Vol. XXI No. 2 FEBRUARY 1930

The Journal of the TEXTILE INSTITUTE

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THE TEXTILE INSTITUTE
ST. MARY'S PARSONAGE, MANCHESTER

THE TEXTILE INSTITUTE

NOTICES: INSTITUTE MEETINGS

Wednesday	5th March	*Manchester*—3 p.m. Meeting of Selection Committee, at Institute.
Tuesday	11th March	*Manchester*—3 p.m. Meeting of Publications Committee, at Institute.
Wednesday	19th March	*Manchester*—1.45 p.m. Meeting of Finance Committee, at Institute.
Wednesday	19th March	*Manchester*—3 p.m. Meeting of Council, at Institute.

Other Organisations

Bradford Textile Society—

Monday	3rd March	*Bradford*—7.30 p.m. Lecture, "A Few Reflections on the Weaving of Artificial Silk," by W. W. Marland, at Midland Hotel.
Monday	17th March	*Bradford*—7.30 p.m. Lecture, "International Co-operation in the Textile Trade," by J. H. C. Hodgson, at Midland Hotel.

Halifax Textile Society—

Wednesday	12th March	*Halifax*—7.30 p.m. Lecture, "Does Retail Distribution Cost too much, and why ?" by J. Walker Clark, C.B.E., at White Swan Hotel.
Wednesday	26th March	*Halifax*—7.30 p.m. Discussion, "Education."

Huddersfield Textile Society—

Monday	3rd March	*Huddersfield*—7.30 p.m. Lecture, "The Functions of the Conditioning House," by E. H. Townend (Bradford Conditioning House), at Technical College.
Monday	17th March	*Huddersfield*—7.30 p.m. Lecture, "The Peculiar Economics of the Textile Industry," by G. R. Carter, at Technical College.

Keighley Textile Society—

Monday	10th March	*Keighley*—7.30 p.m. Lecture, "Personal Decisions in the Textile Trade," by H. Binns, F.T.I., at Kiosk Cafe.

Batley and District Textile Society—

Thursday	27th March	*Batley*—7.30 p.m. Lecture, "Faults in Yarns and Cloths, their Detection and Prevention," by H. R. Hirst, M.Sc., F.I.C., to be followed by Annual General Meeting, at Technical College.

British Association of Managers of Textile Works—

Saturday	8th March	*Manchester*—6.30 p.m. Lecture, "The Increasing Use of Cotton Fabrics for Industrial Purposes," by F. Nasmith, F.T.I., at Athenæum.

Manchester College of Technology Textile Society—

Tuesday	11th March	*Manchester*—7.30 p.m. Lecture, "Artificial Silk Manufacture," by Jas. Innes, at College.

Leicester Textile Society—

Friday	7th March	*Leicester*—7.30 p.m. Lecture, "Making-Up," by Walter O'Brien, at Victoria Hall.

Bacup Textile Society—

Wednesday	12th March	*Bacup*—7.30 p.m. Lecture, "Ring Frames," by James Calvert, at Natural History Rooms.

Wednesday	26th March	*Bacup*—7.30 p.m. Lecture, "Waste Processes," by H. Gartside, at Natural History Rooms.

Todmorden Textile Society—

Wednesday	19th March	*Todmorden*. Lecture, "High Drafting," by F. Hill (Blackburn Technical College).

Nelson Textile Society—

Monday	24th March	*Nelson*. Lecture, "Dobbies," by J. H. Place (Richardson, Tuer & Co. Ltd.).

Wigan and District Mining and Technical College Textile Society—

Friday	21st March	*Wigan*. Lecture, "The Whittaker Loom," by J. Whittaker (Inventor), at Technical College.

Leigh Municipal College Textile Section—

Wednesday	5th March	*Leigh*. Lecture, "Rope Driving," by Mr. Leigh, B.Sc., A.M.I.Mech.E., at Municipal College.

Rochdale Cotton Spinning Mutual Improvement Society—

Tuesday	18th March	*Rochdale*—7.45 p.m. Lecture, "Dobson and Barlow's Mule," by S. H. Kay, at Barlow Street Rooms.

Littleborough Textile Society—

Monday	4th March	*Littleborough*—7.30 p.m. Lecture, "The Steam Engine," by B. Sutcliffe, at Co-operative Cafe.

Society of Chemical Industry (Manchester Section)—

Friday	7th March	*Manchester*. Lecture, "Fine Chemicals," by Dr. F. L. Pyman, F.R.S.

Oil and Colour Chemists' Association (Manchester Section)—

Friday	14th March	*Manchester*. Lecture, "Colours Used in the Rubber Industry," by G. F. Thompson, A.I.R.I.

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THE TEXTILE INSTITUTE

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THE JOURNAL OF THE TEXTILE INSTITUTE

Vol. XXI FEBRUARY 1930 No. 2

PROCEEDINGS

Lancashire Section

Meeting at the Institute, Manchester, on Friday, 6th December 1929, Mr. W. T. Boothman in the chair.

HIGH DRAFTING*

By W. A. Walsh

(Messrs. Howard & Bullough Ltd., Accrington)

INTRODUCTION

As you are aware, there are many "high draft" systems and textile machinists, like all other manufacturers, have to supply what their customers demand. Consequently, if a particular customer is persuaded by the inventor, or is the inventor himself of a system which he considers the best, it naturally follows that a licence has to be arranged to supply that particular system. In addition to supplying several such systems, most textile machinists have also to be in a position to offer to customers an arrangement which will justify the extra cost entailed and give good results, so as to bring forward repeat orders.

There are no fixed dividing lines determining where ordinary drafts finish or higher drafts commence. It is the arrangement provided for drafting rather than the amount of draft used which constitutes the features known as "high drafting." The term "high draft," like that of artificial silk, is a misnomer, and a better description is "through drafting." With the ordinary 3-roller arrangement, a much higher draft, say 15 or more, can be exerted on long cottons and fine roving, as against a draft of about half that amount on short cottons and coarse roving, but the larger draft, under the first conditions, does not necessarily imply "high drafting."

The object, then, of "high drafting" arrangements is to extend the control so as to include the maximum number of short fibres whilst allowing the longer fibres to be pulled through, and as a result of the extended control, higher drafts can be used. This is illustrated by Plate I. Herein

Fig. 1 shows the usual 3-line roller ring frame with bottom rollers 1 in., $\frac{7}{8}$ in., 1 in. diameter as used for cottons of about $1\frac{1}{8}$ in. staple. For this cotton the usual setting between the centres of front and second bottom roller is $1\frac{1}{32}$ in.

Fig. 2 shows graphically the percentage of pulled through, controlled, and floating fibres.

Similar particulars are shown on this plate in Figs. 3, 4, 5, and 6. Figs. 3 and 4 relate to 3-line roller ring frame with smaller diameter middle bottom rollers than Figs. 1 and 2, whilst Figs. 5 and 6 relate to 4-line roller ring frames.

The use of "high drafts" with the usual 3-roller system presents greater difficulties with a coarse roving and short cotton than with a fine roving and long cottons, on account of the closer settings necessary, in the attempt to extend the control to the shorter fibres. The difficulties arising with ordinary roller arrangements have led to the introduction of a great number of "high draft" arrangements, which, whilst allowing a close setting to maintain control, are designed to allow the long fibres to be pulled through.

* In the unavoidable absence of Mr. Walsh, this paper was read by Mr. Wilson.

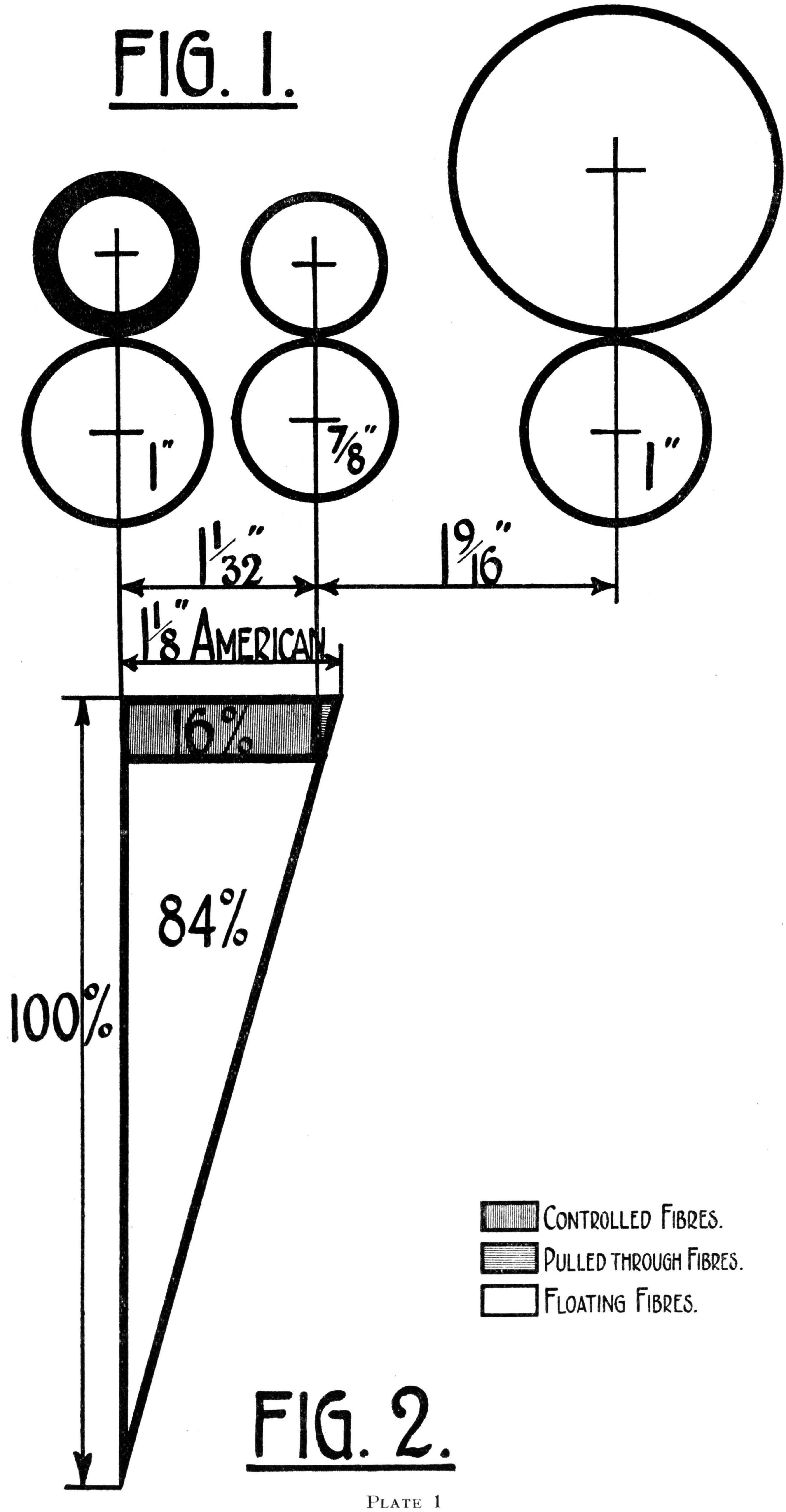


FIG. 1.
1"
7/8"
1"
1 1/32"
1 9/16"
1 1/8" AMERICAN
16%
84%
100%
CONTROLLED FIBRES.
PULLED THROUGH FIBRES.
FLOATING FIBRES.
FIG. 2.

PLATE 1

EARLY INVENTIONS

The record of inventions relating to the textile industry taken out by Englishmen, and particularly Lancashire men, is a record of which we have every reason to be proud. In this record, if a diligent enough search be made, it will usually be found that most of the modern inventions, especially those taken out on the Continent, have been anticipated.

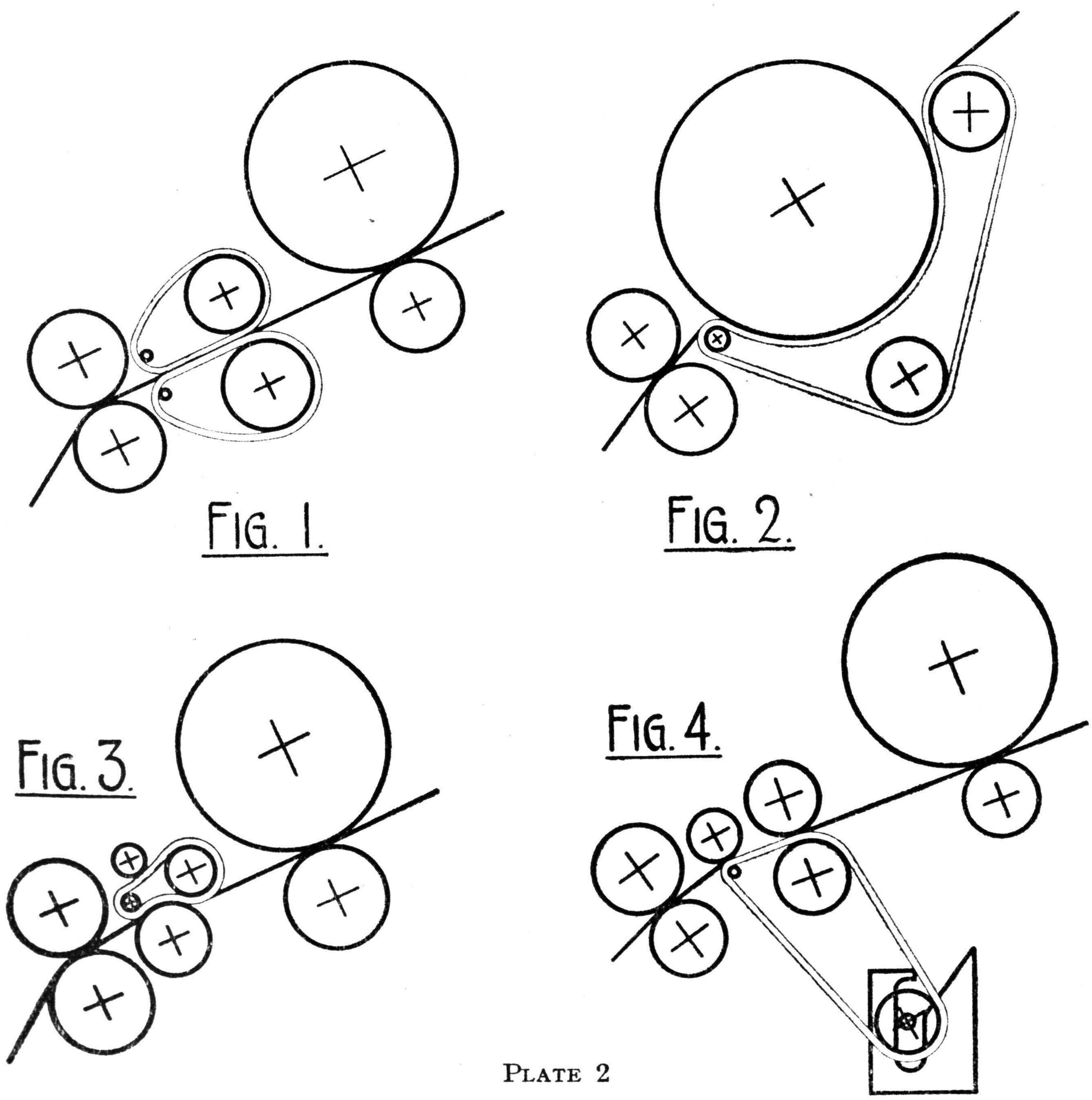


PLATE 2

There is filed in the English Patent Office a patent taken out in 1823 by Philip Chell relating to drafting arrangements which clearly defines the "pull through" idea. One passage from it reads—

> The introduction of the endless revolving straps to support and carry forward the material to be operated upon between the rollers, and which I likewise believe to be entirely new.

This invention over a hundred years ago clearly anticipates the idea but not the present arrangement of the Casablanca system.

Whilst "high draft" arrangements on a limited scale have been in use for upwards of 30 years, the advent of the Casablanca system gave the impetus to other systems, and the birth of the present vogue may be stated to be about 1912.

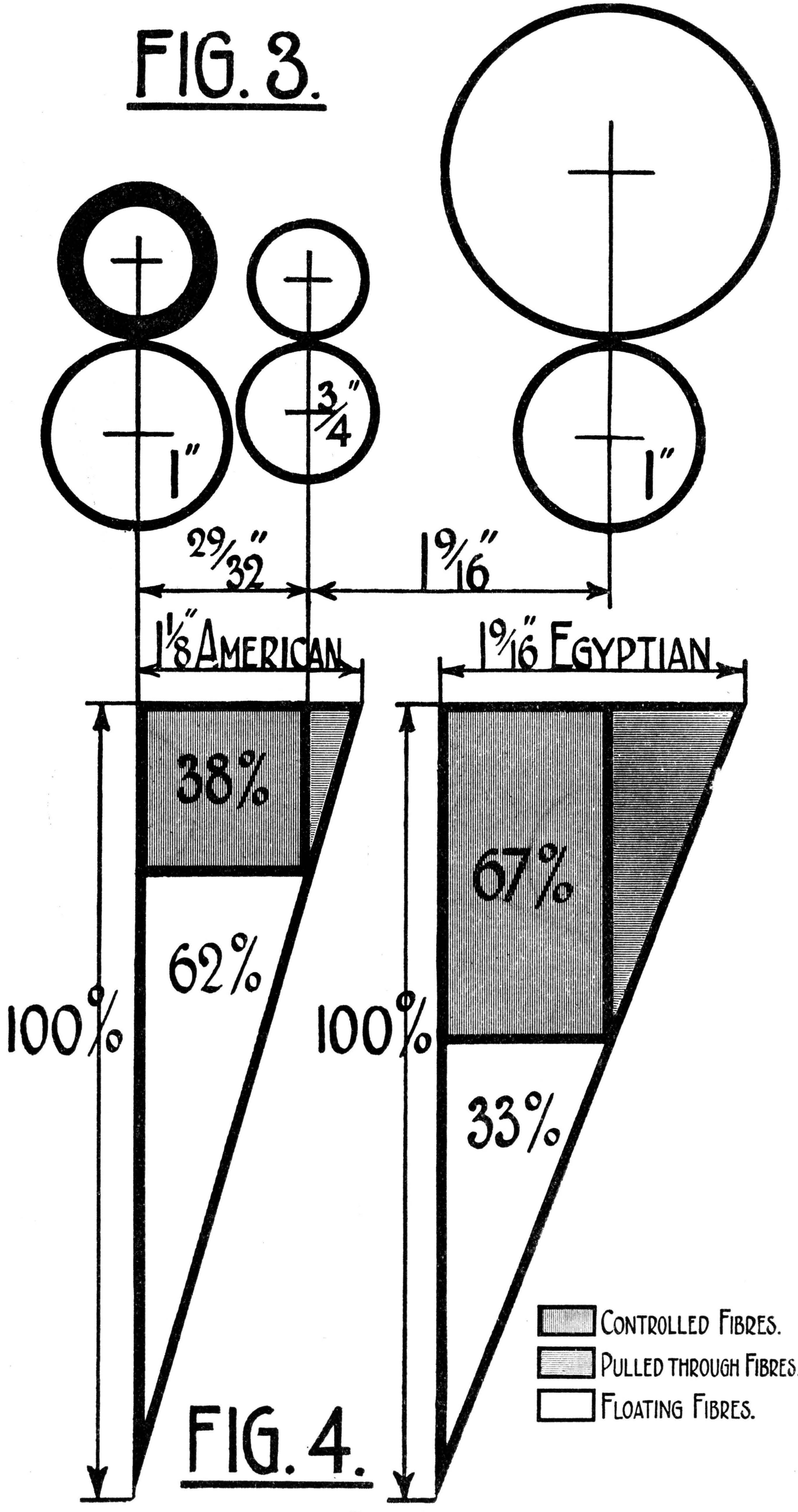


FIG. 3.
1"
3/4"
1"
29/32"
1 9/16"
1 1/8" AMERICAN
1 9/16" EGYPTIAN
38%
62%
100%
67%
33%
100%
CONTROLLED FIBRES.
PULLED THROUGH FIBRES.
FLOATING FIBRES.
FIG. 4.

PLATE 1

THE PRINCIPAL MODERN SYSTEMS

The various arrangements which are in use can be divided into three main systems—

(1) *Tape systems.*

(2) *Three-roller arrangements with various types and disposition of top rollers.*

(3) *Four-roller arrangements with various types of second top rollers, and variations to the weighting of the third top rollers.*

Three- or four-roller arrangements are classified by the number of Bottom rollers used without reference to the Top rollers. These are illustrated by Plates Nos. 2, 3, and 4.

Plate 2 shows the tape arrangements.

Plate 3 shows the 3-roller arrangements, and also a special arrangement with bottom rollers having a "bridge" between. See Fig. 7.

Plate 4 shows the 4-roller arrangements.

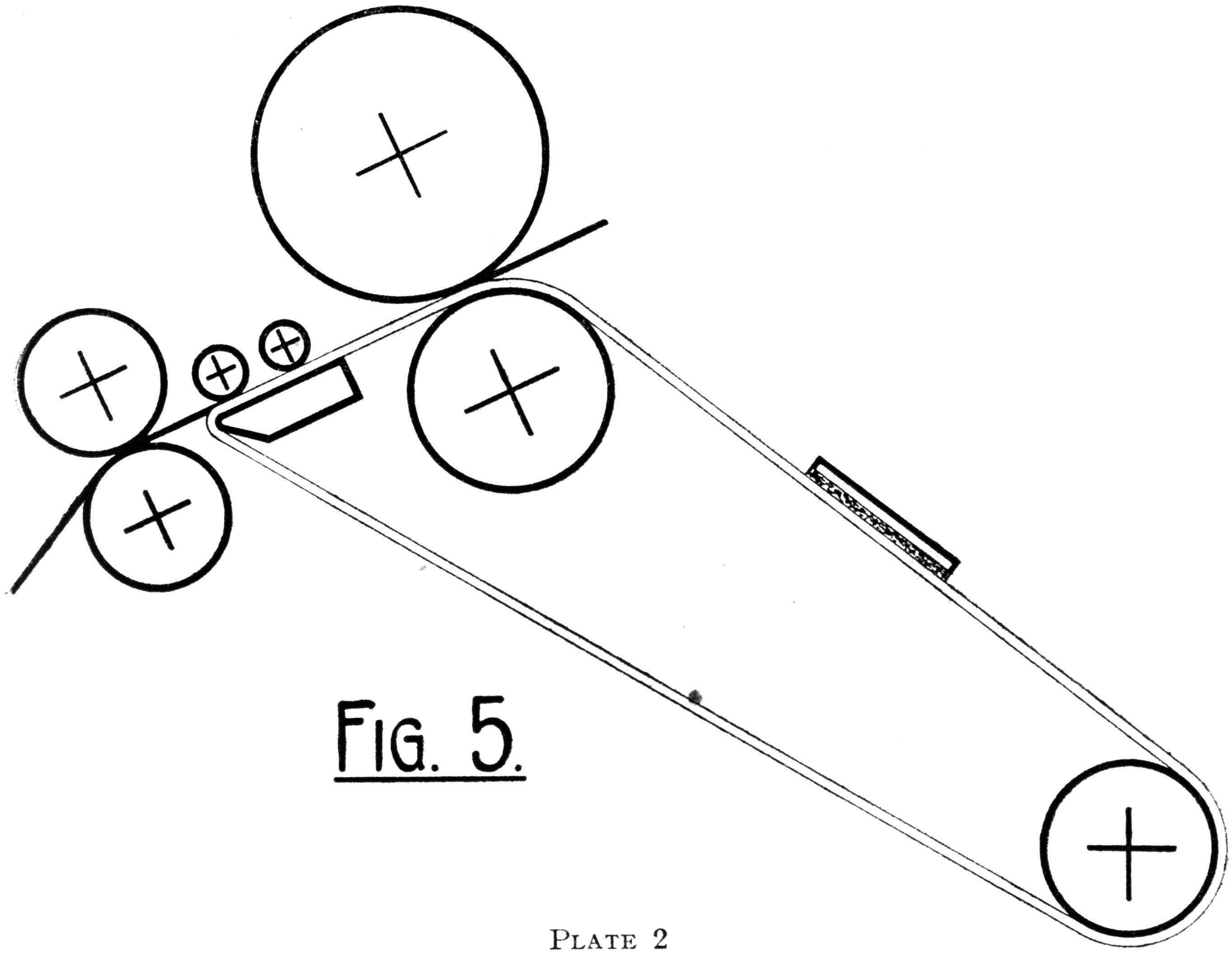


FIG. 5.

PLATE 2

You will note all these arrangements are devised to give a close setting to the front pair of rollers, and at the same time to give control in the drafting field and to allow of a pull through or continuous drafting. Theoretically, the Casablanca system attains this continuity of drafting, but in the opinion of many the tape systems have serious disadvantages. The first experiments with the Casablanca system were made on our frames, and in the year 1913 we were asked to take over the licence for this system. We did not do so, as we already had attained some measure of success with "high draft" on 3-roller ring frames, using a light second top roller of 3 oz. weight.

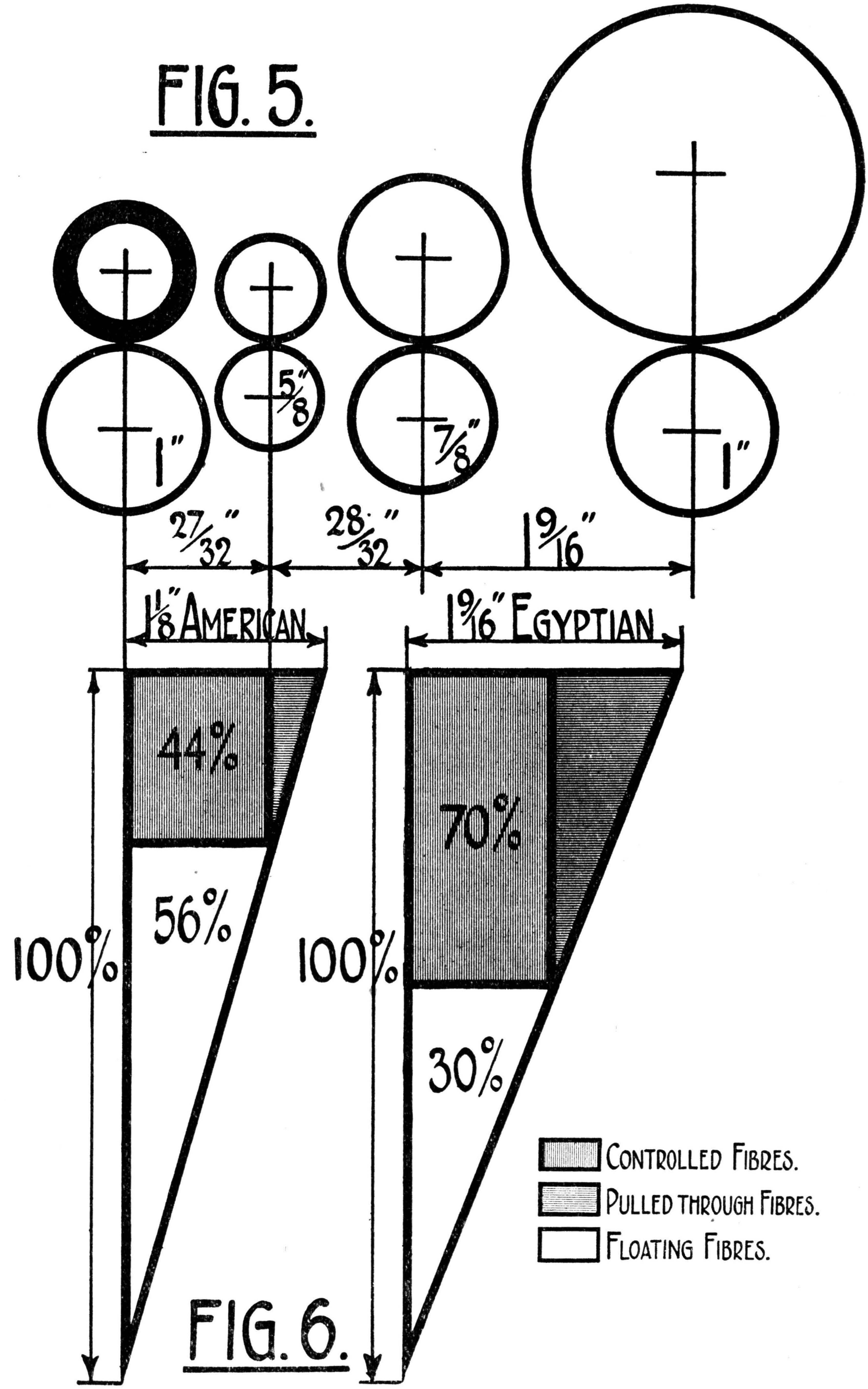


FIG. 5.
1"
5/8"
7/8"
1"
27/32"
28/32"
1 9/16"
1 1/8" AMERICAN
1 9/16" EGYPTIAN
44%
56%
100%
70%
30%
100%
CONTROLLED FIBRES.
PULLED THROUGH FIBRES.
FLOATING FIBRES.
FIG. 6.

PLATE 1

Many thousands of spindles were supplied by us as far back as the year 1911 to the particulars shown on Plate 5, Fig. 1, namely, $1\frac{5}{32}$ in., $\frac{7}{8}$ in., $1\frac{5}{32}$ in. bottom rollers; with top rollers $1\frac{1}{8}$ in. uncovered front, $\frac{3}{4}$ in. second, and 2 in. back. You will note the second bottom roller is of large diameter, as the cotton used for the counts to be spun allowed for a wide setting.

We were also making 3-roller arrangements in 1904, as shown by Plate 5, Fig. 2, having bottom rollers $\frac{3}{4}$ in., $\frac{5}{8}$ in., and $\frac{3}{4}$ in., with top rollers $\frac{9}{16}$ in. uncovered, $\frac{5}{8}$ in., and 2 in., whilst we made 4-roller arrangements in 1895 having bottom rollers $\frac{3}{4}$ in., $\frac{3}{4}$ in., $\frac{3}{4}$ in., and $\frac{31}{32}$ in., with top rollers $\frac{11}{16}$ in. uncovered, $\frac{5}{8}$ in., $\frac{5}{8}$ in., and $1\frac{3}{4}$ in., as shown by Plate 5, Fig. 3.

