inches) and very much finer in cross section (1·04 against 1·5). Russian flax resembles Courtrai in some characteristics and Irish in others, thus the mean length of fibre in rove is short (6·9 inches), whilst the average cross section is coarse (1·3). Consideration of these results and of curves such as are shown in diagram 11, appear to indicate that the mean fibre length shows less change between grades of similar kinds of flax or between different sorts of flax than the average cross section of the fibre strands, so it would appear probable that the latter is the more important characteristic as regards the spinning quality of the fibre. It may prove on further investigation that the mean group cross section of the 1-inch fibre, or what has been termed the limiting fineness of breakdown, is even more important than the average cross section; at all events it should prove a more convenient means of comparison as the length factor is fixed.

TOW SYSTEMS: VARIOUS SORTS AND QUALITIES

Similar measurements to those described for line systems were made on three tow systems; three combed tow systems were also examined as to change of weight mean length throughout the system, with some measurements of average area of cross section.

The following cases* were investigated—

Tow—(1) For 40's lea yarn—mixture of Irish and Courtrai root tow from hackling machines.

(2) For 20's lea yarn Irish—mixture of roughing tow and tops from the hackling machine.

(3) For 45's lea yarn Courtrai—mixture of roots and tops from the hackling machine.

Combed Tow—(1) For 20's lea yarn—Irish rescutched tow.

(2) For 25's lea yarn—Courtrai rescutched tow.

(3) For 40's lea yarn—Courtrai hackling machine tow.

The results of the analyses of the slivers at each stage of the preparing system are given in full for one tow system in Table I. It is not considered

* In each case the fibre was given the normal preparing considered best from mill experience.

necessary to show the results graphically, as inspection of the table readily shows that the four columns giving the results from first drawing to rove, are practically identical, the differences being of the same order as would be obtained in four repeats on the same material. That is, there is no change of fibre dimensions, either as regards length or cross section after the fibre leaves the first drawing.

On comparison of the means for length and cross section of the fibre leaving the card and the first drawing, it will be seen that an apparent increase in length and cross section is shown on passing over the first drawing. An examination of columns 1 and 2 in each of the sections showing the percentage weight and percentage number, show that there is less weight of fibre of 1 and 3 inches and a fewer number of 1-inch fibres in the first drawing slivers compared with the card sliver. Since there is no fibre lost in passing over the first drawing, this means that fibres which were grouped in the 1-inch group in the card sliver, have been placed in longer groups in the first drawing sliver, that is, fibres which were doubled and curled up in the card sliver have been straightened out on the first drawing frame and so become sorted into their correct lengths. As will be seen by comparing the mean lengths shown in Table II., the same behaviour was found in all the Irish tow systems examined and in Courtrai rescutched tow, but not with Courtrai hackle tow; in this case there was no change with the 45's tow and a slight decrease with 40's combed tow. It would appear therefore that the effect only appears or is more pronounced with very coarse fibres. In a combed tow system there is also an apparent increase in length of fibre on leaving the comb; this, of course, is due to removal of a large percentage of fibre in the noils, a good proportion of which is very short fibre.

It will be seen from Table II. that the rescutched tows, both for Courtrai and Irish are noticeably shorter than the fibre in the tows; the differences in average cross section are still more pronounced. In the tow, the cross section of the Irish is again very much greater than that of the Courtrai fibre, both also being very much larger than the respective figures for line fibre. These remarks also apply to the mean group cross section for 1-inch fibres as shown in the last section of this table. The cross section of rescutched Courtrai and Irish were both considerably greater than for ordinary machine tow, the Courtrai rescutched tow having a cross section approximately the same as the Irish machine tow.

Table III. shows the weight-length distribution in the roves and it will be seen that the chief differences exist in the amount of 1 inch fibre and in the value of the maximum percentage. Whilst the maximum percentage in line roves was found to be between 17·5 and 19·5, the tows give values 26–28·5 and the combed tows 30–37; also the maximum percentage occurs at a mean group length of 3 inches for combed tows and 5 inches for tow and 5 or 7 inches for line. Each class of fibre therefore appears to have a distinct type of distribution curve, but the differences which exist between different sorts of fibre in the same class appear to be unimportant in comparison with the difference between the types.

The results for weight mean length and average cross section for these tows are shown to the right of diagram 11*, the corresponding curves for line flaxes of Irish and Courtrai of the nearest yarn lea being also inserted from the left-hand side of the diagram. The Courtrai flax curves are all drawn in full line, while the Irish flax curves are all dotted, to permit of easy discrimination.

* See Author's note on page T434

Table I.

Flax.—Irish and Courtrai Root Tows from Hackling Machine, for 40's Lea Yarn.

Mean Group Length	Per cent. by Weight in Sliver from					Per cent. by Number in Sliver from					Mean Group Cross Section $\times 10^5$ sq. cms.				
Inches	Card	1st Drg.	2nd Drg.	3rd Drg.	Rove	Card	1st Drg.	2nd Drg.	3rd Drg.	Rove	Card	1st Drg.	2nd Drg.	3rd Drg.	Rove
1	14·4	9·4	9·4	8·9	9·2	55·5	45·1	43·1	44·6	43·6	1·15	1·17	1·23	1·23	1·17
3	28·5	22·4	20·9	22·1	24·8	24·9	27·3	26·9	24·6	28·4	1·69	1·56	1·45	1·85	1·62
5	27·1	28·0	27·4	27·3	28·5	12·9	15·6	16·6	15·8	16·2	1·86	2·02	1·84	2·14	1·96
7	16·6	20·4	22·5	22·2	20·3	4·4	7·3	8·4	10·0	7·4	2·41	2·25	2·14	1·96	2·17
9	8·5	11·6	12·5	12·5	11·5	1·6	3·1	3·4	3·6	3·2	2·67	2·32	2·36	2·37	2·20
11	3·4	5·3	5·3	5·0	4·5	0·5	1·1	1·3	1·2	0·9	2·52	2·33	2·12	2·40	2·48
13	1·1	1·6	1·4	1·5	0·9	0·2	0·3	0·3	0·3	0·2	2·22	2·50	2·27	2·36	2·26
15	0·4	0·6	0·4	0·2	0·2	0·04	0·1	0·05	0·03	0·03	2·74	2·61	3·01	2·50	2·35
17	0·05	0·2	0·04	0·03	—	—	0·02	0·01	—	—	1·86	3·01	2·01	3·40	—
	—	—	—	0·01	—	—	—	—	—	—	—	—	—	1·80	—
Weight mean length inches	4·9	5·6	5·6	5·6	5·4	—	—	—	—	—	—	—	—	—	—
Average cross section $\times 10^5$ sq. cms.	1·46	1·55	1·52	1·65	1·55	—	—	—	—	—	—	—	—	—	—

Table II.

Tows and Combed Tows of various sorts and grades.

Sliver leaving	Weight Mean Length in inches						Average Cross Section $\times 10^5$ sq. cms.						Mean Group Cross Section of 1 inch Fibre $\times 10^5$ sq. cms.					
	Tow			Combed Tow			Tow			Combed Tow			Tow			Combed Tow		
	Irish and Courtrai 40's	Irish 20's	Courtrai 45's	Irish Rescutched 20's	Courtrai Rescutched 25's	Courtrai Hackle Tow 40's	Irish and Courtrai 40's	Irish 20's	Courtrai 45's	Irish Rescutched 20's	Courtrai Rescutched 25's	Courtrai Hackle Tow 40's	Irish and Courtrai 40's	Irish 20's	Courtrai 45's	Irish Rescutched 20's	Courtrai Rescutched 25's	Courtrai Hackle Tow 40's
Card	4·9	4·8	4·9	3·8	3·5	4·3	1·46	1·75	1·14	—	—	—	1·15	1·48	0·88	—	—	—
Doubler	—	—	—	4·4	4·0	3·9	—	—	—	—	—	—	—	—	—	—	—	—
Comb	—	—	—	5·0	4·8	5·6	—	—	—	2·44 (5·0)*	—	1·14 (5·0)*	—	—	—	2·20	—	0·74
First drawing ...	5·6	5·5	5·0	5·1	4·8	5·6	1·55	1·78	1·31	—	—	—	1·17	1·46	0·96	—	—	—
Second drawing ...	5·6	5·4	5·1	4·7	4·9	5·8	1·52	1·62	1·16	—	—	—	1·23	1·31	0·81	—	—	—
Third drawing ...	5·6	5·7	5·0	4·7	4·8	5·4	1·65	1·89	1·14	—	—	—	1·23	1·70	0·86	—	—	—
Rove	5·4	5·5	4·8	4·5	4·7	5·2	1·55	1·79	1·10	—	1·72 (4·4)*	—	1·17	1·43	0·94	—	1·5	—

* These average cross section measurements were made on different samples from those used for the determination of weight mean length recorded in columns 4, 5, and 6, so the actual weight mean lengths in these samples are given in brackets below.

This diagram, therefore, shows the entire results obtained for cross section and length, for all these different kinds and grades of flaxes, both line and tow. It has already been pointed out that in this diagram the Irish and Russian line flaxes form a group distinct from the Courtrai flaxes. So now it will be seen that the tows probably form distinct groups for Irish and Courtrai, each being about equally displaced in relation to its line flax group. Rescutched tows are again still further displaced in relation to the tows of each class, and the movements are consistent since Courtrai tow falls into the Irish line group, and Courtrai rescutched tow falls into the Irish tow group of approximately the same lea. This may be expressed by saying that the relative differences in fibre dimensions found between Irish and Courtrai fibre, more particularly cross section, persist whatever the type of fibre being considered, whether line, machine tow, or rescutched tow.

The addition of these tow results to this diagram now confirm and show in a very striking manner the conclusion derived at the end of the discussion on the line results, that the average cross section of the fibre strands was probably a more important characteristic in connection with spinning quality of the fibre than the mean length of the fibre. In line fibres there was found a tendency for the length to be shorter in the finer sorts, accompanied by a decrease in average cross section. Now, however, in the tows we have fibres much shorter than the fibre in the finest sort of Courtrai, but the average cross section is much greater. These facts, together with the fact that it is the average cross section at any length (or the limiting mean cross section of the 1-inch group), and not the mean fibre length, which is in the order of yarn lea in each class group, appear to show very definitely that cross section of fibre strand is most intimately connected with the spinning quality.

SUMMARY OF CONCLUSIONS FROM TOW RESULTS

(1) The machine tow fibres are both shorter and much coarser than the fibres in the corresponding kind of line, and rescutched tow fibres are again still shorter and coarser than the fibres in the corresponding kind of tow.

(2) The behaviour over a tow system is of an entirely different character from that over a line system. An apparent increase in mean length is shown on passing over the first drawing frame, shown to be due to straightening out of long fibres which were doubled or curled up on leaving the card. In combed tows an apparent increase in mean length is again shown on combing, this being due to removal of short fibre in the noils. After leaving the first drawing frame, no further change of any appreciable amount takes place in the length or cross section of the fibres of any sort of flax tow.

(3) Both in machine tow and in rescutched tows, the great difference found in average cross section between Irish and Courtrai line flax was found to persist.

(4) The results confirm those of the line systems in regard to the probability of cross section being a more important characteristic than mean length as regards spinning quality, since in the cases examined, the cross sections have been found to be in the same order as the mill sorting.

(5) These conclusions would indicate that in order to derive the maximum amount of information from tests on this sorting machine, determinations of cross sectional areas are very essential in addition to the length distributions and average length. Also that such measurements should be made at more than one stage of the preparing when comparing the behaviour of different flaxes.

Table III.

Tows and Combed Tows of various sorts and grades

Mean Group Length	Per cent. by Weight in Roves					
	Tow			Combed Tow		
	Irish and Courtrai	Irish	Courtrai	Irish Rescutched	Courtrai Rescutched	Courtrai Hackle Tow
Inches	40's	20's	45's	20's	25's	40's
1	9·2	10·6	13·7	11·9	8·7	7·4
3	24·8	24·2	27·7	36·8	34·9	29·4
5	28·5	25·8	28·1	27·3	31·5	29·7
7	20·3	19·1	17·4	14·7	16·2	19·7
9	11·5	11·8	9·1	6·5	6·2	8·7
11	4·5	5·4	3·2	1·9	2·0	3·5
13	0·9	2·1	0·4	0·7	0·4	1·1
15	0·2	0·7	0·3	0·1	0·1	0·2
17	—	0·2	—	0·1	—	0·03

PART II.

In the previous section particulars were determined of the changes in fibre dimensions and of the relative amounts of the fibres of different sizes as the preparing proceeded. In tow systems it was shown that there was no breakdown, the preparing merely straightening the fibres and gradually reducing the weight of the sliver. In line systems, however, considerable changes in dimensions and weight distribution of the various sized fibres occurred, and these were examined in detail under normal preparing conditions; as a result of the study of the changes which occurred with different sorts of fibre, some conclusions were drawn as to the way in which the breakdown took place. For example, the comparison of Cut line with Long line indicated that in the latter case the ends of the fibre strands were weak and were easily pulled or broken off into lengths of 1 inch mean group length (that is less than two inches in length), which was mainly effected by the spreadboard and the doubler. In later stages the breakdown was accompanied by the formation of fibre of 1, 3, and 5 inches in length in varying proportions, and this process was continued with the same result for many more than the normal number of drawings. Consideration of the change in cross section of individual groups, showed that (except for the shortest lengths), each drawing was accompanied by a decrease in cross section; this appeared to show that the short lengths must be produced mainly by a peeling off from the sides of long fibres, since the short length fibres are of fine cross section. Evidence was also found that in some kinds of fibre, such as Irish or Russian, short lengths were produced in the later stages of the system by being broken off from the ends of long coarse fibres.

In this section some experiments are described which were made with the object of investigating the method in which the breakdown occurs, from an entirely different point of view. In these experiments, the same flax was used throughout (50's Courtrai Long line) and the effect of alterations of working conditions on the dimensions of the fibres were studied. Only the weight mean lengths of the fibres in the samples were determined as a measure of the breakdown effect. Various changes in working conditions were made, generally using the extreme changes provided for by the machine manufacturers, and care was taken to have only one variant at a time, so far as possible.

As was shown in a previous paper,* dealing with the accuracy of repetition on this sorting machine, with line flax a difference of at least 0·2 inch in the weight mean lengths of different samples is necessary in order to show any significant difference in average fibre length.

FIRST SERIES OF EXPERIMENTS

Altering Weight of Sliver Entering the Frame

Slivers were taken from the second drawing with 4, 6, and 8 doublings, and each was drafted in turn over the same row of pins on the third drawing frame.

Sliver from 2nd Drawing doubled	Weight Mean Length after drafting on 3rd Drawing
4 times	9·36 inches
6 times	9·26 ,,
8 times	9·21 ,,

Assuming that the average length of fibre was the same in the three slivers from the second drawing, no really significant difference in length was shown after drafting, due to alteration of the weight of the sliver drafted.

Packing of the Fibres in the Pins

On a fourth drawing frame, as the fallers rose at the back and penetrated the sliver, the fibre was pressed down by hand, hard against the top of the gill stock. In this way the fibres were packed very much closer together, in this case only occupying less than one-half of their former space. A sample of sliver drafted under these conditions was tested.

On 4th Drawing Frame	Weight Mean Length after Drafting
Normal conditions	8·1 inches
Fibres pressed down in gills	8·0 ,,

Therefore no significant change in the amount of breakdown occurred, due to closer packing of the fibres in the gills.

Effect of Pressure on the Pressing Rollers

To see whether the pressure applied to the pressing rollers had any effect on the amount of breakdown produced by the following drawing frame, the pressure on the front pressing rollers of the second drawing frame was altered to the widest possible extremes and then these slivers were drafted in turn over the same row of pins on the third drawing.

Sliver leaving 2nd Drawing under Pressure	Weight Mean Length after drafting on 3rd Drawing
150 pounds	8·86 inches
450 ,, ...	8·88 ,,

Therefore the pressure on the front pressing rollers may be varied between these limits, without showing any effect on the breakdown in the next drawing.

Effect of Amount of Draft

The effect of draft was tested on several frames, and several varieties of flax, and the results are shown in Table IV.

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* *Loc. cit.*

Table IV.

Flax	Frame	Draft	Weight Mean Length after Drafting
45's Courtrai	Doubler	12	11·55 inches
,,	,,	25	11·55 ,,
120's Courtrai	,,	12	9·89 ,,
,,	,,	25	9·99 ,,
30's Irish	,,	12	11·4 ,,
,,	,,	25	11·6 ,,
50's Courtrai	2nd drawing	10	10·2 ,,
,,	,,	14	10·0 ,,
,,	3rd drawing	10	9·18 ,,
,,	,,	14	9·0 ,,
,,	4th drawing	10	8·28 ,,
,,	,,	14	8·18 ,,

From these results the amount of draft does not appear to have any significant effect on the amount of breakdown.

Effect of Speed of the Frame

The third drawing frame was run in the usual way, but very slowly, with the following result—

Sliver leaving 3rd Drawing	Weight Mean Length after Drafting
At normal speed	9·18 inches
Speed as slow as possible	9·22 ,,

The amount of breakdown, therefore, was not affected by the speed at which the drawing frame was run.

ADDITIONAL EXPERIMENTS

It is evident from the results given above that great differences in running conditions may be made without affecting the breakdown of the fibre. The above changes cover all the usual provisions for varying the working conditions, but no evidence was found as to the factors contributing to the breakdown. Other factors which might be considered as having some possible effect are the length of the reach, the length of the nip, the pitch of the pins in the gills, and the pitch of the faller screw as affecting the total number of pins in the sliver. These factors are not variable on the machines, but some data on their effects was obtained in an indirect way.

Drafting of the same Fibre on Different Frames

A sliver from the second drawing frame, in which the weight mean length of fibre was 10·0 inches, was taken and drafted on the doubler, the second, third, and the fourth drawing frames, in each case the requisite number of doublings being made to make the weight of sliver entering the frame as nearly as possible the same as usual for the particular frame. In this case, of course, many variants are involved; some of these, such as draft and speed, have already been shown to be without effect, but others such as reach and pitch of pins were unknown factors. The results obtained were as follows—

Normal 2nd drawing sliver (mean length 10·0 inches)

Drafted on Frame	Reach inches	Pitch of Pins per inch	Weight Mean Length after Drafting
Doubler	26	16	9·1 inches
Second drawing	22	28	9·23 ,,
Third drawing	20	32	9·18 ,,
Fourth drawing	18	36	9·38 ,,

The amount of breakdown, therefore, was very much the same on all these frames, in spite of the differences in reach and pitch of pins. The longest fibre in the original second drawing sliver was 25 inches, so that on the doubler there was no question of breakdown being brought about by fibres being longer than the reach, and the pins were fairly wide spaced, yet the same breakdown was obtained as on the third drawing frame, for example, where the reach was 5 inches shorter than the longest fibre in the sliver being drafted, and the pitch of the pins was just twice as fine as that on the doubler. The same result was again obtained on putting this sliver from the second drawing straight on to the fourth drawing frame.

From these results it would appear that neither the reach not the exact pitch of pins is very important in determining the amount of breakdown.

Location of Point of Breakdown

In all flax drawing frames, the fallers have a small positive lead on the fibre, the relative velocities of fibre and faller remaining the same until the fibre is gripped by the front pressing rollers. It is conceivable, that if the back pressing rollers were very efficient and if the pins should become very firmly engaged with the fibre, that this lead of the fallers on the fibre might be sufficient to produce breakage of the fibre at the back of the frame; this was not considered very likely, as a small percentage of fibre of length greater than the reach is usually found in any sliver, which indicates that slipping occurs at the back rollers. In order to establish definitely whether the breakdown occurs at the back or the front of the drawing frames, the following experiment was made.

A sample was run through with the front pressing roller removed, so that there was no drafting and the only action on the sliver was that of the faller lead. The following result was obtained—

	Weight Mean Length
Normal entering 3rd drawing	10·0 inches
Leaving 3rd drawing, no draft	10·08 ,,

Hence there is no breakdown effect shown due to the faller lead, and so it appears that the breakdown actually occurs at the front of the drawing frame during the drafting, and yet, as shown above, alteration of the amount of draft over a wide range did not alter the amount of the breakdown, nor was it affected by the speed of the frame, which alters the relative speed of the fibre and the gills in the same way as altering the draft. From these results it began to appear that as the breakdown was brought about by any drafting, under widely different conditions of support, it must be dependent on some condition of the fibre, either natural or artifically produced. In the latter case there are two possibilities, either the fibre may be left in some particular condition on leaving the preceding drawing frame, or some particular condition may be produced on the fibre by an action of the pins when penetrating the sliver. This was tested directly.