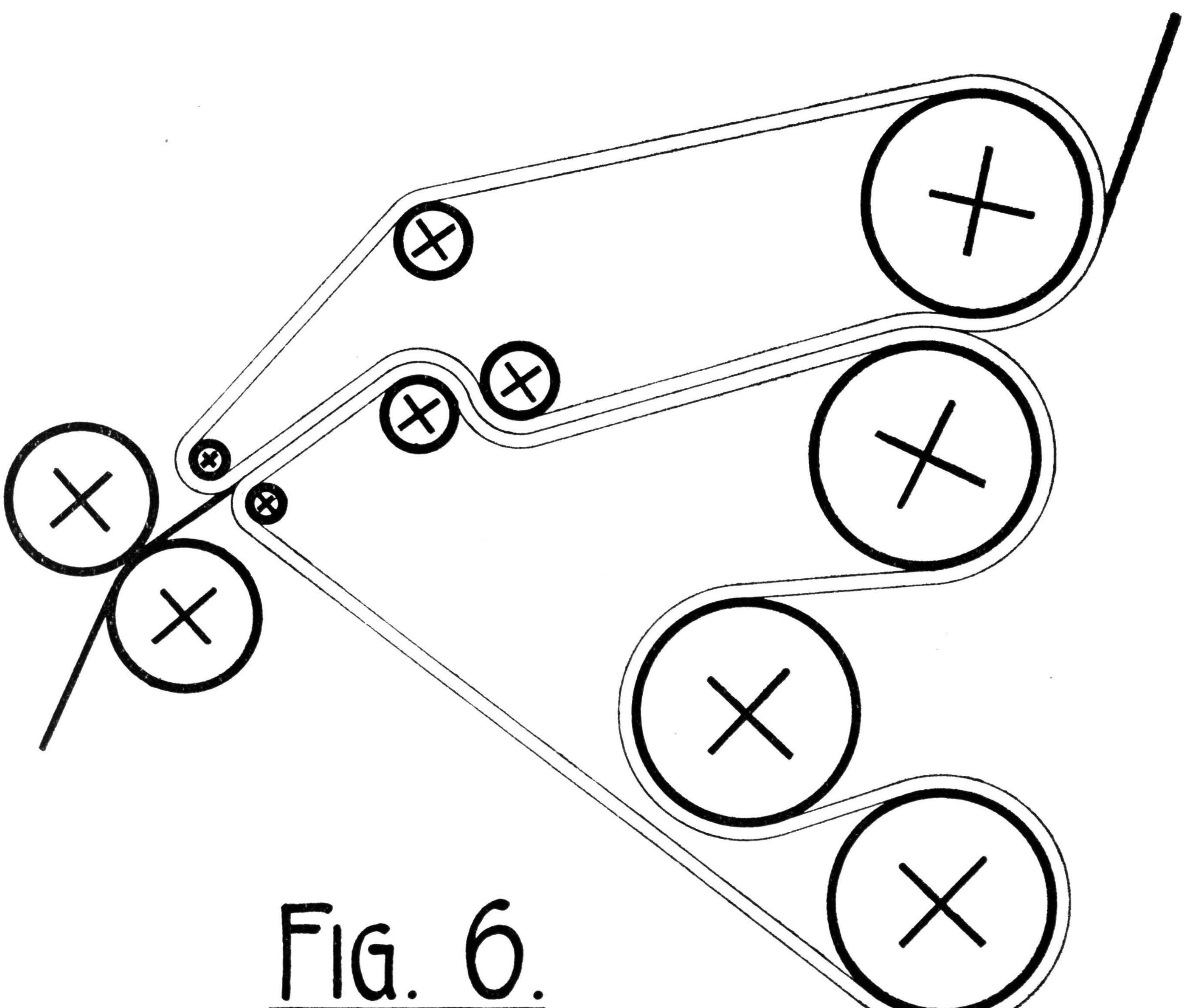


FIG. 6.

PLATE 2

Whilst the 3-roller arrangement with small diameter second bottom roller and light second top roller is the simplest "high draft" arrangement in use, it has the following defects—

(1) If the back top roller is lifted to insert a new roving, the adjacent roving will be out of control and will run through without being drafted.

(2) The drafting takes place between the front and back pairs of rollers, and no intermediate or break draft is present to break down the twist in the roving to prepare it before it passes to the drafting field.

In the 3-roller arrangements, with two top rollers on the middle bottom roller as shown by Plate 3, Figs. 2, 5, and 6, an attempt has been made to overcome the defects of the simple 3-roller arrangement. It can be taken as a desirable feature

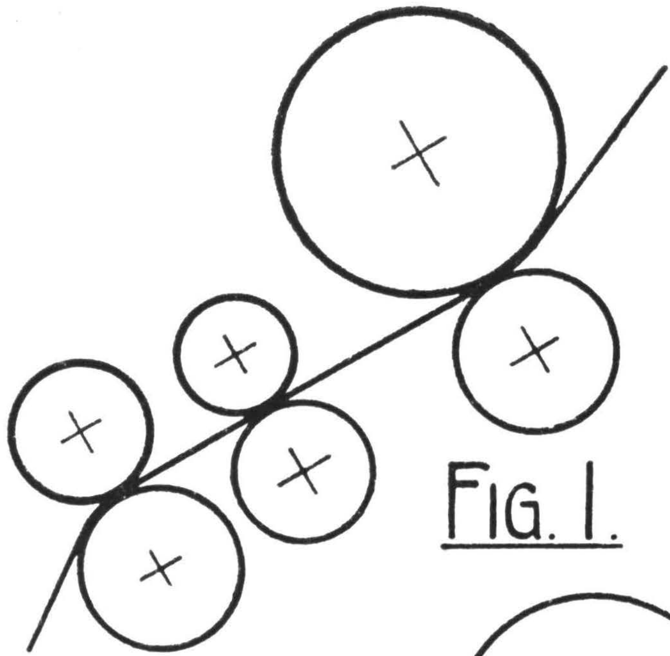


FIG. 1.

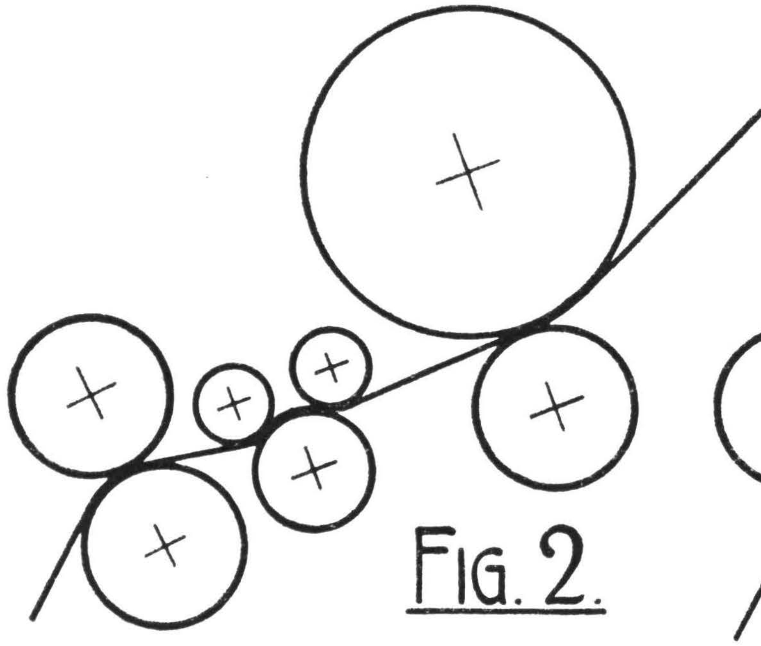


FIG. 2.

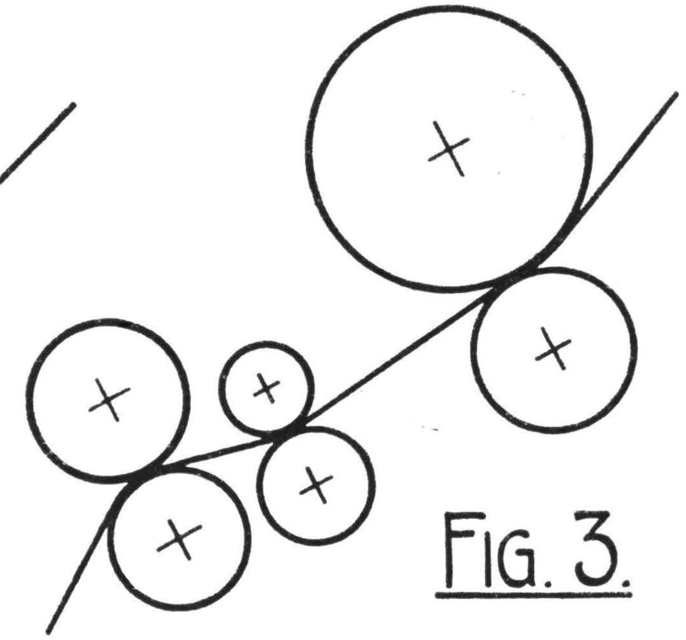


FIG. 3.

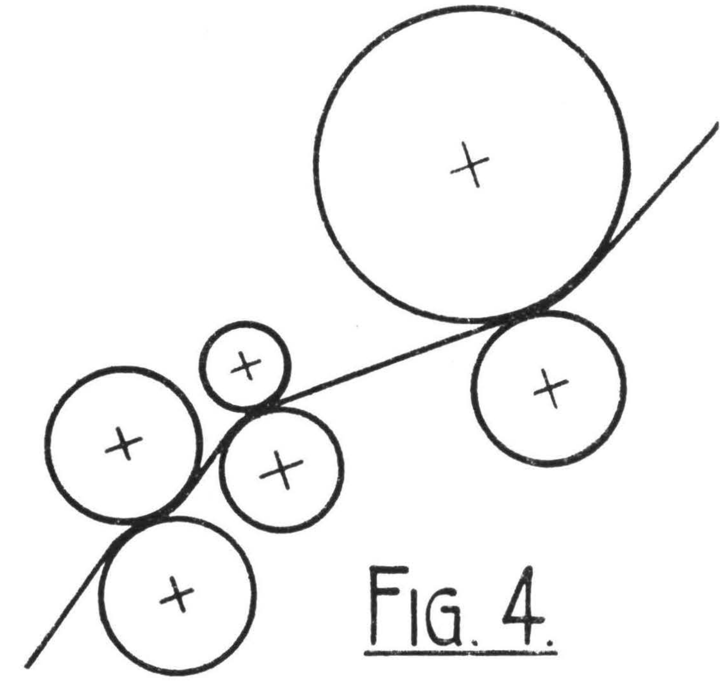


FIG. 4.

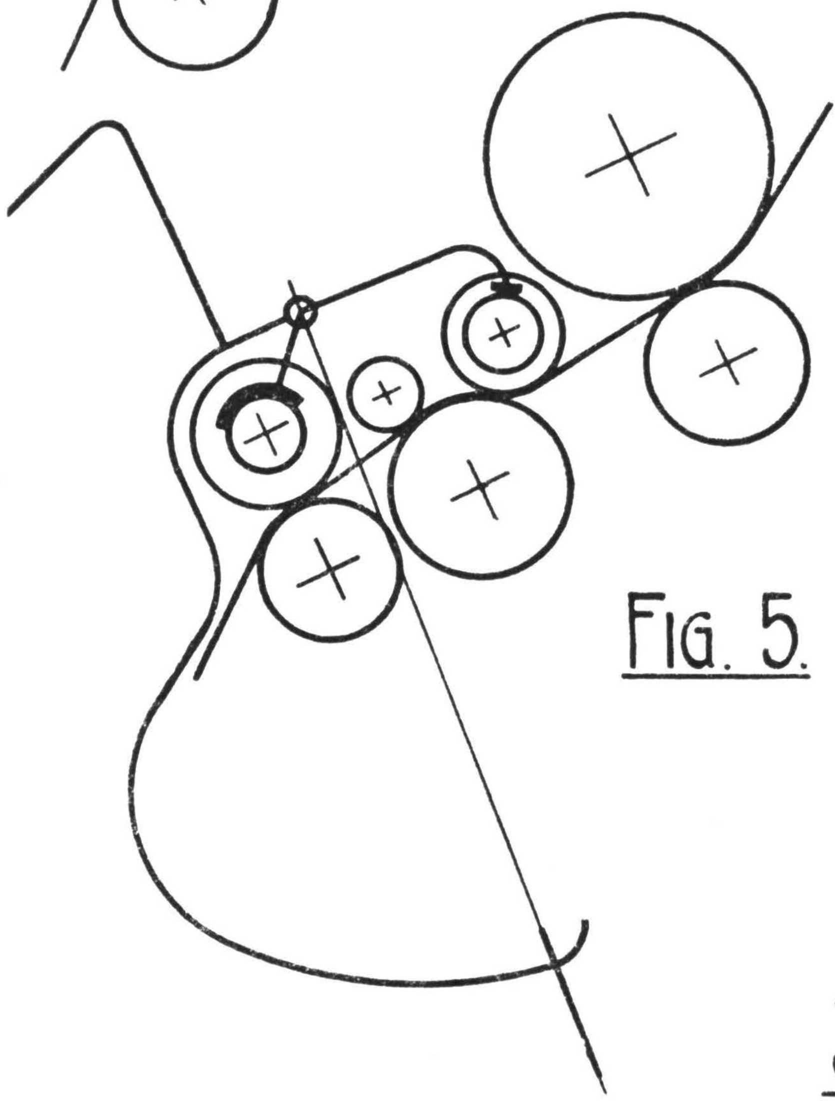


FIG. 5.

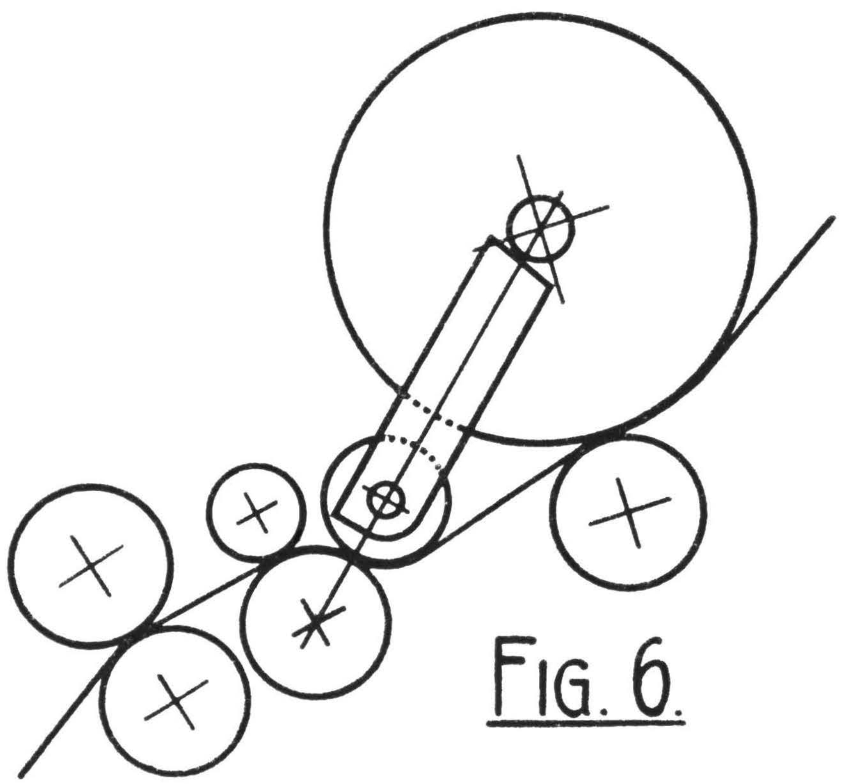


FIG. 6.

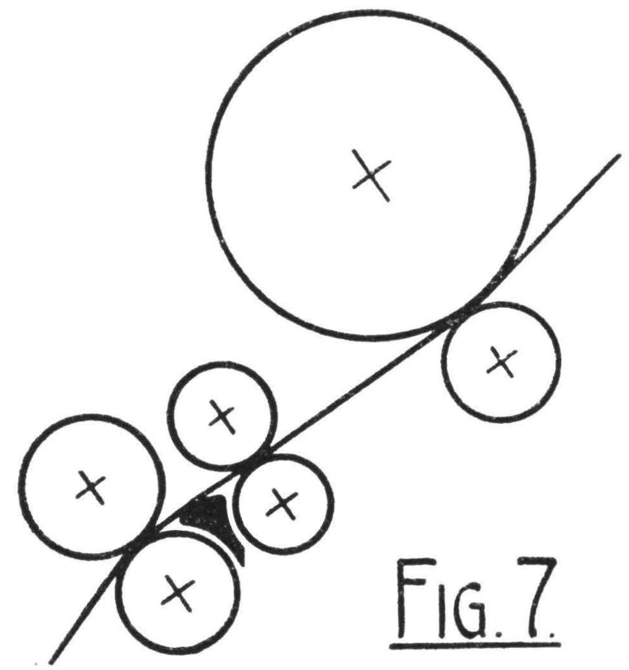


FIG. 7.

3-ROLLER ARRANGEMENTS.

PLATE 3

that the path of the roving through the rollers should be in a straight line, and the 3-roller arrangements with two top rollers on the middle bottom roller do not fulfil this condition.

In the 4-roller arrangements, the main point of difference, apart from the many types of second top rollers in use, is the method of weighting the third top roller. On Plate 4, Fig. 2, the third top roller is weighted by a saddle extended from the weight hook on the front top roller.

SUCCESSFUL HIGH DRAFTING

The primary conditions to be attained in a successful "high draft" system are—

(1) A close setting where the main drafting takes place.

(2) A control of the fibres in the roving, which allows of the minimum number of floating fibres.

Secondary attributes desirable in the use of a "high draft" system are—

(3) Fifty per cent. or more increased draft.

(4) A resulting yarn as strong and level or even stronger than the yarn from a normal draft machine.

(5) The minimum additional work added to the operatives.

(6) Production from the ring frame at least equal to that from a normal draft machine.

(7) No additional expense involved in maintaining the "high draft" roller arrangement.

(8) It naturally follows that the arrangement must be of the simplest form to give conditions (5), (6), and (7).

Much experimental work has been done by us in trying various systems, and after prolonged experience under mill conditions, I am convinced that, generally speaking, the 4-line system shown by Plate 6 will give the closest approximation to the results desired. I wish briefly to draw your attention to the following features of this system—

The break draft between third and back roller is 1·28.

The break draft between second and third roller is 1·54.

These are calculated drafts, and not fully obtainable, because the second and third top rollers are self-weighted. The third line of rollers is necessary to assist in the correct working of the second pair of rollers, and they are set beyond the point where the main drafting ceases. The third top roller must exert a pressure to grip firmly the roving, and generally speaking a self-weighted roller gives the best results, but for very coarse and hard-twisted rovings additional pressure to the weight of the roller may be an advantage.

You will note there are two traverse rods which are always applied whether single or double roving is used. This is necessary, as the distance from front roller to back traverse rod is greater with the 4-roller system than with the 3-roller system, and the additional middle traverse rod reduces the "lag" of the traverse on the front roller which would obtain without it.

The drive to the traverse motion from the back roller is speeded up to compensate for the lower speed of the back roller, due to the higher draft. The traverse motion must be in perfect condition, and the total length of traverse should be, say, $\frac{1}{8}$ in. larger than normal, owing to the greater distance of the traverse rods from the front roller.

Loose-boss front top rollers are advised with roller cloths thicker than usual to give greater cushioning on the front bottom roller. The front top roller should be made as large as possible; for a 1 in. diameter front bottom roller it should not be less than $\frac{15}{16}$ in. diameter, uncovered, or, say, $1\frac{1}{8}$ in. diameter covered. It is better to make this roller $\frac{1}{16}$ in. too big than $\frac{1}{16}$ in. too little. If it is too small, trouble is experienced with roller laps.

The roving should have the minimum amount of twist, which necessitates more attention being given to the various parts of the creel.

There are two under clearers and two top clearers.

The diameter of rollers for cottons of different staple lengths with the settings usually adopted are shown in Table I.

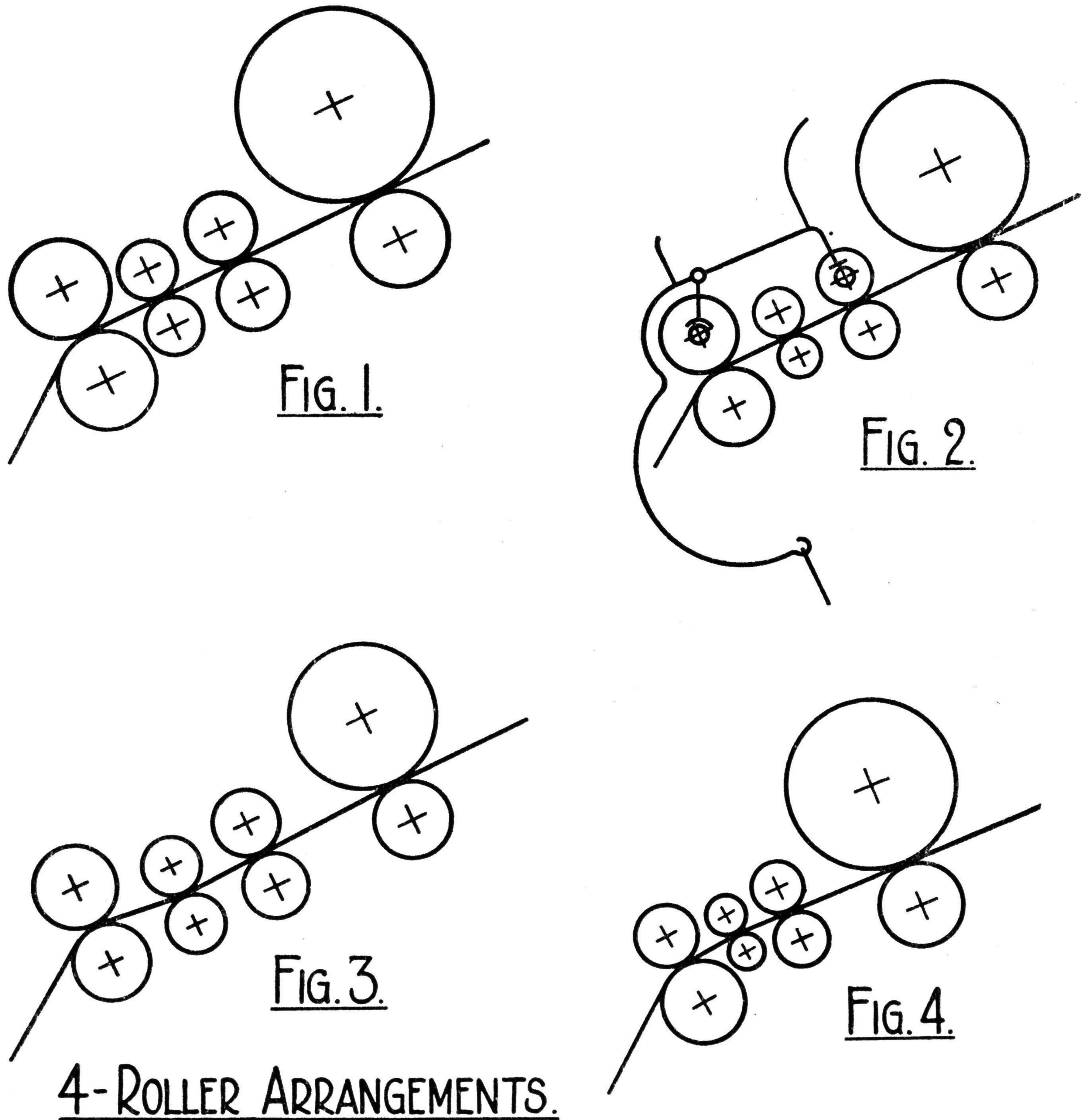


PLATE 4

Table I

(*a*) Rollers and Settings for Indian and American Cotton up to $1\frac{1}{16}$ in. Staple.

	Bottom Rollers	Top Rollers	Settings
1st ...	$\frac{3}{4}$ in. or $\frac{7}{8}$ in. ...	$\frac{11}{16}$ in. or $\frac{13}{16}$ in. uncovered ...	$\frac{25}{32}$ in. adjustable
2nd ...	$\frac{5}{8}$ in. ...	$\frac{5}{8}$ in. (variable) ...	$\frac{26}{32}$ in. adjustable
3rd ...	$\frac{3}{4}$ in. ...	$\frac{7}{8}$ in. ...	$1\frac{9}{16}$ in. fixed
4th ...	$\frac{7}{8}$ in. ...	2 in. ...	

(*b*) Rollers and Settings for American and Egyptian Cotton for Staple $1\frac{1}{16}$ in. and Upwards.

	Bottom Rollers	Top Rollers	Settings
1st ...	$\frac{7}{8}$ in. or 1 in. ...	$\frac{13}{16}$ in. or $\frac{15}{16}$ in. uncovered ...	$\frac{27}{32}$ in. adjustable
2nd ...	$\frac{5}{8}$ in. ...	$\frac{5}{8}$ in. (variable) ...	$\frac{28}{32}$ in. adjustable
3rd ...	$\frac{7}{8}$ in. ...	1 in. ...	$1\frac{9}{16}$ in. fixed
4th ...	1 in. ...	2 in. ...	

The combination of a close setting between the first and second pairs of rollers and a light second top roller is applicable to the spinning of both coarse and fine counts, but for the coarser counts a stronger yarn will be obtained with a second top roller heavier than that suitable for the fine counts. The limitation of weight of the second top roller in combination with close setting is that at which "crackers" will be found. No rule can be stated which is applicable to all conditions, but for coarse and medium counts a highly polished solid cast-iron roller with round-ended tapered nipples is generally used, and for counts of 36's and upwards, a light second top roller made from a steel tube with cast-iron ends and tapered nipples is used. The second top roller pivots are tapered with the end slightly rounded to ensure free rotation.

Defects of 4-Roller System

There is more fly deposited on the weight hooks and roller beam than with the normal draft machines, and this, in conjunction with the extra line of top rollers and bottom rollers, and extra top and bottom clearers, means a little more work for the operatives.

In England, operatives have been paid, in some cases, a little extra, varying from 1½d. to 3d. per 100 spindles per week.

Unless care is exercised in making the piecings in the roving, there is a tendency to produce more "slubs" on the 4-roller system than on the 3-roller system. This latter defect may be overcome to a considerable extent if the spinners will twist in the rear end after putting in a new roving bobbin, otherwise the tail end is not drafted.

For yarn to be as free from "slubs" as possible, the best way to run in the end from a new roving bobbin is to present it to the back rollers, and just after it passes between these, to break off the old roving just behind the back traverse rod. The short length of double roving, assuming we are considering single roving in the creel, will then be ejected from the front roller, the end will break down, and will have to be pieced up at the front.

Advantages of the 4-Roller System

The cotton used and the yarn to be produced from same are factors which prohibit one from saying the 4-roller system is beneficial in all cases. Generally speaking, however, especially for medium and higher counts, it can be said that the 4-roller system will allow for 50% higher drafts to be used, and the resulting yarn to be as good as regards strength and regularity as the yarn produced on the ordinary 3-roller system with the lower drafts using the same cotton in both cases.

Alternatively, by using a "high draft" arrangement at the ring frames, and using the normal drafts, it is possible to spin a cheaper cotton than with the ordinary draft arrangement, and to produce as good a yarn. By this method, for some counts a bigger saving may be effected in the raw material than would be effected in wages by increasing the draft at the ring frames.

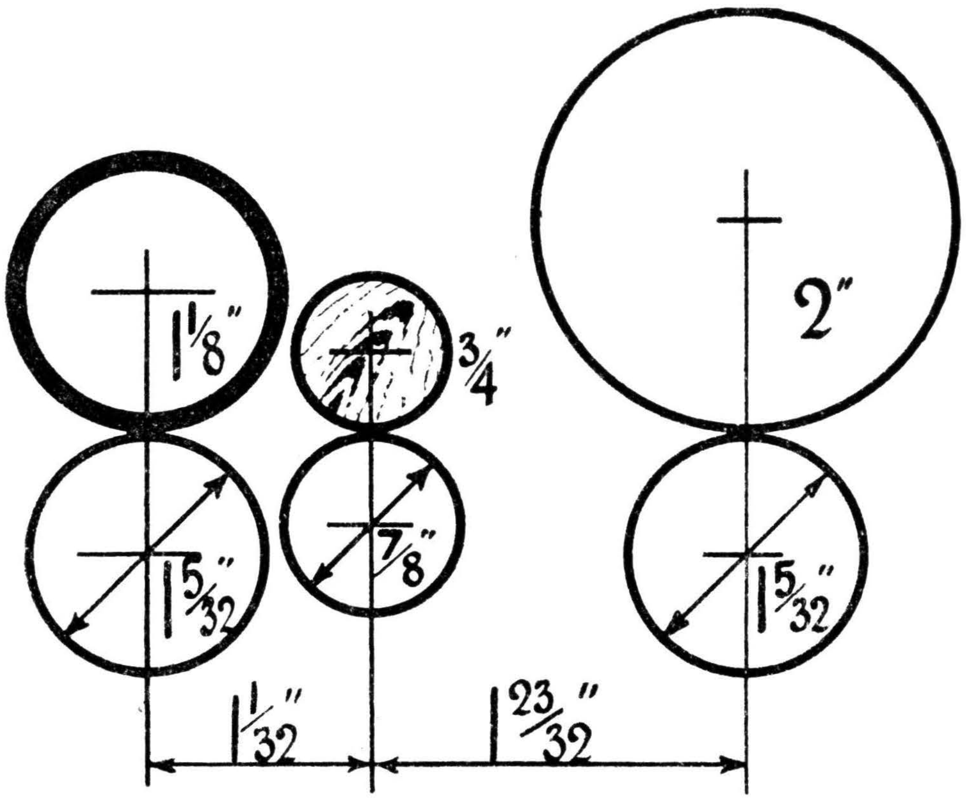
I will now give some of the results which are being obtained with the 4-roller system.

My first example is that of a mill with the usual 3-roller ring frames spinning 23's from 4·6 hank roving, using double roving at the ring frames, which had therefore a draft of 10, and three passages of speed frames were in use.

The installation on 4·6 hank roving had 41,160 spindles, which produced 69,580 lb. of yarn per week.

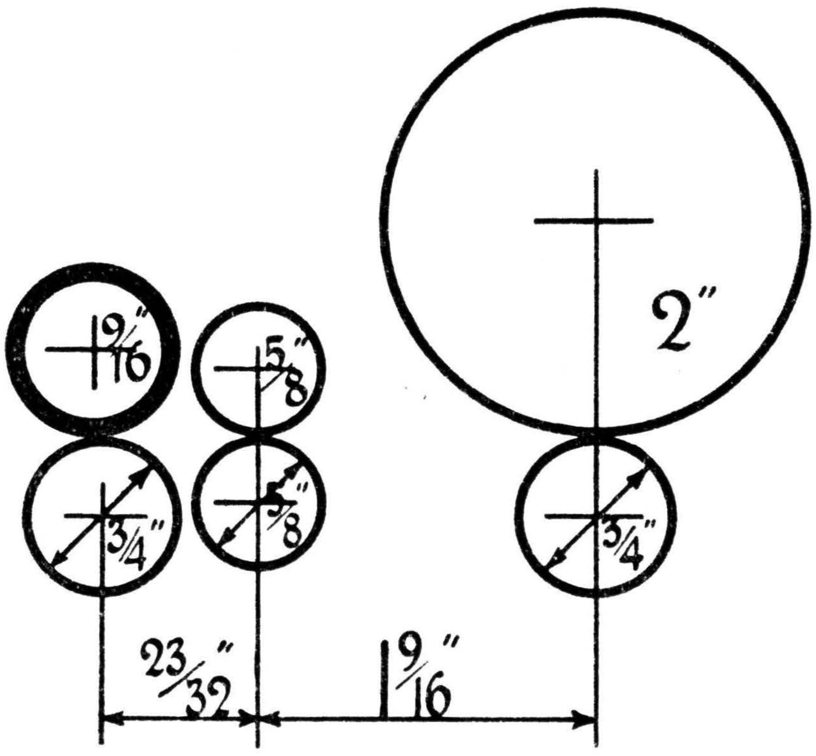
The wage bill to produce the roving, including the men unloading cotton to the finished roving, but omitting the carder and undercarder, was £225 4s. 10d. This gives ·777d. per lb. of roving produced.

The wage bill in the spinning-room, omitting the spinning master and assistant spinning master, was £174 5s. 4d. This gives ·6011d. per lb. of yarn produced.