Effect of Pin Penetration at Back of Drawing Frame

(1) A sliver from the second drawing frame was put over the third drawing without draft, as described above, and then carried on to the fourth drawing and drafted in the usual way. This sliver then was twice pinned at the back of the frames by fallers before drafting, so if compared with a normal sliver drafted on the third drawing, any difference would be due to this extra pinning. The following results were obtained—

	Weight Mean Length
Sliver leaving 2nd drawing	10·0 inches
Pinned only, 3rd drawing; no draft	10·08 ,,
Do. do. then drafted on 4th drawing	8·8 ,,
Normal leaving 3rd drawing	9·18 ,,
Do. do. after 4th drawing	8·1 ,,

Hence twice pinning of the sliver before drafting causes a greater breakdown on drafting than the usual single pinning (from 9·18 to 8·8), but not so great as when twice pinned and twice drafted, and so it would appear that both pinning at the back of the frame and the drafting on the previous frame each have some effect in creating the condition of the fibre necessary to bring about the breakdown.

(2) The effect of pin penetration at the back of the frame was also tested in another way. The number of fallers engaged was altered by removing every other faller in one case and by removing two out of every three fallers in another case, which reduced the number of times the sliver was pinned. The following results were obtained—

Sliver drafted	Fallers	Weight Mean Length after Drafting
On 3rd drawing	Normal	9·18 inches
	Every other one removed ...	9·47 ,,
On 4th drawing	Normal	8·1 ,,
	Every other one removed ...	8·39 ,,
	Two out of every three removed	8·53 ,,

The results show rather definitely that reduction in the number of times the sliver is penetrated by the fallers causes a reduction in the breakdown on drafting, and therefore confirms the results of (1), where the breakdown was increased by extra pinning before drafting.

From the experiments so far carried out, therefore, we may conclude that breakdown occurs at the front of the drawing frame under the action of drafting, whatever the amount, but the fibre is prepared for this breakdown by being left in some necessary condition—

(1) By the effect of the previous drafting.

(2) By the effect of penetration of the sliver by the pins at the back of the frame. This is presuming that the same material is used, and it is probable that there may be conditions depending on the natural state of the fibre.

Visual Examination of Action of Pins

The slivers in a head were carefully cut, leaving a length of about 4 inches remaining in the gills. This block of fallers was then carefully lifted out of the machine for examination. On viewing the fibre through a magnifying glass, numerous cases were observed in which pins were situated between the main fibre strand and a branch with a free end, but no case of direct penetration of the pins into a fibre strand or a ribbon of strands was seen. A number of fibres were gripped at the ends between the fingers and slowly drawn forward through the gills, as might be the case in drafting; in very few cases was any decided resistance encountered. Quite a large proportion of these fibres after extraction appeared to be much longer than the length of the sliver from which they had been pulled. Examination of these particular fibres showed that they consisted of a coarse main stem and a finer branch, held together over a short length with the branch folded back along the stem, so that the two free ends, which originally had been at the same side of the junction, were now on opposite sides. Apparently these fibres are produced as a result of a pin entering between the stem and the branch, and on pulling the stem forward, the branch is held against the pin by the other fibres for some time, after which the branch follows through with the stem, so that on extraction the branch is bent back on itself, possibly with the join with the stem reduced in length.

In the usual preparing process this fibre is presented to the next frame in the reverse direction; hence if the end of the branch protrudes beyond the end of the stem, it would be gripped first, and the restraint imposed on the stem by the surrounding fibres and the pins would probably give sufficient resistance to permit of the branch being pulled clear under the action of the drafting. If the end of the branch is not protruding beyond the end of the stem, but is fairly close to it, cases may arise in which a pin penetrates a fork between stem and branch, and then the two ends become gripped by the front drawing rollers almost simultaneously; here the branch would get torn away from the stem or it would break at the pin, according to the relative strengths of the fibre and the join. A third case occurs when the end of the turned back branch is not near the end of the stem; here the most likely effect is for the branch to get turned back again into its original direction, and this might occur whether penetration of the fork by a pin happens or no.

It must be borne in mind that the entanglement of the fibres, due to short branches not lying close to the stem but sticking out at all angles, would also act in much the same way as pin penetration between a branch and its stem. It may be that some such effect is accountable for the extra breakdown which was shown to be produced by drafting irrespective of pin penetration. Probably these remarks apply with most force to branches of some length; in a sliver all kinds of conditions exist simultaneously, and no doubt other branches, such as very short or stiff branches, pass through without reversal of direction unless directly pinned. This view of the manner in which the breakdown is effected, seems to imply that the main effect of the pinning and the drafting is a reversal of direction of certain side branches, which apparently is the artificial condition of the fibres in the sliver referred to above. This, therefore, appears to place some importance on the direction in which the branches point, the condition advantageous to breakdown being that in which the branch points in the direction of motion of the sliver through the frame, as this presents the fork in the right way for the pin to become operative in the manner explained. It therefore follows that the reversal of direction of the slivers in consecutive drawings, would also appear to be of importance. This reversal of the slivers between each drawing is the normal procedure, possibly because it is the most straightforward way of dealing with slivers in cans. This point appeared to be of considerable interest, particularly as it is possible to test by direct experiment, and so obtain confirmation or otherwise of the opinions described above.

Effect of Direction of Sliver

Two lots of samples were prepared from 50's Courtrai Long line. The fibre was spread in the ordinary way and carried on to the second drawing, samples of the slivers being taken from each stage. In the one case the normal procedure was adopted, the slivers being reversed between each drawing, so that the directions of the fibres were also reversed every drawing. In the other case, the slivers were always kept the same way by inverting the cans at the back of the frames, so that in this case the fibres were always kept in the same direction. The usual measurements of weight mean length and average cross section were made on each sample, and the results are shown in Table V.

It will be seen that when the fibre direction is reversed at every drawing, the amount of breakdown in length is definitely greater than when the fibre is always kept in the same direction, and a similar effect on the cross section

Table V.

Sliver leaving	Direction of Fibre in Drawings			
	Reversed (normal)		Constant	
	Weight Mean Length inches	Average Cross Section $\times 10^5$ sq. cms.	Weight Mean Length inches	Average Cross Section $\times 10^5$ sq. cms.
Spreadboard	14·3	1·77	14·3	1·77
Doubler	11·95	1·45	12·7	1·45
First Drawing ...	11·42	1·33	12·25	1·37
Second drawing ...	10·2	1·26	11·20	1·28

is indicated. The results, therefore, appear to give a direct experimental confirmation of the validity of the views expressed as to the manner in which the breakdown occurs.

Further, it may be noted, that even when the fibre direction is kept constant, a considerable amount of breakdown occurs. On the hackling machine both ends of the fibre are combed from the centre, so that when put on the spreadboard there are probably branches pointing in all directions. According to the opinion already expressed, when the fibre direction is kept constant, after a certain number of drawings these branches should all become turned in one direction, and then reversal of direction should cease, together with breakdown from this source. Probably a number of drawings are required to bring about such a condition, and if it is attained, breakdown would presumably still occur as a result of branches being held back by entanglement with the other fibres and the pins. The smaller amount of breakdown obtained when the fibre direction remains constant, after a number of drawings, possibly represents the same effect as was noted earlier, namely, the amount of breakdown due to drafting in excess of the pinning effect at the back of the frame (pages T430 and T431).

SUMMARY OF CONCLUSIONS

From the results given, it appears that, at least for Courtrai Long line, the following conclusions may be drawn—

(1) Such factors as the amount of draft, weight of sliver, pressure on the front pressing rollers, speed of frame and tightness of packing in the pins, do not have any decided effect on the amount of breakdown of the fibre passing over the drawing frames.

(2) The breakdown takes place at the front of the drawing frame.

(3) The same sliver may be drafted on such different frames as a doubler and other frames up to the fourth drawing, and the same breakdown obtained, in spite of the great differences in reach and pitch of pins.

(4) The breakdown is connected with the number of times the sliver is penetrated by the gills, and the drafting leaves the sliver in some condition which assists the breakdown on the following frame.

(5) Results of visual examination offer an explanation of (4). It was seen that pins penetrate between branches and their stems, and when pulled forward, these branches, if pointing in the right direction, are bent back on the stem and may also be partially pulled off. On presenting this fibre in the reverse direction to the next drawing frame, this branch may be gripped

before the stem, when it would act like a weak end and be pulled off; if the branch is pinned at the fork but the stem becomes gripped first, it would probably be reversed in direction and so stand the best chance of being pinned again in the same way when again the fibre is reversed on the next drawing.

(6) The above view places importance on the action of reversal of direction of the sliver at each drawing, as being an aid to the breakdown of the fibre. This was confirmed by a direct experiment, in which it was found that if the fibre direction is kept constant in successive drawings, less breakdown is obtained than when the slivers are reversed in direction in successive drawings.

(7) It is concluded from the experiments in this section, that the breakdown of flax fibre strands which occurs on drawing frames, is partly the result of a combined action of the penetration of the sliver by the pins and of the drafting, the two effects together forming an arrangement for peeling off side branches from the main fibre stand. The actual breakdown may not take place after the first pinning, since one or more draftings (according to the position of the branch on the stem) may be necessary to prepare the branch, to put it in such a condition that it may be easily stripped off. Entanglement of the branches with the other fibres and the pins also appears to aid in the breakdown, acting in the same way as the pins which penetrate into a fork between a stem and a branch, and this effect is thought to be operative whether or no the fibre is reversed between successive drawings. The amount of breakdown would then be expected to depend very much on the character of the fibre strands, particularly on its capacity for branching.

(8) The results substantially confirm the conclusions arrived at in the first part of this paper, as to the nature of the method of breakdown of flax fibre strands on the usual preparing machinery. The reduced rate of breakdown of cross section there found would then appear as a natural consequence of the peeling arrangement, as a continually decreasing number of branches would be present. In the same way, the absence of breakdown with tow fibre would appear to be due to the absence of side branches of suitable type, which are presumably stripped or broken off in the card.

Received for publication, 16*th April* 1926

* *NOTE*—Author's note supplied subsequently—In this case the lines are only put in to show the positions of the 1 inch group corresponding to the group of points representing the measurements on each system. It is not intended to imply, as was the case with line fibre, that extra drawings would bring about changes represented by points on these lines, since we have no evidence of any breakdown occuring with tow fibres.

39—THE LEVELNESS OF MULE YARNS

By S. G. Barker, Ph.D., D.I.C.
(The British Research Association for the Woollen and Worsted Industries)

In a note of criticism of my paper on the "Gravimetric Method for Investigation of the Variation of Levelness of Yarn," A. E. Oxley makes certain statements which call for serious comment.

In wool, twist and count on short lengths are closely, though perhaps not absolutely connected. The nature of wool tends to allow the twist to distribute itself more in the thin places and less in the thick ones. Faults due to uneven twist on short lengths, when counts are constant, exist, but are comparatively rare. It is therefore seen that in the case of wool, places of maximum weight or count are usually places of minimum twist, and *vice versa*. Work is now proceeding on the exact determination of this relationship. The gravimetric test has recently been employed for the investigation of the variation of thickness of woollen yarns in woven fabrics. The work is almost complete, and will be published shortly. Up to date they show that at places where an apparently thick piece of yarn shows up prominently this portion of yarn is of higher count and conversely. The detailed examination of twist at these points is also proceeding. I wish, however, to emphasise—

(1) That the gravimetric method does detect these variations of thickness due to variations of quantity of material in woollen yarns.

(2) There is some connection between count and twist in short lengths of woollen yarns. Thin places taking up greater twist and *vice versa*. Hence, since thin places would weigh less, the gravimetric method is applicable.

(3) Any method employing compression is unsuitable for woollen yarns, as, e.g., that due to Oxley.

(4) I did not attribute the periodicity to any definite cause without further investigation. My reference to Williams' work, which considered twist, shows that I did not overlook twist as a possible explanation. To quote from the paper regarding thick and thin places, I say—"They may be due to various causes . . . . Variations may also be due to irregular action of the mule itself or to variations of the condenser, but mere surmise on this point is unwise without further investigation."

This statement clearly shows that I refused to attribute the phenomenon to any cause whatever without further investigation. I mention Williams' work as a possible line of action. Oxley's statement that I apparently consider "that levelness of yarns can be satisfactorily interpreted in bulk of cotton, ignoring completely variations of twist," is absolutely incorrect. I do not consider that levelness of yarns can be satisfactorily interpreted in "bulk of cotton" or otherwise, since I have no justification for such an assumption, having done no work in this direction on cotton, neither do I make such a statement. On the contrary, I state in discussing the method due to Oxley that in the case of woollen yarns "the true variations would be even more difficult to determine by this method than in the case of cotton, since count, twist, and the volume or bulk compressibility would have to be allowed for in such observations." These are serious objections, in my opinion, but the statement proves that I was alive to the existence of the influence of twist as well as count. In conclusion I would point out that in an earlier paper with King, I have duly acknowledged the form of the micro-balance &c. to Dr. Balls, F.R.S., but I do claim that this is the first time its use has been applied to woollen yarns. I accept Oxley's correction *re* "shoe and plate." Finally, in the case of wool, our experiments conclusively show

(*a*) Thick places occur at distances apart equal to the mule draw, and these can be detected by the gravimetric method.

(*b*) Faults due to portions of thick and thin yarns in woven fabrics can be analysed by the gravimetric method.

(*c*) Variations of twist have also to be considered, but in view of the facts above mentioned may be closely related to count variations.

(*d*) Two subsequent papers are almost complete and will show that gravimetric analysis of the yarn has much to reveal in connection with faults in wool fabrics.

* I wish, however, to record that in connection with Oxley's criticisms of my paper, I was not afforded the usual courtesy of allowing an author's reply to accompany and be published immediately after the criticisms.

"Torridon,"
Headingley, Leeds,

5th August 1926.

* The Editor regrets that a desire to secure the speedy publication of a communication which only just arrived in time for insertion in the July issue, made it impossible to publish a reply from Dr. Barker at the same time.

ABSTRACTS

1—FIBRES AND THEIR PRODUCTION

(B)—ANIMAL

Coat of the Lapland Wolf. J. C. Ewart. *Nature*, 1926, **117**, 914 (from *Proc. Roy. Soc. Edinburgh*, 1926, June).

The coat of some mammals consists of simple fibres with solid cortex and cuticle, as in wool fibres; others have pith forming a discontinuous medulla, as in furs, and these are true hair fibres. In the Lapland wolf the long coarse fibres which form the outer coat have the structure of true hair. The short fine fibres of the inner coat are typical fur fibres. Instead of the fibres of a bundle occupying one pit or follicle, the root of each fibre is lodged in a separate follicle. In some dogs there are in addition to wool fibres and fur fibres, numerous fibres, the inner half of which has the structure of wool and the outer of true hair. Sometimes the inner third resembles wool, the middle third fur, and the outer third true hair. —B.R.A.W. & W.I.

(C)—VEGETABLE

Cotton Pests in Barbados. C. C. Skeete. *Rev. Appld. Entomol.*, 1926, **14**, Ser. A, 47 (from *Rept. Dept. Agric. Barbados*, 1924-1925, 5-6, and 9-10).

Platyedra (*Pectinophora*) *gossypiella* occurs in almost all the cotton growing districts of the Island, and efforts are being made to prevent its further spread by enforcing legislation. *Alabama argillacea* should be controlled by dusting with Paris green. Infestations of *Aphis gossypii* were rapidly reduced by parasites. —B.C.I.R.A.

Cotton Pest in South Africa. *Rev. Appld. Entomol.*, 1926, **14**, Ser. A, 11 (from *J. Dept. Agric., Union S. Africa*, 1925, **11**, 380-381, 384-385).

The larva of a species of *Pyroderces* on cotton, provisionally regarded as *P. simplex*, has given rise to a certain amount of alarm owing to its superficial resemblance to the pink bollworm. It does not, however, appear to be responsible for any primary damage and is regarded as a scavenger. —B.C.I.R.A.

Cotton Cultivation in Peru. *Bull. Imp. Inst.*, 1925, 480 (from *Peru*, 1925, **2**, No. 9, 53 and 93).

Cotton is planted during the period September to November, when rising temperatures coincide with the river flush of water required for irrigation. The alluvial soils brought down from the Corderillas by the rivers make an admirable medium for cotton growing, and the yields are generally phenomenal. *Gossypium hirsutum* in the Zara valley yields an average crop of 1,297 lb. per hectare. The yields in the valleys of the Chancay Huacho, Lima, Lurin, and Mala fluctuate between 900 lb. and 2,076 lb. per hectare. The valley of the Chincha and the high parts of the valley of the Ica average 1,211 lb. and 1,405 lb. respectively. Sea Island in the valley of Pativilca gives an average yield of 970 to 1,107 lb. per hectare and in the valley of the Chira Mitafifi averages 1,384 lb. The perennial indigenous cotton (*G. peruvianium*) is grown on the largest scale in the valleys of Piura, Sechura, Catacaos, and Chira. It averages only 392 lb. per hectare in the first year, but this is increased to 588 lb. in later years. Piura cotton is known as "full rough." The same variety grown in the valleys of Ica and Palpa produces "moderately rough Peruvian" at an average yield of 908 lb. per hectare. A brief reference to Tanguis and the production and export figures up to 1923 are given. —B.C.I.R.A.

Seed Injury from Fungi and Insects. L. C. Doyer. *Internat. Rev. Sci. and Pract. Agric.*, 1926, **4**, 150-154.

The author outlines the methods in use at the seed testing station, Wageningen, to investigate the injury caused by fungi and insects to various kinds of seeds. *Colletotrichum linicolum* and *Botrytis sp.* were present on flax seed and it was found that treatment with Upsulun dry disinfectant or with Germisan proved very effective in the control of *Botrytis* infection. These dry disinfectants are especially valuable for use with flax seed for which solutions with few exceptions are unsuitable. —L.I.R.A.

Investigation in regard to Weed Seeds found among the Seeds of Argentina, with reference to their Origin and Distribution in the Producing Districts of Argentina. W. V. Petery. *Inter. Rev. Sci. and Practice of Agric.*, 1925, **3**, 1163-1171.

In an investigation of the seeds of various Argentina crops with a view to determining their place of origin from the particular weed seeds found in them. it was found that the weed seeds found in flax samples were of somewhat the same nature from all districts, so that the place of origin of flax seed could not be determined by this method. A fairly lengthy list of the weed seeds found in flax seed samples is given. —L.I.R.A.

Hypertrophied Lenticels on the Roots of Cotton Plants. J. Templeton. *Ministry of Agriculture, Egypt. Tech. and Sci. Service*, 1926, Bulletin 59, pp. 7.

In cotton plants growing in excessively moist soils, the lenticels on the upper portions of the root become hypertrophied into large white protuberances. A series of experiments were made with plots which were irrigated with equal quantities of water every one, two, three, and four weeks respectively. The increase in the amount of water supplied was reflected in an increase in the number and size of the lenticels. It is suggested that the presence of hypertrophied lenticels might serve as a method of ascertaining when to decrease the amount of water given in irrigation. This would lead to the saving of water at a time, before the arrival of the flood, when water is tending to become scarce. By growing cotton plants in soil covered by a layer of water it was shown that while hypertrophied lenticels developed even if the water were aerated, the degree of hypertrophy could be increased by reducing the supply of oxygen to the roots.

—R.W.M.

Pectin of Sugar Beet; Composition of——. F. Ehrlich and R. v. Somerfeld. *Chem. Zentralblatt*, 1926, **1**, 2367 (from *Biochem. Zeits.*, **168**, 262-323).

Pectin is extracted from sugar beet by heating with water under 1 to 2 atmospheres excess pressure. The "hydropectin" so obtained consists of 25-35% araban and 65-75% calcium-magnesium pectate. Treatment of hydropectin with hydrochloric acid gives a mixture of two isomeric digalacturonic acids, $C_{10}H_{14}O_8(COOH)_2$, both of which on acid hydrolysis yield crystalline *d*-galacturonic acid. Ehrlich's former conception of galactose-galaturonic acid as a constitutent of pectin is now discarded. The araban consists almost entirely of 1-arabinose residues, as shown by hydrolysis with dilute acids. Pectic acid is described, and is said to contain acetyl groups easily split off by acid, alkali, or hot water. From the analytical results the formula $C_{43}H_{62}O_{37}$ is assigned to pectic acid, complete hydrolysis giving four molecules of galacturonic acid, two of methyl alcohol, three of acetic acid, one of arabinose, and one of galactose.

—L.I.R.A.

Sea Island Cotton Flower: Colour Inheritance. L. S. Burd. *Trop. Agric.*, 1926, **3**, 56-57.

In the 1923 season three plants with white flowers were noticed in a plot of golden yellow flowered pure strain A.N. Sea Island cotton. The F_1 plants raised from the white and yellow seed consisted entirely of plants with pale yellow petals; F_2 produced approximately yellow: intermediate: white in the ratio 1:2:1, but three if not four shades of yellow were observed. The conclusion is tentatively drawn that the fundamental difference between the white and yellow flowered plants is due to a single pair of Mendelian allelomorphs, and that there is also at least one modifying factor which may control the depth of yellow pigment in coloured individuals. —B.C.I.R.A.

Cotton Pests in Ceylon. J. C. Hutson. *Rev. Appld. Entomol.*, 1926, **14**, Ser. A, 39 (from *Ceylon Administ. Repts.*, *Dept. Agric.*, 1924, D15-16).