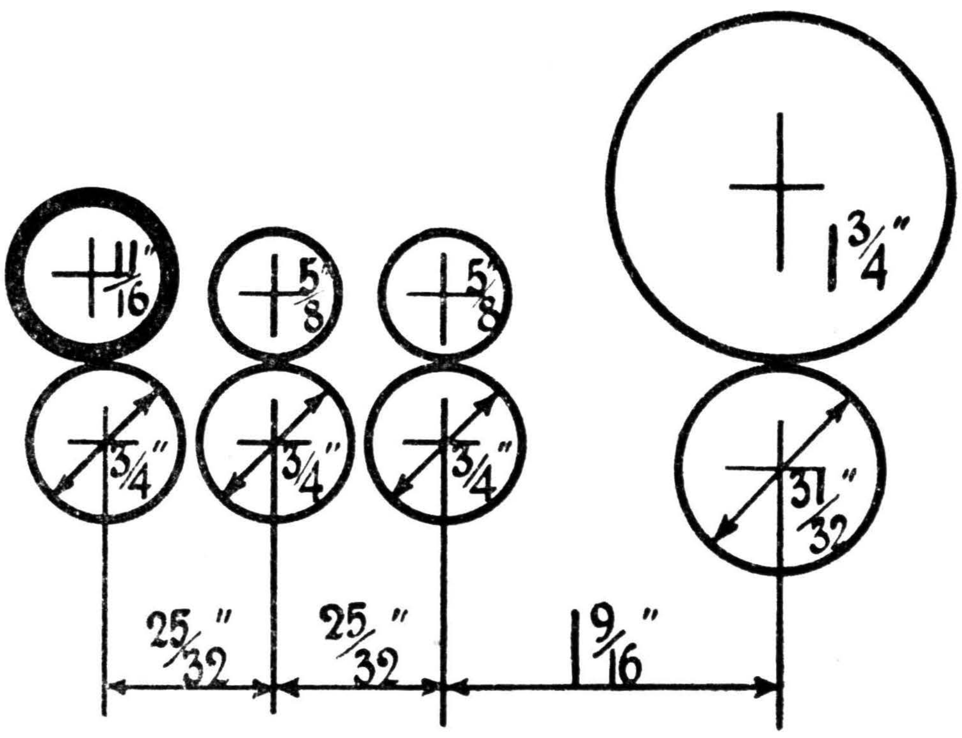
MIDDLE TOP ROLLER.
WOOD.
WEIGHT 2·99 OUNCES.

FIG 1.



MIDDLE TOP ROLLER.
CAST IRON.
WEIGHT 6·07 OUNCES.

FIG. 2.



SECOND TOP ROLLER.
CAST IRON.
WEIGHT 5·54 OUNCES.

FIG. 3.

The total wage cost was therefore 1·3781d. per lb. of yarn produced.

Trials were made with the 4-roller system, and it was proved that higher drafts could be used at the ring frames without impairing the strength and regularity of the yarn. It was decided in the first instance to reduce the hank roving from 4·6 to 3·4, which increased the draft at the ring frames from 10 to 13·53. Three passages of speed frames were retained.

H. & B's Standard Arrangement of 4-Roller High Drafting.

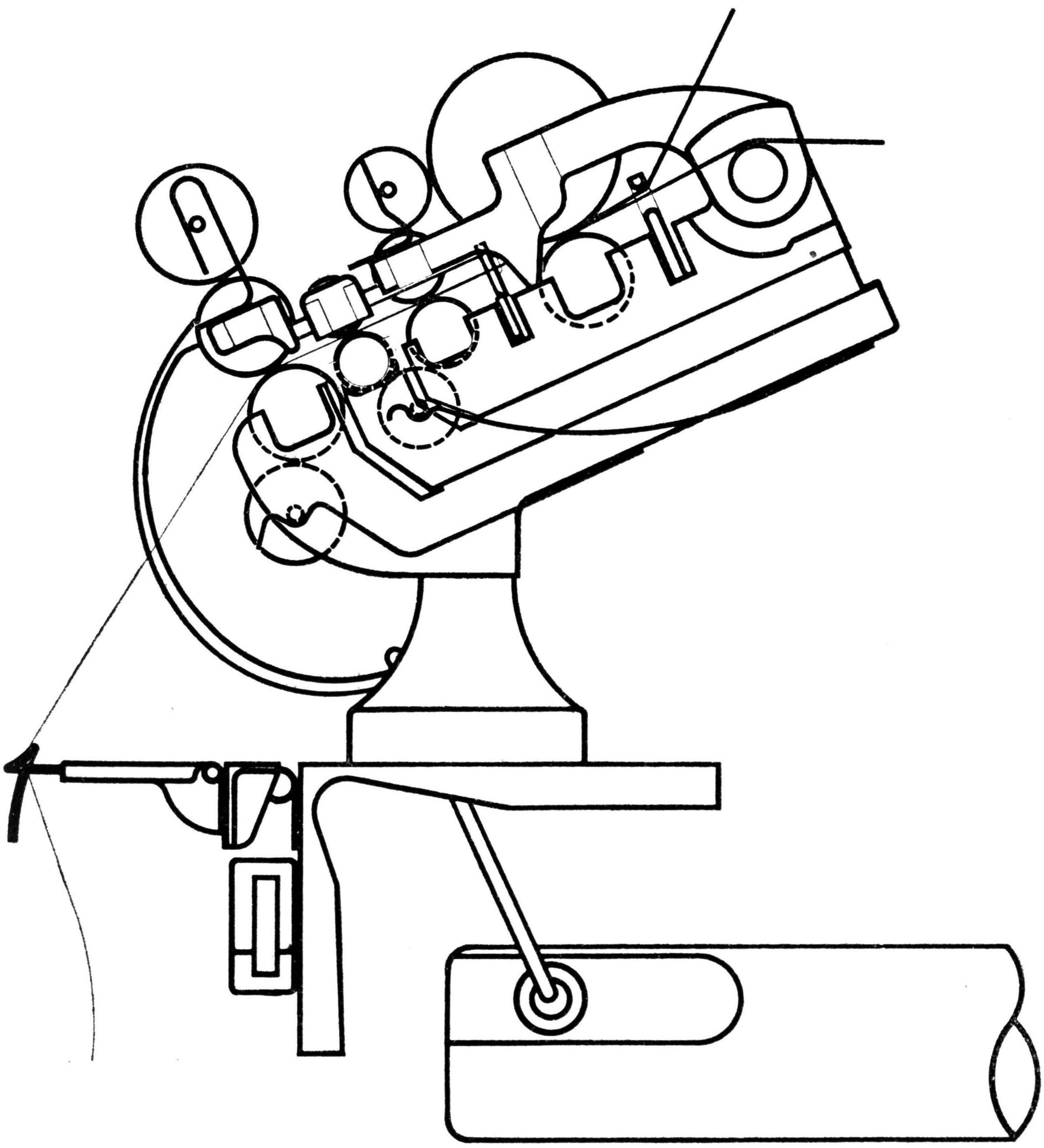


Plate 6

Owing to the arrangement of the machinery, the space available, and other reasons, more cardroom machinery was used than was necessary to make the coarser hank roving. For example, the spindle speed of the roving frames was reduced from 1050 to 850 on installing the "high draft" system, as it was considered that two frames on 3·4 hank could not be satisfactorily followed with a spindle speed of 1050 r.p.m., and since the frames were available, there was no point in retaining the higher speed.

Ten thousand and eighty more ring spindles were added, and it was then decided to increase the number of preparations from 10 to 12. This involved the addition of 14 cards, two sets of drawing and two slubbing frames. The number of intermediate frames was kept the same, and the number of roving frames reduced from 56 to 40.

As will be seen later, the first installation only partially utilised the economies which could be made, but even so, the wage bill to produce the roving is practically the same, viz., £226 8s. 7d. for "high draft" against £225 4s. 10d. for ordinary draft.

The 10,080 extra ring spindles increased the weight of yarn produced from 69,580 lb. to 86,620 lb. per week. This gives ·6273d. per lb. of roving produced.

The wage bill in the spinning-room is £221 4s. 8d., which on the production of 86,620 lb. of yarn, gives ·6129d. per lb. of yarn produced. It will be noted that this is slightly higher than with the ordinary draft. This is accounted for by the extra wages to be paid to the spinners on the "high draft" system. The total wage cost is therefore 1·2402d. per lb. of yarn produced, as against 1·3781d. per lb.

Further trials were made with increased draft on the 4-roller ring frames, and after exhaustive tests it was proved beyond question that yarn could be spun from a coarser hank roving and omitting the intermediate frames, which was equal in strength and regularity to the yarn spun on the ordinary 3-roller frames.

An installation of 43,680 spindles, producing 73,840 lb. of yarn per week was installed, omitting intermediate frames, and a 2·76 hank roving with 16·66 of a draft in the ring frame was adopted.

With this latest addition, the wage bill to produce the roving, including the men unloading cotton to the finished roving, but omitting carder and under-carder, is £168 8s. 4d. This gives ·541d. per lb. of roving produced.

The wage bill in the spinning-room, omitting spinning master and assistant spinning master, is £181 6s. 8d. This gives ·584d. per lb. of yarn produced.

The total wage cost is therefore 1·125d. per lb. of yarn produced.

When this installation had been working for some time, it was found that the yarn was slightly stronger than from the ordinary 3-roller system or the 4-roller system, using three passages of speed frames. The conclusion was that this was due to the increased humidity obtained in the latest installation.

The results are summarised in Table II.

Table II

	Ordinary 3-Roller System	Drafts	4-Roller High Drafting System — 1st Installation	Drafts	4-Roller High Drafting System — 2nd Installation	Drafts
Hank Draw.	·155		·17		·166	
Hank Slubb.	·64	4·13	·72	4·23	·86	5·18
Hank Inter.	1·50	4·17	1·56	4·33		
Hank Roving	4·60	6·13	3·40	4·36	2·76	6·42
Ring counts spun, 23's … …		10·00		13·53		16·66
	(Double at Inter. Roving and Ring Frames)		Double at Inter. Roving and Ring Frames.		(Double at Roving and Ring Frames)	
	Wage cost per lb. of yarn up to roving, ·777d.		Wage cost per lb. of yarn up to roving, ·6273d.		Wage cost per lb. of yarn up to roving, ·541d.	
	Ditto for spinning, ·6011d.		Ditto for spinning, ·6129d.		Ditto for spinning, ·584d.	
	Total wage costs in blowroom, cardroom and spinning-room 1·3781		Total wage costs in blowroom, cardroom and spinning-room 1·2402d.		Total wage costs in blowroom, cardroom and spinning-room 1·125d.	

It will be seen that the difference in wage costs from men unloading cotton to yarn on bobbins, between ordinary 3-roller system and second installation 4-roller high draft system, is 1·3781 less 1·125 = ·2531d. per lb. of yarn. In the second installation on the "high draft" system, there were exactly 50% fewer speed frames than in the ordinary 3-roller system. This resulted in a reduction in—

(1) *Productive expenses.*

(2) *Establishment expenses.*

(3) *Financial expenses.*

With regard to productive expenses, the largest saving was due to the reduction in power, this being approximately ·04d. per lb. of yarn. Other items under productive expenses, such as oil, leather, ropes, bands, brushes, repairs, etc., are ignored.

The second installation on "high draft" cost approximately £8,000 less in machinery, and the floor space occupied was considerably reduced when compared with an installation on ordinary 3-roller drafting.

The Establishment expenses, such as taxes, rates, rents, and insurance, and the Financial expenses, such as interest and depreciation, I do not propose to elaborate, but the saving on these, along with the saving in production expenses and the reduction in wage costs of ·2531d. per lb. of yarn, have resulted in a total saving of approximately ·5d. per lb. of yarn produced, which on a basis of a production of 73,840 lb. of yarn per week, means a saving of approximately £150 per week.

The foregoing data have generously been given to us by one of our customers for the purpose of this paper; it is a case, however, where low counts are being spun from much better cottons than are usually used for such counts, but the data are comparative, and will therefore, I trust, be of interest.

The next example embodies data obtained from one of our customers in India. In this case the counts spun are 20's, from Indian cotton of staple length —·9 in. On the ordinary 3-roller ring frames, a 2-hank single roving requiring a draft of 10 was used.

Our 4-roller high draft arrangement was installed, and 1·3 hank intermediate requiring a draft of 15·4 was used.

The yarn spun on the 4-roller arrangement is 5 to 6 lb. per lea stronger than that spun on the ordinary 3-roller system.

Over 10,000 additional ring spindles were added without any increase to the number of speed frames, the additional cards being available.

The actual spindle speed is 10,000 r.p.m.

The turns per inch, 17·2.

Diameter of ring, 1⅝ in.

Production 8¼ ozs. per spindle in 10 hours.

This case is not typical of the results usually obtained on 20's in Lancashire. The yarns spun in India, either on ordinary 3-roller or 4-roller high -draft ring frames, would not usually be considered satisfactory in Lancashire. No definite statement can be made which is true for all cases on these counts, as so much depends on the cotton used, and in many cases it is better to only slightly reduce the normal hank roving and retain three passages of speed frames, and to use the "high draft" 4-roller arrangement at the ring frames with a draft only slightly increased. By the adoption of this method, a cheaper cotton can be used to give a yarn equal in strength and regularity to that spun on the ordinary 3-roller ring frames.

Further examples from our Continental customers using our 4-roller "high draft" arrangement may be of interest.

Table III

Hank Intermediate or Roving	Counts	Drafts	Remarks
(1) 1·75 Intermediate (single)	21	11·4	Yarn is as strong as formerly obtained from 3-hank roving. Second top roller, cast-iron. Weight 2,250 grains.
(2) 4·6 Roving (double)	38's and 42's	16·5 to 18·2	Cotton used (American). Second top roller, steel tube. Weight 1,500 grains.
(3) 4·0 to 5·0 Roving (double)	40's and 50's	20's	Second top roller, steel tube. Weight 1,020 grains.
(4) 5·5 to 6·0 Roving (double)	45's to 60's	16·3 to 20	Second top roller, steel tube. Weight 1,000 grains.

In conclusion, four summaries of machinery, Tables IV, V, VI, and VII, are presented to show the difference between the machinery required for new 40,000 ring spindle mills on 36's and on 70's spun on ordinary 3-roller ring frames and on 4-roller "high draft" ring frames. Whilst many variations to these summaries can be made, they are representative of many installations on these counts.

Machinery on Table V would cost approximately £2,000 less than the machinery in Table IV, and the reduction in cardroom wages would be approximately £19 per week. Machinery in Table VII would cost approximately £3,000 less than the machinery in Table VI, and the reduction in cardroom wages would be approximately £25 per week.

Table IV

36's Ordinary Draft.	Lb.	Draft
1 No. 7 hopper bale opener, 38 in. wide, delivering to mixings 2 No. 9 hopper feeders, 38 in. wide 2 Openers with 24 in. diameter porcupine cylinders, 38 in. wide 2 Single Crighton openers 2 Cage exhausters to suit No. 9 hopper feeders 2 No. 9 hopper feeders, 38 in. wide 2 Single Buckley opener combined with scutcher and lap machine, 38 in. wide 3 Single beater finisher scutchers, 38 in. wide	= 38,483	
60 Revolving flat cards, 37 in. on the wire, 50 in. cylinders, 26 in. doffers at 609·3 lb. each of ·14 hank	= 36,560	
15 Drawing frames with 2 heads of 4 deliveries each = 40 finishing deliveries at 905 lb. each of ·14 hank	= 36,200	—
5 Slubbing frames of 100 spindles each = 500 spindles at 71·7 lb. per spindle of ·625 hank	= 35,850	4·8
10 Intermediate frames of 142 spindles each = 1,420 spindles at 25·0 lb. per spindle of 1·55 hank	= 35,500	5·1
28 Roving frames of 180 spindles each = 5,040 spindles at 6·97 lb. per spindle of 5·0 hank	= 35,148	5·71
100 Ring frames of 400 spindles each = 40,000 spindles at ·87 lb. per spindle of 36's double roving	= 34,800	14·4

Table V

36's High Draft.	Lb.	Draft
1 No. 7 hopper bale opener, 38 in. wide, delivering to mixings 2 No. 9 hopper feeders, 38 in. wide 2 Openers with 24 in. diameter porcupine cylinders, 38 in. wide 2 Single Crighton openers 2 Cage exhausters to suit No. 9 hopper feeders 2 No. 9 hopper feeders, 38 in. wide 2 Single Buckley openers, combined with scutcher and lap machines, 38 in. wide 3 Single beater finisher scutchers, 38 in. wide	= 38,050	—
60 Revolving flat cards, 37 in. on the wire, 50 in. cylinder, 26 in. doffers at 602·3 lb. each of ·11 hank	= 36,140	
12 Drawing frames with 2 heads of 4 deliveries each = 32 finishing deliveries at 1,121·2 lb. each of ·11 hank	= 35,880	
4 Slubbing frames of 86 spindles each = 344 spindles at 103·5 lb. per spindle of ·50 hank	= 35,622	4·5
6 Intermediate frames of 142 spindles each = 852 spindles at 41·5 lb. per spindle of 1·25 hank	= 35,382	5·0
16 Roving frames of 180 spindles each = 2,880 spindles at 12·21 lb. per spindle of 3·5 hank	= 35,164	5·6
100 Ring frames of 400 spindles each = 40,000 spindles at ·87 lb. per spindle of 36's double roving	= 34,800	20·57

Table VI

70's Ordinary Draft.

			Lb.	Draft
1	No. 7 hopper bale opener, 38 in. wide, delivering to mixings 1 No. 9 hopper feeder, 38 in. wide 1 Single Buckley combined with scutcher and lap machine 2 Single beater finisher scutchers	=	17,630	
40	Revolving flat cards, 37 in. on the wire, 50 in. cylinders, 26 in. doffers at 418·7 lb. each of ·17 hank	=	16,750	
4	Sliver lap machines at 4,162·5 lb. each	=	16,650	
4	Ribbon lap machines at 4,125 lb. each	=	16,500	
24	Combers at 590 lb. each (15% waste)	=	14,150	
12	Drawing frames with 2 heads of 4 deliveries each = 32 finishing deliveries at 437·5 lb. each of ·20 hank	=	14,000	
4	Slubbing frames of 96 spindles each = 384 spindles at 36·0 lb. per spindle of 1·1 hank	=	13,840	5·5
8	Intermediate frames of 142 spindles each = 1,136 spindles at 12·0 lb. per spindle of 3·3 hank	=	13,710	6·0
32	Roving frames of 180 spindles each = 5,760 spindles at 2·35 lb. per spindle of 11·0 hank	=	13,575	6·6
100	Ring frames of 400 spindles each = 40,000 spindles at ·336 lb. per spindle of 70's double roving	=	13,440	12·7

Table VII

70's High Draft.

			Lb.	Draft
1	No. 7 hopper bale opener, 38 in. wide, delivering to mixings 1 No. 9 hopper feeder, 38 in. wide 1 Single Buckley combined with scutcher and lap machine 2 Single beater finisher scutchers	=	17,316	
40	Revolving flat cards, 37 in. on the wire, 50 in. cylinders, 26 in. doffers at 411·2 lb. each of ·15 hank	=	16,450	
4	Sliver lap machines at 4,087·5 lb. each	=	16,350	
4	Ribbon lap machines at 4,050·0 lb. each	=	16,200	
24	Combers at 579·2 lb. each (15% waste)	=	13,900	
9	Drawing frames with 2 heads of 4 deliveries each = 24 finishing deliveries at 575·4 lb. each of ·15 hank	=	13,810	
3	Slubbing frames of 80 spindles each = 240 spindles at 57·1 lb. per spindle of ·75 hank	=	13,720	5·0
6	Intermediate frames of 142 spindles each = 852 spindles at 15·9 lb. per spindle of 2·2 hank	=	13,625	5·8
18	Roving frames of 180 spindles each = 3,240 spindles at 4·2 lb. per spindle of 7·0 hank	=	13,608	6·3
100	Ring frames of 400 spindles each = 40,000 spindles at ·336 lb. per spindle of 70's double roving	=	13,440	20·0

Yorkshire Section

Special Meeting in the Council Chamber of the Town Hall, Bradford, on Thursday, 9th January 1930, Lieut.-Col. B. Palin Dobson in the chair.

THE LATEST ASPECTS OF RATIONALISATION

The Council Chamber of Bradford Town Hall was almost filled on this occasion, and the importance of the occasion was marked by the presence of the President of the Institute, who presided. Among those on the platform with Col. Dobson were the Lord Mayor of Bradford, Alderman A. H. Rhodes, Sir Donald Horsfall, Mr. Wilfrid Turner, Sir W. E. B. Priestley, Mr. R. G. Bailey, Chairman of the Yorkshire Section, and Mr. C. S. Ickringill, Hon. Secretary of the Section. Introducing the lecturer, Sir Josiah Stamp, the President thanked him for consenting to come to Bradford, and expressed confidence that those present were to be interested and instructed by so eminent a lecturer.

In the course of his speech, Sir Josiah Stamp said that judging by recent comments from influential quarters, a reaction was setting in against the process of rationalisation. Indeed, if by rationalisation we really meant processes which preserved the *status quo*, or which restricted output; if we really meant nothing but mass production, monopolisation, and trustification, then indeed the outlook was serious. Such a trend might be self-protective, but it would inevitably also be nationally destructive. What were the facts ? We had a number of industries which for various reasons were in difficulties, and could not market a reasonable proportion of their total productive capacity at prices which would cover their costs. Two methods appeared to offer a solution—one was to utilise devices for keeping up prices, and the other to keep down the costs. True rationalisation, he urged, was a means of reducing costs by greater efficiency. Pure individualism, particularly on a small scale, found a way out of such difficulties by the economic annihilation of the less fit units. Though ultimately, no doubt, these less-fit units had to succumb, in their dying struggles they enfeebled the fit and reduced the whole industry to a precarious position. True rationalisation did not seek to defeat or defer economic consequences, but having ascertained the inevitable, sought to bring it about more quickly by definite action. Its action was more humane and more certain; the units now going under might not be the least efficient, but merely the weakest financially. Such "selection" was arbitrary, and would be avoided by true rationalisation, which would proceed upon a basis of technical efficiency and the greatest potential good.

In the public mind, said the lecturer, rationalisation was confused with quotas, trusts, rings, and tariff walls. All these tended to inhibit the action of economic laws. But if the term was associated with things which it did not connote, a new term must be found. It was idle to suppose that in the present-day foreign trade small individual units would hold their place against large-scale units. It was no good kicking against the facts.

Referring to the textile industries, Sir Josiah said the small-scale industrialistic units, the backbone of Victorian progress, depended for continued progress upon supplies of personal capital provided by its abstemious living proprietors. Modern taxation had completely altered the supply of capital, and it must now be attracted from the rivulets of the many; only large semi-public corporations could command this capital. We might not like this difference of outlook or control, but it was inevitable, and therefore we must make friends with it.

Alluding to the industries which were in difficulties at the present time, the speaker said first there came those in which the total output capacity was an uneconomic conception, because it could only be marketed if prices were so low as not to return net costs for that output.

This could arise even where there was no great difference of efficiency between the different units. Merging or combination would be a true rationalisation if it saved selling and advertised costs, and if it concentrated like production in particular units instead of splitting it amongst many. Arrangement for quotas and price-fixing did not force lower costs, and therefore preserved the relative *status quo* of the people in the industry, but made no contribution to the national problem or the export industries. It suited industries made up of jealous or rather selfish proprietors with no great difference in average capacity or enterprise. By common action they might not disturb the relations between themselves, but they might get the same aggregate profit, at a lower rate, from a large and cheaper production.

In the second class, total output capacity was a most unreal conception, because with wide differences in efficiency, a section of that total must be made by some units which had costs much lighter than the others, and could only be kept in existence at prices which would lose the whole trade. No merging or device which maintained these units in production could possibly be real rationalisation. The passion for quotas and output restriction in such industries was a national menace.

Highly capitalised units in the steel industry could only produce real benefits in low costs if they were pretty fully occupied—the drag of the quota going to the less efficient prevented this, and as a result a first-class plant half occupied might have very high costs.

A third class were the industries which were sharing a reduced world demand at common world prices, and were not relatively different from other countries in efficiency or costs. Here, as possibly in the artificial silk industry, temporary limitation and price-fixing might well be superior to general rationalisation. But too many imagined themselves in this class who were really only hiding from themselves the truth about a general loss of world position through high costs, or a high percentage of obsolete units which were a drag on efficiently and cheaply-produced total output.

The chief causes of "stickiness" about rationalisation were—

(1) A disinclination on the part of highly individualistic producers to believe that their conditions were permanently bad. So long as they thought themselves in the trough of a trade cycle that would automatically come better they had no compelling incentive to unite or take drastic action.

(2) The lack of a catalyst or agent that would precipitate action, particularly if the financial supports behind the different units were rival banking interests.

(3) A desire to preserve the ancient status in any financial merger, regardless of potential future differences through technical equipment. Any merger was so capitalised to be unable to break up the *status quo*, and close the least efficient units, was doomed to failure. But if it were so heavily capitalised that it attempted to save potential losers from any actual loss, it was also hopeless.

(4) Secrecy and conservatism which kept anyone from knowing the total position of an industry or the relation of its parts. Mergers arranged on a purely financial basis, without some preliminary technical examination to guide the relative financial interests, were unlikely to be successful. A study of the German accomplishment was full of meaning as to the imperative need for early action in several parallel industries in this country.

"My opinion about Germany is that a very large part of her remarkably rapid recovery is due to the extraordinary energy she has put into rationalisation—by which I mean not merely cartels or groups, but actual scrapping of factories and renewal of plant. She has had to do this very extensively on borrowed money, and for a time she is going to suffer before she can get the benefits from a financial point of view. For example, in the coal and iron and steel industry the remaining units are carrying the capital cost of closing the inefficient ones, and they are finding it very burdensome; but there is no question about the increased output at low costs which the existing units are able to give.

Another drawback of the rapidity of the German rationalisation is that the inevitable contribution to unemployment which is involved has proceeded a good deal faster than absorption. It is complained, too, by the industrialists that the rapid rise in wages and the heavy capital charges are depriving them for some time of any benefit. Rationalisation has hardly touched agriculture, despite the fact that the characteristic element of the German system has been not merely intense application to particular industries, but a nation-wide organisation of a most complete description for securing national efficiency in manufacture and distribution.

Germany has been modelling her methods on the United States, but there are two important differences. She has not such a wide market, and her labour is so much cheaper that she cannot profitably carry the process of mechanisation so far as they can in the United States. Where it would pay to replace labour by machines in the States, it does not in Germany.

The day has gone by when we can afford to ignore the important advantages obtained by large systematised German units compared with our own. Tranquillity is a fine thing, but it lies very near to danger.

I think that the activities of the Lancashire Cotton Corporation promise more favourable results than one might dare to hope for, seeing that they have only been in existence nine months. They are already in sight of 10 million spindles, and have under way centralised buying and selling, centralised services, and the avoidance of cross-traffics. They at any rate are not confusing mere financial grouping with rationalisation, because the technical aspect is prominent. That is clear from the number of cases they have rejected as being so backward as to make it impossible to bring them up-to-date with any reasonable expense.

Is it not probable that the woollen industry will have to go through a similar stage ?"

A vote of thanks to Sir Josiah Stamp was carried on the motion of Sir Donald Horsfall, Bart., seconded by Mr. Wilfred Turner.

London Section

Informal discussion meeting at the Institute Rooms, 104 Newgate Street, London, E.C., 4th December 1929, Mr. L. J. Mills in the chair.

LEATHER AND SKINS FOR CLOTHING PURPOSES

The Chairman said they were particularly fortunate in having Mr. Lamb, Principal of the Leathersellers' Technical College, to address them, and he was sure they would have a most interesting lecture.

Mr. Lamb said that he wished his audience to consider leather and skins from a clothing point of view. There was an old saying that there was nothing like leather. He would try and convince everyone that that was so. Everyone knew leather was the outer covering of an animal in a form which had been made soft and supple, and subsequently manufactured into articles of clothing and footwear. Leather was made up of innumerable fibres, and for that reason there were no mechanical means for reproducing it or for producing a substitute for leather. One found in leather, especially when used for clothing, that it contained properties which ensured perfect ventilation, and, unlike other materials of a non-porous character, it allowed the waste products of the human body, that was perspiration, to pass through or to be absorbed by the leather without condensation. It could also be made wind resisting and to some extent waterproof. It was further light weighing, soft, and durable. In its hygienic properties it was far in advance of any of its substitutes. The fibres in the leather had to be very carefully preserved during the tanning processes, and it must necessarily have a good tensile strength. The raw material for a leather coat was usually sheepskin, and the first operation these skins were subjected to was soaking in water. After the skins had been left for a few hours the wool could be quite easily removed. Then followed the process of dissecting the fibres in order to ensure softness and pliability. That was carried out either by liming, or could be done by the paddle method. As soon as the article was clean it was necessary to get rid of the lime in its entirety before the tanning operations were commenced. That process was termed "bating," which meant that the skins were first washed with water and were then subjected to enzyonic treatment. Then followed the tanning operations, and if done by vegetable means, the skins were either suspended or laid flat and were moved from one bath to another, which gradually increased in strength. There were four or five different ways of tanning. It could be done by the ordinary vegetable method, it could be carried out successfully with alum or with chrome, or it could be done with oil. The vegetable tanning was a process employed for tanning sole leather, alum was employed in quite large quantities for gloves, but chrome was used for clothing leather of the better qualities and for a variety of different types of leather, such as glacé kid and calf leathers.

Continuing, Mr. Lamb said that in all classes of leather clothing the average lady had no knowledge of the quality of the leather she was purchasing. But there was leather and leather. Unfortunately, the lady would only set up one standard so far as leather was concerned; provided it was leather, that was all she cared about. There was good leather and bad leather, and he was sorry to say a good deal of bad leather was now being used in the leather clothing business. One of the most difficult operations in the preparation of leather for clothing was the dyeing and colouring, the more so because to-day manufacturers had to comply with many drastic requirements.

Considerable progress has been made in recent years in the manufacture of fancy leather, in the direction of considerably improving the finished appearance by the selection of dyestuffs fast to light and rubbing, and the obtaining of a more uniform and regular colour throughout the surfaces of the leather by the application of the so-called "pigment finishes." These finishes contained finely ground mineral pigments held in a state of suspension in a solution containing a binding agent such as shellac, casein, or gum arabic. These finishes were more generally applied by spraying at high pressure on to the surface of the dyed leather. This method of finishing overcame the difficulties incidental to the obtaining of a regular and uniform dyed surface upon a material which had been subjected during its lifetime, as was the case with the skin of an animal, to many accidents and defects.

A hearty vote of thanks to the lecturer was proposed by Mr. E. B. Fry, and carried with acclamation, Mr. Lamb briefly responding.

Lecture at Barrett Street Trade School, London W., on 18th November 1929; Mr. E. B. Fry in the chair.

VAT DYES, OR WHAT SHOULD THE PURCHASING PUBLIC UNDERSTAND BY FAST DYE

Referring to the fact that the public lectures arranged by the London Section of the Institute were, by the kindness of the Company, usually held in the Clothworkers' Hall, the Chairman said that it was an experiment, and, he thought, a successful experiment to hold this lecture in the West End. A further lecture would also be delivered in this end of London and he felt sure the Section Committee would regard the venture as justified and to be proceeded with next session. After a brief reference to the history of the Institute and its objects Mr. Fry introduced the lecturer, Mr. J. Blair.

The lecturer said he hoped to make clear what classes of dyes could be said to measure up to the public's present idea of fastness. It was important to realise that the public was being gradually educated to more stringent demands for fastness. Vat dyes very largely satisfied these demands but they could not be applied to all materials nor was it so easy to match shades with these dyes as it was with other classes of dyes only slightly inferior in fastness.

The lecturer described what were now known as vat dyes and the means of dyeing them based upon the use of the soluble leuco compound. These were reduction products and on oxidation the original insoluble coloured forms were secured on the fabrics under treatment. This to some extent explained the fastness of vat dyes. A brief historical outline of the dye-making industry was then given, and reference made to the work of Wohler, Perkin, Meldola, A. G. Green, Clavel, and others in this country and on the Continent.