Cotton pests reported in the Island are the pink bollworm, *Platyedra gossypiella*, which is becoming prevalent in the Southern Province, *Cosmophila indica*, *Earias* spp., *Sylepta derogata*, *Eupterote geminata*, *Stauropus alternus*, which was recorded for the first time on cotton in Ceylon, and *Dysdercus cingulatus*. —B.C.I.R.A.

Cotton Cultivation in the Sudan. R. A. Wardle. *Text. Merc.*, 1926, **74**, 150.

The Southern Sudan is not an ideal area for rain-grown cotton owing to the shortness of the rainy season and the uncertain distribution of the annual rainfall, but indigenous short staple cottons have been grown for at least 80 years. Experiments have shown that American long staple varieties could be successfully grown and would produce cotton sufficient in quantity and quality to justify the establishment of cultivation in the Central and Southern provinces. It is doubtful whether Egyptian cotton could be grown as a rain crop on a commercial scale. The Government policy for encouraging and improving cultivation is outlined. The present low yield per acre is attributed to the primitive agricultural methods in use. The problem of transport is acute, particularly in the south. The quality and quantity of the labour available in the centre provinces is fairly good, but in the southern provinces labour is unsatisfactory. This year about 15,000 bales of rain cotton should be produced in the Sudan. —B.C.I.R.A.

Tellapathi and Cambodia Cotton Cultivation in India (Vizagapatam). *Empire Cotton Growing Review*, 1926, **3**, 57 (from *Digest of Operations of the Dept. Agric.*, *Madras*, June 1925).

Tellapathi cotton (*G. herbaceum*) is sown only on small areas and is not of much commercial importance. It is generally sown on the drier soils as a mixed crop with either red gram or gingelly. Experiments with Cambodia cotton for many years have averaged poorly, though as much as 1,200 lb. kapas per acre has been harvested. The variety has proved to be very adversely affected by abnormal seasonal variations, and an excess of soil water produces a check in growth from which it does not readily recover. —B.C.I.R.A.

Cotton Cultivation in S. Rhodesia. C. L. Robertson. *Empire Cotton Growing Review*, 1926, **3**, 59 (from *Rhodesian Agric. J.*, 1925, **22**, 745).

The climatic conditions differ greatly from those in the cotton belt of N. America, and a map is given showing roughly the distribution of the conditions, the shaded part being that which apparently will suit cotton without irrigation. —B.C.I.R.A.

Flax Sickness of Soil; Investigations on the Biological Causes of the——. A. N. Kletschetow, *Rev. App. Mycology*, 1925, **5**, 100 (from *J. Landw. Wissenschaft, Moscow*, 1924, **1**, No. 7-8, pp. 511-521, through *Z. f. Pflanzenkr.*, **53**, No. 5-6, pp. 208-209).

The author investigated the causes of "flax sickness" of the soil at the Agricultural Academy of Moscow (Petrovsko-Razoumovskoye), where flax was cultivated on some plots for nine consecutive years, at the end of which the crop completely refused to grow. As the soil was copiously manured with mineral and organic fertilisers, and other plants, e.g., *Capsella bursa-pastoris* and *Thlaspi arvense*, developed vigorously on it, there could be no question of exhaustion of the soil, nor of the accumulation in the soil of toxic substances secreted by the flax. On the other hand, the presence of the following parasitic fungi was determined—*Asterocystis radicis, Thielavia basicola, Colletotrichum lini, Fusarium lini, Macrosporium sp., Alternaria sp., Cladosporium herbarum*, a species closely related to *Phoma exigua* Desmaz (on the roots of flax), and *Pythium de Baryanum*. The author comes to the conclusion that the trouble is due not to any one of these fungi alone, but to the combined action of the whole series.
—L.I.R.A.

Cotton Cultivation in the Union of S. Africa. General Kemp. *Empire Cotton Growing Review*, 1926, **3**, 81-86.

The Minister of Agriculture reviews the present condition of cotton growing in S. Africa. —B.C.I.R.A.

Cotton Cultivation in Malta. *Empire Cotton Growing Review*, 1926, **3**, 170 (from *Report Supt. of Agric., Malta*, 1924-25).

The good winter rainfall has encouraged the farmers to attempt to win a catch crop of cotton. Cotton is also under irrigation on a small scale in the West District. Upland long-staple on the Experiment Farm has done badly for want of rain and owing to the unsuitable soil. Small crops are being cultivated, however, on a commercial scale and proving more productive than the old varieties. The staple is longer, whiter and slightly lighter in weight. Calabria or Gallipoli cotton shows a resistance to root rot and a staple superiority that has caused its rapid spread over both islands. The production is just about as good, and in the long run should prove remunerative. —B.C.I.R.A.

Cotton Pests Control in Cyprus. *Empire Cotton Growing Review*, 1926, **3**, 58 (from *Ann. Rept. Dept. Agric., Cyprus*, 1924, p. 5).

The cotton bollworms are increasing, and drastic measures have been taken to combat them. A closed season in affected areas is enforced prior to which all plants must be pulled up and burnt.
—B.C.I.R.A.

Cotton Pests on the Gold Coast. G. S. Cotterell. *Rev. Appld. Entomol.*, 1926, **14**, Ser. A, 9 (from *Gold Coast Rept. Agric. Dept.*, 1924-1925, pp. 34-36).

The following are recorded as attacking cotton in the Mandated Territory of British Togoland—*Sylepta* sp. (cotton leaf roller), which is a minor pest and is heavily parasitised; *Aphis gossypii*, which becomes a serious pest during the dry weather but disappears with the rains; *Earias* spp., common early in the season; *Helopeltis*, only a pest at the beginning of the season and disappearing entirely at the end of the rains; *Dysdercus* spp., which are pests of major importance accounting for 40-50% of the potential yield in some parts; and *Oxycarenus* sp., which does not cause staining but possibly affects the vitality of the seed. —B.C.I.R.A.

Pink Bollworm: Control. L. Trabut. *Rev. Appld. Entomol.*, 1926, **14**, Series A, 118 (from *Bull. Agric. Alg.-Tun.-Maroc.*, 1926, **32**, 1-2).

It is pointed out that the chloropicrin or sulphuric acid treatment of cotton seed, whilst doubtless efficacious against pests attacking the outside of cotton seed, is useless against pink bollworm, which lives within the seed. Heat seems to be the only effective treatment for this pest, and will kill up to 98% of the larvæ, but sufficient still remain to continue the infestation, and the germination of the seed is affected. —B.C.I.R.A.

Cotton Diseases in Porto Rico. M. T. Cook. *Rev. Appld. Mycology*, 1926, **5**, 227 (from *Rev. Agric. Puerto Rico*, 1925, **15**, 300-301).

The diseases which have so far been reported as occurring on cotton in Porto Rico are enumerated. They include leaf spot, areolate mildew, rust, anthracnose, boll rot, and root diseases due to *Fusarium* sp. and *Sclerotium rolfsii*. A brief description is given of the symptoms of each disease. A warning is given of the possibility of the introduction of other diseases from abroad, especially from the Antilles and the United States. —B.C.I.R.A.

Cotton Wilt Disease. N. G. Zaprometoff. *Rev. Appld. Mycology*, 1926, **5**, 175 (from "Diseases of Cultivated Plants in Middle Asia," 165 pp., *Uzbekistan Plant Protection Station, Tashkent* (Russian), 1925).

Cotton seedlings suffer from a wilt attributed to *Nectriella vasinfecta*, the mycelium of which clogs the vascular bundles and interferes with the water supply of the plant. Generally the infected seedlings show a swelling at the base of the stem, together with an oblong brown canker which in wet weather turns pink. Inside the host tissue the fungus produces hyaline micellular micro-conidia, and on the surface of the dead tissue, 3-5 celled macro-conidia of the *Fusarium* type. Chlamydospores are also occasionally produced. The perithecia of the fungus are found on the roots and underground portions of the stem. —B.C.I.R.A.

Cotton Bollworms in S. Nigeria. A. W. J. Pomeroy. *Fourth Annual Bull. Dept. Agric. Nigeria,* 1925, pp. 89-108.

Details of the life histories and essential descriptions of six different species of bollworms found on the cotton plant in Nigeria. *Argyroploce leucotreta*, Meyr., was found more prevalent on Meko than on Allen cotton. *Diparopsis castanea* Hmpsn., *Earias bilaga* Walk., and *Earias insulana* Boisd. were more numerous on late sown cotton, though they occurred throughout the season. *Prodenia litura* F. in the late season and *Heliothis obsoleta* F. in the late season were also found on both native and exotic varieties. —B.C.I.R.A.

Allen Cotton Cultivation in Nigeria (Kabba Province). H. B. Waters. *Fourth Annual Bull. Dept. Agric. Nigeria,* 1925, pp. 115-119.

Early sown Allen cotton suffered severely from "leaf roll," and native cotton yields were in all cases at least 20% higher. American cotton is therefore not recommended. —B.C.I.R.A.

Ishan Cotton Cultivation in S. Nigeria. C. J. Lewin and T. G. Mason. *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 109-114 and 126-127.

In seeking to improve the coarse native production of *S. peruvianum* types, a variety of *G. vitifolium* from the Benin Province in the Palm Belt is under consideration. Single plant selections averaging 33·6 m.m. in staple length, with a ginning outturn of 32%, are being propagated. The peculiar condition of the W. Provinces, where most of the cotton is grown, necessitate probably the growth of a mixture of early and late varieties. In some years pests destroy the early varieties, and in others severe Harmattan damages the late. Great uniformity in character of lint may therefore have to be sacrificed. Ishan is not a pure strain, for a number of plants produced seeds with red lint, which it is hoped to eliminate by selection. —B.C.I.R.A.

Cotton Cultivation in Nigeria (Umuahia). H. Roebuck. *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 161, 162, 164, and 165.

Field trials of Ishan and Munshi native varieties against Allen are reported. —B.C.I.R.A.

Cotton Cultivation in Nigeria (Ilorin). T. Thornton. *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 171-175, 180, and 182.

Field trials and rotations with Allen and native cottons are reported, with notes on pest attacks. —B.C.I.R.A.

Allen Cotton Cultivation in N. Nigeria (Zaria). *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 192-217.

The total rainfall for the season lasting from April to October was 46·32 in. at Zaria, with July, August, and September exceeding 10 in. Though the yield per acre was adversely affected by an attack of cotton leaf roll, the average for the farm was practically double the yield for the previous year. Bollworm attacks were less, whilst boll shedding was very general. At the Maigana Seed Farm, yields averaging about 290 lb. seed cotton per acre were achieved. About 631 acres of native grown Allen in the district were kept under supervision, and the British Cotton Growing Association purchased the crop. —B.C.I.R.A.

American Cotton Cultivation in S. Nigeria. T. G. Mason and H. C. Wright. *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 3-31.

The 1924-25 experiments revealed no significant differences in the yielding capacities of American and native cotton. The number of open bolls per acre produced by American cotton was in a large measure a function of the specific conductivity of the 1 to 5 soil extract; whilst the hygroscopic coefficient of the subsoil was an additional influence on the number of native cotton open bolls. Great loss of crop was experienced in the late phases of the development of the boll, through bollworm and through internal boll disease, which was more pronounced on American than on native cotton. Anthracnose was second only to bollworm in reducing the native yield. A tendency on the part of native cotton to postpone flowering until the termination of the rains was noted, whereas American set most of its bolls before the rains ceased. A new disease, "leaf roll," was discovered in the course of the work. —B.C.I.R.A.

Cotton Boll Rot Diseases in S. Nigeria: Causes. T. Laycock. *Fourth Annual Bull. Dept. Agric., Nigeria,* 1925, pp. 32-49.

Internal Boll Rot.—The responsible fungus, which has not yet been determined, is probably allied to *Nematospora* and corresponds to Nowell's Type C. Only negative results were found in a search for the fungus on *Dysdercus*; but the evidence clearly indicates that the disease is introduced through seed puncturing, and the stainer is probably a carrier. Infection was completely demonstrated six days after boll puncturing. No alternative host has been discovered in Nigeria.

Anthracnose (*Glomerella gossypii*).—Before this disease attacks the bolls readily it appears that the host has to experience a setback, due to the sudden advent of severe Harmattan, which is invariably accompanied with very low night temperatures and heavy precipitations. Anthracnose appears to be a facultative parasite attacking only the bolls, which may be completely rotted.

Fusarium Boll Rot.—Fusarium occurs on the vegetative as well as the reproductive parts of the cotton plant. It is a saprophyte, and damp conditions, together with prior wounding by pests or bacteria, favour its development.
—B.C.I.R.A.

Cotton Cultivation in Nigeria (Moor Plantation, Ibadan). *Fourth Annual Bull. Dept. Agric., Nigeria*, 1925, pp. 122-159.

Although particularly dry, 1924-25 was reported a good season for cotton. September and October rainfall was below normal, rains ended early, and an exceptionally severe Harmattan was experienced. Best results were achieved with 15th July sowings. Allen is several weeks earlier than native cotton, and whilst Allen produces a large proportion of first and second grade, there is little native cotton in the first grade and a good deal is third grade. Ishan cotton yielded well but was found very variable. A small plot of Meade cotton yielded 224 lb. seed cotton per acre. In seasons like that of 1924-25 the experimental plots of Allen yield equally well with native; and as there was a tendency to discard Allen at the beginning of the season this result is interesting. It still remains to be seen whether Allen will do as well as native in a really bad season, the last two seasons having been exceptionally favourable. Cotton and maize grown together yielded a half crop of maize and almost a full crop of cotton, as compared with pure plots of both. It would appear that the maize did not suffer from competition with the cotton; and for some reason the cotton benefited from the presence of the maize. Rainfall for the year was 44·39 in., as compared with a fifteen years' average of 50·15 in.
—B.C.I.R.A.

Cotton Bollworm and Stainer in S. Nigeria: Control. A. W. T. Pomeroy and O. B. Lean. *Fourth Annual Bull. Dept. Agric., Nigeria*, 1925, pp. 50-63.

The Moor Plantation is the centre of a nine square miles zone in which all cotton had been uprooted three months before sowing the new crop, and all silk cotton trees, *Eriodendron* and *Bombax* spp., had been destroyed. Comparing this closed area with Forest and Savannah areas for intensity of pest attack, no marked decrease in stainer attack was apparent; but the control measures appeared efficacious in diminishing bollworm attack.
—B.C.I.R.A.

Cotton Stainers in Nigeria: Infestation. F. D. Golding. *Fourth Annual Bull. Dept. Agric., Nigeria*, 1925, pp. 64-81.

Near Zaria in N. Nigeria, probably as a result of excessive aridity, stainer bugs were almost completely absent from cotton. At Ibadan the main migration of *Dysdercus* was induced in response to the attraction exerted by heavy flowering. The August influx was of *D. superstitiosus*, and a second infestation of another form of that species and also of *D. melanoderes* occurred in the second week in October. Date of planting experiments of exotic varieties in contiguous plots were found inadvisable owing to the spread of the pest from the earlier plots and the heavier infestation of the late plots. Allen cotton was more subject to infestation than either of the indigenous varieties Meko and Ishan; whilst Meko interposed between Allen plots suffered more than Meko grown alone, owing to the diffusion of the pest from Allen as this variety grows less attractive. Parasitism on *Dysdercus* diminished with increasing dryness and cessation of rains, as did the number of *Dysdercus* bugs themselves. —B.C.I.R.A.

Insect Cotton Pests in S. Nigeria; Occurrence of—— F. D. Golding. *Fourth Annual Bull. Dept. Agric., Nigeria*, 1925, pp. 82-88.

The rhizophagous larvæ of *Syagrus calcaratus* F. were responsible for the death of a considerable number of May and June sown Allen plants at the Moor Plantation, Ibadan; but cotton sown in July was comparatively immune. Native plants when attacked show a greater power of recuperation. Moist soil conditions are required by the larvæ; and it is probably the amount of July and August rainfall that determines the prevalence of the pest.

Helopeltis bergrothi, Reut., attacks the stem, leaves, bolls and buds of the cotton plant and causes greater damage to the native than to exotic varieties. *G. vitifolium* suffered more than *G. peruvianum*.
—B.C.I.R.A.

Cotton Production in South Africa. P. Koch. *South African Cotton Growers' J.*, 1925, **2**, No. 4, pp. 39 and 53.

Figures are given for (1) the annual production of lint in the Union, 1910-11 to 1924-25; (2) the Transvaal, Natal and Zululand, the Cape and Swaziland production in 1922-23 and 1923-24; (3) the areas planted in each of these provinces 1924-25; and (4) the potential areas in these provinces. There are also data as to the number of ginneries and their location and organisations and officers engaged in the industry.

The first estimate of the Union crop was 30,000 bales. This was reduced to 15,000 bales in the third estimate. Of the total loss 10% was ascribed to "washaways," 30% to the shedding occasioned by unfavourable weather, and 60% to insect damage. —B.C.I.R.A.

Cotton Cultivation in S. Africa. *South African Cotton Growers' J.*, 1926, **2**, No. 7, p. 11 (from *Dept. Agric. Rept.*, *Union of S. Africa*).

The 1923-24 crop exceeded that of the previous season by 33·8%, and amounted to practically 7,000 bales of 500 lb. Owing to drought and locusts the Western Transvaal crop was almost a failure. In spite of heavy loss from floods, washaways, and insect attack, the 1924-25 crop will be more than double the 1923-24 crop; and large stretches of land are being cleaned and prepared for the 1925-26 crop. The only serious obstacle is the alarming increase in pests, particularly the bollworm.

—B.C.I.R.A.

(D)—Artificial

Cellulose: Hydration. J. Strachan. *Paper Maker*, 1925, **70**, 615-620.

A condensed report of a paper which claims to give a complete physical conception of the phenomena known as "hydration" in the processes of paper making. The subject is discussed under the headings cellulose as a colloid, structure of the cellulose fibre, "wetness" and hydration, pressure phenomena, physical explanation of beating, theory of felting and measurement of the degree of hydration.

—B.C.I.R.A.

Artificial Silk Developments. *Chemical Age*, 1926, **14**, 297.

The Australian Government is preparing to assist development of rayon production from the lighter eucalyptus plant, which experiments have shown is a suitable source, needing only slight modification of machinery. The Snia Company of Italy is financing a factory in Moscow, and is negotiating for an English factory, possibly in Liverpool, which will employ 2,000 people and turn out 5,000 lb. of rayon a day. The Western Viscose Silk Mills of Bristol expect to be manufacturing this year. From America comes news that cotton yarn or fabric can now be dipped in a solution and converted to rayon.

—F.G.P.

Developments at Strassbourg. *Chemical Age*, 1926, **14**, 42 (Supt.).

A large factory has been recently opened occupying 15 hectares, and three further blocks are in progress. Strassbourg will shortly approach in size the enormous works of Courtauld's, in America and England, and those being erected at Calais. Everything in the way of installation, plant and transport is on the most up-to-date lines, and ensures economy in time and labour. The enterprise is largely due to the efforts of Dr. Bronnert, of Strassbourg. —F.G.P.

Sulphite Pulp and Its Uses. H. Hibbert. *Dyer and Calico Printer*, 1926, **56**, 29.

A chart showing the derivation of various classes of artificial silk and paper from wood. —A.J.H.

Patents

Fine Viscose Filaments: Preparation. W. Mendel. U.S.P. 1,580,844. (from *Silk J.*, 1926, **3**, No. 25, 781).

The invention relates to a means of producing viscose silk filaments without including therein free sulphur or its derivatives, and so avoiding the pit formation normally occurring in cellulose hydrate filaments and due to sulphur elimination. In this way the filament is sufficiently strengthened to be spun as fine as natural silk. The process consists in subjecting viscose to the action of PO_4 ions, preferably by the addition of a solution of tri-sodium phosphate to the coagulating bath. The apparent effect is to prevent the formation of sulphur or its derivatives in insoluble form. The PO_4 ions accelerate the ageing process, and this must be borne in mind if phosphate is introduced at a stage earlier than the coagulation stage.

—B.C.I.R.A.

Fellmongering Preliminary to Tanning. F. Ullman, Assee. of H. Beufey. E.P. 246,114.

Hides and skins are depilated by immersing them in solutions containing lime and less than 1% of sodium hydrosulphide.

—B.R.A.W. & W.I.

Cellulose Thiourethanes: Preparation. L. Lilienfeld, Zeltgasse, Vienna. E.P. 248,246.

The process for making cellulose thiourethanes described in Specification 231,801 is modified by using as the starting material any cellulose derivatives containing the group CSS, other than cellulose xanthofatty acid &c. Suitable starting materials are cellulose xanthic acid or xanthates, or the products obtained by treating these with oxidising agents, or the products of the reaction between the esters of chlorocarbonic acid and cellulose xanthic acids or xanthates, or the esters of cellulose xanthic acids &c. The process is varied only as regards the initial cellulose derivatives from the process of the parent specification. A number of examples are given.

—B.C.I.R.A.

Artificial Silk Dry Spinning Apparatus. Soc. pour la Fabrication de la Soie Rhodiaseta, Paris. E.P.248,696.