The lecturer made special reference to the efforts to produce indigo synthetically and described the process now employed in its manufacture by the Society of Chemical Industry at Basle. The relative fastness of indigo on wool and cotton was discussed and its quality of fading pure emphasised.

Mr. Blair then proceeded to describe the progress made in the manufacture and use of anthraquinone vat dyestuffs—ranges made by various manufacturers being indicated. These dyes presented the highest fastness known among coal-tar dyestuffs. A brief résumé of the history of Sundour fabrics and their development followed, in which reference was made to the full story given by Mr. James Morton to the Royal Society of Arts in April 1929. Some reference was next made to the Hydron colours and to the relative cost of using vat dyes in place of other classes of dyes. Except in good depths of shade the extra cost per yard of fabrics dyed did not amount to much.

Finally, the lecturer came to the consideration of what should be understood by the public as fast dyes. The term was not the same to the purchaser of a casement cloth as to the purchaser of knitting wool. Tests for fastness to light, washing, water, alkali, acid, perspiration, rubbing, storing, chlorine, and ironing were applicable and different dyes gave different results which should interest and inform the public. Three factors determined fastness—(1) shade; (2) purpose; and (3) kind of material. These points were elaborated by the lecturer, who described fastness tests employed by the Clayton Aniline Company, and the work of the Committee appointed by the Society of Dyers and Colourists to inquire into the possibility of defining degrees of fastness of dyed materials. A description of the Neolan colours, a speciality of the Society of Chemical Industry, Basle, was given and particulars of their use for wool, silk, and leather. The lecturer illustrated his discourse with tests, charts, and specimens.

A good discussion ensured in which many questions were asked from the point of view of the user as well as from that of the retailer or wholesaler. A hearty vote of thanks was accorded to the lecturer.

Scottish Section

Meeting at "Spread Eagle" Hotel, Jedburgh, on Wednesday, 22nd January 1930.

A party of about 22 members assembled at the hotel for lunch prior to visiting the works of Messrs. North British Artificial Silk Ltd., Jedburgh.

In the absence of Mr. Hartley, works manager, Mr. A. R. Knight extended a welcome to the Institute, and said that they were very pleased to have the opportunity of showing the members through the works that day. He hoped that the visit would prove of interest to all those present, and particularly those who handled rayon yarn in the course of their daily work. They would find no secrecy in the works, and were at liberty to ask any questions about particular processes viewed during their progress through the premises.

Mr. J. Macpherson Brown, Galashiels, on behalf of the Institute, expressed a word of thanks to the company for their kindness and courtesy in allowing the members to visit the works, and said that they appreciated very much the spirit which had prompted the directors to grant the necessary permission. Referring to Mr. Knight's remarks, he made an appeal for greater co-operation among the members of the Institute on general subjects, and said that they need not be afraid of giving away any information on matters of common interest, while there were many ways in which it was possible to work together for the benefit of the industry as a whole, and their own separate interests in particular.

Mr. J. H. Lester, Manchester, a Vice-President of the Institute, who accompanied the party, also spoke, and appealed to members to realise that there were great possibilities for closer co-operation on the lines Mr. Brown had suggested, and that the activities of the Institute provided an excellent medium for co-ordination towards that end.

Thereafter the members spent a very interesting and instructive afternoon visiting the works, conducted by Mr. Knight, who gave a detailed explanation of the various manufacturing processes employed in the production of rayon yarn.

Irish Section

Meeting at Belfast Municipal College of Technology, Thursday, 23rd January 1930.

The second meeting of the session was held in the Municipal College of Technology, Belfast, on Thursday, 23rd January 1930, when a lecture was delivered by Mr. W. F. Whiteford (London), on "Costs and Statistics for the Linen Trade."

Mr. W. H. Webb, who presided over a very large attendance, appealed for a larger membership of the Irish Section of the Institute, and said every firm ought to have at least one of its members subscribing. Mr. Webb said that in the linen trade they had got behind in administration, and that Germany and U.S.A. were far ahead of them in that respect, though not in technique. He thought the report of the linen delegation to America was wonderful, and he hoped and believed it would mark a turning point in the trade.

Mr. Whiteford delivered an interesting lecture, and spoke of the need for standard costs and up-to-date statistics for the trade.

On the proposition of Mr. Garrett Campbell, seconded by Mr. F. Anderson, a hearty vote of thanks was passed to Mr. Whiteford and Mr. Webb.

NOTES AND NOTICES

The Late Sir Frank Warner

The passing of Sir Frank Warner, K.B.E., of Woodcroft, Mottingham, Kent, on Thursday, 23rd January, evoked wide-spread sorrow among a large circle of friends and business associates in many parts of the country and abroad.

He was born in London on 13th September 1862, the son of the late Benjamin Warner, founder of the firm of Warner & Sons, silk manufacturers, with works at Braintree, Dartford, and London. Leaving school in 1878, he went to Lyons for a year's course of study under Professor Audibert in the art of silk manufacture. Prior to entering his father's silk manufacturing business in London in 1881, he served for two years in a firm of importers in the city of London, and as a junior salesman in the warehouse of a firm of silk manufacturers in Wood Street. Joining his father's firm after a qualifying period in the factory, he was placed in control of the designing, cloth construction, and colouring of the hand-loom fabrics produced. In 1891 he became a partner in the firm, and on his elder brother's retirement in 1914, he became sole partner.

His success in an exacting business was due to an artistic temperament, an inborn sense of colour values, a love of beauty in all its forms, and a highly developed technique, enabling him to produce fabrics which speedily acquired a world-wide reputation for excellence of production and beauty of design. His technical skill was shown in his invention of three-pile velvets (which he patented), of which an example is to be seen in the Victoria and Albert Museum. To this artistic and technical skill were added the qualities of organisation and business acumen. He was a born leader of men. His mental grasp, his wise judgment, his power of getting things done were shown not only in the development of his own large business, but in the wider field of public service to which he soon began to devote himself. Few men have had greater calls upon them, and none have responded more generously, not only in the wide field of the numerous Committees and Congresses of which he was a prominent member (usually the Chairman), but also in the more intimate relationships of business and social life. His knowledge and experience were always at the service of those who came to him for advice and help. It is impossible to give any idea of the wide range of his activities, but naturally the claims of his own trade appealed very strongly to him. He devoted many years of service to furthering its interests, serving from 1910 to 1917 as President of the Silk Association of Great Britain and Ireland. He was also the inspirer and Chairman of the British Silk Research Association (the first Research Association formed in the country); Chairman of the Advisory Committee of the Imperial Institute on Silk Production; the author of the standard work "The Silk Industry of the United Kingdom," and of many addresses and papers to Schools of Art and other similar organisations.

For many years he was in close contact with the Department of the Board of Trade in all matters relating to textiles, and in 1917 he was officially appointed as Advisor to the Board on textiles (other than cotton). His work for his country was recognised in 1918, when a knighthood was conferred upon him. He was also an officer of the Legion of Honour, granted to him during the Paris Exhibition of Modern Art in 1925. As a citizen he was a Freeman of the City of London; a Liveryman of the Worshipful Company of Weavers; and for a number of years a member of the City Corporation.

His connection with the Textile Institute began in September 1909, when the small band of enthusiasts who had gathered round Messrs. George Moores and J. H. Lester (the founders of the Institute) met to make the arrangements for its official inauguration. Mr. Warner (as he then was) was among those present, and his application for membership is dated 21st December 1909. The inauguration took place on the 22nd April 1910, and at the first meeting of the newly formed Council which followed on the 6th May, Mr. Warner was elected Chairman, and Professor Barker, Vice-Chairman. This office he retained until 1918, when he succeeded Sir William Mather as President for two years 1918-19, 1919-20. The task of building up and guiding a new organisation during the first ten years of its existence is always difficult, but when this period includes four years of war, some idea of the difficulties which had to be overcome may be realised. The Institute owes much to Sir Frank Warner. His tact, resourcefulness, and driving force were only equalled by the close comradeship and mutual trust which he inspired in all those who were working with him.

It is not too much to say that the success of the Institute as we know it to-day is due largely to the foundations that were laid, and the work that was done during his chairmanship.

The last few years of his life were clouded with sickness and sorrow. His own health failed, and he had more than one serious breakdown, which compelled him to relinquish his public work and other outside interests. Then in March 1928, after a lingering illness, Lady Warner died, and the home life, which had meant so much to him, could never again be the same. In the September following, his only son, Mr. Cloudesley Warner, who had been his partner in business since 1922, died in Normandy. Such cumulative sorrow was too much for his enfeebled frame, and although he retained his courage and sweetness of spirit, the zest of life was gone. He was still able to take some interest in his business, but after attending a Board Meeting he took a chill which developed into pneumonia. The finest medical skill was unable to arrest the progress of the disease, and in the early morning of the 23rd of January the web of life was completed, and the loom of life stopped. His body rests at Chislehurst, but his spirit, the spirit of a very gallant gentleman, is enshrined in the hearts of his friends.

The Late Mr. William Eastwood

A member of the Institute for many years, and an ardent supporter of the organisation at a time when his activities in textile works management were outside his own country, thus depriving him of really intimate contact with Institute affairs, Mr. William Eastwood, whose death took place early in January, was an individual of outstanding ability on the technical side of the industry. In pre-war days he was engaged in directing large-scale industrial organisations in Russia, and in those years he was a helpful member of the Institute as a correspondent, able and willing to give reliable information on many matters, including language translations. Like many others, he suffered considerably during the revolution in Russia, but nevertheless was ultimately able to return to his own country. During recent years he was a frequent visitor to the Institute headquarters, and the announcement of his demise came as a great shock to many of his fellow members. Mr. Eastwood had experience of many European countries, and he was an accomplished linguist. His death took place in Italy whilst on a visit to Milan. He was widely known in textile circles on the Continent, and had been responsible for several introductions therefrom to Institute membership.

Institute Annual Meeting

The next Annual General Meeting of Members of this Institute has been fixed to take place at Bolton, on Wednesday, 7th May. A programme will be issued in due course, giving particulars of the proceedings. The President of the Institute, Lieut.-Col. B. Palin Dobson, of Bolton, has kindly accepted nomination by the Council for re-election for a further year. Members are asked to note the date and place of the annual meeting at which a really good attendance is hoped for. An important item in the proceedings will be the contribution of the

Annual Mather Lecture of the Institute. The Council has already invited Mr. H. G. Hughes, B.Com., the Director of the Cotton Trade Statistical Bureau, to give this lecture, and the invitation has been accepted. The title of the contribution will be announced later.

Textile Institute Diplomas

Election to Associateships of the Institute have been completed as follows since the appearance of the previous list (November issue of this *Journal*) —

ASPDEN, John (Clitheroe).
BARROW, Christopher (Manchester).
CRAWSHAW, Harry (Burnley).
ETHERINGTON, Burton (Rochdale).
PILKINGTON, John (Oldham).
STUART, William Litherland (Halifax).
SUTTON, George Donald (Bolton).
WHITWORTH, John Richard (Royton, nr. Oldham).

Elections to Institute Membership

Whilst the monthly additions to our membership roll continue to be recorded in most satisfactory numbers, yet the Propaganda Committee, which gives constant attention to this vital matter of advancement of membership strength, asks for the assistance of members generally in this connection. Progress is discounted, however, by withdrawals which arise from various causes, hence the need for persistent effort. The Secretary would always be pleased to approach individuals on receipt of names and addresses, and would supply application forms and suitable literature on request.

The following is a list of new members elected at the February meeting of Council—E. Asquith, 3 Green Top, Pudsey, nr. Leeds (Designer and Inside Manager); B. K. Bose, 235 Windsor Road, Oldham (Spinner); M. M. Charap, c/o S.A. Fabrica Argentina de Alpargatas, Buenos Aires, S. America (Chemist); Miss Irene Clark, 3 Charles Street, Nelson, Lancs. (Student); G. Davis, "Amberlea," Huthwaite Road, Sutton-in-Ashfield, Notts. (Hosiery Manufacture, Clerk); G. V. Doraiswamy, c/o 4 Hollywood Road, Smithills, Bolton (Textile Student); B. B. Dutton, Westgarth, 56 Albert Road West, Bolton (Cotton Spinning, Apprentice); B. Dyson, 36 Newsome Road, Huddersfield (Textile Teacher); W. Ellison, Lawside Dyeworks, Dundee (Director and Secretary); E. Gminder, Gustav Wernerstrasse 26, Reutlingen, Germany (Textile Manufacturer); F. C. Hewitt, 76 East Main Street, Webster, Mass., U.S.A. (Supt., Cotton Finishing Plant); N. Hodgkinson, Wesley Villa, Rawtenstall, Rossendale (Student); H. Jolly, Peel Mills, Turton Street, Bolton (Cotton Spinning, Director); Robert M. Jones, Saco-Lowell Shops, Newton Upper Falls, Mass., U.S.A. (Research Engineer); J. A. Kirby, 33 Stephens Road, Withington, Manchester (Textile Student); L. S. Little, P.O. Box 102, Slatersville, R.I., U.S.A. (Vice-President and General Manager); J. H. Mackie, Wm. Hollins & Co. Ltd., Pleasley Works, Mansfield, Notts. (Mill Manager); Horatio B. Marchant, Textile Department, Technical College, Bradford (Student); John Ryan, Lancashire Cotton Corporation Ltd., Blackfriars House, Parsonage, Manchester (Executive Director); F. Watkinson, Crag House, Summerseat, Bury (Cloth Salesman); N. H. Williamson, "Alcuin," Bankhall Lane, Hale, Cheshire (Asst. Manager, Artificial Silk Manufacture). J. McKay Adan, 261 Clifton Road, Aberdeen, was elected to Life Membership of the Institute.

Council Meeting

At the last meeting of the Council of the Institute—Wednesday, 19th February—there was an excellent attendance, and a fairly lengthy agenda was submitted. Mr. Henry Binns (Vice-Chairman) presided. A draft copy of the annual balance sheet and accounts to end December 1929 was presented from the Finance Committee, and approved, and satisfaction was expressed owing to the improved state of the finances as shown by the revenue account. In this connection, it was reported that owing to a recent decision of the Inland Revenue authorities, it had been decided to accept agreement whereby income-tax will be payable on profits, but as a result it is expected that, after completion, members of the Institute will be able to claim allowance in respect of membership subscriptions. It was also reported that arrangements were proceeding for the holding of the annual general meeting at Bolton on Wednesday, 7th May. In recognition of their services, the Institute Medal is to be awarded to Col. F. R. McConnel, Messrs. J. Crompton, W. Frost, and T. Fletcher Robinson, and the presentations will be made at the annual meeting. The celebration of the coming-of-age of the Institute in 1931 has already received consideration by the Propaganda Committee, and a list of recommendations has been prepared. The various Section Committees are to be asked to offer suggestions as to co-operation in the celebration proceedings, which will probably cover two days, at Manchester, in April of next year.

REVIEWS

Year Book of the National Association of Cotton Manufacturers. Published by the Association at Boston, Mass., U.S.A.

The 1929 Year Book brings the total to twelve of this well-known and interesting series. The book as usual has been divided into two sections—Statistical and Technical—and in each former tables have been carefully revised and new material added. Of the latter it is suggested that study should be made of the domestic consumption of cotton by grade and staple for the year ending 31st July 1928, and the grade and staple report for the 1928-1929 cotton crop. For the first time the cotton manufacturer has a detailed picture of the particular parts of the crop in which he is interested. The data from the Census of 1927 are more descriptive of the industry, as they include more divisions by classes of fabrics and also divide the production of cloth into groups of fabrics with yarn numbers averaging 40's and below and above 40's. The Association is again to be commended on the comprehensiveness and careful compilation of its statistics. T.

The Chemical Age Year Book, Diary, and Directory 1930. Published by Benn Bros., London. (Price 10s. 6d. nett.)

The new edition of this Directory follows the style and make-up of previous years. In this respect perhaps a little criticism would not be out of place. The first 60 pages are devoted exclusively to advertisements, and while this is doubtless advantageous from an advertiser's point of view, it would be equally advantageous to the general purchaser and reader if the title and contents pages were given precedence. As it is time is lost in searching for these pages; alternatively the present form could be retained and tinted paper used to indicate the commencement of information. T.

The Meaning of Rationalisation. By L. Urwick, O.B.E., M.C., M.A. Published by Nisbet & Co. Ltd., London, 1929 (156 pp. and Index. 7/6 net).

On earlier pages of this issue will be found a report of an address by Sir Josiah Stamp on "The Latest Aspects of Rationalisation." The attendance at this meeting was very complete testimony to interest—vital and imperative—in this subject. Discussion in this, as in any other instance, must be based securely on an accepted definition of the term and all that it connotes or excludes. Sir Josiah emphasised this when he said "If it is true that rationalisation means nothing but mass production, monopolisation, and trustification, and all that these things have meant in the past, then, indeed, the outlook is serious. It may be self-protective but it is nationally destructive." The book under notice is the considered production of a member of a voluntary Committee appointed by a meeting of some 50 institutions called to consider the possibilities of co-operation in inaugurating a national movement for rationalisation. It is avowedly published on the authority of the author himself but it is not unreasonable to suppose that he may be assumed to speak with the full sympathy of the other members of the Committee. In an attempt to secure a full understanding of what rationalisation should mean and does mean to those intimately concerned with its propagation it is natural, then, to turn to this monograph. The Industrial Committee of the World Economic Conference, 1927, produced a series of resolutions (Appendix A of this book) under the title of "Rationalisation" which were finally adopted by the Conference as a whole. These resolutions recommended "that Governments, public institutions, professional and industrial organisations, and the general public should influence producers to direct their efforts along the channels described—and diffuse in every quarter a clear understanding of the advantages and obligations involved by rationalisation and scientific management and of the possibilities of their gradual application," and it cannot be logically deduced from this, surely, that rationalisation appeared to the members of the World Economic Conference as "nationally destructive." It will be seen, of course, that Sir Josiah Stamp did not agree with the premise that rationalisation meant nothing but "mass production, monopolisation and trustification, etc." and in conjunction with his lecture this book may very usefully be read. Mr. Urwick deals first with the history and definition of the word and after doing so says that in this book the word may be defined as an attitude or as a process." As an attitude it records *the belief that a more rational control of world economic life through the application of scientific method is possible and desirable.* As a process it implies *the application of the methods of science to all problems arising in the organisation and conduct of production, distribution, and consumption.* Postulating that this is a much wider field than hitherto associated with the word, the author proceeds, in Chapter II, to consider the possibilities and extent of that field; in Chapter III, he defines and discusses the scope of rationalisation; and in Chapter IV he emphasises its importance to the business man. Chapters V—VIII cover scientific management, research, the field of management, and the field of administration. Finally, Mr. Urwick discusses the present position in Great Britain (Chapter IX); gives some suggestions for action (Chapter X); and draws conclusions in Chapter XI from which it is difficult to escape. The book may be heartily commended to all since it is by the "common effort of all classes of the community" that lasting improvements can be made and benefits secured. H.L.R.

La Grande Œuvre de la Chimie. Essays by various authors edited by Jean Gerard. Published by "Chimie et Industrie," Paris, 1929.

This is a collection of essays each dealing with differing aspects of chemistry in its relationships with human affairs. Not only industrial, hygienic, and physiological aspects of the subject are dealt with, but aspects of a philosophical character as for example, "La Chimie et l'évolution de l'humanité" and "La Chimie et la société moderne." The volume is issued as part of the scheme inaugurated by the French Society of Chemical Industry to commemorate the life and work of Marcelin Berthelot. The book contains a mass of information and serves admirably as a picture of the enormous part played by chemistry and chemists in almost every aspect of human activities. The illustrations are crude and not in keeping with the work as a whole. T.

Elektrobetrieb in der Textilindustrie. By Dr. Ing. Wilhelm Stiel. Published by S. Hirzel, Leipzig, 1930 (price, RM. 33).

The title chosen by the author, which may be translated as "Electricity in the Service of the Textile Industry," is indeed a very happy one, as his book covers not only the subject of driving textile machines by electric motors, but shows very clearly how electricity can be utilised in many other ways, to equal advantage, in the textile factory.

This book is the first in the world's literature which systematically shows how electricity may be applied for driving and other useful purposes in the textile industry, no matter which branch of the industry may be chosen—it shows also how much further ahead the study of electro-technics in regard to textiles is on the Continent than in either England or America. As an instance, the special drives mentioned for ring spinning frames, flyer frames, jute flyer frames with individually driven spindles, individual mule drives, electric spindles for ring frames, printing machine drives, etc., might be cited.

Not only is this book of immeasurable use to the electrical engineer, but should be in the hands of all engaged in the textile trades, progressive textile machinery makers, and textile students, especially at such a time as this when rationalisation of the means of production is so much to the fore. As a book of reference, whenever the question of the use of electricity is raised, it must prove to be of invaluable assistance.

The book, which comprises some 650 pages with about the same number of diagrams and six double-page drawings showing the diagrammatic lay-out of textile machinery, is divided into three main parts. The first part after the introduction, which gives a short history of the textile industry, including several extremely useful tables of the world's spindles, looms, etc., deals with the general question of source of power, whether steam, electricity, or oil, going very closely into the problems of mill heating and the utilisation of heat for process work. There are a number of excellent diagrams and curves illustrating the author's remarks. This first part concludes with very clear examples of methods for dividing up, controlling, and generally distributing electric circuits to their best advantage for the particular duty they are designed to perform, with chapters on transformers, converters, and the layout of typical generating stations. The second part deals exclusively with the interesting subject of electric motor drives in textile works, which drives, the author divides into four main groups, showing the many advantages of not only what is generally known as individual electric drive, that is, one or perhaps two motors to a machine, but goes further to point out that even better results may be obtained by individually driving the various parts of one machine, by means of a larger number of small electric motors, such as are now becoming general in the drive of artificial silk spinning frames, jute spinning frames, etc., where each spindle is driven individually.

The data given by the author in the various power consumption curves must prove of great interest and usefulness, especial mention perhaps should be made of those consumption curves relating to ring spinning frames. The second part covers not only the application of the electric motor to various textile machines, but draws special attention to the type of motor which should be used in each case from the bale opener in the cotton mill to all the preparation machines and finishing machines in the flax, hemp, jute, worsted, wool, real silk, artificial silk, artificial wool, and rope industries. For all the separate machines used in these industries the fundamental principles for the arrangement of the individual electric motors are shown and the accompanying sketches and lay-outs leave nothing to be desired.

Before leaving this second part attention is drawn to the chapters on electrical driving of knitting frames, sewing machines, and lace machines and last, but by no means least, those devoted to the numerous drives in bleach works, dye works, and print works. Drives for printing machines have always been an interesting subject from the electrical engineer's point of view, and are now very clearly described with the various possibilities by the author.

If any distinction can be made, perhaps this second part is the most valuable as it contains really excellent constructive information, leaving little or nothing to the imagination.

The third main part treats with those essentials to the efficiency and comfort in any textile works, essentials which are only too often completely lost sight of —these are lighting and heating, etc. Here again tables are given clearly showing the amount of artificial light required to illuminate effectively the various departments in relation to the floor area of those departments, taking into account the decoration, shape, and machinery installed. A special chapter is given on electric heating, arrangements being shown for the heating of the different departments, both by water, steam, and hot air. Other subjects dealt with in this part of the book are the electric air purification plant, static electricity, and its effect on cards, drawing frames, spinning frames, etc., and the electro-magnet and its uses, whilst further chapters deal with measuring instruments for power and temperature control, special diagrams and arrangements are shown for remote control of humidity, etc. The subject of electrically operated warp and weft stop motions is clearly explained.

No book of this nature would be complete without some mention of the uses of electricity in chemistry and the author deals at some length with the subject of electrolysis and copper recovery plants. The last chapters show how electricity may assist transport in the mill, not only by using electrically-driven overhead travellers, but also by the adoption of electric trucks—these should be of especial interest in the scattered mill. The mechanic's shop, a most useful, but often overlooked portion of any textile works, has not been forgotten. A complete index of articles on the subject of electric drives previously published is added, together with an alphabetical index of the contents.

Taken all round this book is the most comprehensive one of its kind ever published and Dr. Stiel, who for many years has been head of the Textile Department of Messrs. Siemens-Schuckert, Berlin, is to be congratulated and thanked for the clear way in which he has dealt with a subject at once so immense and of such vital importance. Although as yet this book is only published in German an early translation into English is hoped for. R.H.F.

The Finishing of Woven Fabrics. By Eber Midgley, F.T.I. Edward Arnold and Co., London (207 pp. and Index; 18/- net).

The primary object of this book is stated by the author as an attempt to demonstrate the underlying principles of the chief factors in cloth finishing, and as will be seen from the following brief review the attempt has met with considerable success in view of the wide field which the author has to cover in a volume of some 200 pages.

Part I—General—deals briefly with the constituents of woven fabrics and their effect on appearance and handle in finishing, and also on the influence of materials, yarn, and cloth structure on the finished fabric.

Part II includes chapters on Crabbing, Scouring, and Milling and Finishing of all wool materials. With reference to the first of these processes there are a few excellent illustrations for comparison between crabbed and uncrabbed fabrics. The processes of scouring, milling, and raising are only briefly dealt with, although useful diagrams of the essential machines are given. Descriptions of the processes and machines for drying and tentering, steaming and brushing, cropping, pressing and permanent finishing are also included in this section.

Part III deals with the Finishing routine for Union Fabrics, composed of cotton warp, worsted, mohair or alpaca weft. The processes are—crabbing, scouring, drying, and singeing. These processes are interesting by comparison with the treatment given to all-wool goods. Particulars are also given of the variation in dimensions of a few standard cloths after the various finishing operations.

Part IV deals with the Mercerising and Schreinering of Cotton Goods. Mercerisation is made use of in the finishing of cotton goods to develop a lustre much superior to that obtainable on more expensive makes of cloth such as the lustrous fabric obtainable from cotton warp and fine botany worsted weft. The author also gives tables of particulars showing the variation in cotton yarns before and after mercerising. Schreinering is dealt with at considerable length, and the general principles underlying the production of a silky lustre on cotton goods by this process are elucidated.

Part V concludes the work and deals with the influence of the Dyeing and Finishing Processes on woven fabrics.

The author has been successful in embodying an outline of practically all the essential processes in a comparatively small volume. Each section could have been greatly extended by consideration of various details in cloth finishing and their effect on the routine of finishing. The author, however, makes no pretence at an exhaustive treatise, but as indicated above, an attempt to demonstrate the underlying principles involved in cloth finishing In this he has been most successful and the book is a useful contribution to general textile technology and should be of the greatest value to those desirous of obtaining a general knowledge of the finishing of the various types of woven fabrics. D.R.C.

Wool Year Book. Compiled and published by the *Textile Mercury*, Manchester, 1930 (xciii+696; price 7/6).

Reviewing the year 1929 in the twenty-second edition of the Wool Year Book, regret is expressed that the high hopes with which the Yorkshire textile trade entered upon the year were not justified. The revised sections of the volume prove that the year was not devoid of encouraging features, having particular regard to the collaboration now taking place between investigators in this and other countries with a view to the general betterment of trade. As usual all processes are dealt with from raw material to the finished goods, including artificial silk in addition to wool. List of technical schools, textile societies, trade associations, and a glossary of textile terms complete this handy work of reference. T.

Principles of Woollen Spinning. By Howard Priestman. Published by Longmans, Green & Co., London (334 pages and Index. 15/- net).

A first edition of the book was published in 1908 and this notice relates to the second edition now available, dated January 1924.

In general, the book preserves the same character as the first edition, although alterations have been made; the only really new feature is an extra chapter on "Woollen Frame Spinning," comprising approximately 20 pages

The work is somewhat disappointing; one expects more up-to-date information and perfected detail in a new edition of a technical book. On page 84 a table is given showing "Persons employed in various Countries in the Woollen, Worsted, and Shoddy Industries, including Dyeing," where the information is not later than 1902; again, the table giving "Return of Persons employed in Factories" concerns the year 1901; further, table 9 shows "Spindles running in 1904; table 10 relates to value "in dollars" of "Materials used" in the years 1860 to 1907; table 11, "Statistics of Shoddy made and used in the United States" refers to 1900; whilst table 12, "Method of Costing a Carbonised Carded Dyed Black Merino," would have been much more useful if changed from a pre-war to a post-war basis.

In passing, a number of details are noted on which comment by the author might have been usefully made, or novel features discussed and reasons set out for the inclusion of variations from orthodox methods. On page 48, the author states "it is well known that soap is a necessity for milling, and as acid causes the very opposite effects to those produced by soap, there is good reason to postpone carbonising until the milling has been effected"; though this fact may be well known, it would have been helpful to student readers, particularly those interested in certain trades where acid milling is general, to know more of this subject.

Dealing with the Fearnaught, a detail diagram is given on page 144 which is certainly unusual, and any machine made on these lines would have to be specially ordered; the stripper is shown on the feed side of the worker, whereas it is normally mounted on the side of the worker nearest delivery; further the teeth on the stripper instead of having a definite "set" as illustrated, are in practice almost straight.

Again, when discussing the Garnett machine on page 147, it is stated "Garnetting is a near approach to carding proper, although the only rollers that have flexible clothing are the fancies," a diagram is also given, Fig. 21, showing Garnett fancy with flexible type of clothing akin to the clothing on an ordinary carding fancy—surely the ordinary practice in Garnetting is to have the fancy covered with Garnett wire—the author should have explained this departure from the normal.

In a similar way, on page 191, a diagram of a portion of a carding machine is given, with the stripper mounted on the doffer side of the worker; it is suggested that in a book on "principles," in case of any change from the standard—as this undoubtedly is—attention should be directed to the alteration and an explanation given.

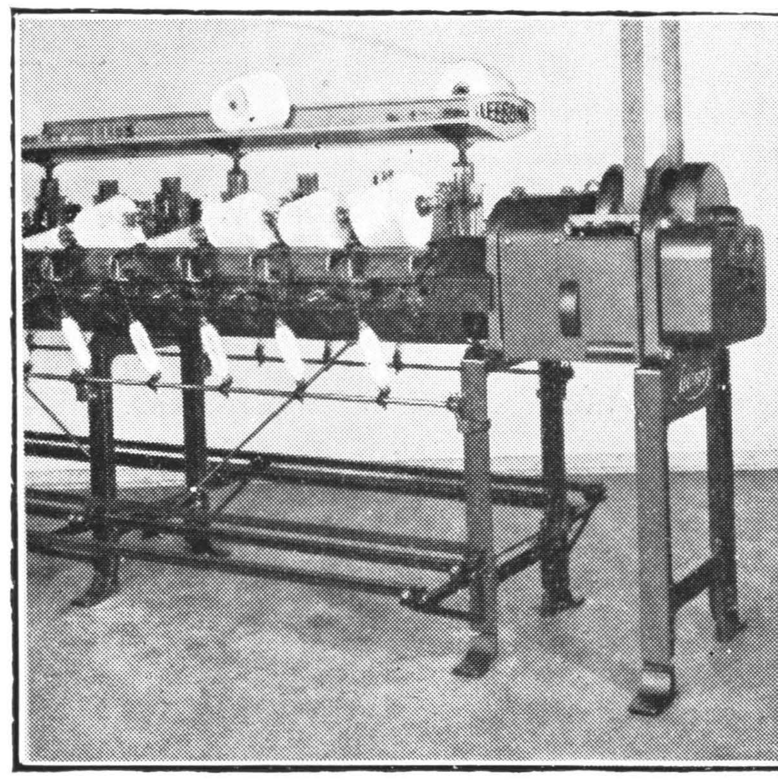
Relating to the same diagram, when referring to the setting of the rollers, the author points out, "it must be possible to move every stripper nearer or further from the centre of the swift (line 4, Fig. 41), as well as along a line connecting their centre with that of the worker that they clear (line 5), yet on page 200 is given another diagram showing relationship of cylinder, worker, and stripper as they are under normal conditions but showing the setting bracket of the stripper capable of adjustment *only* in relation to the cylinder, which is, of course, the usual arrangement.

Turning to condensers, a rather novel form of double rubber condenser is indicated on page 251. This idea seems out of place in a work on "principles." Probably the author intended it as the basis for an application to be made to the Patent office, but owing to an oversight it has received prior publication. At any rate it is unusual and does not seem capable of giving good work on average materials under ordinary working conditions.

In chapter 10, "The Mule," is given a diagram, Fig. 93, "Spindle and Roller Gearing"; perhaps when a further revision of the book is required, this diagram will be modified by deleting the scheme for spindle driving, or a full and correct drawing substituted.

Regarding matter in section on "Woollen Frame Spinning"; statements are made which should be queried, as for instance, "there are quite a definite number of turns in the portion which lies between the deflector rods and the back rollers, and it is here that the greatest amount of drafting is done," the last sentence is open to serious doubt, for assuming "no fibre measures $1\frac{1}{2}$ inches in length" and "the twisting tube is nearly 6 inches long," the drafting must take place between the nip of the front rollers and bottom grip of the twist tube, or between front rollers and top edge of the twister tubes, or where the roving is deflected and the twist changes in direction; just in accordance with the number of turns of twisting tube per unit length delivered by back rollers.

The detailed comparison of production costs for spinning on mules and frames is formulated on the basis of wages for labour, cost of power, and rent for space occupied. Information as to influence of capital costs, running expenses, adaptability, costs for extreme changes, yarn and fabric characteristics due to the use of respective machines, would have been appreciated. Ho.



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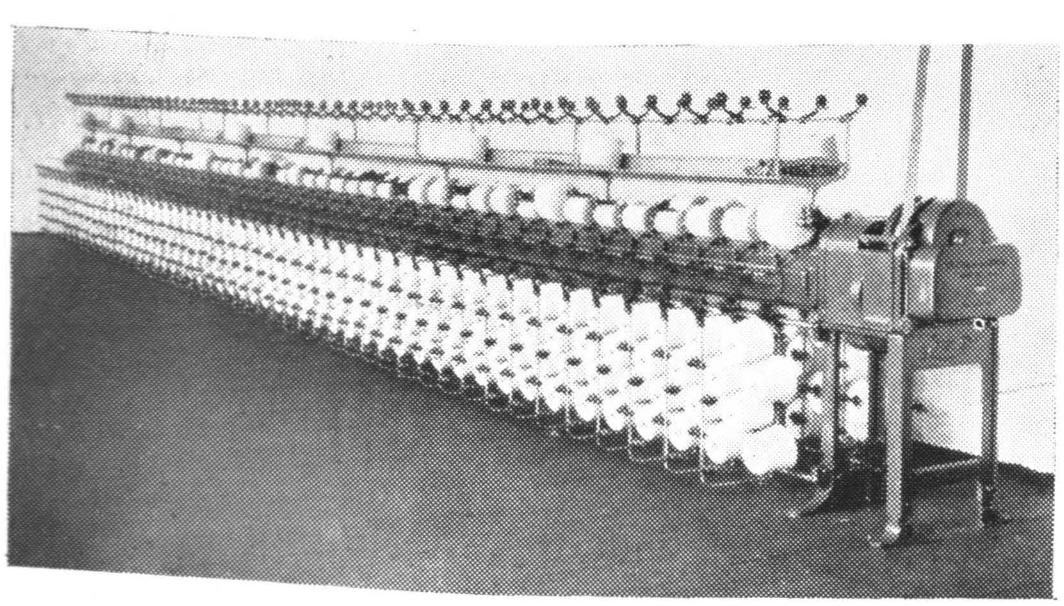

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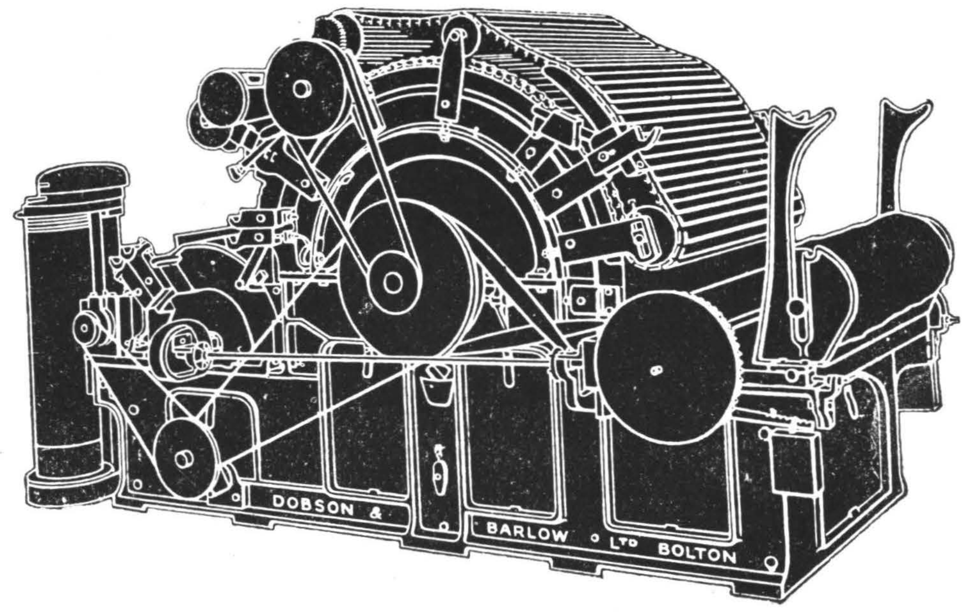

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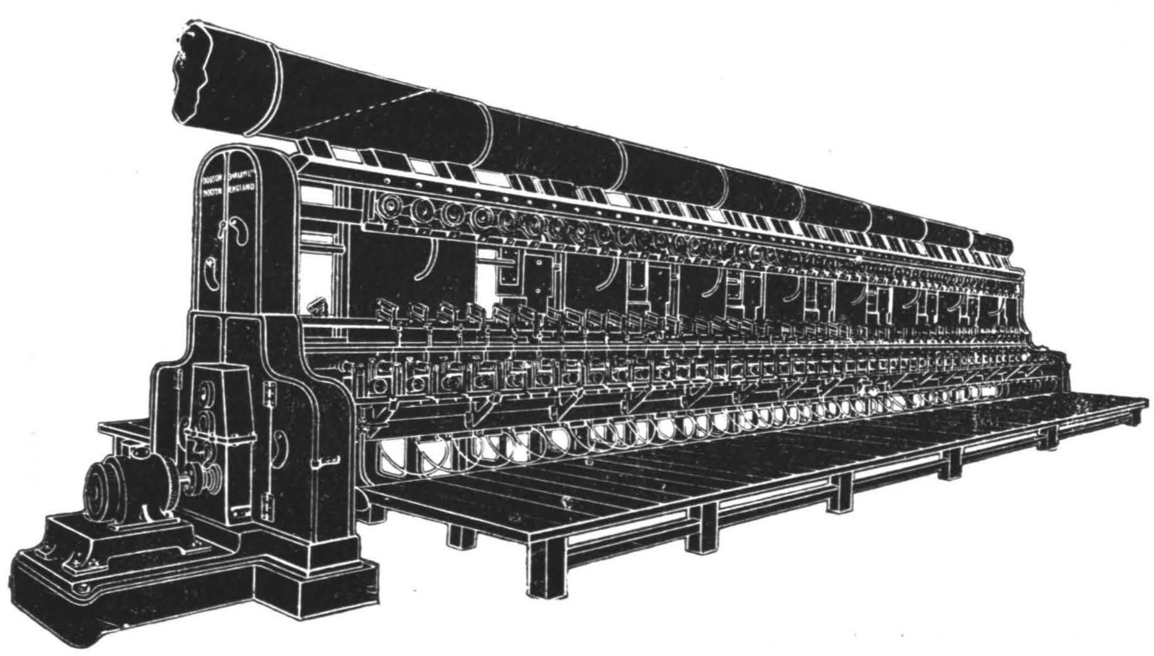

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TRANSACTIONS

3—THE THERMAL CONDUCTIVITY OF TEXTILE MATERIALS AND FABRICS

By J. B. Speakman and N. H. Chamberlain

(Leeds University)

The thermal conductivity of textile materials and fabrics has been studied by many observers. Their results have been collected and summarised in the usual works of reference, such as the International Critical Tables, and no useful purpose would be served by attempting afresh to review the extensive literature of the subject. With the exception of the work of Rood[1] and of Sale and Hedrick,[2] measurements of the thermal conductivity of textile materials have hitherto been recorded only on account of their academic interest, or because of some specific use as heat insulators in scientific work or refrigerator practice. From the point of view of the textile technologist, the value of existing data is small. The majority of observers have made no attempt to define the fabrics examined with any exactitude, none of the structural details from which manufacturers would construct or identify a cloth being given. This dissociation of pure science from textile technology is responsible for a number of attempts to make qualitative comparison of the warmth properties of textile fabrics, and this in turn has given rise to controversy regarding the relative merits of the various textile fibres as heat insulators. It is clear that the *qualitative* comparison of fabrics can only indicate their relative merits *as fabrics*, and attempts which have been made to extend the results to the component fibre substance are misguided and misleading.

The purposes of the present investigation are therefore threefold—first, to determine the relative merits of various textile fibres as heat insulators by making observations on loose fibre in various states of compression; second, to determine the influence of trade processes on the warmth properties of the finished fabric; and third, to study the thermal conductivity of as wide a range of fabrics as possible, giving in each case structural details to facilitate identification and reproduction.

It is important at this stage to recognise that the term "specific conductivity" or "thermal conductivity" does not have its usual precise significance when applied to a heterogeneous system such as a fabric. Not only is the transfer of heat accomplished by convection and radiation as well as conduction, but one of these factors, convection, may vary considerably according to the design of apparatus. Results of the greatest value will be obtained when the apparatus is so designed that the convection factor operates in much the same way as when the fabric is actually in use. Since the present investigation is intended to refer mainly to clothing materials worn next to the skin, and covered with other thicknesses of cloth so that free air has no access to them, determinations of thermal conductivity were carried out on fabrics contained between metal plates in an enclosed space, so as to eliminate convection initiated by external agencies as far as possible. The study of fabrics in use as outer clothing requires a totally different procedure, and the results of this, the second section of the investigation, will be detailed in another paper. The research will be completed by a study of the transparency of fabrics to radiant heat, and it should ultimately be possible to prophesy the warmth of textile fabrics under all possible conditions, merely from a knowledge of their structural details. It must, however, be recognised that such an analysis of the transmission of heat through fabrics takes no account of the fact that the distribution of water through the specimen is different under experimental conditions from that holding under service conditious. The precise significance of the divergence is difficult to estimate, and still more difficult to determine experimentally.

EXPERIMENTAL

Design of Apparatus

The type of apparatus most generally employed by previous observers consists of a modification of the "plate" or "wall" method originally suggested by Lees[3] in his classical paper on the subject of thermal conductivity. This method was not designed particularly for use with textile fabrics, and, as might be expected, their peculiar properties merit the construction of a new form of apparatus. Its design must take account of at least three main requirements. The first of these concerns the measurement of the thickness of the specimen under examination, which is inevitably a small quantity. Only in rare cases does it rise as high as 5 mms., and the majority of fabrics have thicknesses ranging from 0·5 to 2·5 mms., a range which would include most of the fabrics in general use as clothing materials. The exceptions would be finely-woven cotton, silk, and artificial silk fabrics whose thicknesses may be as low as 0·1 mm. It follows that considerable accuracy in observation is required if the percentage error in the thickness measurement is to remain low. The problem is further complicated by the fact that a fabric does not possess a surface in the physical sense, but is bounded at each face by a layer of material whose density merges more or less gradually into that of air. Consequently, the only feasible method of defining the thickness of a fabric is to place it between two plane and parallel plates, and state the distance between them when both are in contact with the fabric. This distance, owing to the compressible nature of the fabric, varies according to the pressure applied, and a complete definition of the thickness must therefore include a statement of the pressure under which it was measured. In most cases up to the present these conditions have not been observed. Yet another difficulty exists in connection with the thickness determination. If the thickness of a fabric is measured under a cycle of pressures, it rarely returns to its original value at the original pressure, the divergence being greater the more slowly the cycle is conducted. In consequence, the thickness of a fabric used in determinations of thermal conductivity must be measured *in situ* at the time of experiment. As a corollary, it becomes evident that the apparatus must be designed so as to support the fabric at constant thickness and not at constant pressure. In certain cases, notably in the work of Griffiths and Kaye,[4] very high pressures of the order of 500 grams per sq. cm. have been used in order to ensure efficient thermal contact between the sample and the hot and cold discs. Such a procedure is not permissible with fabrics, as it is bound to cause abnormal conditions of density and structure in the specimens, thus rendering the results inapplicable to fabrics under normal conditions of use.

The second requirement of the apparatus is determined by the hygroscopic nature of textile materials. Under normal atmospheric conditions, wool contains about 16% of its weight of water, the amount adsorbed being determined by the temperature and relative humidity of the surroundings. A water content of this magnitude cannot be without effect on the thermal properties of the material, and, indeed, Staff[5] has investigated the relation between thermal conductivity and the amount of adsorbed water in a number of cases for wool and cotton. It is evident, therefore, that the apparatus must make provision for the control of the moisture content of the samples under examination. This is best accomplished by total enclosure, but a difficulty arises. In order to produce a measurable heat flow through the specimen, a temperature difference between its faces is essential. Should this temperature difference be large, or the absolute temperature of the hot plate be high, there is a risk of causing highly unequal distribution of moisture in the sample, culminating in the deposition of a moisture film on the colder plate. Unless the samples tested are perfectly dried, this risk must always be present, but it is preferable to avoid the use of dry samples in order to obtain results under approximately normal conditions. In this event, the only method of minimising the risk is to make the heat-detecting mechanism as sensitive as possible, allowing the temperature difference to be reduced to a minimum. Lees' method of measuring thermal conductivity is not well adapted for use under these conditions, as in order to obtain a temperature difference between the hot and cold plates of a sufficient magnitude for accurate measurement, either the temperature of the hot plate must be raised above the safety limit mentioned above, or the thickness of the sample disc must be increased by the superposition of several layers of the material under test. Either expedient is undesirable.

Finally, the apparatus should be capable of use with loose fibre in all stages of compression.

With these considerations in mind, the apparatus shown in Fig. 1 was finally evolved for use in the present investigation. The principle of the method is that of Bunsen's ice calorimeter and the cylindrical brass tank *P* constitutes the main heat reservoir or transmitter of the apparatus. It is filled with water kept at constant temperature by means of the thermostatic equipment inserted through suitable openings in the brass lid. The thermo-regulator *M* is of the type described by Clark,[6] and has been found both sensitive and invariable over long periods of time. The "heat receiver" consists of the two concentric cylindrical calorimeters *A* and *B*. The calorimeter *A* is the one by means of which measurements are actually made, the outer compartment *B* serving the purpose of a guard ring ensuring parallel heat flow through that area of the specimen immediately above calorimeter *A*. It also serves in some measure as a protection for the inner calorimeter against heat leaks from the external environment. As a final precaution to this end the whole apparatus is immersed during use up to the level of the rim *K* in a bath of finely powdered ice mixed with just sufficient water to prevent it from caking hard. The projecting rim *K* attached to the lower flange of the casing serves to prevent the ice from coming into contact with the warmer parts of the apparatus. The cross-sectional area of calorimeter *A*, which is constructed of accurately cylindrical brass optical tubing, was measured carefully before the apparatus was assembled. Both calorimeters are completely filled with distilled water, previously boiled to remove dissolved gases, from which the necessary ice is subsequently formed. To facilitate freezing and prevent undue supercooling, both calorimeters are provided with short platinum points soldered to the underside of the plate *X*.

In order to follow the volume changes occurring in the calorimeters, both are provided with outlet tubes passing through rubber stoppers inserted through suitable necks at their lower extremities, the outer calorimeter being fitted with two such openings for convenience in filling. The rubber stoppers are clamped firmly in position by spring clamps (not shown in the figure). The outlet tubes are capillary except for a short section ***H*** of wider

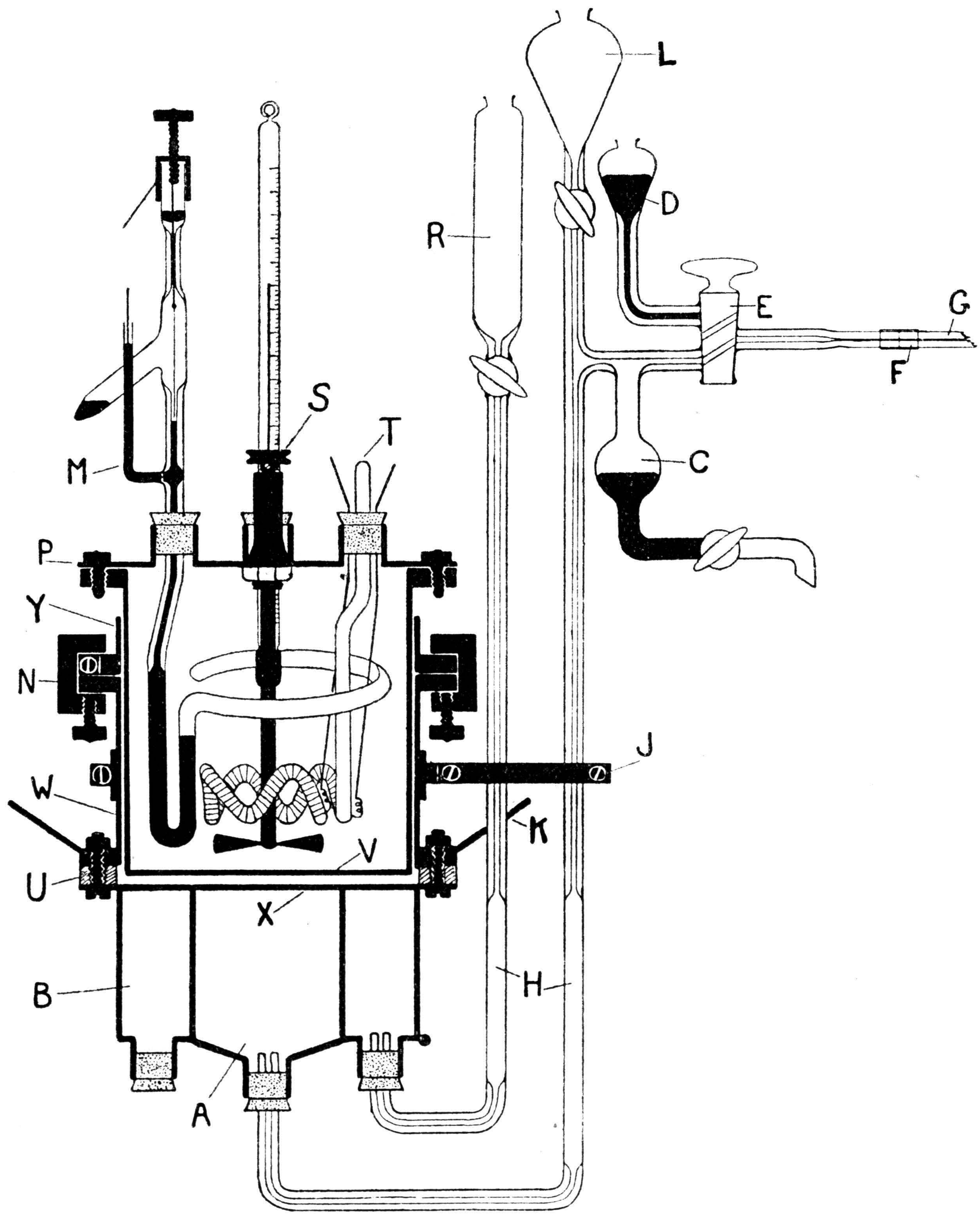

FIG. I

bore at that part of their length which is subsequently immersed in an outer ice bath. This precaution is necessary to ensure that the water drawn into the calorimeters during measurements attains a uniform temperature of 0° C. The tubes themselves are rigidly attached to the body of the apparatus by means of the clamp *J*. The outlet from the outer calorimeter terminates simply in the bulb *R*, in which the water displaced during freezing is accommodated. That from the calorimeter *A* has a similar bulb *L*, but is in addition provided with a side-tube which communicates by way of the tap *E* with a capillary *G* of extremely fine bore, in which the volume changes taking place in the inner calorimeter are actually measured. For this purpose it is provided with hair-line graduations *F* at suitable intervals, the volume of the capillary between successive marks being determined by accurate mercury calibration. By suitable manipulation of the taps, water from the upper bulb *L* may be allowed to fill the capillary. It is then put into direct and only communication with the inner calorimeter, and the rate of arrival of heat in the latter determined by measuring the rate of recession of the water meniscus in the capillary. The meniscus was observed with a telescope, and the time of passage between two marks ascertained by means of a stopwatch.

The specimen under test is contained between the lower plate *X*, which forms the top of the ice calorimeters, and the upper plate *V*, which forms the bottom of the thermostat tank. These two plates were rendered plane and parallel by grinding them down with carborundum powder and oil, first against a steel plate to make them plane, and then *in situ* against each other to make them parallel. They were both finally given a high polish to cut down radiation effects to a minimum. In order to support the thermostat tank in the correct position, with the plate *V* in contact with the upper side of the specimen, a cylindrical casing *W*, in which the tank is a good sliding fit, is attached to the top of the calorimeters, an ebonite washer *U* being inserted in order to prevent undue transference of heat from the thermostat to the guard-ring calorimeter. The joints between ebonite and metal are rendered air- and water-tight by means of piceine cement. The tank may be locked at any point within this casing by means of a sliding sleeve *Y*, carrying a flange similar to that attached to the upper edge of the casing itself. The sleeve is split at one point in its circumference, and is provided with a tightening-screw which permits of its definite location at any point on the tank, whose position is then ensured by clamping the sleeve flange and the case flange together by means of the U-clamps *N*. In this way the upper metal plate confining the specimen may be definitely fixed at any required distance from the lower plate.

As has already been indicated, the thickness of textile fabrics varies considerably with the pressure on the sample at the time of measurement. Consequently, some standard procedure must be adopted in placing the specimen between the plates of the apparatus, to ensure that in all cases the samples used are tested under comparable conditions. This procedure, in the case of fabrics and highly compressed pads of loose fibre, was as follows. The specimen having been laid perfectly flat on the lower plate, the thermostat tank was inserted in the casing, loaded with a weight, and allowed to sink down gradually until the upper plate *V* was in contact with the specimen. The flanges of the sliding sleeve *Y* and of the casing were then clamped together, the sleeve tightened so as to grip the tank firmly, and the weight removed. Under these conditions firm contact between the containing plates and the specimen is ensured. With all the fabrics examined, the pressure applied was always the same, being about 40 g. per sq. cm.

In the case of loose materials at low compression, the required thickness of the specimen necessary for a given density in the apparatus was always known. Hence the sleeve could be set and locked at the correct point before the tank was inserted. All that was then required was to press down the tank until the flanges of the casing and sleeve came into contact, and clamp them. In each case the thickness of the specimen was obtained by measuring with a micrometer gauge the distance between the upper surface of the flange attached to the tank and the lower surface of that attached to the casing before and after inserting the specimen. Eight measurements were made at marked intervals round the circumference and the mean taken, the required thickness being obtained by difference.

It will readily be appreciated that the apparatus described above conforms to all the criteria specified earlier in the paper. The thickness of the sample can be measured under test conditions, and the pressure on it either varied at will or kept constant at any desired figure from test to test. The humidity of the specimens is readily controlled, and loose materials easily tested. Further, owing to the sensitiveness of the heat-detecting mechanism, in no case was a temperature difference of more than 15° C. necessary between the two faces of the specimen; hence the risk of unequal moisture distribution in the samples is considerably reduced. The quantity actually measured, moreover, is not, as in most other cases, an equilibrium temperature, but a time interval which is susceptible of more accurate mensuration than the former. No so-called constant temperature enclosures are necessary, while the guard-ring principle used enables doubtful assumptions and cumbrous corrections to be dispensed with. Finally, all the fabrics tested were used in single thicknesses only, the superposition of several layers in order to form a sample of sufficient thickness being found unnecessary.

EXPERIMENTAL PROCEDURE

(*a*) *The preliminary treatment of the samples* used was as follows—

All samples of loose materials were cleaned by successive extraction with alcohol and ether in a Soxhlet apparatus, with the exception of acetate silk, which was extracted with petroleum ether only, to remove grease. They were then carded by hand in order to ensure uniform distribution of the individual fibres.

The woven wool fabrics were scoured according to ordinary commercial practice, then subjected to any required finishing process, and finally extracted with alcohol to remove any remaining traces of soap. The knitted hosiery fabrics, both wool and cotton, which were in all cases new samples received from the makers, were also extracted with alcohol. In this connection, it should be noted that Speakman[7] has recently shown that wool treated with hot alcohol retains up to 10% of its weight of alcohol in dry air. The alcohol is not lost *completely* until the material is placed in an atmosphere of over 90% humidity. On this account, certain of the later samples were wetted out with water and dried subsequent to immersion in alcohol. No difference could, however, be detected between samples so treated and those in which traces of alcohol remained.

The cotton fabrics were for the most part tested just as received from the makers, because, owing to the more elaborate finish usually applied to cotton goods, a more valuable test would in this way be made. Certain fabrics were, however, tested both in the untreated condition and also after scouring with soft soap and hot water, followed by extraction with alcohol, in order to ascertain the order of the difference likely to be caused by the presence of finishing materials. The results obtained will be discussed later.

The artificial silk, real silk, and linen fabrics were for the most part examined as supplied by the makers.

Before being tested, each specimen was conditioned for at least 24 hours in a large desiccator completely immersed in a thermostat at 25° C., over a sulphuric acid solution of density 1·272 at 15° C., which according to Wilson,[8] gives a relative humidity of 65% at 25° C.

(*b*) *In making a determination of thermal conductivity*, the following routine was observed.

The sample was removed from the conditioning enclosure, rapidly transferred to a weighing tube, and weighed. Meanwhile the apparatus itself was immersed in its outer ice bath for about an hour in order to cool the water in the calorimeters to near 0° C., and so facilitate the freezing of the necessary ice. This was accomplished by evaporating methylated ether, placed in the thermostat tank, by means of an air blast, the tank being in its lowest position, with the plates *V* and *X* in contact. It was eventually found by experience that once freezing had been initiated by this means, it was better to continue it by employing, instead of ether alone, a mixture of ether and light petroleum spirit of boiling point 40°–60° C. in roughly equal proportions. The risk of causing distortion of the metal parts by too rapid formation of ice was thereby minimised, as the degree of cooling which could be obtained by the use of the above mixture (—7° to —10° C. with the air blast available), whilst sufficient to ensure steady formation of ice in both calorimeters, was considerably less than that obtainable with ether alone (—16° C.).

Having frozen a sufficient quantity of ice, as indicated by the rise of the water level in the bulb attached to the outlet of the guard-ring calorimeter, the apparatus was stood with its lower end immersed to a depth of about half-an-inch in tap water at room temperature. Here it remained for a short time in order that the walls of the calorimeters might become slightly warm and so free the ice blocks inside, thus obviating any tendency for the latter to stick, and ensuring that the ice should always be in contact with the underside of the plate *X*.

In the meantime the thermostat tank was temporarily removed from the casing and rapidly replaced by a duplicate cylinder in order to prevent the access of moist air to the cold inner surface of the casing. The thermostat tank itself was warmed up to room temperature and dried; the duplicate was removed, the sample inserted, and the tank replaced. It was found that if these operations were carried out rapidly there was no tendency for a moisture film to deposit on the inside of the casing or on the lower plate *X*. If, however, this did by chance occur, it was remedied by lowering into the casing a copper gauze cage, fitting close to the walls without actually touching, and filled with granulated calcium chloride. In only a few cases, however, was this device necessary.

The sample having been placed in position, the apparatus was again transferred to the ice bath, the thermostat tank filled with powdered ice to prevent loss of ice in the calorimeters by conduction of heat from the air, and the whole system allowed to stand until temperature equilibrium was attained. It was found that progressive freezing took place in both calorimeters for some time, owing to the fact that the ice, when first formed, was below 0° C. Bunsen states that this effect was observable over a considerable period after freezing, the calorimeter being a glass one of conventional pattern and the freezing agent alcohol cooled to —35° C. In our case, owing to the smaller degree of supercooling employed, and to the use of metal apparatus, temperature equilibrium was reached in 1½ to 2 hours.

At the end of this time the actual measurements were obtained as follows. The thermostat tank, having been emptied of ice, was filled with water,* the lid carrying the thermostatic equipment was placed in position, the stirrer started, and the tank brought up to the required temperature (in all cases 15° C.). For the thicker samples a period of approximately 10 minutes was allowed for the establishment of steady flow conditions through the sample. This period was shown to be adequate by the fact that the times recorded for the passage of the water meniscus between two given points on the capillary had invariably ceased to show a progression in the downward direction at its expiration. In the case of the thinner fabrics the attainment of equilibrium was found to be practically instantaneous. The time taken for the meniscus in the capillary to pass between successive marks was determined several times in succession, and a mean value used to calculate thermal conductivity. The final stage of the determination was to remove the apparatus from the ice bath, empty the thermostat, and measure the thickness of the specimen with a micrometer gauge as already described.

(c) *Testing of Apparatus.*

On completion and before use, the apparatus was submitted to various tests to demonstrate its general reliability, and to reveal any mechanical faults which might be present. In the first place, the absence of any leaks from the outer calorimeter to the exterior, and intercommunicating leaks between the calorimeters, was established. The outer ice bath was also shown to be efficient in preventing access of heat to the calorimeters, provided it was well agitated at intervals not exceeding two minutes and was kept replenished with ice. Two further possible sources of error are inherent in the apparatus. The first consists of the asumption that the *inner* faces of the plates V and X are at the temperatures 15° and 0° C. Actually, this is not the case, since it is the outer faces which assume these temperatures. Brass not being a perfect conductor, the inner faces will be at temperatures slightly below 15° and slightly above 0° C., so that the temperature difference between the faces of the specimen is not 15° C. but $(15—x)°$ C., where x is a quantity which varies with the thickness and conductivity of the specimen. This error will be at a maximum with thin fabrics, and can readily be calculated. The thickness of the brass plates is 1 millimetre each, and the conductivity of brass is 0·260. The thermal conductivity of fabrics is of the order 1×10^{-4} cals./sq. cm./sec./unit temperature gradient, and as an extreme case we may assume the thickness to be 0·01 cm. With these data it can readily be shown that the percentage error introduced by assuming the temperature difference to be 15° C. is only 0·8 per cent.

The second possible error is that of drainage in the horizontal capillary. It was not anticipated that this would prove a serious matter, but nevertheless it was decided to carry out an experimental test. For this purpose the glass work of the apparatus was modified so as to include the mercury supply bulb D, connected to the capillary via the second arm of the 2-way tap E. Thus as an alternative to water from the bulb L, dry mercury could be allowed to fill the capillary. The trap-bulb C prevented the mercury discharged from the capillary from reaching the metal-work of the ice-containers. A sample of ebonite was placed between the plates, and the following measurements obtained—

* Direct experiment showed that the weight of water filling the thermostat tank was incapable of producing any measurable deformation of the baseplate V, even when the tank was supported well clear of the fabric.