For the purpose of controlling the cross-section of the filaments in the manufacture of artificial silk by the dry-spinning method, heat is provided so as to maintain at the spinning dies and in their immediate neighbourhood a temperature determined by the desired cross-section. The temperature is independent of that obtaining in the body of the individual spinning cell, and is adjusted according to such conditions as the nature of the cellulose derivative and of the volatile solvent, the proportion of the volatile solvent, the viscosity of the solution, the pressure employed at the dies, the diameter of the dies and the final diameter of the filaments, and the rate of flow in the cells of the evaporative medium. The invention is particularly directed to the production of filaments not showing a scintillating effect, such threads being produced by adjusting the temperature within a narrow range. —B.C.I.R.A.

Artificial Silk Solution Circulating Pump. Werdohler Pumpenfabrik P. Hillebrand, Werdohl, Westphalia, Germany. E.P. 248,715.

To obtain a circulation or renewal of the liquid in the air vessels associated with the pumps of an artificial silk spinning plant so as to avoid coagulation of the spinning solution in the vessel, the solution is supplied to the vessel through a pipe which opens at or above the normal level of the liquid, and the liquid escapes through a pipe opening at a lower level, and which may be concentric with the first-mentioned pipe. The air vessel may be mounted directly on the pump-casing or on a union-piece interposed between the pump and the spinning nozzle. —B.C.I.R.A.

Viscose Precipitating Baths: Composition. British Enka Artificial Silk Co., Austin Friars, London. E.P.248,750.

In the manufacture of filaments, ribbons, straws, &c., from viscose, there is added to the acid precipitating bath a salt of a bivalent metal, other than zinc, the sulphide of which is not precipitated in the presence of an acid. Nickel and cobalt sulphates are instanced as suitable salts, and a precipitating bath, described by way of an example, contains sulphuric acid, sodium, magnesium and nickel sulphates. A zinc salt may be added to the precipitating bath provided it contains another metal salt as above. Using precipitating baths containing these additions, the dyeing properties of the products are improved both as regards affinity and evenness. —B.C.I.R.A.

Cellulose Thiourethanes: Preparation. L. Lilienfeld, Zeltgasse, Vienna. E.P. 248,994.

The process of the parent specification for the manufacture of articles or materials from alkyl, aryl and aralkyl substituted cellulose thiourethanes such as are prepared by the process described in Specification 231,801, is modified by using as the agent for precipitating or coagulating the thiourethane a strong acid, e.g., 25-65% sulphuric acid, 45-70% phosphoric acid, 20-35% hydrochloric acid, and 70-100% acetic acid. The products after washing and drying show a high lustre and an improved stability both in the wet and dry conditions. The products, immediately after coagulation, are very plastic and may be stretched or bent, the plasticity disappearing when the acid carried by them is diluted or removed as by washing with water. Further, by the use of strong acids threads of finer counts may be obtained. Another precipitating agent such as an acid or neutral salt may be added to the acid bath. The temperature of the bath may vary within wide limit. Some examples are quoted. —B.C.I.R.A.

Artificial Silk: Dry Spinning Apparatus. Vereinigte Glanzstoff-Fabr. A.-G., Elberfeld, Germany. E.P.249,141.

In the dry spinning of artificial threads the filaments are spun into an unheated atmosphere and are heated subsequently to remove the remainder of the solvent. An arrangement is shown in which the filaments are spun downwardly, passed over a guide through the wall of the spinning chamber and into a heating chamber supplied with a winding device and steam pipes. Or the filaments may pass through a heated chamber and be reeled outside. —B.C.I.R.A.

Artificial Silk Spinning Centrifuge. Glänzfaden A.-G., Petersdorf, Riesenbirge, Germany. E.P.249,142.

In electrically-driven centrifuge apparatus for spinning artificial silk the bearing sleeve, which carries the thrust bearing for the spindle and the casing of the stator of the driving motor, is elastically supported in a fixed casing by means of rubber rings. Specifications 235,166 and 236,173 are referred to. —B.C.I.R.A.

Preparation of Cellulose, Cellulose Acetate &c. H. Dreyfus, Waterloo Place, London. E.P.249,173.

A high quality cellulose readily amenable to acetylation or some such esterification, is prepared by a preliminary treatment of cellulose-containing materials, such as wood pulp, with caustic alkali preferably in concentrations of less than 3%, used in the proportion of 10-40 times the weight of the pulp. The second stage of the process is treatment with glacial acetic acid, and preferably comprises boiling for several hours. Acetylation is then carried out according to previously patented processes, viz., E.P.6463/15, 14,101/15, 100,009, 101,555, 207,562. —H.L.R.

Artificial Silk Spinning Frame Winding Mechanism. W. Schulz, West Lichterfelde, Berlin. E.P.249,490.

In winding artificial silk the material is conducted down a guide tube by a jet of liquid, preferably precipitating liquid, so arranged that the liquid is deflected slightly in a direction reverse from that of the rotation of the bobbin, and that the filament contacts with the bobbin at a point whereby the regularity of the winding is not affected by the jet. Either the bobbin or the tube may be reciprocated to lay the filament. —B.C.I.R.A.

Cuprammonium Silk: Spinning. W. Schulz, Lichterfelde-West, Berlin. E.P. 249,845.

To enable an aqueous solution of ammonia to be used as the coagulating bath in the stretch-spinning of cuprammonium cellulose silk, the bath is used at a temperature of 60-95° C., or the travel of the filaments in the bath is increased by employing a minimum distance of 1·5 metres, or by observing both these precautions. In examples, the temperature of the bath which contains 1-2% of ammonia is 80° C., and a spinning length of 2·5 metres is employed. By the use of aqueous ammonia solution as the coagulating medium, it becomes possible to recover the ammonia; it is preferred to employ a bath containing not more than 3-4% of ammonia. —B.C.I.R.A.

Artificial Fibres—

248,468. L. Levy. Artificial Fibres: Pumps and valves.

2—CONVERSION OF FIBRES INTO FINISHED YARNS

(A)—Preparatory Processes

Cotton Seed: Delinting and Sterilising. C. B. Hardenburg. *South African Cotton Growers' J.*, 1925, **2**, No. 5, pp. 25-27.

The details of the method employed by the African Explosives and Industries, Ltd., in Natal, are given. The seed is placed in a large glazed earthenware basin and 95% sulphuric acid is admitted. After about five minutes' immersion all the lint has disappeared and the mass has turned black. The acid is then run off and a fresh lot of 70% to 75% acid is poured in. After the weaker acid is drawn off, a strong stream of water is played on the seeds. Seven washings are given. Treating one bag of seeds lasts one hour. To complete the sterilisation the washed seed is then dipped for a few minutes in a solution of mercuric chloride, 1 : 1,000. The seed is afterwards spread out in the sun to dry, and bagged in new sacks, so that the risk of contamination by spores on the old sacks is prevented. The advantages are discussed. —B.C.I.R.A.

Application of the Synthetic Esters of Fatty Acids to Textile Fibres. S. Spiess and J. L. Bitter. *Text. Rec.*, 1926, **44**, No. 519, p. 77.

An account of some preliminary experiments in utilising synthetic esters of cheap waste oils such as olive oil, the fatty acids of palm oil, cocoanut and earthnut oils for the working up of shoddy. —A.J.H.

Nasmith Cotton Comber. Dobson and Barlow, Ltd. *Text. Mfr.*, 1926, **52**, 89-90.

An improved Nasmith cotton comber is described in which the most notable improvements concern the roller-weighting motion, double feed rollers, top comb slides, waste-collector roller, exhaust air-filter working in conjunction with Roth's aspirator, and oiling facilities. These improvements, details of which are given, increase the efficiency of the machine and its production and facilitate certain settings and the general control of the machine. —B.C.I.R.A.

(B)—Spinning and Doubling

Spinning Mule: "Breaking Out." F. Metcalfe. *Text. Mfr.*, 1926, **52**, 111-112.

A general article on the systematic "breaking out" of mules, that is, changing the quality of the cotton or changing the hank roving with the same quality of cotton. —B.C.I.R.A.

Antique American Spinning Wheels. S. Daniloff. *Text. Rec.*, 1926, **43**, No. 517, 85-86.

A "chair frame" wheel of about 1750, a wheel designed by Thomas Howland and made prior to 1814, and a wheel patented by Elijah Skinner in 1818 are described. The wheels are of the countershaft type, that is, the motion of the driving wheel is transmitted to the spindle through a countershaft. —B.C.I.R.A.

Bare Spindle Ring Yarn: Spinning. W. Scott-Taggart. *Text. Rec.*, 1926, **43**, No. 517, pp. 47-48.

In the method described a varying frictional effect on the spindle for the winding process is obtained by allowing the spindle to revolve in a liquid bath. It is stated that there is neither evaporation nor leakage, and corrosive effects of the liquid are entirely absent. The yarn spun is equal, and in many cases superior, to that produced on the mule. —B.C.I.R.A.

Flyer Frame Cone Belt: Efficiency. *Text. Rec.*, 1926, **43**, No. 514, pp. 45-46, No. 515, p. 47, No. 516, pp. 43-44.

The following conditions affecting the efficiency of a cone belt are reviewed. Quality of leather and piecing of the belt, thickness, width and tension of the belt, and adjustment of the belt forks. —B.C.I.R.A.

(C)—Subsequent Processes

Electric Singeing Machine. Hussa Machine Works. *Text. Rec.*, 1926, **43**, No. 517, p. 97.

The yarn is singed by means of heat radiated from an incandescent electric conductor. It is claimed that the utilisation of heat is almost complete. The heat of the singeing tube can be regulated by almost imperceptible degrees, and it can be adapted to the count of yarn to be singed and to the winding speed. There is no danger of fire. The method of securing complete suction of the residue of combustion and providing a continuous draught of air favouring combustion is shown in an illustration. —B.C.I.R.A.

Patents

Softening of Flax and Hemp Fibres. C. Dubois. F.P.590,532.

After retting, the fibres are treated with hot lyes; after rinsing, they are washed in soapy water, and after beating and carding, they are softened with an appropriate oil. The yarns are then spun and straightened. —Bur. Text.

Oiling of Spindles in Throstle Frames. Serra Sio. F.P.591,084.

The inferior support of the spindles forms a continuous holder disposed longitudinally and in which rests the end of the spindles. The pivot on which they are supported contains apertures which permit the passage of oil. —Bur. Text.

Feed for Holden Comber. J. Devalée. F.P.592,088.

The ordinary ellipsoidal motion is replaced by a vertical motion of the feed rollers; this is combined with a tangential displacement of the rollers from the comb, and detaches them in an opposite direction to the rotation of the comb. The fibres are thus retained by lateral friction against the needles of the comb. Several pairs of rollers with simultaneous action contribute to feed the comb. —Bur. Text.

New Card Clothing. Etablissements Jos. Deiss. F.P.592,717.

The foundation bearing the bent wires is made with cloth or skin of such thickness and quality that the wires are rigidly maintained. The two halves of the wires, one inside and the other outside the foundation, are in a straight line. —Bur. Text.

Electrical Flyer Frame. H. Schneider. F.P.593,170.

The various flyers are individually driven by electromotors. Yarn guides, forming a grooved gutter between the delivery rollers and the hollow axle, introduce the yarn almost vertically. The bobbins are provided with an autobrake the resistance of which to rotation is reduced by special devices. —Bur. Text.

Rubber-Impregnated Cord: Properties. R. Ditmar, G.P.19,240, 62,246, 117,305, 125,748 and 326,335; and Austrian P. 74,065. (From *Gummi-Ztg.*, 1925, **39**, 1682, through *Chem. Abs.*, 1925, **19**, 2759.)

Cord composed of silk, wool, hemp or other fibre can be improved in strength and in durability by impregnating it with rubber latex. When used for violin strings the appearance of catgut can be imitated and the tone of the instrument is much improved. The cord is first impregnated with rubber by immersing it in latex, which may also contain a little glycerol and a reducing agent such as quinol. When dry it is coated with spermaceti or with hard paraffin, and finally with soap-stone or with a lustre varnish. The process may be modified by adding sulphur to the latex, in which case the cord is vulcanised before the final protective coating is applied. Similarly, cord may be treated with solutions of rubber in organic solvents and vulcanised so that it is suitable for use in racquets, chairs &c. Excellent results are also obtained with "solvol" instead of latex. —B.C.I.R.A.

Hard Waste Lubricating Machine. W. Tatham, Ltd., and R. I. Berry, Vulcan Works, Rochdale. E.P.248,179.

Hard fibrous waste as it leaves a breaking-up or opening machine is treated with a soapy liquid on both sides of the fleece by rotary liquid distributing means. The fleece, travelling up a lattice, is treated on its upper side by a brush and a roller dipping into a trough. As the fleece falls from the lattice it is treated on its under side by an auxiliary rotary device comprising a brush and a roller dipping into a second trough. This trough is carried by brackets on the lattice frame, and the brush is mounted in pivoted adjustable arms. A splash guard with side-pieces is provided. Both the troughs may be supplied from a reservoir by a single pipe. —B.C.I.R.A.

Opening Machinery Cleaning Grids. Soc. F. Laroche et Fils, Cours, Rhone, France. E.P.248,333.

The cleaning grids of machines for treating fibres comprise a thin metal plate provided with slits, the metal being beaten out to form protuberances with edges on the inside and hollows on the outside. The openings provide a clear passage for the dirt, &c., along tangential paths, and being long and narrow, oppose the passage of the fibres. —B.C.I.R.A.

Carding Engine. G. C. Laurency, Twickenham, Middlesex. E.P.248,475.

In an arrangement for straightening and parallelising the fibres taken from the doffer of a carding engine the fibres are seized by a leather or similar covered roller, or a roller with a channelled surface, co-operating with a casing comprising a series of flexible blades, held up and pressed against the roller by springs. The fibres seized and passed forward have their near ends combed by the doffer. At a given point they are combed by a card-covered roller rotating more quickly than the leather-covered roller. This roller is also provided with blades. A further leather covered roller is provided to draw the fibres from the card-covered roller and the drawing operation may be repeated as often as desired. The flexible blades are arranged helically under the rollers. Where ring doffers are employed the blades, which are wider than the rings, are arranged at right angles to the axis of the roller. The card-covered roller may be provided with a brush to remove waste and dirt when necessary. —B.C.I.R.A.

Spindle Reversing Gearing. G. Piering, A., P. and A. Lehmann, Plauen, Vogtland, Germany. E.P.248,697.

The spindles of a spinning or doubling frame are driven through a connection from the spindles of friction rollers which are actuated by friction discs on a shaft, and can be shifted to forward, reverse, or stopping position. —B.C.I.R.A.

Spindle Winding-on Mechanism. O. G. J. Struycken de Roysancour, Delft, Holland. E.P.248,745.

In order that the tension of the yarn as it is winding-on the spindle may be independent of that as it is twisting in spinning and roving frames, the yarn is passed round a braked rotary roller in a driven tube and is wound on a spindle by means of a guide fixed on a bell depending from the tube, by a flyer device of known type, or by an ordinary ring and traveller. The winding-on may be effected by a dragged bobbin arrangement or by a driven spindle, and in the latter case the speed of the spindle is variable in accordance with the winding, or the delivery of the yarn is regulated. The roller may be braked by pads which bear on its ends and are carried in a spring holder by an adjustable ring which bears against a friction ring on the roller, or by a braked ring.

—B.C.I.R.A.

Spindle Driving Mechanism. J. Speak and Tweedales & Smalley (1920), Ltd., Castleton, Manchester. E.P.248,912.

In order to facilitate reversal of a spindle driving apparatus for spinning, doubling, twisting and like machines, tension pulleys and a cylinder or auxiliary pulleys are provided, so arranged that their upper peripheral portions are approximately level with the lower flanges of the spindle whorls. The driving apparatus will then work equally well in either direction. Each tension pulley is mounted on a pivoted weighted arm, so that change in tension due to reversal and variation in length of the driving band can be taken up.

—B.C.I.R.A.

Carding Engine. A. Egli, Heidenheim, Wurttemberg. E.P.248,988.

In a cotton carding engine a closed box with a grid on its open top is arranged below the licker-in to produce a sucking action between the licker-in and the grid whereby the good fibres are carried forward and only the dirt and waste allowed to fall through the grid. The box and the grid are adjustable vertically to vary the width of the gap between the licker-in and the grid. A knife is placed to exclude the production of an ejecting air current under the inner edge of the table. —B.C.I.R.A.

Yarn Clearing Device. T. Gibson, Carmoney, Antrim. E.P.249,005.

Yarns are cleared by means of a die of hard material and preferably in the form of a ball, and freely mounted in a slotted tube so that it is supported by the yarn and may rise and fall, and rotate about the yarn, or may have a rotary movement only. The ball is inserted through a gap and its accidental removal during use is prevented by a rubber plug or other spring. The tube is turned about a hinge, when the yarn is arrested by the attempted passage of a slub, so that the ball may fall into a cup and be readily cleared and re-threaded.

—B.C.I.R.A.

Spindle Bearings. Compagnie d'Applications Mécaniques, Ivry, Seine, France. E.P.249,081.

A spinning spindle is mounted in a ball bearing, the inner race ring being fixed to the spindle and the outer race ring being slidable in a housing and under the action of a spring which is calibrated so that the footstep bearing is practically relieved from the load and only serves to position the spindle. The outer race ring may be carried in the step bearing tube or in the outer casing. The bearing tube is held in the casing by a leaf spring. —B.C.I.R.A.

Spindle Driving Mechanism. Soc. Alsacienne de Constructions Mécaniques, Mulhouse, Haut-Rhine, France. E.P. 249,102.

The patent relates to the driving of inclined spindles in continuous spinning and twisting machines by means of tapes, flat bands or belts. In the arrangement shown groups of four spindles are driven by a drum or pulleys so arranged that the driving portion of the belt is perpendicular, or approximately so, to the axis of the spindle, the tension pulley is movable about an axis perpendicular to the portion of the belt which runs therefrom to the spindle, so that the normal inclination of the belt is altered only slightly as the tension pulley moves, and a directive pulley or drum is applied, so that the belt is perpendicular, or approximately so, to the axes of the spindles. An alternative arrangement is shown. —B.C.I.R.A.

Roller Drawing Head. R. Hird, Burley-in-Wharfedale, nr. Leeds. E.P.249,298.

The spring weighting hooks of spinning, doubling and twisting machines are anchored to brackets on a pivoted rail, which is connected by brackets and links to a pin on a worm wheel, so that by operating the wheel the rail may be moved to release the ends of the hooks and thereby relieve the top rollers from the action of the springs. —B.C.I.R.A.

Opener, Conveyor, or Cylinder Lags. J. Young, R. M. Young and W. Young, Bolton, Lancs. E.P.249,337.

Lags for application to the conveyors of hopper bale breakers, hopper feeders, or to the cylinders of openers, &c., are formed of a metal strip with teeth formed integral therewith and projecting in a forward direction. The teeth may be stamped or pressed out of the metal strip, or out of a blank, or may be forged or cast integral with a flat bar. Additional teeth may be formed on the rear edge of the strip, and may be staggered in relation to the teeth. —B.C.I.R.A.

Comber Detaching Roller Weighting Device. J. Hetherington & Sons, Ltd., Ancoats, Manchester, and J. Horridge, Bolton, Lancs. E.P.249,347.

In an arrangement for weighting the detaching rollers of cotton and other combing machines in which the rollers can be relieved from the weights, an arm hooks over the back roller and is attached at its other end to an arm on a rocking shaft. The first-named arm is provided with an inclined slot which may have a depression at its upper end. A hand lever carries a pin which engages the slot and is pivoted at its lower end to the weight lever at a point between the fulcrum and the point of attachment of the weight. The weight lever carries a stop adapted to rest on the framework when the weight is taken off the rollers. If the handle is moved to the right, the weight lever is lifted and the pin rests in the depression of the slot. If the handle is moved to the left, the weight lever is lowered until the stop rests on the framework. Similar weighting arrangements for the middle and front rollers are described. The device may be operated by a treadle. —B.C.I.R.A.

Lap-Forming Apparatus. L. Schorsch, Gorkan, Czecho-Slovakia, and A.-G. J. J. Rieter et Cie, Winterthur, Switzerland. E.P.249,564.

The fleece collected on the cages is passed by an upwardly inclined double lattice band to a second vertical pair of bands which are oscillated across a transversely moving apron or table. The doubled fleece is compressed by rollers, and is passed from the apron through rollers and is wound on a lap. —B.C.I.R.A.

Roller Drawing Head. U. Dittmar, Breisgau, Baden, Germany. E.P.249,714.

Subsidiary rollers are mounted between the drawing rollers of machines for spinning sliver from a carding engine, and their surfaces are slightly spaced from each other so that the slivers may be drawn without being positively clamped on the subsidiary rollers. The subsidiary rollers may be slightly reduced in diameter at their working surface, the reduction being not more than a fraction of a millimetre, and the working surface may be grooved circumferentially and the ends grooved longitudinally. —B.C.I.R.A.

Self-Weighting Drawing Roller. A. Lees and Co. Ltd. and R. Taylor, Oldham, Lancs. E.P.249,739.

A self-weighting drawing or drafting roller for textile machinery, of the kind in which a centrally fixed boss on the roller is connected to loose tubes mounted around the spindle on opposite sides of the boss by a leather covering, has the cover held firmly in position by providing on the boss a cavity or cavities into which the leather may be forced and thereby fixed in position. The leather covering may be burnt into the grooves and burnt over at the outer ends of the tubes. —B.C.I.R.A.

Roller Drawing Head. J. E. Lees, Oldham, Lancs. E.P.249,903.

A roller is mounted so as to exert pressure by its own weight, or by the additional weight imparted by an applied weight or spring upon sleeves which are freely mounted on axles so that the weight of the axle is not transmitted thereto, and which constitute the upper rollers of sliver drawing apparatus, or upon the barrels of axially aligned rollers, thereby ensuring their common rotation. —B.C.I.R.A.

The following is a list of patents of which abridgements have recently appeared in the *Illustrated Official Journal* (*Patents*)—

Preparatory Processes—

248,421. B. Sunderland. Balling apparatus for slivers from Noble combs.

248,913. Platt Bros. Ltd. and H. Nield. Guards for scutchers, beaters, openers &c.

249,196. T. D. Moore. Flax cleaning machine.

249,214. F. Spivey. Rotary fibre-spraying apparatus for oil.

Spinning—

249,253. O. Elliott. Thread guide and snarl catcher.

249,444. A. Trachsler. Spindle ball bearing.

249,975. J. & T. Boyd, Ltd. Spinning: Yarn severing device.

3—CONVERSION OF YARNS INTO FABRICS

(A)—PREPARATORY PROCESSES

Weighting and Dulling Artificial Silk. W. Bruckhaus. *Text. Mfr.*, 1926, **52**, 240.

A translation from *Die Kunstseide.* Artificial silks are weighted by means of barium sulphate precipitated within the fibres by the double reaction between barium chloride and sulphuric acid, whereby their lustre is diminished so that they more closely resemble natural silk. Artificial silks may also be weighted with tin phosphate and silicates. —A.J.H.

(B)—SIZING

The Sizing of Yarns: Use of Quellin in Textile Mills. *Wool Record*, 1926, **29**, 1647.

Makers claim that quellin in dressing mixtures produces great binding power and suppleness of the finished material. It is soluble in cold water, and when mixed forms a thick gummy cream with pronounced adhesive and strengthening properties. It forms a powerful binding basis for other sizing ingredients, and in the case of medium and heavy sizing permits of the use of an increased percentage of China clay with a reduced quantity of starches, thus giving the required weights and cheapening the cost. Tests have shown that an increase of 25% in the breaking strain of yarns is produced when sized with quellin mixture. —B.R.A.W. & W.I.

Starch Solution: Preparation. P. Petit and Richard. *Compt. Rend.*, 1926, **182**, 657-659.

A clear solution of starch is prepared by passing starch paste six times through a vapouriser under a pressure of 1 kg. of air, carbon dioxide or hydrogen. The product filters through paper and has a molecular rotation of 210°. The properties of the solution on standing, on treatment with amylase and on boiling are described. From the cellulose residues obtained on boiling under pressure which behave as "condensed amyloses," the author concludes that these bodies exert a very strong protective action on the starch of the paste, and that they are removed by the mechanical action employed in preparing the solution. —B.C.I.R.A.

Diastatic Power of Malt. See Section 6.

(C)—WEAVING

Healds: Manufacture. H. M. Lord. *Text. Merc.*, 1926, **74**, 413.

A general lecture on the selection of heald yarns and the care of healds. —B.C.I.R.A.

Shuttle-Truing Machine. Staubli Bros. Ltd. *Text. Mfr.*, 1926, **52**, 128-129.

A machine for truing worn shuttles and sharpening shuttle-tips is described. It enables shuttles belonging to the same loom to be trimmed to the same size and angle, and as the shuttle-tips are sharpened and polished to a gauge, the various shuttles of a loom make contact with the picker at the same point. —B.C.I.R.A.

Artificial Silk Warp Loom Fabrics. W. Davis. *Silk J.*, 1926, **2**, No. 23, pp. 47-48.

The production of striped and checked artificial silk fabrics on the warp loom is discussed. Knitted ties and girdles are produced in this way, and plain knitted blouse fabrics are being replaced by warp loom fabrics which show a finer mesh and are less liable to stretch and go out of shape. —B.C.I.R.A.

Loom Picker. *L'Avenir Text.*, 1926, **8**, 123-126.

A new type of reversible double-nosed picker for underpick looms is made from a strip of buffalo hide moulded and riveted to have two flat noses, two straight sides and a central opening varying in size with the type of loom and picking stick. The noses are furnished on the inside with thickening pieces of oak or chrome tanned leather which have convex surfaces adjacent to the opening. The convexity is calculated according to the arc described by the picking stick and the height of the picker on the stick. This convexity reduces the wear of the picker on the picking stick, and wear is reduced to a minimum by inserting guides of buffalo hide between the picking stick and the picking noses. The guides have a concave and a straight surface which exactly fit the convex surfaces of the leather thickening pieces and the straight surfaces of the picking stick. —B.C.I.R.A.

Braiding Machine. *L'Avenir Text.*, 1926, **8**, 126-134 (from *Moniteur de la Maille*).

A detailed account is given of an improved braiding machine which can be operated at greater speeds than the machines in general use. —B.C.I.R.A.

Knitting Machine Patterning Mechanism. J. B. Lancashire. *Text. Rec.*, 1926, **43**, No. 516, p. 71.

A short article on the principles of jacquard designing, dealing with the production of multi-colour effects on flat knitting machines. —B.C.I.R.A.

(G)—FABRICS

Non-Laddering Fabrics. J. Chamberlain. *Text. Mfr.*, 1926, **52**, 77-78.

The causes of laddering in knitted fabrics are discussed, and the constructions of so-called "non-laddering" fabrics are described. These may be made by using two separate yarns, one to give the required effect on the surface and the other having greater weaving properties at the back. Compound weft stitches such as racked stitches, interlock, &c., are of a non-laddering type, but are not used to any great extent for hose because of their excessive weight. Non-laddering warp-knitted stitches have been in use for over 150 years. The chief objection to the use of warp fabrics of a close formation is that they are costly to produce owing to the slowness of production. Weft-knitted stitches such as the twisted loop stitch would furnish true non-laddering fabrics, but the methods in use for the production of this stitch are not simple. The stitch was used about 30 years ago for the production of hard-weaving underwear for the German Army. —B.C.I.R.A.

PATENTS

Improvements to Automatic Looms. Société des Ateliers Diederichs. F.P.589,833.

This apparatus, which permits the use of cops, is characterised by a turning magazine presenting a series of holes for the ends of the spindles. This magazine, which is usually stopped by a lock, is released by the hammer of the changing of bobbin, runs in a guiding to the point of the inferior spindle, and presents a new hole to the point of the following spindle. A brake device is added. —Bur. Text.

Metallic Fabrics. M. Rogé. F.P.592,201.

The fabrics are metallised generally by insufflation of metallic powders through a pistol. After this first operation the fabrics are bent between two cylinders and stretched on a table and dusted by a device which retrieves the particles of waste metal. The fabrics, then dull, are polished between two metallic rollers, turning at variable speeds, which produce a gliding and sliding. This patent describes various combinations of designs obtained by this process for articles of furniture and coating. —Bur. Text.

Looms: Warp Release. H. Gillet. F.P. 592,752.

This system is based on the principle of the transformation of a slow rectilinear displacement of a load in a quick circular motion which is alternately locked and unlocked by a light brake automatically actuated by a system determined by the angular motion of the beam in two directions at the time of closing and opening the shed. This system is suspended from the beam by an endless chain. —Bur. Text.

Needle Loom. J. Gabler. F.P.593,223.

Two bobbins of weft are disposed on each side of the loom. The two weft inserters are provided with means for giving and catching the weft (fork and hook), which can act alternately as givers or catchers. The needles themselves separate the warp. —Bur. Text.

Knitting Machine Bobbin. F. Fröhlich, Schleussig, Leipzig, Germany. E.P. 248,309.

A bobbin for a knitting or like machine comprises a cylindrical upper portion and a conical stepped lower portion, longitudinally slotted to receive bars which extend beyond the surface of the bobbin. The bars are held away from the bottom of the slots by a grooved disc. After the thread is completely wound the disc is removed and the bars are withdrawn to relieve the thread tension. The cylindrical upper portion is preferably covered with fabric, rubber or the like. —B.C.I.R.A.

Core-Covering Braiding Machine. W. Lusebrink and C. Ernestus, Donberg, Elberfeld, Germany. E.P.248,352.

The patent relates to machines for covering cores by winding and for simultaneously connecting them together at intervals by a braided covering. Hollow spindles mounted in a baseplate convey the cores. One spindle carries a rotary disc on which are mounted bobbins. The other spindle carries a toothed wheel which meshes with other wheels which drive annular toothed segments mounted on strikers carrying bobbins. Binding threads drawn from bobbins mounted on discs on the first spindle are threaded through eyes and are laid alternately on the threads from the bobbins on that spindle and those carried by the strikers. —B.C.I.R.A.

Knitting Machine Pattern Wheel. Lord Hollenden (S. H. Morley), G. and C. Hope-Morley, C. Morley, London, and G. Ball, Nottingham. E.P.248,437.

Pattern wheels and cams, for knitting and other machines, are constructed with the active cam surface composed entirely of segments adjustable on lines tangential to a circle about the axis of the pattern wheel or cam. The segments are arranged in the angle between a flange projecting from the body of the wheel and the periphery, and are supported by screw-studs entering slots in the flange, these slots being tangential to a circle of smaller diameter than the periphery. Each segment is also provided with an adjusting screw which bears on the periphery. —B.C.I.R.A.

Loom Change Box Motion. J. Pilling and Sons and T. Holt, Colne, Lancs. E.P. 248,494.

The cam or tappet operating the lever, rod and drop boxes is mounted on a short shaft, &c., driven by change gearing, including a compound change wheel whereby the speed of the shaft, relative to the speed of the loom, may be varied. The number of consecutive picks inserted by each shuttle can thus be varied. According to the provisional specification, carrier wheels are employed which are carried by a swinging arm or quadrant. —B.C.I.R.A.

Loom Jacquard. T. Dracup, Lane Close Mills, Bradford. E.P.248,534.

In order to cause all the warp threads to lie in one plane when lifted, the hooks are given an increasing lift from the front to the back of the harness, by making each hook successively shorter from the front hook to the back hook and by making the nebs of the hooks of such length that they lie in a horizontal plane when the hooks are in their bottom position. In a modification the knives are placed at different levels, the hooks being of the same length, and their nebs being graduated in length so that their ends are at the same distance from the tops of the knives when the hooks are in their lower position. —B.C.I.R.A.

Loom Picker. J. and J. Booth, Ramsbottom, Lancashire. E.P.248,584.

Pickers are formed from sheets of raw hide which have been partially tanned on both sides to form thin skins of leather but having a tough core. —B.C.I.R.A.

Multiple Fabric Loom. A. John, Gera-Reuss, Germany. E.P.248,600.

The warps for separate fabrics pass from a common warp beam over a guide beam, and the fabrics pass over separate breast beams to a common beam. One set of warps passes over a movable intermediate guide beam, the corresponding breast beam being also movable. If the weft of one warp breaks the other warp will be woven a few more picks before stopping. Means are provided for adjusting the warps before restarting. —B.C.I.R.A.

Shuttle Threading Device. C. Bourgeois, Rouen, France. E.P.248,675.

The threading device for loom shuttles according to Specification 242,611 is modified by having both ends rounded, an elongated window in the head which is made narrower than the body, and rounded entrance edges for the slit leading to the guide-eye. The weft is guided and held in the eye by the reduced portion of a lateral peg. An axial thread retaining slit for use during automatic threading is formed in the nose of the shuttle. —B.C.I.R.A.

Circular Knitting Machine Striping Mechanism. A. de Horevitz, Paris. E.P.248,695.

For producing vertically striped stockings, socks, &c., two kinds of needles differing in total length and in the thickness of their butts are provided. The length from the hook end to the top edge of the butt is the same for all needles. When the needles are raised by the cam surface, the hooks of one set are placed in such a position that they are able to take one yarn whilst the hooks of the other set, being raised to a higher level, are able to take both yarns. —B.C.I.R.A.

Circular Knitting Machine Patterning Mechanism. Scott & Williams Inc., New York, U.S.A. E.P.248,772.

Details are given of pattern control mechanism in which idling means for the operating ratchet pawl may cause the rotation of the pattern drum to be suspended at the completion of a cycle or at any desired point in the cycle. —B.C.I.R.A.

Heald Control Mechanism. C. Wilbraham, Manchester, and Hacking & Co. Ltd., Bury. E.P.248,857.

The healds are positively lowered or raised by means of tappets, &c., and are raised or lowered by means of springs, each heald being connected at two or more points by means of straps operating in the same vertical plane and pressing over pulleys to a lever, &c., rocking on a shaft within limits defined by a stop. Each lever, &c., is connected with a spring so arranged that when a spring is stressed and the corresponding lever, &c., is turned anticlockwise, the leverage through which the heald pulls on the levers, &c., increases, whilst the leverage through which the spring acts decreases. —B.C.I.R.A.

Lace: Weaving. C. Goodley, Nottingham. E.P.248,908.

To make filet net on a curtain machine provided with one set of spool threads controlled by a single bar at the same time as open and patterned work and combination effects, the bar moves one gait to the left when the carriages are in the back combs, then rests for a moment and moves two more gaits to the left. It moves similarly to the right when the carriages are in the front combs. The warp bar moves two gaits to the left, rests and moves one gait back whilst the carriages are in the back combs, and moves two gaits to the right, rests and moves one gait back whilst the carriages are in the front combs. The jacks can take up two operative positions. In one case open and patterned work can be produced by working the jacks in an ordinary way whilst a square or filet net or ground can be produced simultaneously in another part of the curtain by working the respective jacks as described in Specification 224,773. By moving alternate jacks in to intercept both spool and warp threads combination effects are obtained. —B.C.I.R.A.

Looms: Warp Let-off Motion. Soc. Anon. A. Saurer, Arbon, Switzerland. E.P. 249,124.

The warp passes from the beam over a back rest supported by arms connected by bars and cranks to a shaft furnished with levers acted on by springs. The arms are mounted on stud shafts carrying the warp beam, which can be driven by a member on a worm wheel geared to a worm on a shaft carried by one of the arms. When the warp is used up and the arms move to the right two friction discs contact and the warp beam is rotated and continues to rotate until more warp is delivered than is required. When this occurs the back rest and arms move to the left under the action of springs, and the rotation of the warp beam is stopped until the excess warp is used up. —B.C.I.R.A.

Heavy Fabric Looms. J. H. and T. Hindle, Haslingden, Lancs. E.P.249,197.

In looms particularly for weaving heavy wide fabrics the lay, carried by one or more intermediate swords in combination with the ordinary end swords, is operated by one or more intermediate cranks on a crankshaft mounted in intermediate cross frames, to which are attached the front and back beams, so that the thrust in beating up is sustained by the back beam placing the intermediate frames in compression. The intermediate swords are shaped to clear the warps, are attached to the lay beam, and are loosely mounted on shafts supported on pairs of bearing brackets bolted to transverse rails. The crankshaft having the ordinary end cranks is provided with one or more intermediate cranks corresponding to the intermediate swords. The crankshaft is driven by an auxiliary driving shaft conveying power across the loom at two or more points by gears to reduce torsional deflection in the crankshaft. —B.C.I.R.A.

Loom Take-up Motion. J. H. Hindle and T. Hindle, Haslingden, Lancs. E.P. 249,198.

A take-up motion specially useful for wide, heavy fabric looms, comprises two smooth rollers driven in the same direction and at the same speed. The cloth passes then forward over an idle roller held tightly by the tension in the fabric against the peripheries of the two driven rollers, and backwards over the lower roller. Thence the cloth passes to a driven roller surmounted by a lap roller. The three moving rollers are driven through gearing operated by linked pawl and ratchet mechanism from a crank on a shaft rotating at crankshaft speed. —B.C.I.R.A.

Straight-Bar Knitting Machine. W. Cotton, Ltd., and C. H. Aldridge, Loughborough, Leicester. E.P.249,226.

A mechanism is described for the production of patterned fabric for fancy hosiery on machines of the "Cotton" type in which two supplementary carrier rods located in front of the narrowing machines are independently rocked and moved endwise under control of a pattern chain. —B.C.I.R.A.

Circular Knitting Machine Plating Mechanism. T. G. Whyte and T. Smith (trading as Whyte & Smith), Shepshed, Leicestershire. E.P.249,230.

Reverse plating effects are obtained by using two kinds of sinkers A and B, the length of the butt of B being longer than that of A, and a cam to give the sinkers B an additional movement and so reverse the relative position of the two yarns. The sinkers B are then quickly retired by a second cam to prevent them from drawing long loops. —B.C.I.R.A.

Circular Rib Knitting Machine Plating Mechanism. T. G. Whyte and T. Smith (trading as Whyte & Smith), Shepshed, Leicestershire. E.P.249,231.

Reverse plated effects are obtained in a rib machine by the use of a pair of tangentia yarn guides connected together so that when either guide is in position to feed the yarn which forms the ground the other guide occupies the plating position. The invention is described in connection with the type of machine with two cylindrical needle-beds. —B.C.I.R.A.

Loom Shedding Mechanism. W. Simmchen and Ipag International Patent Exploiting Co., Aussig, Czecho-Slovakia. E.P. 249,331.

Heald frames or bars are detachably connected at their ends by dowels or tenons to hangers, each of which is guided vertically by three guiding rollers. The hangers have racks meshing with toothed sectors of linked bell-crank levers operated by a dobby. The guiding rollers are mounted on spindles and are separated by discs of larger diameter. The hangers may be slotted to receive dowels or tenons on the heald frames or on ferrules on the heald bars; or the dowels may be carried by the hangers. —B.C.I.R.A.

Brake Lining, Clutch or Belt Fabric. G. A. Sowerby, Bentham, Yorks, and W. M. Angus, Newcastle-on-Tyne. E.P. 249,341.

A fabric for use as a lining for brakes or transmission bands or clutches has end portions which have faces woven on one side with warp and weft of material of greater resistance to wear than the warp and weft forming the rest of the face between the said end portions. Thus a woven strip may have at both sides an upper face formed of asbestos warp and asbestos weft, and a lower face of cotton warp and asbestos weft, whilst the centre part has an upper face of cotton warp and cotton weft. The lining may be impregnated. —B.C.I.R.A.

Loom Beat-up Motion. D. Kenyon and H. Evans, Great Harwood, Lancs. E.P. 249,388.

In a loose-reed loom the reed is locked to make the beat-up by adjustable wedge-pieces, on a slide rod, engaging between the inclined ends of reed-case levers and wedges underneath supported on an anchor-bar. Additional security is given by tapered locking pieces on the reed case spindle and the anchor-bar. The slide-rod is spring-pressed against an adjustable cam-bar on the loom frame, so that it is moved to the left during the insertion of the weft to free the reed. If the shuttle encounters an obstruction the reed is thrown over to allow the shuttle to pass, and the reed is then swung back by a band lever on the reed case spindle without stopping the loom. —B.C.I.R.A.

Shuttle Peg. F. W. Bresges, Reydt, Rhineland, Germany. E.P.249,449.

A shuttle peg is slidably connected to its pivoted socket by screwed connection between the end of the peg and a spiral spring anchored near the opposite end of the socket. Relative movement between the two parts is limited by a pin and slot connection. —B.C.I.R.A.

Lucas-Lamborn Loom. Lucas-Lamborn Loom Corp., Manhattan, N.Y., U.S.A. E.P. 249,455 (from *Text World*, 1926, **69**, 3169).

The principle feature is the shuttle motion. Instead of being shot through the shed the shuttle is carried by means of two mechanical arms. The movement is imparted by a crank drive, the crank acting with a combination of levers to give a longer travel on one side of the centre than on the other, so that the shuttle starts at slow speed, increases, then slows down. The shuttle is transferred from one carrier to the other at the centre, the transfer arrangement being effected by a latching mechanism tripped to release the shuttle from one arm and engage it in the other. The shuttle is equipped with a positive tension device consisting of a lever which gives constant tension, irrespective of the size of the package left in the shuttle. The shuttle carries a much larger package of yarn than usually, and the opening of the shed is wider than that generally employed; strain on the warp is absorbed by a compensating whip roll. Contact between the shuttle and the warp is eliminated. —B.C.I.R.A.

Looms: Pirnless Weft-Inserter. A. Mullor, Seine, and L. Carriol, Paris. E.P.249,471.

The weft is inserted in loop form from each side of the loom by means of a "shuttle" or weft carrier cut away at its upper side and provided with a transverse spindle. A rocker pivoted on the spindle is provided with two plates or strikers and two forks. Its movements are limited by pins and controlled by a spring. The weft is led from spools at each side of the loom to eyelets on rockers which are controlled by cam and lever mechanism and are provided with abutments for actuating the plates and hooks of the spindle rocker, and with thread-gripping hooks. When the "shuttle" is shot to the left the raised rear fork engages weft from the right-hand spool and takes it in loop form through the shed. The weft thread is freed from the "shuttle" by the rear plate striking the abutment whereby the rocker is swung, allowing the weft thread to fall on and be retained by the left-hand thread-gripping hook. At the same moment weft from the left-hand spool is engaged by the shuttle hook and drawn to the right. —B.C.I.R.A.