Cross-sectional area of the inner calorimeter=18·20 sq. cm.
Temperature of thermostat=15° C.
Thickness of ebonite=0·576 cm.
Volume of capillary between marks=17·22 cubic mm.
Times for contraction between marks (mean of 10 observations)—
(*a*) With mercury as indicating liquid=99 seconds.
(*b*) With water as indicating liquid=100 seconds.
Conductivity of ebonite=0·000320.*

The drainage error is plainly inappreciable.

The possibility of a constant error in the apparatus and procedure was eliminated by determining the specific conductivity of a blanket cloth having a thickness of 2·24 mm. and an overall density of 0·1916 g/cc. This was found to be $85{\cdot}1 \times 10^{-6}$, and it is satisfactory to note that recalculation of Sale and Hedrick's data[2] for a blanket having a thickness of 2·5 mm. and a density of 0·1728 g/cc. gives the value $81{\cdot}9 \times 10^{-6}$ for its conductivity.

RESULTS

The Thermal Conductivity of Loose Materials

Subsequent to actual manufacture, most textile fabrics are subjected to various "finishing" processes whose aim is to render the material more suitable for use in particular circumstances. Among wool finishing processes are included milling, raising or napping, cutting and pressing, and while they must all influence the warmth-retaining properties of the material, some at least are definitely applied with this end in view, as, for instance, the milling and subsequent raising of blankets. A study of the effect of such processes on the thermal conductivity of fabrics is necessary if we are to gain any practical knowledge which will be of service in designing fabrics for use under prescribed conditions. Most finishing processes, however, result essentially in alterations of the density and thickness of the fabrics operated upon. This is particularly true of wool fabrics in which greater variations in these two quantities are possible than with any other material, owing to the unique structure of the wool fibre itself. Hence a study of the effect of variations of these two factors upon the conductivity of samples of loose materials forms an important preliminary to the study of fabrics. In such experiments the effect of thickness and density upon the conductivity may be studied in its simplest form, without the added complication of a more or less definite structure which is present in all fabrics.

There are four ways in which heat may traverse a mass of fibrous material such as wool or cotton, namely, by radiation from one of the confining surfaces to the other, by convection in the air filling the interstices of the specimen, by conduction through the air and by conduction through the material itself. The "apparent conductivity," i.e. the total transmission of heat by all these agencies in the case of a loose material which is itself a heat insulator, will approximate more or less closely to that of air, the sample being, as it were, for the most part composed of this medium. Although the effect of radiation can be ignored,[9] the convection factor

* This value is in all probability too low, because it was impossible to ensure perfect thermal contact at all points between ebonite and brass. The usual device of smearing the solid under examination with glycerine or other liquid could not be employed, because it would then have been impossible to remove the specimen from the apparatus after measurements had been made. No such difficulties are experienced with fabrics for two reasons—they are extremely flexible and air is an essential part of their composition.

precludes any theoretical prediction of the relations between conductivity and thickness and conductivity and density.

(*a*) *The Relation between Conductivity and Thickness at Constant Density.*

The material chosen for these experiments was an Australian merino wool of 80's quality. Two sets of observations were made, the first with wool compressed as far as possible by hand in the apparatus itself, and the second with the material arranged as loosely as possible consistent with uniform distribution. The results are summarised in Tables I and II.

Table I

Thickness of Sample cm.	Density of Sample g./cc.	Specific Conductivity $K \times 10^6$
0·078	0·0297	68·2
0·154	0·0263	70·1
0·242	0·0238	73·2
0·360	0·0232	79·3
0·493	0·0237	83·9
0·642	0·0234	85·0
0·760	0·0231	88·9
0·978	0·0237	97·6

Table II

Thickness of Sample cm.	Density of Sample g/cc.	Specific Conductivity $K \times 10^6$
0·123	0·1313	64·5
0·244	0·1651	72·3
0·500	0·1623	83·6
0·739	0·1641	86·4

(*b*) *The Relation between Conductivity and Density at Constant Thickness.*

A consideration of the preceding results led to the adoption of an arbitrary standard thickness of 5 mm. for these experiments, because at this thickness readings could be obtained with sufficient rapidity to ensure reliable results, while the effect of small variations from this standard thickness is negligibly small. Preliminary experiments were made with seven different materials compressed by hand in the apparatus itself, but the maximum density attainable in this way was only 0·1761 g./cc., or approximately one-eighth of that theoretically possible in the case of wool. A number of observations were made with several materials compressed to different degrees, but the variation in conductivity was so small as to be insignificant, and only the values for extremes of density will be quoted (Table III).

Table III

Material	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
Australian crossbred wool, 56's quality	0·474	0·0127	88·0
	0·460	0·1761	82·9
Australian merino wool, 80's quality	0·493	0·0237	83·9
	0·500	0·1623	83·6
Turkey mohair, 5's quality	0·458	0·0254	80·9
	0·493	0·1616	81·3
Japanese silk waste	0·485	0·0252	73·9
	0·498	0·1626	83·0
Egyptian cotton	0·502	0·0122	89·0
	0·460	0·1681	90·6
Viscose silk	0·495	0·0235	85·9
	0·472	0·1590	89·1
Acetate silk	0·485	0·0242	80·5
	0·464	0·1732	84·4

It is shown later in the paper that the density of fabrics varies from 0·15 to 0·60 g./cc., the vast majority having densities outside the range covered by the preceding experiments. The mechanical construction of the apparatus would not permit of higher values being obtained by the compression *in situ* of a mass of carded fibres, and a separate apparatus was accordingly constructed for use in a hydraulic press. This consisted of a brass casting whose interior was machined to the same diameter as the main apparatus. A solid cylidrical brass plunger was turned to make a very good fit within the casting, which was screwed down by means of projecting lugs to a brass baseplate. The material to be compressed was carded as before, then placed in the cavity of the casting and thoroughly wetted with distilled water. The plunger was placed in position and allowed to rest on the upper surface of the material, thus serving to retain it in position during the subsequent operation of boiling. The whole compression apparatus was immersed in boiling water for approximately 30 minutes in order to bring the wet material up to steam temperature, then rapidly removed, placed in a hydraulic ram, and a sufficient pressure exerted to compress the material within the desired space. Pressures up to 450 lb. per square inch were used. The apparatus was allowed to cool in the ram, the disc of material being afterwards removed and then kept under pressure in a screw press between thick pads of blotting paper until most of the water had been removed. Finally, the pad was transferred to the humidity room (65% relative humidity at 22·2° C.), and allowed a minimum of three days to "condition" before being tested in the apparatus. In the case of wool, the discs of material had to be compressed to thicknesses less than 5 mm. to compensate for the elastic recovery which always took place during conditioning. In consequence, the samples used were not always at the standard thickness when tested, but those which were seriously in error had their conductivities corrected by reference to the conductivity-thickness relationship already obtained. In the case of cotton this difficulty did not arise.

The results obtained with compressed wool pads were consistent and reproducible, but unaccountable variations were at first encountered with compressed cotton. Their cause was finally located in the fact that the fibres in the compressed pads were not distributed entirely haphazardly, but tended to be arranged with their long axes parallel to the faces of the sample. The cause of this orientation lay in the fact that in preparing the cotton for compression it was carded by hand and the carded material stripped from the cards in a series of sheets or laps in which the fibres were definitely placed side by side. It had then been the custom to place a series of laps one upon the other, insert the pile so obtained in the press, and compress the whole, still in the same position, into the space desired. Upon occasion, however, the flat arrangement of the laps mentioned above was more or less interfered with in the operations preceding the actual compression, and the results obtained with such pads showed the variations already mentioned. This explanation was shown to be valid by preparing two pads of the same density, one with the laminated arrangement of the fibres preserved as far as possible, and the other with this arrangement destroyed by turning the pile of card laps on its side before compressing. The results obtained with these two samples were as follows—

Sample	Density g./cc.	Thickness cm.	Specific Conductivity $K \times 10^6$
Laminated	0·276	0·459	85·7
"Unlaminated"	0·275	0·467	92·6

The results given in Table IV were obtained with samples in which every endeavour was made to destroy preferential orientation of the fibres.

Table IV

Material	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$	Specific Conductivity corrected to Thickness of 5 mm. $K \times 10^6$
64's Merino Wool	0·469	0·025	78·5	
	0·497	0·070	79·1	
	0·451	0·128	79·9	
	0·459	0·176	81·3	
	0·571	0·200	82·3	
	0·340	0·362	88·4	94·7
	0·516	0·416	97·0	
	0·249	0·503	101·6	112·6
	0·312	0·618	115·7	123·8
	0·201	0·811	134·2	146·7
	0·240	0·903	155·5	166·7
Egyptian Cotton	0·502	0·0122	89·0	
	0·490	0·0588	86·1	
	0·500	0·0988	83·6	
	0·474	0·1294	87·5	
	0·460	0·1681	90·6	
	0·477	0·270	93·2	
	0·467	0·275	92·6	
	0·538	0·385	99·5	
	0·518	0·612	135·2	
	0·510	0·622	133·1	
	0·538	0·901	169·3	
	0·512	1·028	268·6	
Viscose staple fibre	0·495	0·0235	85·9	
	0·482	0·0239	86·0	
	0·490	0·0472	81·7	
	0·495	0·0696	79·9	
	0·477	0·0970	82·0	
	0·482	0·1196	84·1	
	0·479	0·1386	80·8	
	0·472	0·1590	89·1	
	0·326	0·3434	101·0	
	0·371	0 4656	120·1	
	0·345	0·6052	134·9	
	0·361	0·7893	180·6	
	0·358	0·7991	181·0	
	0·416	0·8030	183·5	
	0·370	1·199	258·2	
	0·366	1·188	298·6	

The preceding observations possess a certain intrinsic interest, and serve also to show the superiority of wool as an insulator over cotton and viscose silk (Fig. 2). It is, however, difficult to assess their value in relation to the thermal conductivity of fabrics, because there must always remain some doubt whether the fibre arrangement is precisely the same with different fibres. Fortunately, the development of the study of fabrics, to be discussed later in the paper, led to the discovery of a more reliable method of evaluating the relative merits of the several textile fibres as heat insulators, and the work on compressed pads of loose fibre was accordingly abandoned.

The Thermal Conductivity of Wool Fabrics

It has so far been shown that the thermal conductivity of heterogeneous systems such as compressed pads of textile fibres is dependent on the thickness of the sample tested and to a smaller extent on its density. A study of the effect of trade finishing processes on these two variables, and the corresponding changes in the thermal conductivity of fabrics, was therefore undertaken. Unfortunately, the investigations had to be limited to wool fabrics because of the absence of suitable machinery for manipulating the remaining textile fibres. As a preliminary to the study of finishing processes, the effect of weave structure on thermal conductivity was determined.

(a) The Effect of Weave Structure on Thermal Conductivity.

Two series of fabrics were constructed, the first consisting of seven fabrics of diverse weave, woven in the same loom from the same warp and to as nearly as possible the same loom particulars. This series will be designated

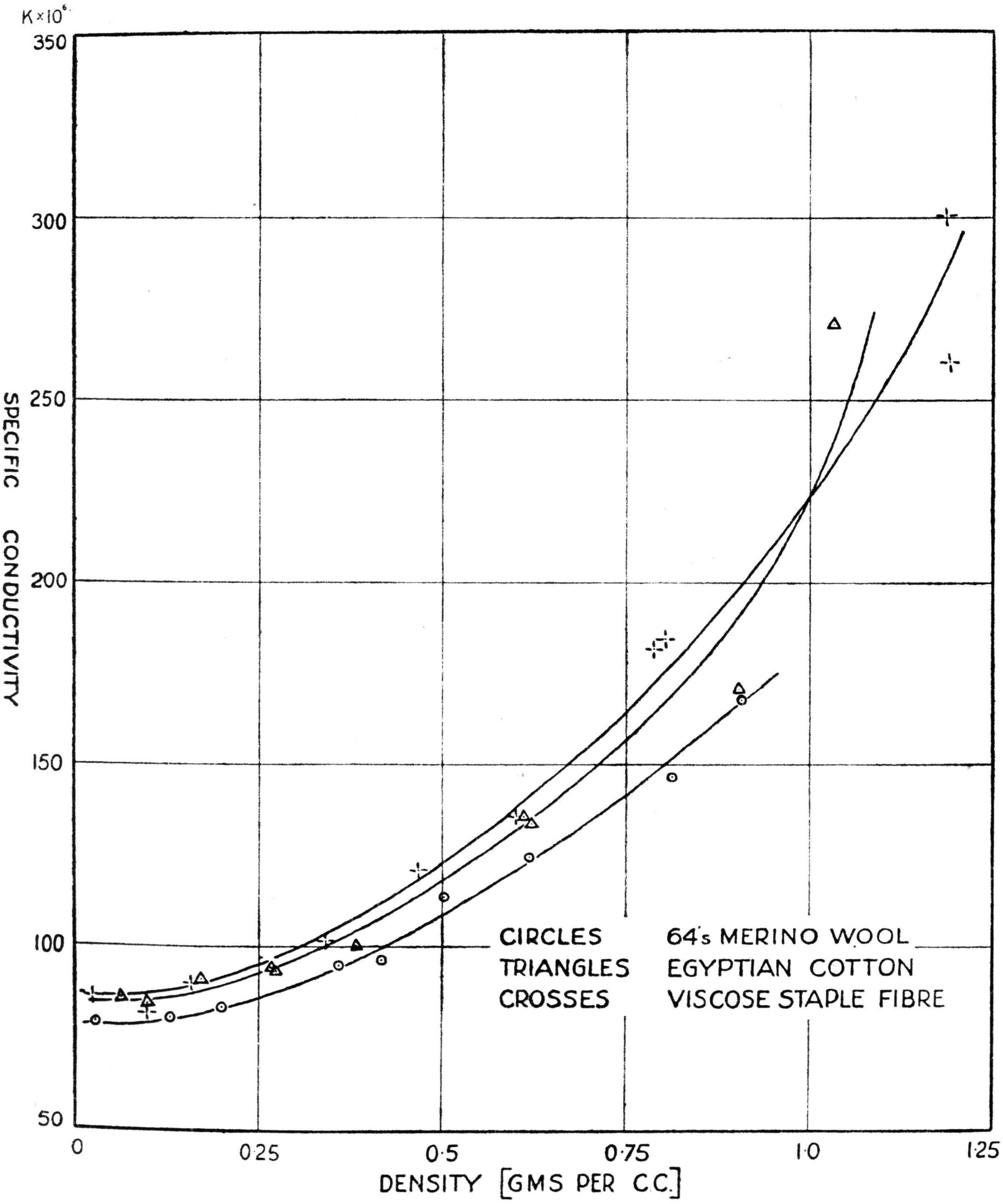

FIG. 2

as W1. Owing to the differing properties of the weaves employed, the fabrics finally produced differed slightly from one another in particulars, on account of the different shrinkage occasioned in scouring. The results obtained are given in Table V, full particulars of the fabrics being shown in the appendix. The second series consisted of six much thicker fabrics, also woven in the same loom and from the same warp. In this case the various pieces were milled to some extent in order to bring the particulars of the finished fabrics more nearly into agreement. This series is identified as W^2, and the results obtained are given in Table VI.

Table V

No. of Fabric	Weave	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
$W^1 1$	2/2 Twill	0·076	0·359	84·6
$W^1 2$	4/4 Twill	0·093	0·338	90·8
$W^1 3$	2/2 Twilled Hopsack	0·076	0·416	88·7
$W^1 4$	2/2 Hopsack	0·071	0·406	85·4
$W^1 5$	Broken Crow	0·068	0·423	90·0
$W^1 6$	3/1 Repp	0·071	0·428	88·1
$W^1 7$	3/1 Twill	0·076	0·366	89·1

Table VI

No. of Fabric	Weave	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
$W^2 1$	Honeycomb	0·419	0·158	95·4
$W^2 2$	4/4 Warp Rib	0·264	0·285	98·3
$W^2 3$	4/4 Hopsack	0·266	0·245	93·3
$W^2 4$	Plain	0·193	0·271	87·9
$W^2 5$	3/1 Twill	0·306	0·228	96·3
$W^2 6$	Weft Cord	0·301	0·248	97·6

It is clear from these measurements that weave structure affects the thermal conductivity of a fabric only indirectly through the variations which it is able to cause in the thickness and density.

(*b*) *The Effect of the Milling Process on Thermal Conductivity.*

Owing to the independence of conductivity and weave structure, it is possible to study the effect of wool finishing processes on the warmth-retaining value of a single fabric with the certain knowledge that the results will be of general application. Probably the most important of such processes is that of milling. Hence the following experiments were carried out with a view to determining to what extent and in what manner this process affects the thickness, density, and conductivity of wool fabrics.

The material used was a white worsted cloth of twill weave, described in the table given in the Appendix under number $M^1 1$. From this material two ranges of samples were prepared. The first consisted of eight pieces milled to varying extents in the fulling stocks, potash soap being the milling agent; the second, of a further eight pieces milled in the milling machine with hard (soda) soap. Both series are necessary, as the effect produced by the two methods is not the same. The fulling stocks tend to produce a fluffier appearance on the face of the cloth, combined with greater thickness and softness of handle, than the milling machine. The extent of milling in both cases was ascertained by measuring before and after the process the area of a large rectangle marked out on the sample by coloured stitching. The percentage decrease in area was taken as a measure of the extent of the milling process. The results obtained in the two cases are summarised in Tables VII and VIII.

Table VII

Samples Milled with Soft Soap in the Fulling Stocks

No. of Fabric	Degree of Milling (% Contraction of Initial Area)	Thickness cm.	Density g./cc.	Specific Conducitivity $K \times 10^6$
$M^1 1$	0	0·124	0·328	97·6
$M^1 8$	7·90	0·162	0·258	94·9
$M^1 9$	11·79	0·157	0·277	94·0
$M^1 6$	12·31	0·157	0·279	96·1
$M^1 2$	19·77	0·188	0·262	90·1
$M^1 4$	31·94	0·233	0·253	94·4
$M^1 3$	32·43	0·226	0·250	95·0
$M^1 7$	41·34	0·224	0·283	96·4
$M^1 5$	44·06	0·254	0·268	95·2

Table VIII

Samples Milled with Hard Soap in the Milling Machine

No. of Fabric	Degree of Milling (% Contraction of Initial Area)	Thickness cm.	Density g./cc.	Specific Conductivity K × 10^6
M^28	0	0·117	0·343	97·7
M^21	7·48	0·147	0·295	93·1
M^22	11·85	0·155	0·279	92·3
M^23	19·61	0·162	0·287	94·9
M^24	27·05	0·174	0·300	91·3
M^27	30·65	0·183	0·301	93·8
M^26	34·60	0·193	0·303	96·2
M^25	40·61	0·204	0·316	96·9

A study of these results reveals the following points of interest. In both series the initiation of the milling process is marked by an increase in thickness, a decrease in density, and a drop in conductivity. This is in keeping with the production of a fibrous cover on the face of the cloth, which, by reason of the layer of air entrapped by it, tends to lower the conductivity of the material. As shrinkage progresses the thickness of the samples in series M^1 increases, but the conductivity and density remain approximately constant. The raising of a cover seems to counterbalance the slight tendency of the fulling process to raise the density, and so keeps the conductivity constant. In series M^2 the same effect is present but to a lesser degree. In this case not only is the thickness finally attained by the fabric less, indicating a smaller amount of cover, but the density shows a tendency to rise as milling progresses; the covering effect is no longer sufficient to neutralise the increase in density and the conductivity rises.

It is of considerable interest to study the conductivity of a range of fabrics milled in the same manner as the foregoing, but in which the covering effect is absent. This may be done in practice by first milling the samples as before, and then running them over the cutting machine in order to remove any cover which may have been formed during milling.

(*c*) *The Conductivity of Fabrics Milled and Subsequently Cut.*

Samples were taken from each of the fabrics comprising the series M^2, and these were then run through the cutting machine together, so that the surface of each was cropped to the same extent as judged by appearance. The results obtained from the series of samples so prepared are indicated in Table IX. In general, the conductivity of these fabrics is distinctly higher than those from which they are derived. This serves to confirm the suggestion already advanced as to the effect of a fibrous layer in reducing the conductivity of a fabric.

Table IX

Fabric No.	Degree of Milling (% Contraction of Initial Area)	Thickness cm.	Thickness of Cover Removed mm.	Density g./cc.	Specific Conductivity K × 10^6
MC.8	0	0·098	0·19	0·382	99·6
MC.1	7·48	0·111	0·36	0·352	98·0
MC.2	11·85	0·117	0·38	0·354	101·6
MC.3	19·61	0·122	0·40	0·356	100·9
MC.4	27·05	0·129	0·45	0·362	103·3
MC.7	30·65	0·132	0·51	0·361	95·2
MC.6	34·60	0·139	0·54	0·360	100·0
MC.5	40·61	0·139	0·65	0·385	100·8

(*d*) *The Conductivity of Raised Fabrics.*

The foregoing experiments are unanimous in indicating that a fluffy surface or cover, if developed on a fabric, tends to lower its conductivity.

Hitherto, however, we have considered only the cover which is raised upon cloths as an incidental result of the milling process. This very cover is formed on many types of fabrics to a far greater degree by the process of raising, and in many cases with the express intention of rendering the fabrics more valuable from a warmth-retaining standpoint. It is of interest therefore to carry the investigations one stage further, and determine experimentally the effect of the raising process upon the fabric itself and upon its conductivity.

For this purpose a further supply of the same cloth (No. $M^1 1$) was obtained and divided into suitable sample lengths. These lengths, nine in number, were then milled together in the milling machine to 30% contraction. This was done to provide a firm structure for raising, so that the samples which would subsequently be severely raised might not suffer an undue amount of damage in the process; and also to simulate as far as possible normal commercial practice. After milling, the samples were placed on the card-wire raising machine, which was run at its lowest speed. One sample was removed initially, and kept as the unraised standard. The remainder were taken from the machine at intervals, the last to be removed having run long enough for the raising process to have reached its limit.

The results obtained from this series of samples, given in Table X, show an immediate increase in thickness and decrease in density at the start of the process. The conductivity also drops, which again confirms the conclusions already arrived at. After a time, however, the reverse changes appear to occur, the thickness showing a continuous decrease while the density and thermal conductivity tend to increase. This undoubtedly indicates that from sample R4 onwards the machine is not actually raising the cloth at all, but is, in fact, removing the cover already formed. As a matter of interest, a piece of the sample R9 was removed after raising, and run through the cutting machine in the same way as those in the MC series, so as to remove the whole of the raised cover. The resulting fabric had a thickness of 1·39 mm., an overall density of 0·371 g./cc, and a specific conductivity of $101{\cdot}4 \times 10^{-6}$.

Table X

No. of Fabric	Degree of Raising (Times Round the Machine)	Thickness cm.	Density g./cc.	Specific Conducitivity $K \times 10^6$
R.5	0	0·167	0·334	97·9
R.1	1	0·195	0·284	94·2
R.2	2	0·188	0·291	92·5
R.3	4	0·190	0·287	94·3
R.4	6	0·193	0·283	93·3
R.6	8	0·185	0·292	93·5
R.7	11	0·183	0·298	94·2
R.8	15	0·178	0·308	93·8
R.9	20	0·180	0·296	94·4

(*e*) *The Conductivity of Knitted Wool Fabrics.*

For these experiments samples were obtained from as many external sources as possible in order to obtain a representative selection of the types at present in use. The results are arranged in order of increasing thickness of fabric in Table XI to demonstrate the increase in conductivity with thickness. As was to be expected, the range of densities encountered in knitted fabrics is smaller in extent than in the case of woven materials.

Table XI

Fabric No.	Type of Raw Material Used	Thickness cm.	Density g./cc.	Specific Conductivity K × 10⁶
K.2	Fine crossbred	0·051	0·331	73·5
P.1	—	0·054	0·266	66·1
P.4	—	0·058	0·318	76·1
K.8	Fine crossbred	0·061	0·288	76·0
K.10	Dry spun Botany	0·063	0·283	73·2
K.6	Medium crossbred	0·066	0·287	75·4
P.2	—	0·073	0·227	74·2
K.3	Fine crossbred	0·078	0·273	81·7
K.7	Fine crossbred	0·081	0·286	83·3
K.11	Dry spun Botany	0·083	0·253	83·4
K12	Dry spun Botany	0·091	0·273	81·1
K.1	Fine crossbred	0·101	0·255	83·3
P.3	—	0·101	0·281	86·1
K.5	Medium crossbred	0·106	0·255	85·4
K.9	Fine crossbred	0·117	0·241	88·5
E.8	Cheviot	0·254	0 220	99·2

The Thermal Conductivity of Fabrics Composed of Fibres other than Wool

The fabrics used in this section of the investigation were obtained from external sources, and precise details of the finishing processes to which they had been subjected are not therefore available. The structures of the finished fabrics have, however, been ascertained as far as possible by analysis, particulars of which will be found in the Appendix.

(*a*) *The Conductivity of Cotton Fabrics.*

The results obtained on woven cotton fabrics are shown in Table XII, and there is an evident tendency for the conductivity to rise with increasing thickness of the fabric.

Table XII

Fabric No.	Thickness cm.	Density g./cc.	Specific Conductivity K × 10⁶
F.5	0·018	0·752	68·4
C.5	0·018	0·657	66·1
O.1	0·021	0·528	67·3
F.3	0·023	0·615	78·2
F.5A	0·023	0·602	83·4
C.4	0·023	0·555	75·4
F.3A	0·029	0·481	89·8
F.2	0·030	0·698	105·3
F.2A	0·030	0·695	102·7
F.4	0·036	0·501	98·2
F.1	0·038	0·567	96·9
F.1A	0·043	0·504	97·1
F.4A	0·043	0·398	104·0
C.3	0·043	0·341	85·8*
C.2	0·048	0·363	100·2
O.4	0·054	0·362	92·4*
C.1	0·068	0·260	99·1

* Samples had been napped, and possessed a fluffy surface.

Taking certain results in detail, the effect of raising can again be seen in samples C.3 and O.4, whose conductivity is decidedly below the average observed in this region of thickness. The samples comprising series F (F.1 to F.5) all had the appearance of being rather heavily finished, and details of the same fabrics after soap scouring to remove finishing materials are given under the notation F.1A to F.5A. As might be expected, the effect of scouring is to increase the thickness and decrease the density of the fabrics.

Cotton fabrics specially designed for underwear purposes were also studied, three samples of knitted fabrics and three of cellular fabrics being examined. The results are summarised in Table XIII, and it is evident that the cellular structure has the advantage over knitted fabrics in so far as heat-retention in stagnant air is concerned.

Table XIII

No. of Fabric	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
Cellular Fabrics—			
A.7	0·076	0·172	95·1
A.6	0·081	0·185	106·3
A.1	0·098	0·197	104·8
Knitted Fabrics—			
V.2	0·066	0·229	108·8
V.3	0·073	0·263	118·2
V.1	0·088	0·218	114·1

It will be noted that the values obtained for the conductivity of cotton materials are, on the whole, greater than those found for wool fabrics, despite the fact that the thicknesses are, generally speaking, less.

(*b*) *The Conductivity of Silk Fabrics.*

Measurements were made on two woven and two knitted samples of real silk fabrics. The data obtained are given in Table XIV, but the value obtained for the conductivity of the first fabric may be unreliable owing to its very small thickness.

Table XIV

Fabric No.	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
Woven fabrics—			
O.12	0·011	0·749	49·7
O.13	0·018	0·603	64·4
Knitted fabrics—			
O.14	0·101	0·285	114·0
O.15	0·038	0·379	76·4

(*c*) *The Conductivity of Artificial Silk Fabrics.*

With two exceptions, the artificial silk fabrics examined were knitted materials. Sample O.8 was a woven cuprammonium silk fabric; O.3 was knitted from hollow-fibre viscose; and K.4 was a similar structure made from ordinary solid-fibre viscose, for comparison; O.10, O.9, and O.11 were knitted cellulose acetate silk fabrics, while S.3 was a woven fabric of viscose silk, the yarn being made on the woollen system from short fibre.

Table XV

Fabric No.	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
O.8	0·018	0·675	72·9
O.3	0·026	0·370	75·4
K.4	0·029	0·499	91·3
O.10	0·029	0·394	72·6
O.9	0·033	0·344	68·3
O.11	0·044	0·252	67·7
S.3	0·054	0·391	83·6

(*d*) *The Conductivity of Linen Fabrics.*

Only one linen fabric was examined, the following figures being obtained.

Fabric No.	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
O.5	0·029	0·568	86·8

(e) The Conductivity of Mixture Fabrics.

Fabrics composed of a mixture of wool and cotton have been in use for a considerable time, and have found many applications. In recent times, and more particularly since the artificial fibres came into prominence, other mixtures, such as cotton with artificial silk, have been produced in order to combine to some extent the excellent manipulative properties of wool and cotton with the undoubted decorative advantages of artificial silk. Such mixtures are in fairly extensive use as clothing materials, and it appeared necessary to examine at least a small selection of fabrics of this type. Of the eight mixture fabrics obtained, four were cellular underwear materials (A.2 to A.5), the first two being wool-cotton mixtures. S.1 and S.2 were suitings composed of viscose and wool yarns in which the two fibres were scribbled together in manufacture. E.7 was a cotton suiting, the structure being a warp-backed one in which the backing threads contained the wool fibres. V.4 was a knitted fabric composed of two distinct yarns, one of wool and one of cotton, the structure being such that the fabric possessed a woollen exterior and a cotton interior face. Details of the analysis of these fabrics and the results obtained are given in the following table.

Table XVI

Fabric No.	Composition of Material	Thickness cm.	Density g./cc.	Specific Conductivity $K \times 10^6$
A.5	Cotton viscose	0·048	0·280	87·6
A.3	Wool 54·3%, cotton 45·7%	0·091	0·164	93·2
A.4	Cotton viscose	0·098	0·165	93·7
A.2	Wool 55·7%, cotton 44·3%	0·119	0·159	93·7
S.1	Wool 33·1%, viscose 66·9%	0·043	0·427	82·8
S.2	Wool 27·8%, viscose 72·2%	0·043	0·429	83·4
E.7	Wool 18·9%, cotton 81·1%	0·068	0·546	114·2
V.4	Wool 41·8%, cotton 58·2%	0·122	0·211	96·0

It will be noted that the conductivities of the cellular fabrics are distinctly lower than those of similar materials made from cotton only; and that the knitted fabric V.4 has decided advantages over the all-cotton knitted fabrics V.1, V.2, and V.3 (Table XIII).

DISCUSSION OF RESULTS

Up to the present attention has been confined simply to the value of the specific conductivity of a fabric and its relation to the physical characteristics of the structure. The value of a fabric as a heat-insulator is, however, not determined solely by the specific conductivity, and a better index of the fabric's worth would be the quantity of heat transmitted in a given time by the material when the two faces are maintained at given temperatures. The following discussion is therefore concerned mainly with an arbitrary quantity, called for convenience "total heat loss," which is defined as the quantity of heat, in calories, passing through unit area of the fabric in unit time, when one face is maintained at 0° C. and the other at 15° C.

If the specific conductivity of fabrics were a constant quantity, the total heat loss would be inversely proportional, and the utility of a fabric directly proportional to its thickness. It has, however, been shown that the specific conductivity of fabrics is a function of at least three variables; their density and thickness and the nature of the constituent fibres. The total heat loss is obviously affected by the same factors.

The term density, as applied to a fabric, requires special consideration. It is, of course, defined as the average weight of solid material per unit volume of the heterogeneous system, the volume being measured under standard pressure in the apparatus, as already described. Such a quantity must be used with care in comparing fabrics, for it is possible to obtain the same mean density in a variety of ways. For example, one fabric may have a very open weave and extremely hard-twisted yarns, and another a fairly close weave and soft yarns. Fortunately, the degree of heterogeneity of fabrics is not markedly variable, and the influence of density on thermal conductivity is, in any event, relatively small. In consequence, it has been found possible to express the "total heat loss" for the whole range of wool fabrics examined in general terms as a function of thickness and density.

If the thermal conductivity of fabrics were independent of thickness, the total heat loss would be inversely proportional to thickness, and the relation between these two quantities would be represented by a rectangular hyperbola as shown in curve I, Fig. 3. Actually, the conductivity increases with increasing thickness, and the relation between total heat loss and thickness under these conditions will be of the type shown in curve II, Fig. 3. Both curves are hyperbolic in form, but are different in this respect, that whereas in the case of curve I a straight line would be obtained passing through the origin (curve I, Fig. 4), when the reciprocal of total heat loss

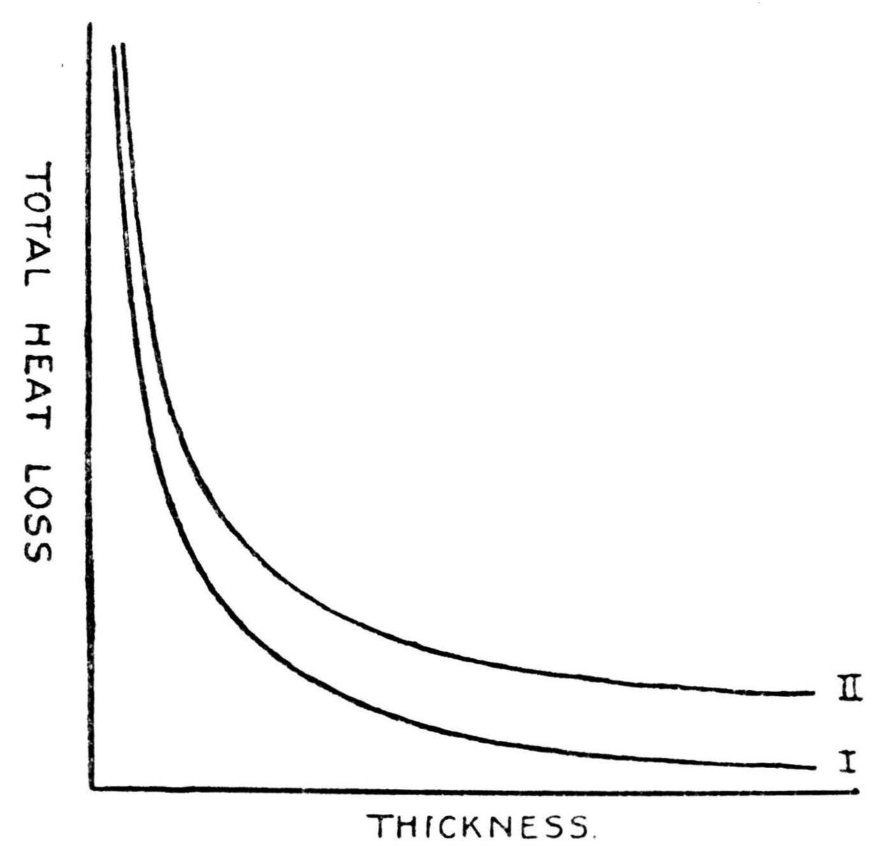

FIG. 3

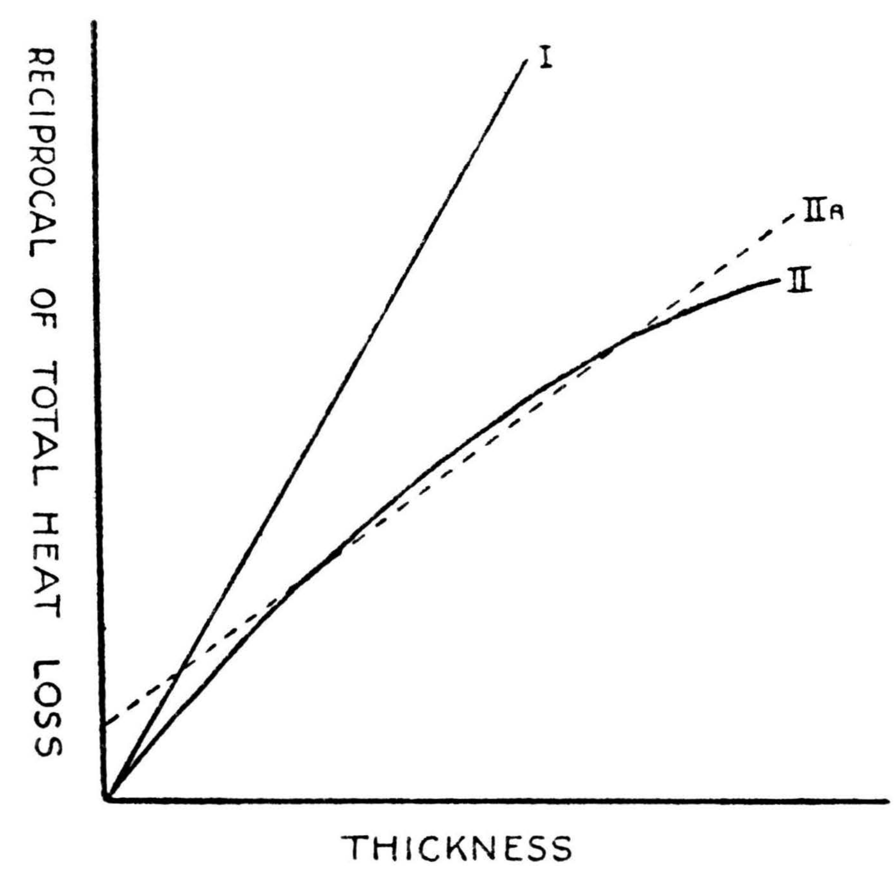

FIG. 4

is plotted against thickness, the corresponding reciprocal graph in the case of curve II would be a curve, as shown in curve II, Fig. 4. In practice, however, owing to the fact that the lower values of thickness are missing, it is found that the reciprocal graph approximates very closely to a straight line having a positive intercept on the reciprocal heat-loss axis, as shown in the dotted curve IIA, Fig. 4. A straight line is actually the best curve which can be drawn through the experimental points (see Fig. 5). The preceding analysis is true only for fabrics of constant density, but while it is known that specific conductivity and total heat loss increase with increasing density, the precise effect of density is best deduced from the experimental results for the fabrics themselves.

All the measurements made on wool fabrics are summarised in Table XVII in order of increasing density. These were sub-divided into groups within which the variation of density was small, as shown by the following figures—

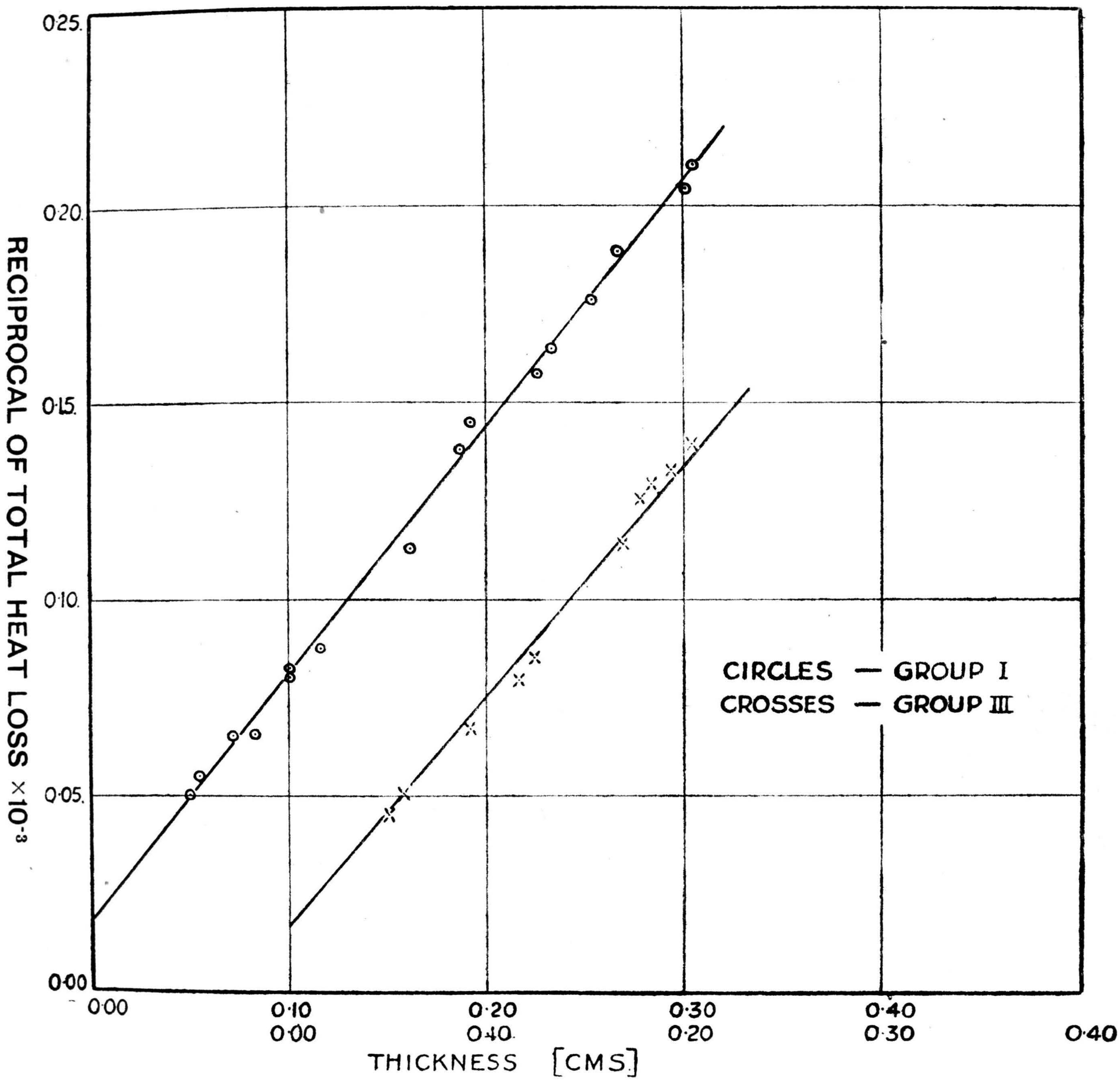

FIG. 5

Group		Density Range (g./cc.)		Mean Density (g./cc.)
I	...	0·228—0·268	...	0·252
II	...	0·271—0·300	...	0·286
III	...	0·301—0·343	...	0·322
IV	...	0·352—0·389	...	0·366
V	...	0·406—0·428	...	0·417

Within each group a linear relationship holds between the reciprocal of total heat loss and thickness. The curves for groups I and III are reproduced in Fig. 5, and it will be seen that the distribution of the individual points about the mean lines is distinctly good. From these lines it is clear that the gradient decreases with increasing density, and that the intercept on the axis of ordinates is approximately constant. The value of the mean intercept was obtained from the two strongest lines, those for groups I and II, and was found to be 16·0. Each line was corrected to this intercept, and the following five equations deduced for the relation between total heat loss (H) and thickness (*d*) at different densities.

Mean Density g./cc.		Equation
0·252	...	$1/H=16+640d.$
0·286	...	$1/H=16+620d.$
0·322	...	$1/H=16+595d.$
0·366	...	$1/H=16+538d.$
0·417	...	$1/H=16+535d.$

A linear relationship holds between the coefficient of *d* and density (Δ) with the exception that the point at density 0·366 is in error. The five equations can therefore be reduced to one general form which may be regarded as an expression for the warmth of a fabric in terms simply of its thickness and density—

$$1/H = 16 + (801 - 639\Delta)d.^*$$

The validity of the equation is indicated by the comparison of experimental and calculated values of total heat loss given in columns 5 and 6 respectively of Table XVII. With the exception of two fabrics, E.2 and E.1, the formula holds good within very narrow limits for all the types of fabric in common use as clothing materials, and by its use a good approximation to the true value of a fabric as a heat insulator in stagnant air can be obtained from measurements of thickness and density only.

Table XVII

Fabric No.	Density g./cc.	Thickness cm.	1 / Heat Loss (exptl.)	Heat Loss (exptl.) Cals/Sec/ sq. cm.	Heat Loss (calc.) Cals/Sec/ sq. cm.	% Error
W²1	0·158	0·419	0·2933 × 10³	3·41 × 10⁻³	3·23 × 10⁻³	−5·28
B.1	0·161	0·259	0·2045	4·89	5·08	+3·89
B.3	0·174	0·229	0·1862	5·37	5·75	+7·08
E.4	0·180	0·101	0·0899	11·12	11·72	+5·39
B.2	0·192	0·224	0·1754	5·70	5·96	+4·56
E.8	0·220	0·254	0·1706	5·86	5·45	−6·99
P.2	0·227	0·073	0·0656	15·25	15·65	+2·62
W²5	0·228	0·306	0·2119	4·72	4·62	−2·22
K.9	0·241	0·117	0·0881	11·35	10·91	−3·88
W²3	0·245	0·266	0·1901	5·26	5·34	+1·52
W²6	0·248	0·301	0·2058	4·86	4·78	−1·64
M¹3	0·250	0·226	0·1585	6·31	6·21	−1·58
M¹4	0·253	0·233	0·1645	6·08	6·06	−0·33
K.11	0·253	0·083	0·0663	15·08	14·49	−3·92
K.1	0·255	0·101	0·0809	12·37	12·44	+0·57
K.5	0·255	0·101	0·0828	12·08	12·44	+2·98
M¹8	0·258	0·162	0·1138	8·79	8·40	−4·44
M¹2	0·262	0·188	0·1391	7·19	7·40	+2·92
P.1	0·266	0·054	0·0544	18·37	19·96	+8·67
M¹5	0·268	0·254	0·1779	5·62	5·68	+1·07
W²4	0·271	0·193	0·1464	6·83	7·29	+6·73
K.3	0·273	0·078	0·0637	15·71	15·43	−1·78
K.12	0·273	0·091	0·0748	13·38	13·70	+2·39
M¹9	0·277	0·157	0·1114	8·98	8·77	−2·34
M¹6	0·279	0·157	0·1089	9·18	8·79	−4·25
M²2	0·279	0·155	0·1120	8·93	8·88	−0·56
P.3	0·281	0·101	0·0782	12·79	12·93	+1·10
M¹7	0·283	0·224	0·1541	6·46	6·46	0·00
R.4	0·283	0·193	0·1379	7·25	7·37	+1·66
K.10	0·283	0·063	0·0573	17·44	18·15	+4·07
R.1	0·284	0·195	0·1379	7·25	7·30	+0·69
W²2	0·285	0·264	0·1792	5·58	5·57	−0·18
K.7	0·286	0·081	0·0649	15·42	15·13	−1·88
R.3	0·287	0·190	0·1342	7·45	7·50	+0·67
M²3	0·287	0·162	0·1138	8·79	8·62	−1·93
K.6	0·287	0·066	0·0583	17·15	17·62	+2·74
K.8	0·288	0·061	0·0535	18·69	18·65	−0·21
E.3	0·289	0·275	0·1802	5·55	5·39	−2·88
E.2	0·291	0·100	0·0697	14·35	12·90	−10·1

* Cf. Sale and Hedrick, *loc. cit.* p. 543. These authors find a relationship between "thermal resistance" and thickness of blankets, which is essentially similar to that described in this paper.

Table XVII—*continued*

Fabric No.	Density g./cc.	Thickness cm.	1 / Heat Loss (exptl.)	Heat Loss (exptl.) Cals/Sec/ sq. cm.	Heat Loss (calc.) Cals/Sec/ sq. cm.	% Error
R.2	0·291	0·188	0·1355 × 10³	7·38 × 10⁻³	7·60 × 10⁻³	+2·98
R.6	0·292	0·185	0·1319	7·58	7·71	+1·71
M²1	0·295	0·147	0·1053	9·50	9·43	−0·74
R.9	0·296	0·180	0·1271	7·87	7·93	+0·76
R.7	0·298	0·183	0·1295	7·72	7·82	+1·29
M²4	0·300	0·174	0·1271	7·87	8·20	+4·19
M²7	0·301	0·183	0·1300	7·69	7·85	+2·14
M²6	0·303	0·193	0·1337	7·48	7·51	+0·40
R.8	0·308	0·178	0·1264	7·91	8·10	+2·40
M²5	0·316	0·204	0·1404	7·12	7·23	+1·54
P.4	0·318	0·058	0·0508	19·68	19·73	+0·25
M¹1	0·328	0·124	0·0848	11·80	11·20	−5·09
K.2	0·331	0·051	0·0462	21·63	21·71	+0·37
R.5	0·334	0·167	0·1138	8·79	8·76	−0·34
W¹2	0·338	0·093	0·0683	14·65	14·20	−3·07
M²8	0·343	0·117	0·0799	12·52	11·89	−5·03
MC.1	0·352	0·111	0·0755	13·24	12·51	−5·51
MC.2	0·354	0·117	0·0768	13·03	12·02	−7·75
MC.3	0·356	0·122	0·0806	12·41	11·63	−6·29
W¹1	0·359	0·076	0·0599	16·69	16·83	+0·83
MC.6	0·360	0·139	0·0926	10·79	10·48	−2·87
MC.7	0·361	0·132	0·0925	10·81	10·95	+1·29
MC.4	0·362	0·129	0·0833	12·01	11·17	−6·99
W¹7	0·366	0·076	0·0569	17·58	16·92	−3·75
R.10	0·371	0·139	0·0920	10·87	10·59	−2·57
MC.8	0·382	0·098	0·0656	15·25	14·16	−7·15
MC·5	0·385	0·139	0·0920	10·87	10·74	−1·19
E.5	0·389	0·091	0·0641	15·59	15·08	−3·27
W¹4	0·406	0·071	0·0554	18·04	18·36	+1·77
W¹3	0·416	0·076	0·0571	17·51	17·65	+0·80
W¹5	0·423	0·068	0·0504	19·86	19·20	−3·32
W¹6	0·428	0·071	0·0537	18·61	18·71	+0·54
E.1	0·451	0·075	0·0477	20·97	18·36	−12·45

Application of the Formula to Fabrics other than All-Wool Fabrics

The same formula can be used to compare fabrics composed of materials other than wool with all-wool fabrics of equal weight and thickness, and in this way unequivocal comparison of the several textile fibres as heat insulators can be made; for the total heat loss of a given fabric can be determined experimentally, and the total heat loss of a theoretical fabric of identical structure, but composed of wool, may be calculated. Calculations of this kind have been carried out in the case of all the non-wool fabrics examined, and the values so obtained are given in column 5 of Table XVIII. The difference between actual and calculated heat loss is in each case given in column 6. For woven cotton fabrics, the mean deviation is 23·6%, i.e. wool fabrics are 23·6% more efficient as heat insulators than cotton fabrics of identical thickness and weight. For knitted fabrics the difference appears to be greater, the mean deviation being 32·1% for the three samples tested. Of the four real silk fabrics examined, three show an approximately constant deviation of 23%, while the fourth, a knitted sample, has a deviation of only 11 per cent. Artificial silk fabrics also show a variable deviation, while the mixture fabrics show deviations between the zero of wool and the 23·6% average of the cellulose fabrics. In all cases wool fabrics appear to be definitely superior as heat insulators to those composed of other fibres.

Table XVIII

Group	Fabric No.	Density g./cc.	Thickness cm.	Heat Loss (exptl.) Cals/Sec/ sq. cm.	Heat Loss (calc. for same Structure in Wool) Cals/Sec/ sq. cm.	% Error	Comments
A—Cotton	C.1	0·260	0·068	21·86 × 10⁻³	16·90 × 10⁻³	−22·42	Pique 11 ribs per inch
	C·2	0·363	0·048	31·30	23·08	−26·26	Pique 20 ribs per inch
	C.3	0·341	0·043	29·94	24·35	−18·66	Winceyette (fluffy material)
	C.4	0·555	0·023	49·19	38·07	−22·60	Fine rib structure
	C.5	0·6575	0·018	55·09	43·76	−20·56	Normal structure
	F.1A	0·5043	0·043	33·87	27·33	−19·32	Washed cotton suiting
	F.1	0·5672	0·038	38·25	30·61	−19·97	Ditto unwashed
	F.2A	0·6955	0·030	51·34	37·46	−27·05	Washed drill (very hard fabric)
	F.2	0·6979	0·030	52·64	37·52	−28·73	Ditto unwashed
	F.3A	0·4809	0·029	46·43	32·98	−28·97	Zampa washed
	F.3	0·6151	0·023	51·01	39·41	−22·74	Zampa unwashed
	F.4A	0·3980	0·043	36·24	25·31	−30·15	Cretonne washed
	F.4	0·5007	0·036	40·91	30·01	−26·65	Cretonne unwashed
	F.5A	0·6022	0·023	54·38	39·11	−28·08	Sheeting unwashed
	F.5	0·7525	0·018	56·99	45·95	−19·36	Sheeting washed
	A.1	0·1972	0·098	16·04	12·18	−24·06	Gauze weave
	A.6	0·1853	0·081	19·68	14·03	−28·70	Gauze weave
	A.7	0·1725	0·076	18·78	14·60	−22·26	Gauze weave
	O·1	0·5285	0·021	48·05	38·86	−19·16	Mercerised—normal structure
	O.4	0·3616	0·054	25·66	21·37	−16·72	Flannelette (fluffy material)
	V.1	0·2177	0·088	19·45	13·48	−30·70	Knitted cotton underwear (V.1–V.3)
	V.2	0·2294	0·066	24·75	16·89	−31·76	
	V.3	0·2634	0·073	24·31	16·08	−33·86	
B—Art. Silk	K.4	0·4989	0·029	47·23	33·35	−29·40	Viscose, knitted
	O.3	0·3698	0·026	43·49	32·58	−25·20	Viscose, hollow fibre
	O.9	0·3443	0·033	31·07	28·43	− 8·50	Open knit, acetate silk
	O.10	0·3942	0·029	37·57	31·32	−16·63	Knitted hose, acetate silk
	O.11	0·2517	0·044	23·09	22·64	− 1·95	Gauze knit, acetate silk
	O.8	0·6748	0·018	60·77	44·13	−27·38	Normal structure, Cuprammonium Silk
	S.3	0·3909	0·054	23·21	21·85	− 5·86	Viscose, scribbled yarns
C—Real Silk	O·12	0·7494	0·011	67·74	51·17	−24·45	Bleached spun crepe
	O·13	0·6030	0·018	53·67	42·60	−20·62	Spun silk
	O.14	0·2847	0·101	16·93	12·74	−24·75	Heavy ribbed knit, from underwear
	O.15	0·3788	0·038	30·16	26·85	−10·97	Plain knit, from underwear
D—Linen	O·5	0·5685	0·029	44·91	34·84	−22·42	Plain weave coarse linen
E—Mixtures	A.2	0·1595	0·119	11·80	10·08	−14·57	Gauze weave, wool cotton
	A.3	0·1645	0·091	15·36	12·61	−17·90	Gauze weave, wool cotton
	A.4	0·1653	0·098	14·35	11·89	−17·14	Gauze weave, cotton art. silk
	A.5	0·2799	0·048	27·36	21·80	−20·32	Gauze weave, cotton art. silk
	S.1	0·4273	0·043	28·89	25·83	−10·59	Suiting, wool 33·1%, art. silk 66·9%
	S.2	0·4289	0·043	29·10	25·86	−11·14	Suiting, wool 27·8%. art. silk 72·2%
	V.4	0·2108	0·122	11·80	10·28	−12·88	Knitted, wool 41·78%, cotton 58·22%
	E.7	0·5461	0·068	25·20	21·39	−15·12	Suiting, wool, cotton

SUMMARY

(1) The relation between thermal conductivity and thickness has been determined for compressed pads of loose wool at two widely different densities.

(2) The relation between thermal conductivity and density at constant thickness has been determined for compressed wool, cotton, and viscose silk.

(3) The effect of various finishing processes on the thermal conductivity of wool fabrics has been determined.

(4) The specific conductivities of a wide range of wool, cotton, linen, silk, artificial silk, and mixture fabrics have been determined.

(5) It has been found possible to express the warmth of all-wool fabrics by means of a general equation involving only measurements of their thickness and density.

(6) By the use of this equation, unequivocal comparison of the several textile fibres as heat insulators has been made.

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APPENDIX

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Fundamental Constants Used in Calculation

Latent heat of fusion of ice $=79{\cdot}51$ cals. per gram.
Density of mercury at 20° C. $=13{\cdot}5462$ g./cc.
* Density of ice at 0° C. $=0{\cdot}9168$ g./cc.
* Density of water at 0° C. $=0{\cdot}99987$ g./cc.

* These figures are mean values obtained from the results of several independent investigators.

TABLE OF CLOTH PARTICULARS

The following table contains all the available technical data with regard to the fabrics used. It is complete as regards the fabrics manufactured in the University, and as complete as it has been possible to make it with regard to the remainder.

COMPLETE LIST OF PARTICULARS OF ALL FABRICS EXAMINED

(1) Woven Fabrics

Series	No.	Wt. per yd. (56″ wide) ozs.	Weave	Ends per Inch	Picks per Inch	Warp			Weft			Finishing Particulars
						Counts	Twist		Counts	Twist		
							2/fold	Single		2/fold	Single	
W^1	1	12·53	2/2 twill	128	73	2/60's worsted	20	25	2/60's worsted	20	25	Scoured only
	2	14·42	4/4 twill	140	84	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
	3	14·50	2/2 twilled hopsack	142	83	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
	4	13·21	2/2 hopsack	128	75	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
	5	13·18	Broken crow	133	74	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
	6	13·96	3/1 Rep	130	90	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
	7	12·75	3/1 twill	128	65	2/60's ,,	20	25	2/60's ,,	20	25	,, ,,
W^2	1	30·41	Honeycomb	44	28	12 sk. woollen	—	9	12 silk woollen	—	9	,, ,,
	2	34·46	4/4 warp rib	44	38	12 ,, ,,	—	9	12 ,, ,,	—	9	Milled 45·90%
	3	29·86	4/4 hopsack	44	36	12 ,, ,,	—	9	12 ,, ,,	—	9	,, 32·14%
	4	23·98	Plain	39	33	12 ,, ,,	—	9	12 ,, ,,	—	9	,, 29·20%
	5	31·95	3/1 twill	44	39	12 ,, ,,	—	9	12 ,, ,,	—	9	,, 40·46%
	6	34·26	Reversible weft cord	44	38	12 ,, ,,	—	9	12 ,, ,,	—	9	,, 37·06%
M^1	1	18·67	3/3 twill	78	63	2/28's worsted	11	15	2/28's worsted	11	15	Scoured only, unmilled
	2	22·60	3/3 ,,	87	72	2/28's ,,	11	15	2/28's ,,	11	15	Milled 19·77%
	3	25·97	3/3 ,,	94	78	2/28's ,,	11	15	2/28's ,,	11	15	,, 32·43%
	4	27·03	3/3 ,,	96	75	2/28's ,,	11	15	2/28's ,,	11	15	,, 31·94%
	5	31·20	3/3 ,,	105	81	2/28's ,,	11	15	2/28's ,,	11	15	,, 44·06%
	6	20·05	3/3 ,,	81	70	2/28's ,,	11	15	2/28's ,,	11	15	,, 12·31%
	7	29·05	3/3 ,,	104	80	2/28's ,,	11	15	2/28's ,,	11	15	,, 41·34%
	8	19·14	3/3 ,,	80	66	2/28's ,,	11	15	2/28's ,,	11	15	,, 7·90%
	9	19·97	3/3 ,,	83	67	2/28's ,,	11	15	2/28's ,,	11	15	,, 11·79%
M^2	1	19·88	3/3 ,,	74	72	2/28's ,,	11	15	2/28's ,,	11	15	,, 7·48%
	2	19·86	3/3 ,,	75	74	2/28's ,,	11	15	2/28's ,,	11	15	,, 11·85%
	3	21·31	3/3 ,,	78	78	2/28's ,,	11	15	2/28's ,,	11	15	,, 19·61%
	4	23·91	3/3 ,,	82	82	2/28's ,,	11	15	2/28's ,,	11	15	,, 27·05%
	5	29·56	3/3 ,,	91	90	2/28's ,,	11	15	2/28's ,,	11	15	,, 40·61%
	6	26·85	3/3 ,,	88	87	2/28's ,,	11	15	2/28's ,,	11	15	,, 34·60%
	7	25·63	3/3 ,,	84	85	2/28's ,,	11	15	2/28's ,,	11	15	,, 30·65%
	8	18·42	3/3 ,,	78	63	2/28's ,,	11	15	2/28's ,,	11	15	Scoured only, unmilled
R	1	25·42	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	Milled 30%, raised 1 round
	2	25·13	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 2 ,,
	3	25·00	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 4 ,,
	4	25·02	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 6 ,,
	5	25·55	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, unraised
	6	24·74	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, raised 8 round
	7	25·00	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 11 ,,
	8	25·13	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 15 ,,
	9	24·47	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 20 ,,
	10	23·67	3/3 ,,	93	86	2/28's ,,	11	15	2/28's ,,	11	15	,, 30%, ,, 20 ,, cut close
MC	1	17·95	3/3 ,,	74	72	2/28's ,,	11	15	2/28's ,,	11	15	,, 7·48%, cut close face and back
	2	18·99	3/3 ,,	75	74	2/28's ,,	11	15	2/28's ,,	11	15	,, 11·85%, ,, ,,
	3	19·92	3/3 ,,	78	78	2/28's ,,	11	15	2/28's ,,	11	15	,, 19·61%, ,, ,,
	4	21·45	3/3 ,,	82	82	2/28's ,,	11	15	2/28's ,,	11	15	,, 27·05%, ,, ,,
	5	24·56	3/3 ,,	91	90	2/28's ,,	11	15	2/28's ,,	11	15	,, 40·61%, ,, ,,
	6	22·97	3/3 ,,	88	87	2/28's ,,	11	15	2/28's ,,	11	15	,, 34·60%, ,, ,,
	7	21·85	3/3 ,,	84	85	2/28's ,,	11	15	2/28's ,,	11	15	,, 30·65%, ,, ,,
	8	17·16	3/3 ,,	78	63	2/28's ,,	11	15	2/28's ,,	11	15	Scoured only
B	1	19·12	2/2 ,,	—	—	—	—	—	—	—	—	Milled and raised to extent unknown
	3	18·29	2/2 ,,	—	—	—	—	—	—	—	—	,, ,, ,,
	2	19·68	2/2 ,,	—	—	—	—	—	—	—	—	,, ,, ,,
E	1	15·52	Plain	43	37	2/20's worsted	10	18	2/20's worsted	10	18	Scoured only
	2	13·35	,,	42	26	2/20's ,,	10	12	2/20's ,,	10	12	,, ,,
	3	36·5	2/2 twill	—	—	—	—	—	—	—	—	Very heavily milled, exact extent unknown
	4	8·33	Crepe	40	37	18's worsted	—	13	18's worsted	—	15	Scoured only
	5	16·25	Probably broken twill	—	—	—	—	—	—	—	—	Doeskin (dress-face) finish. Black dye
	7	17·03	Warp backed 2/2 twill	54 face 51 back	64	—	—	—	—	—	—	
A	1	8·87	Gauze	32	50	—	—	—	—	—	—	Scoured only
	2	8·71	,,	22	40	—	—	—	—	—	—	Scoured only (44·3% cotton, 55·7% wool)
	3	6·87	,,	38	42	—	—	—	—	—	—	Scoured only (45·7% cotton, 54·3% wool)
	4	7·43	,,	42	32	—	—	—	—	—	—	Scoured only
	5	6·16	,,	70	51	—	—	—	—	—	—	,, ,,
	6	6·88	,,	50	50	—	—	—	—	—	—	,, ,,
	7	6·01	,,	35	45	—	—	—	—	—	—	,, ,,
C	1	8·12	Pique, 11 ribs per inch	110 ground	100	45's cotton ground	—	27	38's cotton	—	25	As finished by makers, particulars unknown
				22 wadding	—	10's cotton wadding	—	9				
	2	7·99	Pique, 20 ribs per inch	120 ground	96	45's cotton ground	—	25	38's cotton	—	20	As finished by makers, particulars unknown
				20 wadding	—	2/32's cotton wadding	—	23	—		—	
	3	6·73	2/2 twill	70	61	—	—	—	—	—	—	As finished by makers, (surface napped)
	4	5·85	2/1 warp rib	83	80	—	—	—	—	—	—	As finished by makers
	5	5·43	Plain	77	77	—	—	—	—	—	—	,, ,,
F	1	9·89	Warp and weft rib pattern	104	83	21's cotton	—	16	21's cotton	—	19	,, ,,
	1A	9·95	Warp and weft rib pattern	104	83	21's ,,	—	16	21's ,,	—	19	As F.1, but scoured in soft soap
	2	9·60	2/1 turned twill	120	74	28's ,,	—	20	23's ,,	—	16	As finished by makers