Circular Knitting Machine Pattern Wheel. Soc. Etablissements Lebocey Frères, Seine, France. E.P.249,486.

A toothed wheel gearing with a perforated steel band is substituted for the usual pattern wheel. A line of irregularly spaced perforations registers with a swinging arm controlling thread guides or other devices and having on it a projection. As the band travels downwards a spring holds the arm in a position where the perforations register with the projection on the arm. The unperforated parts by acting on the top edge of the projection force the arm away from the wheel. Larger sized patterns than would be obtainable by the use of an ordinary pattern wheel can thus be produced. —B.C.I.R.A.

Looms: Anti-Balloon Shuttle Construction. A. and J. Calvert, Blackburn. E.P. 249,985.

To prevent ballooning, &c., a shuttle body is continued around and in proximity to the end of the skewer. For this purpose the slot in the shuttle is of keyhole section, one part being wide enough to pass the skewer and the other part being of circular or other shape. —B.C.I.R.A.

The following is a list of patents of which abridgements have recently appeared in the *Illustrated Official Journal (Patents)*—

Weaving—

248,348. W. Harris. Warp let-off device.

248,362. E. Zattera. Cop-changing mechanism.

248,484. J. E. Grosvenor and W. T. Picking. Looms: Comber-board.

249,392. E. Hollingworth. Carpet jacquards.

249,582. Clark & McKee, Ltd. Fabrics from horsehair &c.

249,729. W. Gledhill. Looms: Warp let-off weighting device.

Knitting—

249,731. E. A. Hirner. Knitting device to permit use of undyed yarn in heel, foot, and toe of half-hose.

4—CHEMICAL AND OTHER PROCESSES

(B)—Scouring and Degumming

Scouring and Dyeing of Artificial Silk. E. Greenhalgh. *Dyer and Calico Printer*, 1926, **56**, 52-53.

The scouring, dyeing and finishing of knitted artificial silk fabric (tubular and

flat) is described. Palmer and Hunt blanket finishing machines are suitable, and cause no distortion of the fabric.
—A.J.H.

Bleaching and Blueing Silk. C. Zentsch. *Dyer and Calico Printer*, 1926, **56**, 36-37. (From *Silk*.)

A description of methods for degumming and bleaching natural silks. Cyanol extra, Acid Violet, Quinoline Yellow, Patent Phosphine, and Chrysoidine are suitable dyes for tinting bleached silks. —A.J.H.

(C)—Washing

Wool Washing and Its Bye-Products. M. Rindl. *S. African J. of Industries*, 1923, **6**, 628.

The amount of potash present in wool depends largely on the breed of the sheep. Results are recorded of experiments on Australian merino wools, where only 2·3% of potash have been obtained by extracting with cold water, but between 4·5 and 6·25% from stained pieces and locks, and this makes extraction profitable in Australia on account of the excessive price of potash fertilisers. Very little potash is recovered in England, but in France the wool scoured yields quite a profitable amount. A method of extracting potash salts used in the United States is to allow washings from certain slaughter-houses to run through peat, which absorbs the potash, the material then being used as a filler for certain complete fertilisers. In Belgium, France and Germany the wool is subjected to preliminary treatment with cold water on the counter-current principle; the solution is allowed to circulate until it attains a specific gravity of 1·12. This is evaporated nearly to dryness in iron pans, and the pasty mass is calcined in reverberatory furnaces or destructively distilled in clay gas retorts. The carbonaceous residue is crushed, lixiviated in iron or wooden vats, and the clear liquid evaporated, furnishing successive crops of potassium chloride and carbonate. Statistics are given relative to potash recovery and the wool washing activities in the Union are recorded.
—B.R.A.W. & W.I.

(E)—Drying and Conditioning

Hank Drying and Conditioning Machine. Plews & Turner. *Text. Merc.*, 1926, **74**, 340-341.

The main essentials of the machine are a hot-air chamber, a series of poles on which the hanks are hung while under treatment, an endless chain operated for conveying the hanks through the drying chamber, and a special arrangement for blowing hot air on to the hanks in such a way that both sides of the hanks are treated, thus obtaining a maximum drying and conditioning effect. The machine is simple in operation, easily controlled, and its first cost is low. —B.C.I.R.A.

Artificial Silk Drying Machine. Tomlinsons, Ltd. *Text. Merc.*, 1926, **74**, 300.

The machine is of the chamber type, especially designed for drying artificial silk on stretcher frames. It may comprise two, four or more chambers, separated by small compartments which are divided by a partition into two heating chambers. The fans are also double, one half drawing air into the heating compartment and the other half impelling it forward into the next drying chamber. The chambers are charged in turn at regular intervals, and the opening and closing of all valves is automatically controlled by opening and closing the doors in removing the dry yarn and inserting the wet yarn.
—B.C.I.R.A.

Cheese Drying Machine. *Text. Rec.*, 1926, **43**, No. 517, p. 96.

The machine has been designed for drying yarn in the form of cheeses, spools, bobbins and cops. The convection principle of drying is employed, air at a high temperature being used to induce the moisture to come through the mass of yarn for removal by the hot air which continuously passes over and round it. The cheeses, &c., are mounted on metal rods, and the drying process is assisted by the heat of the air conducted to the centre of the cheeses by the rods. The rods are mounted on a pair of endless chains near their centre, so leaving the ends free. The chains, following a sinuous path, travel from end to end of the machine six or more times as desired. On the last passage through the drying chamber the dry yarn meets a current of cool air and is gradually cooled before emerging from the machine. —B.C.I.R.A.

(G)—Bleaching

Importance of Dye Fastness to the Bleacher. See Section 4I.

(H)—Mercerising

High-speed Mercerisation of [Cotton] Piece Goods. T. P. Gates. *Dyer and Calico Printer*, 1926, **56**, 14-16.

The results are given of a systematic investigation of the influence of concentration, temperature, and purity of the caustic soda lye, twist in the yarn, the preparation of the fabric, the moisture-content of the fabric, and sketching in the mercerisation of cotton piece goods. Caustic soda of 19% (by weight) yielded the best results, especially at temperatures exceeding 25° C., and saturation with caustic soda for 30 secs. is sufficient, regardless as to whether the fabric consists of hard or soft spun yarns. Non-scoured fabrics are difficult to mercerise owing to the resistance exerted by impurities to penetration of the fabric by the caustic soda. —A.J.H.

(I)—DYEING

Turkey-red Oil and Its Competitors. H. Pomeranz. *Text. Mfr.*, 1926, **52**, 241-242 (from *Leipziger Monats.*).

A description of methods for preparing Turkey-red oil by the sulphonation of castor oil. —A.J.H.

Straw Bleaching and Dyeing: Modern Methods. C. Williams. *Dyer and Calico Printer*, 1926, **56**, 12-13.

A description of methods for dyeing plait, braids and trimmings containing cellulose acetate silk with Celatene dyestuffs. —A.J.H.

Three-Colour Effects on Fabrics Containing Acetyl Cellulose. H. Kay. *Dyer and Calico Printer*, 1926, **56**, 25.

Methods for dyeing textile materials containing cotton, cellulose acetate silk and wool in three colours in one or two baths are described. Neutral dyeing acid colours, direct cotton dyes, and the usual dyes for cellulose acetate are used. In the two-bath process, the cotton is dyed last at a temperature not exceeding 30° C., so that the wool remains unstained. —A.J.H.

Mechanism of Dyeing. A. Brass. *J. Soc. Dyers and Col.*, 1926, **42**, 168 (from *Z. Angew. Chem.*, 1925, **38**, 855).

The author has carried out dyeing trials with Indanthrene colouring matters (blue, orange, golden orange and yellow), treating cotton with the dye vat in atmospheres of nitrogen and of carbon dioxide. He has tested the patterns before and after oxidation with boiling soap solution, and arrives at the conclusion that the vat acid has an affinity for cotton, but that its alkali salt has not. An excess of alkali in the vat will be unfavourable to the liberation of hydrolysis of the vat acid, and will impede the dyeing process, as has actually been found to be the case in Indigo dyeing by Binz and Rung. —L.I.R.A.

Sulphonated Oils. J. B. Crowe. *Dyer and Calico Printer*, 1926, **56**, 34-36.

The preparation, uses and analysis of Turkey-red oils are described. —A.J.H.

Textile Dispersants. *Dyer and Calico Printer*, 1926, **56**, 48.

A brief discussion of dispersing agents and their application in dyeing and printing. Oranit is suitable for assisting the solubility of vat dyes in dyeing, and Oranit BF in printing; Oranit FW is suitable for adding to acid dyebaths (for wool), and Oranit CC is an excellent dispersing agent for basic dyes. Cykloran FC is a good substitute for oleine in the preparation of solutions of Naphthol AS compounds. —A.J.H.

Developments in Calico Printing. R. Sansone. *Dyer and Calico Printer*, 1926, **56**, 50-51.

An account of plant used for naphthol-preparing fabric before dyeing with developed colours. —A.J.H.

Dyeing Satins in the Piece. L. J. Matos. *Dyer and Calico Printer*, 1926, **56**, 51.

High quality satins having a real silk face are dyed while mounted spirally upon a chiffon dye reel; abrasion of the face is thus avoided. —A.J.H.

Batik Dyeing. P. Mijer. *Dyer and Calico Printer* 1926, **56**, 54-55.

Detailed description of methods employed by natives in Java for producing batik effects on cotton materials. The batik art was practised in Java at least as early as 1563. —A.J.H.

Dyes: Fastness. R. P. Foulds. *Industrial Chemist*, 1926, **2**, 147-149.

Discussing the importance of dye fastness to the bleacher and finisher, the author suggests that it would be a great advantage if some standard of the fastness of a colour to every influence under which it may come could be worked out and adopted throughout the trade. Such a step would necessitate the co-operation of dye makers, dyers and merchants, and launderers. —B.C.I.R.A.

Some Aspects of the Development of Dyes for Cellulose Acetate. A. J. Hall. *Dyer and Calico Printer*, 1926, **56**, 26-27.

A description of methods which have been used for dyeing cellulose acetate silk, reference being made to processes of pretreatment with alkalis (saponification) and swelling agents (e.g., ammonum thiocyanate) and to Ionamines and S.R.A. dyes. The solid-solution theory of dyeing cellulose acetate silk is supported by reference to the absorption by this silk of *o*-nitroaniline from aqueous, it being shown that *o*-nitroaniline is about 180 times more soluble in cellulose acetate silk than in water. —A.J.H.

Dyeing of Artificial Silk. See Section 4B.

(J)—PRINTING

Cotton Cloth: Hand Printing and Painting. D. M. Amalsad. *Indian Text. J.*, 1926, **36**, 141-144.

Details are given of the arts of block printing and hand painting on cotton cloth as practised in Madras. —B.C.I.R.A.

Use of Dispersing Agents in Printing. See Section 4I.

(K)—FINISHING

Dyes: Application. J. Ferguson. *Industrial Chemist*, 1926, **2**, 177-180.

The importance to the textile finishing trades of keeping in touch with progress in foreign countries is emphasised, and recent advances in dyeing and printing as indicated by the pattern cards issued during 1925 are discussed. —B.C.I.R.A.

Finishing of Artificial Silk Fabrics. See Section 4B.

Importance of Dye Fastness to the Finisher. See Section 4I.

(L)—WATERPROOFING

Copper Soap: Preservative Action. W. R. G. Atkins. *J. Marine Biol. Assoc.*, 1926, **14**, 63-69.

The paper describes the efficacy of copper soap dissolved in petrol or benzole as a preservative for fishing nets against the bacterial action of sea water and tendering by sunlight. Experiments on cotton and linen fabrics are also mentioned. —B.C.I.R.A.

PATENTS

Formaldehyde-Aniline Condensation Products: Application. Comp. Nat. de Mat. Col. et Manuf. de Prod. Chim. du Nord Réunis, Etabl. Kuhlmann (from *Brit. Chem. Abstr.*, 1926, B, 536). F.P. 595,705.

Cotton is dyed in brown shades fast to washing, alkali, chlorine, and light by impregnation with a solution containing products obtained by the condensation of formaldehyde and aniline or its homologues in acid solution, being afterwards passed through a solution of caustic soda or sodium carbonate, then washed, oxidised with a dilute solution of sulphuric acid containing a dichromate or persulphate, washed and soaped. The resulting shades may also be diazotised and developed with β-naphthol or coupled with diazo compounds. Alternatively cotton is impregnated with a solution containing lactic acid, the above described condensation products, sodium chlorate, sodium acetate, and copper sulphate or a vanadium salt, then oxidised during six hours at 40° with a solution of a dichromate. White and coloured resists may be obtained by after-printing with a reducing agent such as a sulphite, bisulphite or hyposulphite and suitable dyes. Brown effects are also obtained by printing cotton fabric with a paste containing the condensation products and gum tragacanth thickening, drying, fixing in an alkaline solution, and developing the shade by oxidation with a persulphate. Alizarin and vat dyes may be printed and developed simultaneously by oxidation. —B.C.I.R.A.

Dyes: Fixing. M. Scholz. U.S.P. 1,544,603 (from *Chem. Abs.*, 1925, **19**, 2750).

The colours are fixed in dyed materials by quickly passing them through a hot aqueous saline solution containing a small proportion of acetic acid. —B.C.I.R.A.

Cloth Printing Machine. E. Cadgene and G. Dupont, New Jersey, U.S.A. E.P. 248,254.

A textile fabric is decorated by feeding it past an engraved roller supplied with a colouring composition which is removed from the roller and sprayed on to the fabric by means of a rotating brush. A stencil may be interposed between the spray and the fabric. The web is dried between heating coils, arranged in a drying chamber, and rewound on a reel. —B.C.I.R.A.

Cloth Folding Machine. J. Montforts, Munchen, Sladbach, Germany. E.P. 248,558.

The patent relates to the mechanism for reciprocating the folding arm carriage, the method of securing the folding blades, and the cloth-guiding table. —B.C.I.R.A.

Drying Cylinder Gear Box. W. P. Evans, Swinton Park, Irlam-o-th'-Height, Lancs. E.P.248,568.

The gear box of each of a series of steam-heated rotary drying cylinders is provided with a bearing for the cylinder trunnion, a horizontal bearing transverse thereto for the driving shaft, a cover to enclose the bevel gears, and an oil well into which the gears dip. One of the bevel gears is suitably keyed to the trunnion so as to allow the latter to move longitudinally due to expansion and contraction, against a spring which is held against the trunnion by a stirrup and screw. —B.C.I.R.A.

Dyeing Machine. British-American Laundry Machinery Co., Victoria Street, Westminster. E.P.248,793.

In dyeing, washing and like apparatus, a foraminous drum for receiving the material to be treated is rotatably mounted within a stationary casing containing water or other liquid, the drum being radially spaced from the container around its whole circumference at a sufficient distance to enable dyeing, blueing, bleaching, or other liquid injected by steam through a perforated pipe to be sufficiently mixed with the water in the container before passing to the drum. The water is initially heated by steam passed through pipes at opposite ends of the container to perforated pipes in the bottom of the container. At the junction of one of these pipes with its supply pipe an injection casing is provided which also communicates with a tank containing the dyeing or other treating liquid. When the water has been sufficiently heated a valve is opened and the treating liquid is injected by steam into the water. When the dyeing, &c., operation is complete, valves in the steam supply pipes are closed and the treating solution is drained from the container. The perforated pipes may then be cleaned out by opening the steam supply pipe valves and the outlet pipe valves. —B.C.I.R.A.

Vat Dye Leuco Compounds: Application. J. I. M. Jones, B. Wylam, and J. Morton, Lancaster, and Morton Sundour Fabrics, Ltd., Carlisle. E.P.248,802.

Leuco compounds of vat dyes are converted into stable derivatives by treatment with phosphorus oxychloride or alkylphosphoric halides in the presence of a suitable basic body, tertiary amines being specified. The reaction may be carried out in the presence of a solvent or diluent such as monochlorobenzene or carbon disulphide. The products may be used for dyeing and printing cotton, wool, silk, artificial silk, hemp, raffia, &c., being converted on the fibre into the original vat dyestuffs by mild acid oxidising agents such as an acid solution of ferric chloride. Examples are given of the preparation of compounds from the following:—Leuco flavanthrone and phosphorus oxychloride in the presence of carbon disulphide and pyridine; leuco indanthrone and phosphorus oxychloride in the presence of chlorobenzene and pyridine, &c. Methylphosphoric dichloride is obtained by treating methyl alcohol with phosphorus oxychloride and fractionally distilling the product, first under reduced pressure and then at ordinary pressure. —B.C.I.R.A.

Cloth Singeing Machine. E. Turner & Co., Manchester. E.P.248,810.

A singeing machine comprises a plurality of gas burners arranged to project stable oxidising flames horizontally on to one or both sides of, and uniformly across, the vertically moving fabric, each burner having a single outlet extending the full width of the machine. In one form, the burners are arranged alternately on opposite sides of the frame, the fabric being led down between brushes and the burners, and then through a steaming-box and mangling rollers to a plaiter. A perforated pipe, secured to or resting on a baffle plate above each burner, is adapted to project heated air on to the fabric to remove the combustion products, and two perforated pipes communicating with an exhaust fan remove any charred matter from the fabric after passing the last burner. In a second form the burners are all arranged on one side of the frame, the fabric being led over guide rolls and preferably over a singeing plate when both sides of the fabric are treated. An air heater supplied from a casing, through which flue gases may be led, may be provided to dry the fabric. The burners are preferably constructed as in Specification 249,454. —B.C.I.R.A.

Metallic Powder Ornamented Fabrics; Preparation of——. Soc. Nouvelle de Metallisation, Paris. E.P.249,167.

Textile fabrics are decorated by means of metallic powder sprayed on to the material through a stencil, a sheet of wire gauze being interposed between the stencil and the material. The material may further be treated by dyeing or finishing, also metals of different kinds and colours may be used for various parts of the design. —B.C.I.R.A.

Yarn Dyeing Apparatus. W. J. Mellersh-Jackson, London, for Fuld and Hatch Knitting Co., U.S.A. E.P.249,369.

Yarn is lifted periodically by a rocking arm as it is passed continuously over a wick extending through an opening to the upper surface of a tank which is kept full of dye liquor. The liquor is supplied through a pipe to one end of the tank and excess overflows through an aperture into an outer receptacle, the cover of which supports the tank. The method of operating the rocking arm is described. —B.C.I.R.A.

Dyeing, Mangling, and Wringing Apparatus. T. McConnell, Easthampton, Mass., U.S.A. E.P.249,406.

Yarn, fabric, or other material is fed loosely over a top roller down through an oscillated guide tube and into a dyeing vat. A steam pipe is provided in the chamber beneath the perforated false bottom of the vat from which the dye is withdrawn and circulated by a pump. The yarn is fed down channels formed by guides on the inclined bottom of the vat, and is then passed over a roller above the dye surface, which is rotated at the same speed as the top roller, to a series of angular rollers. Each roller comprises a spider covered with sheets, so that during the passage of the yarn superfluous dye is expressed and the yarn is stretched longitudinally. —B.C.I.R.A.

Yarn Polishing Device. T. McConnell, Easthampton, Mass., U.S.A. E.P. 249,407.

A machine for treating yarn or cloth to produce a soft silky texture comprises feed and delivery rollers, and polishing members comprising spiders carrying arrow-headed arms provided with facings of wood or other polishing material. The polishing members are arranged so that their arms interlock and divert the material, stretched between the feed and delivery rollers, from the straight line as it passes between them. The speed of the polishing members is greater than that of the feed of the material. —B.C.I.R.A.

Differently Sulphured Fabric: Application. Naamlooze Vennootschap Nederlandsche Kunstzijdefabriek, Arnhem, Holland. E.P.249,538.

Contrasting lustre and dyeing effects in fibres are obtained by arranging that the sulphur content of the fibres varies at different points. The material may be prepared by adding sulphur or by desulphurising to the extent desired. With viscose artificial silk, by using a mild desulphurising agent, only the sulphur at the surface may be removed, that in the core remaining untouched. On subsequently dyeing a material so treated there is obtained a lustrous coloured fibre; alternatively, only the outer surface of the fibre may be dyed, the sulphur in the core being either removed or allowed to remain, in which case there is obtained a dull coloured fibre. The process is applicable to the treatment of piece goods; thus the goods may be woven with uniformly sulphured fibres, the sulphur being subsequently removed in selected places either by a sulphur dissolving paste or liquid or by printing with a sulphur fixing agent, such as wax, and then removing the sulphur from the unprinted portions. The dyestuff may be incorporated in the sulphur fixing or dissolving medium. —B.C.I.R.A.

Fabric Breaking Machine. J. Poole, J. E. Whitehead, and Whitehead & Poole, Ltd., Radcliffe, Lancashire. E.P. 249,733.

In a fabric breaking machine of the kind described in Specification 7074/08, a pair of breaking members having annular, axial, or helical interengaging projections and grooves is employed in addition to the pairs of scrolls. The breaking rollers, preferably geared together, are mounted on arms in fixed bearings respectively, the arms preferably being operated synchronously with the arms carrying the outer scroll members, or they may be adjustably mounted on fixed arms. The shaft carrying one of the breaking rollers, which may be composed of independently adjustable parts, is mounted in bearing blocks independently adjustable in the forked ends of the mounting arms. The bearings of the shaft are preferably of the self-aligning kind, so that the shaft may be arranged at an angle to the shaft carrying the second breaking roller. A modification is described. —B.C.I.R.A.

Acid-Dye Sensitised Cotton Fabric: Preparation. P. Karrer, Zurich, Switzerland. E.P.249,842.

Cotton textile materials previous to dyeing are treated in such a manner as partly to esterify the cellulose with aryl or alkyl sulphonic groups, particularly benzene-, toluene-, or naphthalene-sulphonic groups, and are then heated with a solution of ammonia, or of an aliphatic or aromatic amine, or of hydrazine or a hydrazine derivative. Material so treated becomes capable of being dyed with acid dyestuffs. In an example, cotton partly esterified with *p*-toluene-sulphonic groups, is heated in an autoclave with aqueous ammonia solution; the cotton so treated can be dyed with tartrazine, Orange II., sulphorhodamine, &c. —B.C.I.R.A.

Fabrics: Waterproofing and Gasproofing. British Celanese, Ltd., London, T. C. Woodman, Teddington, and W. A. Dickie, Spondon, near Derby. E.P.249,946.

Waterproof or gasproof fabrics are formed by subjecting to heat and pressure woven, knitted or other fabrics made wholly or in part of yarns or threads of filaments or fibres of cellulose esters or ethers or mixtures thereof. The fabric may first be coated or sprayed with, or there may be incorporated with the filaments or fibres, plasticising or softening agents or solvents, such as triacetin, paratoluene sulphonamide or its derivatives, diethyl phthalate, paratoluene sulphonanilide, or high boiling alkylated xylene-sulphonamide derivatives. The softening agents are employed particularly for making gasproof fabrics. Various means of applying the heat and pressure are indicated, and the extent of the melting effect to be produced on the filaments or fibres of the cellulose derivative may be varied by varying the conditions of temperature, pressure or duration of pressure. A fabric made entirely from cellulose acetate yarn, for example, may be pressed between smooth plates at a temperature of 100° C. under a pressure of 500 lb. per sq. in. for five minutes to give a waterproof fabric which retains the structure of the woven fabric. Or the fabric may be passed slowly through heated calender rollers at a temperature of 100-180° C. under a pressure of 300-600 lb. per sq. in., or be passed repeatedly between the heated rollers. In order to increase the melting effect produced on the fibres the fabric may first be treated with a solution of 20 grams of monomethyl-xylene-sulphonamide in 100 grams of benzole for each 100 grams of fabric, and the temperature, pressure, or duration of pressure may be increased to cause the fibres to coalesce more or less completely. —B.C.I.R.A.

The following is a list of patents of which abridgements have recently appeared in the *Illustrated Official Journal* (*Patents*)—

Finishing—

248,366 } Waggon und Maschinenbau A.-G.
248,367 } Fabric guiding device.

248,511. W. Battye. Tentering machine.

249,434. Havannah Mills Co. and G. Roger. Cloth tensioning device.

Dyeing—

248,814. Chem. Fabr. Pott & Co. Sulphonic acid compounds: use in textile processes.

249,413. J. & R. Whitaker. Dye vat construction.

Scouring—

249,496. A. Rechberg and G. Braun, Ges. Degreasing process for textiles.

5—LAUNDERING AND DRY CLEANING

PATENTS

Detergents. J. J. Richardson and J. Richardson, Kingston-upon-Hull. E.P. 249,207.

Saponaceous cleaning compositions for wood, metal or paintwork and for removing stains from carpets, fabrics, &c., consist of soap, soda-ash, waste-lime from water-softening plants, and water, with or without an abrasive. In an example, 9 lb. of stearine soap, 5 lb. of soda ash, 15 lb. of silver sand, 37 lb. of water, and 34 lb. of the waste-lime resulting from the softening of water by passage through an iron tank packed with shavings impregnated with lime, are used. —B.C.I.R.A.

The following is a list of patents of which abridgements have recently appeared in the *Illustrated Official Journal* (*Patents*)—

Detergents—

248,209. R. G. Varcoe. Saponaceous cleansing composition.

249,912. C. W. Fulton and H. W. Hulton. Cleansing compositions.

6—ANALYSIS, TESTING, GRADING, AND DEFECTS

Oil Film: Spreading on Water. A. Marcelin. *Ann. de Phys.*, 1925, **4**, 459-527.

The paper is an experimental analysis of the physical state of floating so-called "unimolecular" films as typified by a film of oleic acid on water. The author applies the terms "surface solution" or "two-dimensional fluid" to extremely thin films of this type. It has previously been suggested that the spreading of a fatty film, which is known to be of the order of unimolecular dimension, is limited to the juxtaposition of the molecules of the fat on the surface of the water. The author considers that the supposition of a limit of spreading is due to insufficiently sensitive apparatus and shows that the spreading of matter, notably of oleic acid, on water may be unlimited; he has detected a film 14 times more expanded than those which had been believed to have attained their limit of area. In such an expansion the film is necessarily discontinuous; like a gas or vapour of which the molecules are not connected in the volume occupied, it exerts againstitscontoura"surfacepressure"which is equal to the lowering of the surface tension of water (caused by the film). The author finds that the variations in the surface pressure p of a film of oleic acid in terms of its area S are represented by a Mariotte's Law, $pS=\text{const.}$, and that the variations in the product pS as a function of temperature are represented by a Gay-Lussac Law $pS=KT$. As a vapour on compression is resolved into a mist of droplets, so fatty matter in the state of a surface film on water is condensed in the form of droplets or discs when the area is progressively reduced; the appearance of the first droplets corresponds on the curve $p=f(S)$ to a peak which is succeeded by a level (signifying a change in physical state), of which the constant ordinate measures the "saturated surface pressure" of the film. The experimental work is described in detail and values obtained for the saturation pressure of a number of organic substances. For oleic acid $Ps=40$ dynes/cm. —B.C.I.R.A.

Cellulose: Action of Concentrated Hydrochloric Acid. K. Atsuki. *Brit. Chem. Abstr.*, 1926, **45**, B8 (from *Cellulose Ind., Tokyo*, 1925, **1**, 53-61).

Cotton cellulose was treated at 10° with 100 times its weight of hydrochloric acid at 40, 41, 43 and 45% strength, and the course of the hydrolysis was followed by measurements of viscosity and specific rotary power. The increase in rotation is more rapid the higher the concentration of the acid. The rotation-time curves show two points of deflection, the first after about five hours with 45% acid or ten hours with 40% acid, and the second after 15 hours with 45% acid, or 30 hours with 40%. The viscosity falls rapidly along the first step of the specific rotation curve and remains constant afterwards. The addition of 1% of zinc chloride or 0·5% of sodium chloride to the acid retards the solution of the cellulose and inhibits to some extent the hydrolysis. The addition of 0·5% of calcium chloride suppresses the solvent action of the hydrochloric acid, the cellulose being disintegrated to a powdery form after a few days. The solution of cellulose is considered to take place by its association with the hydrochloric acid in virtue of its hydroxyl groups reacting as water as long as the concentration of the acid is such that it is still unsaturated with water of hydration; dispersion of the cellulose under these conditions is progressive. The end product of the hydrolysis is dextrose, the intermediate products being colloids and then crystalloids in stages. By precipitation at an early stage after solution the cellulose is obtained in a modified form very highly hydrated. It is physically unsuitable for nitration or acetylation but can be centrifuged and converted into viscose. —B.C.I.R.A.

Cellulose Palmitates: Preparation and Properties. G. Kita, T. Mazume, I. Sakurada, and S. Nakajima. *Brit. Chem. Abstr.*, 1926, **45**, B45 (from *Cellulose Ind. Tokyo*, 1925, **1**, 227-232).

Only a slight degree of esterification is obtained by heating cellulose with palmitic anhydride in the presence of pyridine and chloroform. On the other hand, when cellulose is heated with palmityl chloride and pyridine, preferably diluted with benzene, progressive formation of esters takes place, with the ultimate production of cellulose tripalmitate soluble in benzene or ether. The esters are purified by washing the product with alcohol and extracting with ether or benzene. The mono-palmitate is still fibrous and only slightly swollen; the higher palmitates, whilst retaining a fibrous structure are very much swollen and completely deformed. The tripalmitate from hydrocellulose is completely soluble in ether, that from normal cellulose only partly soluble. The di-palmitate from hydrocellulose is soluble in benzene, but that from normal cellulose only partly. The mono-palmitate is insoluble in benzene but becomes transparent in that liquid. The solutions from ether or benzene deposit elastic films. The melting points, ranging from 180 to 220°, are lower in the esters from hydrocellulose than in those from normal cellulose. In the analysis by saponification, the addition of benzene to the alcoholic potassium hydroxide promotes the reaction. —B.C.I.R.A.

Takadiastase: Constitution. S. Nishimura. *Chem. Zentr.*, 1925, **ii.**, 2212 (from *Chemie der Zelle u. Gewebe*, 1925, **12**, 202-216).

The following enzymes were detected in a takadiastase investigated by the author—Amylase, saccharase, maltase, proteases, catalase, lipase, rennet ferment, lactase, inulase, sulphatase, and amidase. At *p*H 6·0, amylase, saccharase, maltase, proteases, catalase, and lipase could be quantitatively adsorbed by colloidal alumina. The adsorption of the other enzymes was not investigated. The enzymes were liberated by treatment with a phosphate mixture at *p*H 8. Accompanying substances were separated by this treatment since the activity of the enzymes in the final solution was some three times as great as in the original solution. The same increase of activity was noted for all the enzymes. Separation of the enzymes in this way has not been attained. If the final solution was adjusted to *p*H 6 the enzymes could be readsorbed by alumina and the enzymes liberated from this second adsorption differed in their behaviour in that their activities were increased to different extents. Their activities after the second adsorption and liberation as compared with those in the original solution were increased to—Amylase 7·0, saccharase 4·63, maltase, 5·05, proteases 5·53, and catalase 10.0. —B.C.I.R.A.

Tannin: Light-protective Properties. P. S. Meyer and S. Amster. *Chem. Zentr.*, 1925, **2**, 415 (from *Klin. Wehschr.*, **4**, 921-923).

Tannin in 10% vaseline admixture or in 10% alcoholic solution affords an efficient protection from the effects of strong sunlight which are injurious to the skin of some individuals. The protective effect of tannin lasts for some hours and is ascribed to colloid-chemical structure changes in the skin constituents. —B.C.I.R.A.

Colour: Measurement. W. G. Raffé. *Science Progress*, 1926, **20**, 662-674.

A plea for a simple, standardised method of measuring and expressing colour for industrial purposes. —B.C.I.R.A.

Zinc: Estimation. R. Strebinger and J. Pollak. *Microchemie*, 1926, **4**, 15-18.

The micro-determination of zinc, manganese and cobalt by precipitation as pyrophosphate is described. —B.C.I.R.A.

Textile Fabrics: Ultra-Violet Transmission. F. W. Alexander. *Analyst*, 1926, **51**, 54 (from *Special Report by the Medical Officer of Health to the Metropolitan Borough of Poplar*, Oct. 1925).

The apparatus indicates by the degree of fluorescence the intensity of the ultra-violet rays in the radiation emitted from quartz mercurial vapour lamps. The principle adopted is that of an "extinction photometer," ultra-violet rays being allowed to enter a box, in the form of a camera, through a Chance filter, and the extinction point being controlled by means of an iris diaphragm manipulated by a metal arrow pointing to an arbitrary scale for recording purposes. A reflector of silver-plated copper is fixed at an angle of 45° in front of the iris. A focussing wire is provided on the eye-piece side of the iris diaphragm. The diaphragm is fixed close to the Chance filter, which must be sufficiently thick to exclude all visible light and must be polished on both sides. The fluorescent screen is of uranium glass, and can be replaced by a frame carrying a piece of "Seltona" paper, so that a photographic shade of the ultra-violet rays, with and without reflector, can be recorded. Textile fabrics were found to transmit the near ultra-violet rays in the following order—expensive make of artificial silk; jap silk and silk stockings; nainsook and very cheap cotton stockings; fine linen. Long cloth and calico allowed some ultra-violet rays to pass, and unbleached calico gave just perceptible transmission. —B.C.I.R.A.

Cellulose: Bacterial Decomposition. A. C. Thaysen, W. E. Bakes, and H. J. Bunker. *Biochem. J.*, 1926, **20**, 211-216.

Experiments are described which indicate that micro-biological activity is insufficient to eliminate all the cellulose present in plant tissues decaying to form peat. The humic compounds which may be obtained from typical peats consist of two different types, one of which yields a chlorine derivative identical with, or very similar to, that of "natural humus" (lignin humic compound), whilst the chlorine compound of the other is closely related to that of the artificial humus compounds obtainable either by the action of inorganic acids on carbohydrates or from cellulose fibres decayed through ageing. It is suggested that the presence of the latter humus compound in peat may be due to the decomposition of cellulose not eliminated by micro-biological activity. A humus compound of this type was isolated from a sample of Egyptian linen of the 18th Dynasty. —B.C.I.R.A.

Discoloration of Textile Fabrics. *Chemical Age*, 1926, **14**, 303.

While several micro-organisms are known to discolour cotton and wool, none have been found to have that effect on silk. Many grow on silk hosiery fabric without tendering, but *B. Uycoides* and *B. Proteus* will tender it even in the cold. Various aspergilli will grow on tin-weighted silk without damage. —F.G.P.

Surface Tension in the Textile Industry. N. T. White. *Dyer and Calico Printer*, 1926, **56**, 30-31.

Wet processes of textile treatment are more efficient if the liquors employed have a low surface tension, since they then have increased wetting-out powers. The theory of surface tension is discussed, and the surface tensions of a number of aqueous liquors such as are employed in textile processes are given. —A.J.H.

Field Plots: Mathematics. F. L. Engledow and G. U. Yule. *Empire Cotton Growing Review*, 1926, **3**, 112-146.

In making yield trials for comparing varieties or differences in treatment, of agricultural products, the area of ground under experiment should be divided up into as many small plots as can conveniently be worked, and the treatments tried as far as possible on adjacent plots, each treatment being repeated in several places. By means of arithmetical examples, the efficiencies of different arrangements of plots are compared, and a modified theory of sampling errors is developed for testing the significance of differences in yield. The effect of weather variation is also discussed, and corrections are made. The whole paper is written in elementary fashion, and assumes familiarity only with the symbols and ideas of standard deviation, variance and correlation. There is an interesting paragraph explaining the meaning of "probable error" and "standard error" as tests of significance.

—B.C.I.R.A.

Alkaline-Earth Chlorides: Hydrolysis by Steam. P. L. Robinson, H. C. Smith and H. V. A. Briscoe. *J. Chem. Soc.*, 1926, **129**, 836-839.

The chlorides and bromides of calcium, strontium and barium are all hydrolysed by steam under atmospheric pressure at high temperatures, the ease of decomposition decreasing with increasing atomic weight. The lowest temperatures at which decomposition is appreciable are—Calcium chloride 425°, strontium chloride 640°, barium chloride 970°. The bromides in general are more easily hydrolysed than the chlorides. Calcium carbonate decomposes appreciably at 440° in steam.

—B.C.I.R.A.

Patents

Apparatus for Measuring the Shrinkage of a Twisted Yarn. A. Branca. F.P. 591,924.

This apparatus is designed to determine the reduction resulting from a given twisting of a single yarn or of folded yarns, and comprises, at its superior part, a counter indicating the number of a turning hook to which is bound an end of the yarn, and at its inferior part a slide bar supporting a hook for the other end of the yarn and an appropriated weight. A metric or other scale is fixed on the side.

—Bur. Text.

Absorption Testing Device. F. A. Sesler, U.S.P.1,561, 285 (from *Chem. Abstr.*, 1926, **20**, 111).

A device for testing the rate of absorption of liquids by fibrous sheet materials, especially adapted for testing the absorption of binders by paper or textile fabrics, has been patented. —B.C.I.R.A.

Strength Testing Machine. A. Elmendorf, Chicago, U.S.A., and R. Marx, London. E.P.248,888.

Details are given of a method for determining the strength of paper, board, fabrics, leather, &c., in which a clamped area of the sheet material is subjected to the penetrating action of a falling tool and the amount of energy absorbed in penetration is measured. A baseplate carried on tripod legs is provided with a recessed hole communicating with a spring case. The specimen of sheet material is clamped to the baseplate by a heavy annular weight. Rising from the baseplate are two vertical guide members, bridged at the top, which serve as guides for a carriage having four arms and carrying the piercing tool. The carriage may carry an additional weight. A hook member on the carriage engages in the highest position a catch which may be released by pulling a string. A spring member is adapted to be pushed along a scale. In use, the carriage is raised to the highest position and the specimen is clamped, the spring member is adjusted to its zero position on the scale and the carriage is released. After the specimen is pierced the tool engages the cap on the spring at the same time as an arm engages the spring index. The amount the index is moved corresponds with the compression of the spring, and this depends upon the energy left in the falling weight after piercing the specimen. As for any particular apparatus the potential energy of the falling weight at release is constant, the scale may be calibrated in terms of residual energy. The index may take the form of a piston moving in a cylinder of liquid which is pushed up an indicating tube. —B.C.I.R.A.

7—BUILDING AND POWER

(F)—Lighting

Factories: Illumination. K. M. Reid. *Sci. Abs.*, 1926, **29B**, 198 (from *Canadian Elect. News*, 1926, **35**, 45-48).

The author discusses the advantages of good lighting in the factory, showing that the rate of production can be increased. Curves are given showing the relation between the time taken for the eye to perceive a black dot on a white ground and the illumination, and the time required for the eye to discriminate detail. These show clearly the advantage of good illumination, particularly for the astigmatic eye. An account is given of tests made under working conditions over a period of ten weeks during which time the employees were unaware that their production was being tested. During the first two weeks of the test the original artificial lighting and day lighting were used in combination, giving an average illumination of about 5 ft.-candles. A new lighting system of high grade industrial units placed at 8×10 ft. centres and about 12 ft. above the floor was introduced and during the remaining weeks the illumination was adjusted for a week to 6, 13 or 20 ft.-candles. The corresponding increases in production were 4, 8 and $12\frac{1}{2}$%. The increased cost of the 20 ft.-candle illumination was 2·1% of the pay sheets. —B.C.I.R.A.

Incandescent Lamps: Ultra-Violet Radiation. C. Fabry. *Sci. Abstr.*, 1926, **29B**, 51 (from *Soc. Franc. Elect.*, *Supplement to Bull.* No. 50, Oct. 1925, 17-25).

The paper gives the results of experiments on incandescent tungsten filament gas-filled lamps compared with the solar rays. The problem divides itself into two parts—(1) Study of the direct radiation of a luminous body without absorption; (2) study of the absorption exercised by the absorbing body on the various radiations and traced on the spectral curve of transmission. A figure gives the curves for violet rays from the sun and lamp. The rays emitted by the sun are very rich in radiations of feeble wave-length, even for λ less than 300 mμ, and without atmospheric absorption would be insupportable to the eyes; the same would probably apply to the tungsten lamp if its gas globe could be omitted. Curves are also given for the absorption of various kinds of glass with different transmission factors and the atmosphere This last varies very greatly according to the position of the sun, state of the air, position of the observer, &c. The author draws conclusions concerning the constitution necessary for gas globes required to eliminate completely certain extreme radiations. —B.C.I.R.A.

Light Standard. P. Fleury. *Ann. de Physique*, 1926, **5**, 265-358.

The author describes a means of employing radiation from a black body as a standard of light intensity. The radiator used consists of a block of carbon pierced by a small opening (22 mm^2 or 1/100 of the total cross section) heated to about 2075K in a carbon tube furnace. This temperature can be maintained constant to within some tenths of a degree; it is adjusted with precision by determining the radiation emitted by the black body over a narrow region of the spectrum. An auxiliary black body maintained at the melting point of gold (within 0·2 of a degree) serves as a standard of monochromatic light; the ratio N of the flux emitted by the two black bodies is measured on a spectrophotometer—with the interposition of a Talbot disc—in the region of wave length 622 $\mu\mu$ (the spectral band used is defined to approximately 0·2 $\mu\mu$ by the aid of certain rays of the neon spectrum). N can be determined with a precision corresponding to a maximum error of 1·25% on the brilliancy; the radiation of the standard probably does not differ more than 0·6% from that of a perfect black body. A formula is given connecting the black body radiation between 450 and 470 $\mu\mu$ with that of standard carbon filament lamps. —B.C.I.R.A.

Photometry and Lighting. E. Haas. *Compt. Rend.*, 1926, **182**, 1176-1178.

When the uniform illumination of a surface varies over a period of time, the perception of the variations by the eye is dependent on their extent and speed of recurrence. The author measures this property of the eye, which he terms "successive differential sensitivity" to light. The apparatus is described, and consists essentially in a constant light source and a revolving toothed disc used in conjunction with a slit for obtaining periodic variation. —B.C.I.R.A.

(H)—Humidification

Drying Room "Humidimeter." L. Flamand. *L'Avenir Text.*, 1926, **8**, 203-209.

The apparatus, for regulating the humidity of the air of a drying room, is constructed on the wet and dry bulb principle, and comprises two similar precision thermometers bent at right angles, the graduated stems being fixed vertically and at the same height on a wooden panel fixed on the outside wall of the room. The bent portions project through the wall into the drying room atmosphere and are placed preferably in the air current exit.

The bulb of one thermometer is surrounded with fine flannel kept moist by contact with distilled water in a cup which is supplied from a glass reservoir suitably mounted on the panel. —B.C.I.R.A.

(I)—Ventilation

Air Pollution Measuring Apparatus. J. B. C. Kershaw. *Industrial Chemist*, 1926, **2**, 153-158.

Standard apparatus and methods in use for measuring air pollution are described and some figures relating to total soot and dust and to the amount and character of the soluble constituents of air pollution are reproduced from the eleventh report of the Advisory Committee on Air Pollution. The apparatus described includes a standard soot and dust gauge, an automatic air filter and the jet and settlement dust counters. —B.C.I.R.A.

Patents

"Voltolised" Lubricants: Preparation. E. C. Isom. G.P.234,543, 236,294, and 185,931 (from *Oil and Gas J.*, 1925, **24**, 156, through *Chem. Abstr.*, 1926, **20**, 281).

"Voltol" is a lubricant manufactured by subjecting fatty and mineral oils to an electric glow discharge of 4,000 volts at 500 cycles. The process is carried out in a closed horizontal cylindrical steel vessel of 30 cu. m. content, under a reduced pressure of 24-26 inches of mercury with the addition of no other gas. Since the oil is held at 80°, vapours are formed and the "voltolising" is carried on in a rarified atmosphere of oil vapours. None of the properties is affected except the viscosity, but the friction reduction often amounts to 30%. "Normal voltol" is a compounded oil with a viscosity of 1,500 Saybolt at 212° F., consisting of a mixture of fatty oil with mineral oil. Uses of the lubricant include lubrication of internal combustion engines, high-pressure compressor, superheated steam cylinders, marine engines, heavily loaded ring-oiling bearings, &c. The process increases the viscosity of an oil 300% without affecting its original pour test. —B.C.I.R.A.

8—DESIGN

Mutochrome. A. B. Klein. *J. Soc. Dyers*, 1926, **42**, 121-124; and C. F. Smith, *J. Sci. Instr.*, 1926, **3**, 225-227.

The instrument enables any given design or pattern to be studied in an infinite number of colour combinations with the minimum expenditure of time and effort. A series of transparencies, each of which corresponds to one element of the design, is produced on different portions of the same photographic plate. These images are projected on to a screen through separate lenses in such a way that they register accurately. Any individual element can then be coloured at will by inserting a colour filter in front of the corresponding lens, the adjustment of an iris diaphragm controlling the brightness or depth of the colour. The standard instrument has ten lenses. —B.C.I.R.A.

9—COMMERCE, ECONOMICS, LABOUR, &c.

Artificial Silk: Questions in Parliament. *Chemical Age*, 1926, **14**, 374.

Sir P. Cunliffe-Lister said that 10 Rayon factories had been started since 1st July, 1925, of which five are experimental and five producing. Another six are to be started soon. Mr. McNeil said that the net Customs revenue on imported silk and rayon between 1st July, 1925, and 31st March, 1926, was approximately £2,591,000. The fines for attempted evasion up to 28th February, 1926, amounted to £3,103. —F.G.P.

Italy's Silk Trade. *Daily Mail*, 16th July, 1926, p. 7.

Italy now claims second place in the world's output of rayon, there being 16 companies producing, with a total capital of about £11,715,000. The workpeople number about 35,000. Great Britain takes 30% of the Italian rayon. —F.G.P.

Cotton Production 1923-24: Tanganyika. *Empire Cotton Growing Review*, 1926, **3**, 61 (from *Rept. on Administration of Tanganyika Territory*, 1924, p. 47).

A table of production by districts for the years 1923-24 and 1922-23 shows a total increase of 1,700,000 lb. of lint approximately. This is the native crop, which in 1922-23 represented 42·8% of the total, and in 1923-24 represented 64·3%. —B.C.I.R.A.

Cotton Cultivation in Iraq. *Empire Cotton Growing Review*, 1926, **3**, 58.

The cotton remains remarkably free from disease, though the presence of the spotted bollworm is reported. Much irrigated cotton is being forced into premature opening by water shortage; and a dull, weak-stapled cotton is being picked. At the present state of the market, the prices paid to the growers, i.e. Rs.500 per ton for first-class cotton, are too high, and the price will probably have to be reduced. —B.C.I.R.A.

Cotton Cultivation in the Sudan. P. F. Martin. *Text. Rec.*, 1926, **43**, No. 516, pp. 86-90.

The Sudan Government has received guarantees amounting to £13,500,000 under the Trade Facilities Bill; this will be devoted chiefly to experiments on the cultivation and marketing of cotton, which will be carried out on the Sudan Plantation

Syndicate's estates. In a few months time the Gezira Plain will benefit from the Sennar Dam on the Blue Nile, and 300,000 acres will be put under cotton.

—B.C.I.R.A.

Cotton Goods: Indian Imports, 1925. *Text. Rec.*, 1926, **43**, No. 517, p. 79.

An analysis of India's imports of cotton textiles for the year 1925. Statistics show a drop in the total value of the imports as compared with 1924. This was due in part to the state of the market, but in part also to the enormously increased production of the Indian mills. The United Kingdom is still the predominant supplier of piece goods to India, but Japan, owing to greater activity more than to lower prices, is rapidly encroaching on her position. —B.C.I.R.A.

Durango Cotton Cultivation in Australia (Queensland). *Empire Cotton Growing Review*, 1926, **3**, 63-64.

Yields of Durango cotton in the Upper Burnett Settlement have reached as much as half a ton to the acre. The advantage of May ploughing, i.e., before the onset of winter, over spring ploughing (August) was shown by adjacent blocks yielding respectively 1,200 lb. seed cotton and 650 lb. to the acre. Brokers' reports on representative samples collected by the Government Cotton Classer show that the values ranged from $1\frac{1}{4}$d. to $4\frac{1}{2}$d. above April American Futures. The series consisted of seven samples of Durango and one each of Lone Star and Acala; the last named, which was roller ginned, being valued at 450 points on. Up to August last, seed for 15,000 acres had been applied for, of which all, except that for 200 acres, was Durango. It is the policy of the Government to encourage the planting of better quality cotton. In the few instances where Durango was reported to have yielded poorly, the cause was apparently due to unfavourable weather conditions rather than to any inherent fault in the seed. —B.C.I.R.A.

Cotton Cultivation in Australia (Queensland). G. Evans. *Empire Cotton Growing Review*, 1926 **3**, 87-102.

The most serious handicap to cotton production in Queensland lies in the uncertain rainfall. Pink bollworm and high picking costs render ratooning unprofitable; and the abandoned pest-infected ratoon cotton on cleared scrub land now constitutes a menace to the industry. Cotton is not an unqualified success as reclamation crop, and its future lies mainly on the plough land. Growers' costs to the ginnery average 3·74d. per lb. of seed cotton. Including all expenses of sale in Liverpool a price of 15·592d. is required to meet costs per lb. of lint. Growers must therefore concentrate on at least $1\frac{1}{8}$ to $1\frac{3}{16}$ in cotton if cotton is to be grown at a profit. A solution must be found to the problem of picking costs, which at present amount to 2d. a lb. for seed cotton, an undue burden. Only 80 lb. a day is the picking tally, and higher yielding cottons are necessary if this cost is to be lowered. U.S.A. picking costs average $\frac{1}{2}$d. to $\frac{3}{4}$d. a lb. Cotton production on the coast, owing to the prevalence of boll rot, is on the decline; and it is likely that the great majority of the cotton will be produced in the belt varying from 40 miles to 100 miles from the coast. Small acreages of cotton as a subsidiary to dairying is thought the probable line of development.

—B.C.I.R.A.

Cotton Cultivation in S. Rhodesia. G. S. Cameron. *Empire Cotton Growing Review*, 1926, **3**, 147-164.

The condition of cotton growing up to the end of the 1924-25 crop is briefly described. Ginning, which was one of the main problems, is now completely established, and enough equipment exists to gin 50,000 bales if necessary over a period of four months. Owing to rapid extension, 1924 seed supplies were inadequate, and as much as 6d. a lb. was paid for very indifferent seed. The propagation and distribution of unmixed seed is now most important, and for this purpose the Gatooma experiment station programme includes the testing of numerous strains and varieties both local and imported. Means are also being found rapidly to spread the cultivation of the best of the existing commercial stocks. —B.C.I.R.A.

Cotton: Production Statistics. J. A. Todd. *Empire Cotton Growing Review*, 1926, **3**, 165-169.

The 1924-25 world crop was only 4% less than the 1914-15 record of 27,919,000 bales; whilst the estimates for 1925-26 show an increase of 6% over the previous record. A graph clearly demonstrates the course of production since 1902-03, and shows the outstanding influence of the American crop. Separate figures from 1914-15 are given for India and Egypt, showing acreage, crop, yield, consumption, and prices. The Government acreage figures for Egypt are suspect; and an apparent recovery in yield per acre, namely, to an average over 4 kantars per feddan, is dubious. An increased production in the smaller crops from 1,154,000 bales in 1914 to 2,500,000 bales in 1925 is shown in a detailed table.

—B.C.I.R.A.

Cotton Cultivation in Iraq. Khan Sahib A. A. Soofee. *Empire Cotton Growing Review*, 1926, **3**, 171 (from *Mem.* 10 *Dept. Agric., Iraq*, May 1925).

The value of the cotton crop in a test against rice was two and a half times that of the rice for the same area, while it only used about a quarter of the water required by the latter. —B.C.I.R.A.

Cotton Cultivation in Tanganyika, 1925. *Empire Cotton Growing Review*, 1926, **3**, 173.

Though a 50% increase of seed was distributed in 1925, the crop will barely exceed the 1924 crop, which amounted to 15,000 bales of 500 lb. The season was unfavourable, and difficulty in maturing, boll rot, and insect pest attack are reported from the cotton areas. Cotton, however, does not appear to have suffered as much as food crops. —B.C.I.R.A.

Cotton Production in Nyasaland, 1923-24. *Empire Cotton Growing Review*, 1926, **3**, 59 (from *Rept. Dept. Agric., Nyasaland*, 1924).

European production of cotton was only 771 tons on 26,120 acres, a yield which leaves much room for improvement. Bollworm was less marked than previously, but much damage was done by both rot and stainers. The amount of seed cotton produced by the natives was nearly double that grown in 1923. —B.C.I.R.A.

Cotton Growing Profits in U.S.A., Egypt and India. *Int. Cotton Bull.*, 1926, **4**, 199-200.

The Washington Bureau of Agricultural Economics shows that up to July, 1925, American cotton growers have been advantaged in prices for their products to the following extent.

Year	Cotton and Cottonseed	Thirty Farm Products
1921	101	116
1922	156	124
1923	216	135
1924	211	134
1925 (July only)	186	148

In Egypt the average price of G.F. Sakel at Alexandria in 1924 was 221% of the average for 13th January, 1913-31st July, 1914, as compared with a wholesale index of 141 for other commodities, mostly agricultural. In India for July, 1925, the wholesale price of raw cotton at Calcutta was 215% of the price in July, 1914, as compared with 135% for cereals and 180% for miscellaneous food articles. —B.C.I.R.A.

10—MISCELLANEOUS

"Service Recorder." E. Acheray. *L'Avenir Text*, 1926, **8**, 157-163.

The instrument can be applied to all types of machinery, and gives an accurate record of the time during which the machine is running and the time during which it is stopped. The apparatus is arranged to be controlled by some movement due to the actual work of the machine and not by the driving mechanism, so that only useful running is recorded and no record is made when the machine is running empty. The instrument is simple and compact, and it is impossible to falsify the records. It comprises essentially clockwork mechanism which carries a disc marked off in hours sub-divided into 5 minute sections, and a freely oscillating pendulum which carries a stylet of special type requiring neither pencil nor ink. —B.C.I.R.A.

Upper Nile Basin (including Uganda); Physiography. H. E. Hurst. *Ministry of Public Works, Egypt, Physical Department*, Paper No. 21.

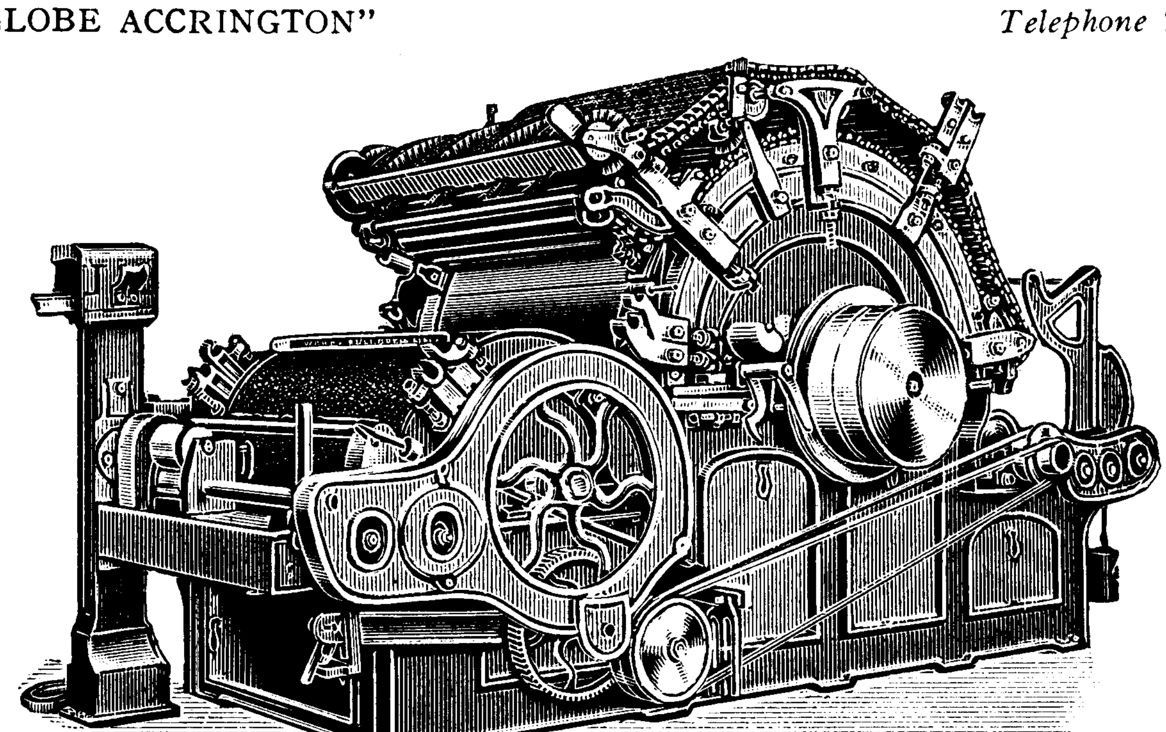
The hydrology and climatology of the Upper Nile Basin, which includes practically the whole of Uganda, and parts of the Belgian Congo, Tanganyika and Kenya are dealt with. Photographs illustrating the various types of country and an excellent physiographical map on a scale of 1 in. to 32 miles approximately are reproduced. It is stated that all authorities who have studied the question are in agreement that the full utilisation of the waters of theNile for the development of irrigation in its basin will ultimately require the prevention of waste in the Sudd region, and the provision of large volumes of stored water in the Great Lakes of Central Africa. This survey considers the proposals for the construction of dams on the White Nile near its source, and the advantages of using Lake Albert as a controlled reservoir are tentatively discussed. A relatively slight work of construction on the Albert Nile might effectively serve this purpose. Recommendations for further work and observations on this problem are made. —B.C.I.R.A.

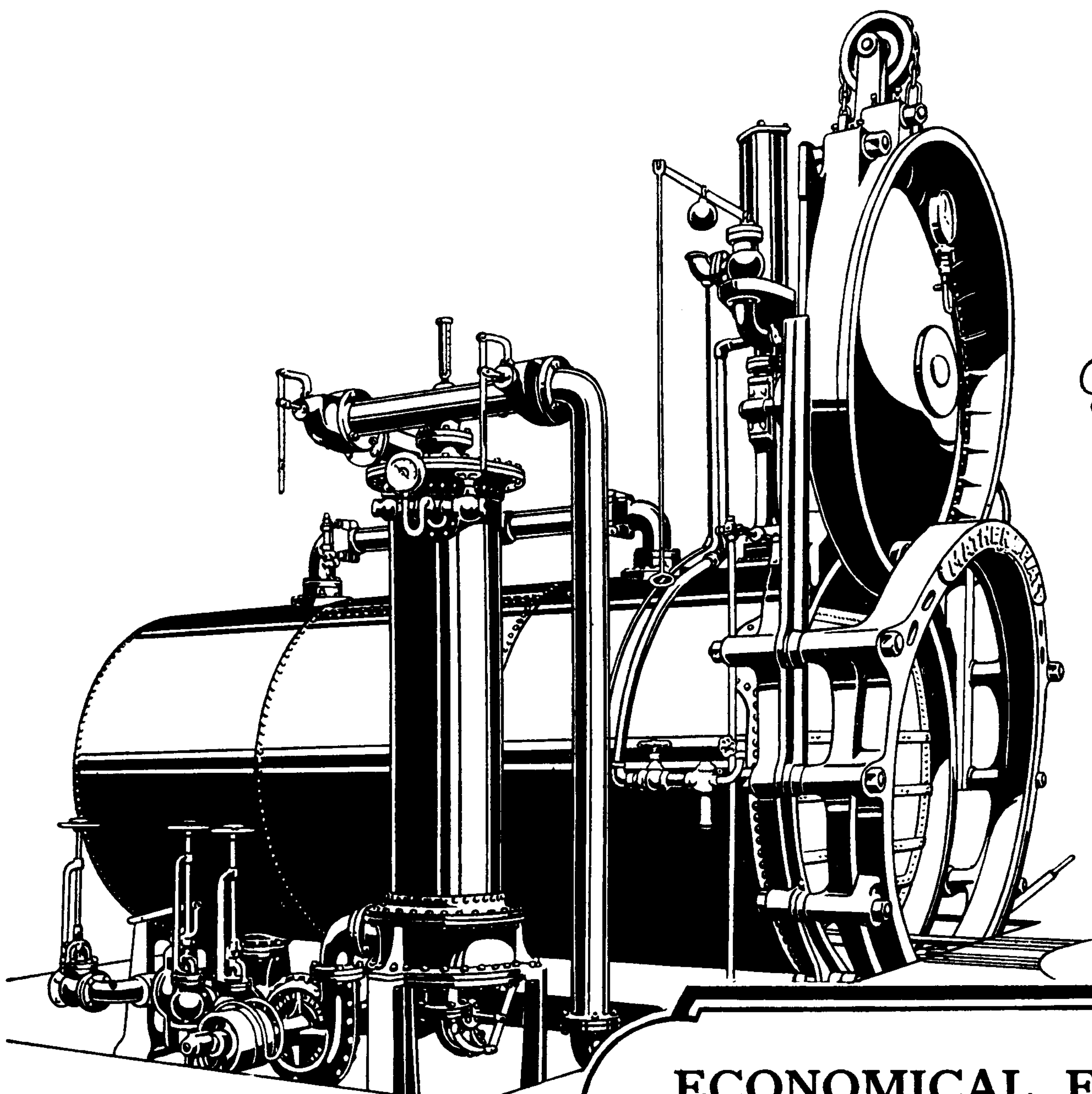
Imperial College of Tropical Agriculture: Research Programme. H. M. Leake. *Tropical Agriculture*, 1926, **3**, 86.

The report of the Imperial College of Tropical Agriculture for the Session 1924-1925 states that work on the cotton crop may be divided into several sections. Attempts are being made to evolve an Egyptian cotton with the staple of Jannovitch and suited for growth in the West Indies. There appears an opening for a plant which would have a more certain market than the Sea Island now grown. Attempts are also being made to improve the staple of the Marie Galante perennial cotton. An investigation of the effect of different water supplies on the characteristics of the lint, and genetic investigations of various characters of the cotton plant have been undertaken. The cotton stainer has received further study with special relation to variability in connection with migration. —B.C.I.R.A.

Smoke Particle: Measurement. J. S. Owens. *Analyst*, 1926, **51**, 2-18.

Methods of measuring the smoke pollution of city air are reviewed. The methods adopted by the Advisory Committee on Atmospheric Pollution are of three types—the deposit gauge, the automatic filter devised by the Committee, and the jet dust counter devised by the author. These instruments are described. —B.C.I.R.A.





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