Complete List of Particulars of all Fabrics Examined. (1) Woven Fabrics—*continued*

Series	No.	Wt. per yd. (56″ wide) ozs.	Weave	Ends per Inch	Picks per Inch	Warp			Weft			Finishing Particulars
						Counts	Twist		Counts	Twist		
							2/fold	Single		2/fold	Single	
	2A	9·57	2/1 turned twill	120	74	28's cotton	—	20	23's cotton	—	16	As F.2, but scoured in soft soap
	3	6·49	Plain	52	42	18's ,,	—	15	15's ,,	—	15	As finished by makers
	3A	6·40	,,	52	42	18's ,,	—	15	15's ,,	—	15	As F.3, but scoured in soft soap
	4	8·27	,,	38	38	11's ,,	—	14	11's ,,	—	14	As finished by makers
	4A	7·85	,,	38	38	11's ,,	—	14	11's ,,	—	14	As F.4, but scoured in soft soap
	5	6·21	,,	70	67	28's ,,	—	20	25's ,,	—	18	As finished by makers
	5A	6·35	,,	70	67	28's ,,	—	20	25's ,,	—	18	As F.5, but scoured in soft soap
O	1	5·09	5-end sateen	—	—	—	—	—	—	—	—	Unknown, apart from mercerisation
	4	8·96	Plain	—	—	—	—	—	—	—	—	Surface napped
	5	7·56	,,	—	—	—	—	—	—	—	—	Scoured only (linen)
	8	5·57	,,	—	—	—	—	—	—	—	—	As finished by makers. Washed in running water
	12	3·78	,,	—	—	—	—	—	—	—	—	Unknown apart from bleaching
	13	4·98	,,	—	—	—	—	—	—	—	—	Unknown
S	1	8·43	2/2 twill	—	—	—	—	—	—	—	—	33% wool, 67% viscose
	2	8·46	Plain	—	—	—	—	—	—	—	—	28% wool, 72% viscose
	3	9·68	2/2 twill	—	—	—	—	—	—	—	—	100% viscose, scribbled yarns

(2) Knitted Fabrics

Series	No.	Details of Structure	Loops per Inch	Material	Weight per Yard (56″ wide)	Series	No.	Details of Structure	Loops per Inch	Material	Weight per Yard (56″ wide)
K	1	Normal	21	Fine crossbred	11·80	P	1	Normal	19	All wool	6·58
	2	,,	32	,, ,,	7·73		2	,,	21	,,	7·61
	3	,,	26	,, ,,	9·75		3	,,	18	,,	13·02
	4	,,	37	Viscose	6·64		4	,,	29	,,	8·46
	5	,,	21	Medium crossbred	12·38	V	1	2-thread structure	29	All cotton	8·79
	6	,,	29	,,	8·69		2	,, ,,	35	,,	6·94
	7	,,	26	Fine crossbred	10·59		3	,, ,,	22	,,	8·82
	8	,,	29	,, ,,	8·06		4	,, ,,	22	Cotton and wool	11·80
	9	,,	21	,, ,,	12·94	O	3	Normal	45	Hollow-fibre viscose	4·41
	10	,,	30	Dry spun Botany	8·18		9	Open knit	29	Acetate silk	5·21
	11	,,	26	,, ,,	11·13		10	Normal	51	,, ,,	5·24
	12	,,	19	,, ,,	11·39		11	Very open gauze	Circ. 12	,, ,,	5·08
							14	Heavy ribbed structure	50	Real silk	13·19
							15	Normal	22	,, ,,	6·60

4—THE ABSORPTION, TRANSMISSION, AND REFLECTION OF RADIANT HEAT BY FABRICS

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I—INTRODUCTION AND SUMMARY

The problem of maintaining the body at normal temperature under conditions of tropical heat is one of thermal equilibrium. In addition to the heat generated by the natural processes of the body, a considerable amount of heat is received from the sun directly or through the medium of the clothes. If the temperature of the body is to remain normal, an amount of heat must be dissipated equal to that engendered by the above causes. The amount of heat received by the body from the sun must be as small as possible, and consequently a fabric possessing a high reflecting power for radiant energy is required. Since the clothes lose heat by the emission of radiation and by contact with cooler air, as much as possible of the heat from the sun remaining after reflection should be absorbed by the clothes. If the condition of the air as regards rate of movement or temperature is insufficient to cause the required heat loss, cooling can only be obtained by the evaporation of moisture generated by perspiration. This evaporation must be obstructed as little as possible, and takes place through the medium of the clothes, or may be brought about by suitable arrangement of a loose garment, which provides a bellows action through the movement of the body.

The requirements of a fabric in order that it may provide suitable clothing under tropical conditions of heat can therefore be summarised as follows—high reflecting and emissive powers, low transmitting power for radiant energy and in addition, high permeability to moisture.

Continuing previous work on this problem (*Shirley Inst. Mem.*, 1926, **5**, 193; or *J. Text. Inst.*, 1926, **17**, T553), the present account describes methods developed for the measurement of the absorption, transmission and reflection of radiant heat by fabrics. No standard method was available which could be applied to material in the form of fabric, but the methods now described are simple in theory, although, in common with other thermal measurements, they require considerable time for operation. It has not been found practicable to measure the factors of absorption, transmission and reflection of radiant heat separately, but these quantities are obtained indirectly from measurements of two combinations of the absorption and transmission factors. The symbols employed are—

A=% of incident radiant heat which is absorbed by the fabric.

T=% of incident radiant heat which is transmitted by the fabric.

R=% of incident radiant heat which is reflected by the fabric.

By definition, $A+T+R=100$.

Using the methods described, twenty-one cotton fabrics have been tested, the majority being typical of those exported to the tropics, and also five artificial silk or artificial silk and cotton union fabrics. The tests on the latter are included as being of general interest, and to show whether any improvement could be effected by the introduction of artificial silk into fabrics for tropical use. Considering for the moment the series of cotton fabrics, the range of variation of the factors encountered is as follows—

I—*Reflecting Power*—from 61% for a sateen and an acid-treated drill (described in Table I, p. T64) to 39% for a light unfilled plain woven fabric.

II—*Transmitting Power*—from 5% for a sateen to 44% for a light unfilled plain woven fabric.

III—*Absorptive Power*—from 34% for a sateen, a duck, and a filled fabric to 17% for a light unfilled plain woven fabric.

It is noteworthy that as much as 60% of the sun's heat may be reflected directly by the wearing of a closely woven and impenetrable fabric. With increasing weight, the absorption and reflection factors increase, the highest reflection factor resulting from a smooth, closely woven fabric such as a sateen or an acid-treated drill. A figure obtained for the reflecting power of the material $R/(100\text{-}T)$ varies little over the whole range of cotton fabrics tested, but the reflecting power of the artificial silk fabrics is decidedly lower. No advantage can therefore be gained by incorporating artificial silk into fabrics from the point of view of increased reflection of radiant heat. The range of variation between different fabrics is greatest for heat transmission and least for reflection. Certain heavily filled fabrics show high reflecting powers, but this power will be considerably reduced on removal of the filling material.

A criterion of unsuitability of fabrics is the value of $\frac{1}{2}A+T$, this referring to garments not in contact with the skin. For garments in contact with the skin the criterion of unsuitability is the value of $A+T$, and in general a measure of unsuitability is given by T plus a fraction of A varying between one-half and unity.

The position of the fabric C (weft sateen; see Table I, p. T64) is very marked in the table of relative values of $\frac{1}{2}A+T$, indicating that of all the fabrics tested, this is most suitable from the point of view of protection from the sun's heat. Next come the fabrics A (duck) and B (acid-treated drill), which are in turn followed by the heavily filled fabrics F, H and K, which afford a high degree of protection in proportion to their weight. Of the remaining fabrics, E and I (drills) and N (twill) are the best, but the unsuitability of the ramie fibre fabrics J and L is marked, this being due most probably to the open type of weave of these fabrics.

On theoretical grounds the emissive powers of fabrics cannot be expected to vary to any great extent, and this is supported by a few actual tests in which a variation of not more than 13% was obtained, the fabrics including one which was lamp-blacked.

In considering the choice of fabrics for tropical wear, the factor of permeability to moisture is of prime importance. A resumé will therefore be given of the general conclusions arrived at regarding the means of transfer of moisture through fabrics, described in the succeeding publication—(*a*) when conditions are such that moisture transfer takes place by diffusion through a layer of air enclosed between the fabric and the body, there is little to choose between fabrics, whatever their construction may be; (*b*) it is debatable whether the ventilation afforded by a fabric which is permeable to air is more effective than the alternative method of ventilation due to the bellows action of a non-permeable garment provided with suitable vents; (*c*) under conditions where a fabric is in contact with a moist surface and is fanned by a breeze, the rate of moisture transfer is dependent on the structure of the fabric (a sateen fabric possesses a small resistance compared with fabrics such as duck and acid-treated drill of the same order of weight).

It has been seen that the fabric C (sateen) is preferable to the others for its heat protecting qualities. In view of the above conclusions regarding moisture transfer, the sateen type of weave appears to offer advantages for wear under tropical conditions, over other types of weave, for equal weights of the resultant fabrics.

II—EXPERIMENTAL

(1) The Determination of the Absorption, Transmission and Reflection of Radiant Heat by Fabrics

(*a*) *Measurement of* $\frac{1}{2}A+T$. A fabric supported a short distance from the heat measuring surface A (Fig. 1) receives heat through an aperture E, the heat absorbed by the fabric causing its temperature to rise so that the receiver registers the transmitted heat and in addition some heat re-radiated by the fabric. In a state of equilibrium all the heat absorbed by the fabric is re-radiated, and since the emission is the same from both fabric surfaces, one-half the absorbed heat is radiated from the lower fabric surface. The receiver top is so arranged that the fabric plane passes through the rim of the vessel, the fabric resting by means of its own weight on extremely fine cross wires. The receiver therefore measures the sum of the transmitted heat and one-half of the absorbed heat, i.e. $\frac{1}{2}A+T$, the effect being independent of the direction or distribution of the heat leaving the lower fabric surface.

(*b*) *Measurement of* $A+T$. The fabric is placed in close contact with the top of a second receiver A′ (Fig. 1), which has a plane absorbing surface. The transmitted heat, together with the heat absorbed by the fabric, is received by the heat measuring surface, the transmitted heat directly and the absorbed heat by conduction. The outer surface of the fabric does not rise appreciably in temperature over its surroundings, heat loss by radiation therefore being negligible.

Knowing $\frac{1}{2}A+T$ and $A+T$ for any specimen of fabric, $A=2[(A+T)-(\frac{1}{2}A+T)]$, $T=2(\frac{1}{2}A+T)-(A+T)$, $R=100-(A+T)$.

(2) The Source of Heat Employed in Testing

The ideal source of heat for testing would be that under which fabrics are used in service. The radiation from the sun varies, however, both in quality and in intensity, so that its use for testing is impracticable. The source of heat employed in obtaining the present results consists of a 500 watt tungsten filament gas-filled lamp, the current being supplied by a storage battery. The distribution of energy from the lamp is that due to radiation from a body at a temperature much lower than that of the sun, consequently the maximum in the curve of energy distribution occurs in a region of much greater wave-length than in the case of the sun. The filament of the lamp, however, is enclosed in a glass bulb which absorbs the longer wave-lengths, becoming heated in the process. An idea of the proportion of heat emitted by the filament which is transmitted unchanged through the glass and received by the fabric, was obtained as a result of a subsidiary determination in which the normal receiver A or A′ was replaced by a quick registering thermopile. On switching off the current through the filament (the filament cools with enormous rapidity compared with the glass bulb and the heated surroundings, which have a larger heat capacity and lower temperature than the filament) the heat registered by the thermopile is approximately one-eighth of that previously received, i.e., approximately seven-eighths of the heat radiated from the filament and received by the

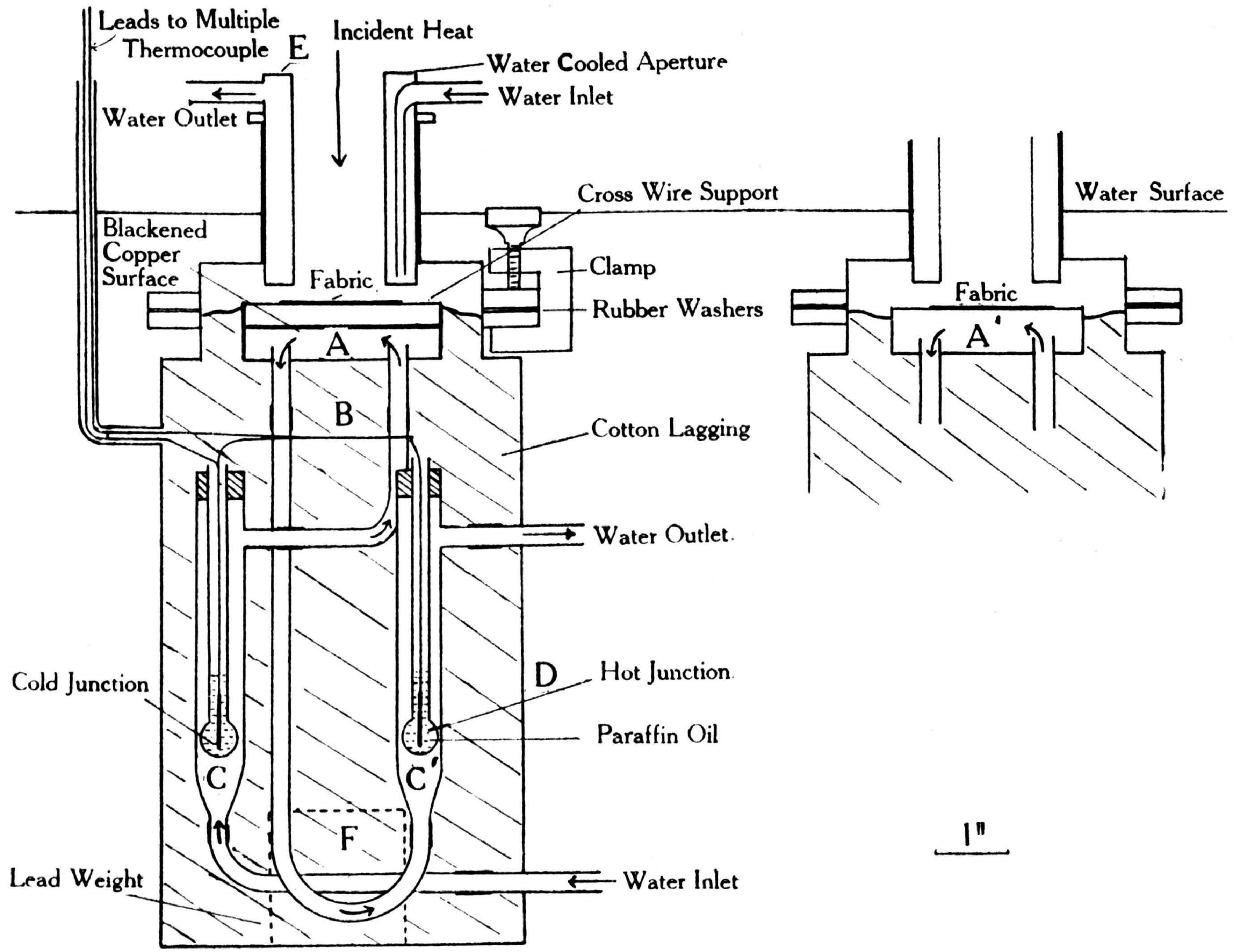
Leads to Multiple
Thermocouple
E
Incident Heat
Water Cooled Aperture
Water Inlet
Water Outlet
Cross Wire Support
Water Surface
Blackened
Copper
Surface
Fabric
Clamp
Rubber Washers
Fabric
A
A'
B
Cotton Lagging
Water Outlet.
Cold Junction
D
Hot Junction.
Paraffin Oil
C
C'
F
Lead Weight
Water Inlet
1"

FIG. 1

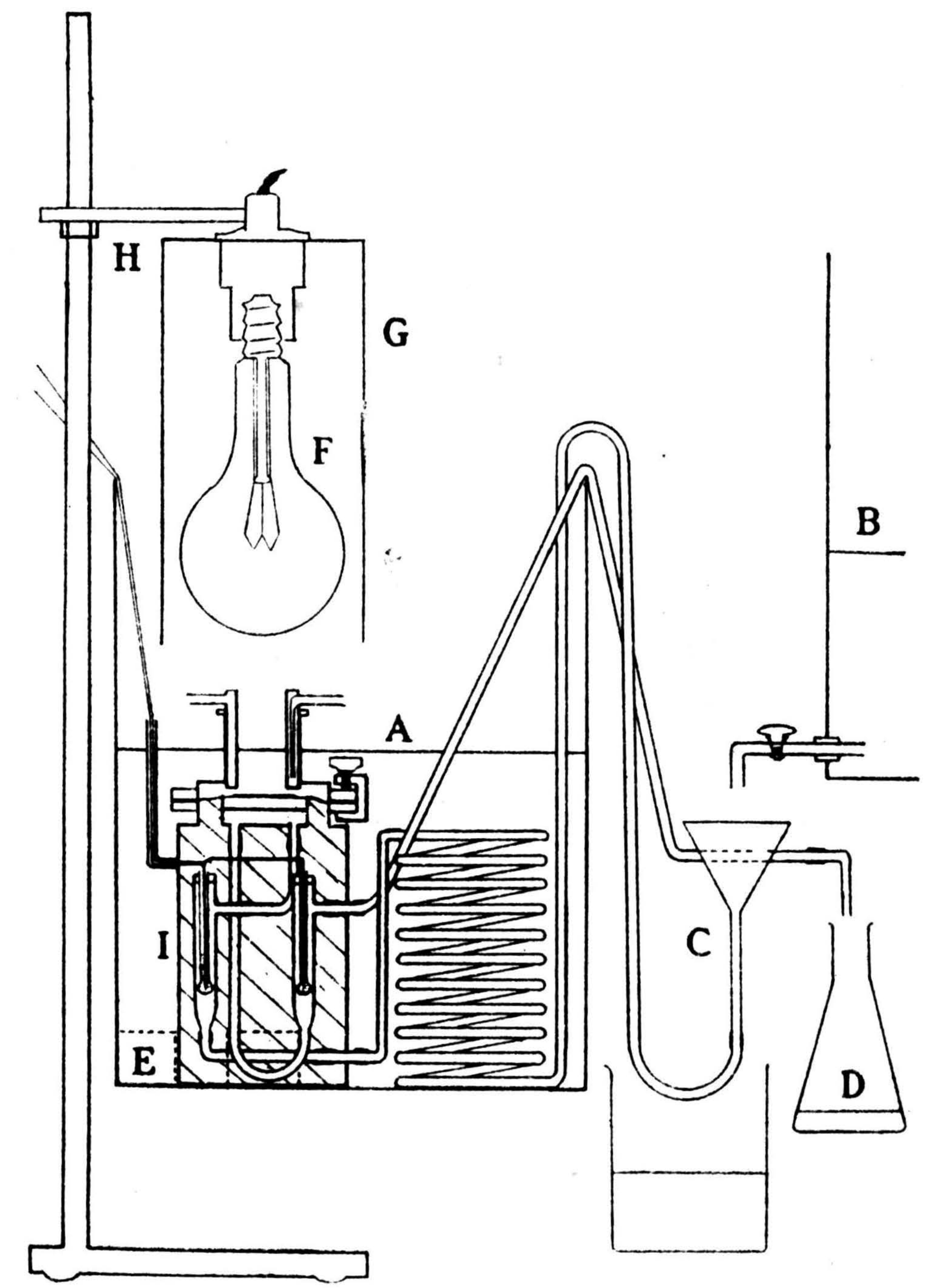
H
G
F
B
A
I
E
C
D

FIG. 2

fabric is transmitted unchanged through the glass. Now the energy received at the earth's surface from the sun is roughly such as would be transmitted by the average type of glass (due to absorption of longer heat waves by the atmosphere), and it is therefore concluded that, as far as the testing of white fabrics is concerned, the results obtained, using the present source of heat, give values for the absorption, transmission and reflection factors that afford a useful means of comparison of fabrics under conditions of service. The effect of increasing the proportion of long heat waves in the source of heat used for testing would be to reduce the amount of heat reflected, since long heat waves emitted by bodies at comparatively low temperatures are easily absorbed. This was confirmed by a test employing a blackened copper surface maintained at a temperature of 100° C. as source of heat in place of the gas-filled lamp. A reduction was then caused in the reflection factor from a normal 61 per cent. down to 7 per cent. It is probable that the reflection factors determined under the conditions of experiment are too low, owing to the proportion of one-eighth of the heat incident on the fabric being of long wave-length, and therefore readily absorbed by the fabric.

(3) Constant-flow Water Calorimeter Measuring Device

The heat measuring device to which reference has been made consists of a cylindrical copper vessel through which a steady flow of water at constant temperature is maintained. In a state of equilibrium the heat received by the surface of the receiver is conducted to the water, the rise in temperature of which is measured by means of differential thermocouples, B (Fig. 1). These consist of 10 couples of copper and constantan in series, alternate junctions being at the same temperature. The cold and hot junctions dip into paraffin oil contained in glass bulbs CC′ (Fig. 1), surrounded by the water flow before and after passage through the receiver.

The amount of heat received (expressed in calories per sec.) is the product of the rate of flow of water (gms. per sec.), the rise in temperature (°C.) of the water flow, and the specific heat of water (=1 to a sufficient approximation).

(4) Manipulative Details

In order to eliminate stray heating or cooling effects, the copper receiver, thermocouple containers, connecting tubes, etc., are lagged with cotton sliver and housed in a metal box, D (Fig. 1), placed under water in a constant temperature bath, A (Fig. 2). The bath, which is thermostatically controlled, is used to maintain the water flow at constant temperature, 20° C., the water passing through a copper coil (25 feet of ¼-inch diameter tube) immersed in the bath.

A constant rate of flow of water is attained by employing a fixed head of water of about two inches. Owing to the presence of dissolved air in tap water causing a decrease in rate of flow, water free from air must be used. Distilled water contained in a large bottle, B (Fig. 2), is allowed to drip into a glass funnel, C (Fig. 2), the excess water flowing over the rim. The rate of flow is determined by collecting in a conical flask, D (Fig. 2), the water run through the apparatus over a period of five minutes. The rate of flow determines the temperature difference to be observed for a given amount of heat received and it is necessary that whilst this temperature difference should be sufficiently large to measure with reasonable accuracy, the actual temperature rise must be small. The use of multiple thermojunctions fulfils these requirements, a rise in temperature of 1° C. corresponding to an electromotive force of 400 micro-volts. The greatest amount of heat received developed an electromotive force of 200 micro-volts, which corresponds to a temperature rise of 0·5° C. The potentiometer, by means of which the electromotive force is measured, may be read to 0·5 micro-volt. Any variation in water flow rate or temperature may cause error due to the considerable thermal lag possessed by the measuring device, and it is therefore necessary to ensure good working of the thermostat and to employ efficient stirring of the bath water.

In both measurements of $\frac{1}{2}A+T$ and $A+T$ the heat received in the absence of the fabric is determined, this being independent of the type of receiver employed. It is not necessary to calibrate the thermocouple used for temperature measurement, since $\frac{1}{2}A+T$ and $A+T$ are expressed as percentages of incident heat, electromotive force being directly proportional to temperature over the small range of temperature encountered. The voltage across the lamp leads is measured by a potentiometer, being maintained constant at 35 volts by means of a rheostat in series with the lamp. The lamp is contained in a lamphouse, G (Fig. 2), which can be placed in the required position by means of a stop, H (Fig. 2). It is necessary that the box, I (Fig. 2) shall always be in the same position relative to the lamp, and this is effected by the use of stops consisting of lead weights, E (Fig. 2). The heat received from the source is measured once daily, whilst the rheostat is adjusted at frequent intervals. A water-cooled lampblacked aperture, E (Fig. 1), gives protection against stray sources of heat and limits the beam of radiation which is incident normally on the fabric. If the radiant heat is incident direct on the measuring surface, as in the $\frac{1}{2}A+T$ determination, the surface is covered with lampblack by holding over burning camphor, and the whole of the radiation is absorbed. The heat may be incident on the fabric when in contact with the receiver, as in the $A+T$ determination, in which case the receiver is blackened with a good dead-black paint, and the fabric is laid without tension on a thin film of seccotine. The reflection factor of the paint and seccotine film is very low (approximately 6%), so that heat loss due to reflection from the background, which is limited owing to absorption by the fabric, is very small.

It is necessary at various stages to interrupt the thermal equilibrium of the apparatus; for example, to replace a fabric sample or to lampblack the receiver surface. To replace a fabric in the $\frac{1}{2}A+T$ determination it is only necessary to remove the water-cooled aperture, which makes a sliding fit, but in the $A+T$ determination the whole apparatus must be removed from the water and the top taken off. This is normally held by three clamps with an insulation of rubber. The fabric is wetted so as not to injure the black paint surface on removal. For these reasons a shorter equilibrium period can be used for the $\frac{1}{2}A+T$ determination (20 minutes) than for the $A+T$ determination (30 minutes). When the $A+T$ receiver is coated with lamp black it is necessary to remove the cotton lagging, a considerable heating effect taking place. After such operations the rate of flow of water may be temporarily increased to hasten equilibrium. A lead weight, F (Fig. 1), is placed in the box so that the apparatus will maintain its position under water by its own weight.

The water-cooled aperture which closes the top of the box takes its temperature from a separate water flow system, the water flow at the same time providing the necessary cooling agent for the thermostatic control of the bath. The inside walls and bottom of the aperture, and also the exposed walls surrounding the receiver, are lampblacked.

(5) A Check on the Working of the Apparatus

If in the $\frac{1}{2}A+T$ determination the fabric is replaced by an opaque disc of material which is lampblacked on both sides, since $R=T=O$ and $A=100\%$, then $\frac{1}{2}A+T=50\%$. This test has been applied with the following results—

Copper foil—low heat capacity, $\frac{1}{2}A+T=50{\cdot}2$ per cent.

Heavy copper disc—large heat capacity, $\frac{1}{2}A+T=49{\cdot}5$ per cent.

Closely woven fabric, $\frac{1}{2}A+T=49{\cdot}8$ per cent.

(6) Procedure for Testing Fabrics and Sampling

In the determination of $A+T$ the fabric is stuck down and has to be wetted before it can be removed. The specimen is therefore useless for further tests, and so the determination of $\frac{1}{2}A+T$ is made first. It is usual to test a batch of samples for $\frac{1}{2}A+T$, and then after changing the receiver to test for $A+T$. Previous to testing, the fabrics are dried in a desiccator containing phosphorus pentoxide. The samples are $1\frac{7}{8}$ inch in diameter, the actual diameter tested being $1\frac{5}{8}$ inch. Six samples are chosen at random from a two-yard length of the fabric.

III—DISCUSSION OF RESULTS

In connection with tests on finished fabrics it is almost impossible to obtain full data regarding details of finish, counts of yarn, etc., owing to the number of hands through which the fabrics have passed during manufacture. Most of the fabrics tested have been supplied as typical of those exported to the tropics, and were with one exception bleached. Twenty-one fabrics have been examined and the results tabulated in Table I, where details are also given of the type of weave, number of ends and picks per inch, finish, market and weight. The fabrics are arranged in order of decreasing weights, as this is the chief and most independent variable.

The range of variation of the factors is—

I—*Reflection*—From 61% for C (sateen) and B (acid-treated drill) to 39% for U (light unfilled plain woven fabric).

II—*Absorption*—From 34% for C, A (duck) and H (filled fabric) to 17% for U.

III—*Transmission*—From 5% for C to 44% for U.

The range of variation is thus greatest for the transmission factor and least for the reflection factor. In a general way, with increasing weight, the factors of absorption and reflection increase whilst the transmission factor decreases. With respect to the correlation of the reflection and transmission factors, it may be pointed out that $R/(100-T)$ varies very little throughout the range (Table I). If we regard T as measuring the holes in the fabric, then $(100-T)$ measures the area of actual material and $R/(100-T)$ the reflecting power of the material (equals 1 for a perfect reflector).

A supplementary series of five artificial silks, and artificial silk and cotton union fabrics was tested and the results are given in Table II. The values for $R/(100-T)$ in this table are distinctly lower than for cotton fabrics, indicating that the artificial silks have a lower reflecting power. There appears to be no advantage gained by the inclusion of artificial silk with cotton from the point of view of reflection of heat by fabrics.

A general conclusion that a high reflection factor results from as close and smooth a surface as possible is arrived at by a study of the figures in

Table I. This is in accordance with what would naturally be expected; the more uneven a surface is, the less chance the reflected heat has of an unobstructed path away from the fabric. Both the fabrics C (sateen) and B (acid-treated drill) which show the highest reflecting power for the series have smooth, closely woven surfaces. The cellular woven fabric D, although nearly equal in weight to the sateen fabric C, has a much lower reflection factor. Of the filled fabrics (F, H, K, M, Q) the reflection factors for the first three, which are heavily filled, are high. This is attributable to the

Table I

Market	Weight in lb. per sq. yard	Ends per Inch	Picks per Inch	No. of Samples Tested	$A\%$	$T\%$	$R\%$	$\left(\frac{R}{100-T}\right)$	$(\frac{1}{2}A+T)$ %	Fabric
—	0·52	96	64	4	34	10	56	0·62	27	A
—	0·44	110	60	6	27	12	61	0·69	26	B
—	0·37	66	250	6	34	5	61	0·64	22	C
—	0·31	—	—	6	27	24	49	0·64	38	D
India ...	0·30	108	48	6	24	18	57	0·70	30	E
Persia ...	0·30	68	72	6	21	20	59	0·74	30	F
—	0·30	98	58	6	23	24	53	0·70	36	G
China ...	0·29	80	88	6	34	11	55	0·62	28	H
India ...	0·28	84	57	6	28	17	55	0·66	31	I
China ...	0·27	47	55	6	22	34	44	0·67	45	J
India ...	0·24	76	78	6	25	19	56	0·69	31	K
China ...	0·21	44	46	6	20	37	43	0·70	47	L
S. America ...	0·20	76	88	6	25	27	47	0·64	40	M
India ...	0·19	80	110	6	26	21	52	0·66	34	N
India ...	0·19	76	88	5	25	24	51	0·67	36	O
S. America ...	0·19	76	88	6	29	23	48	0·62	38	P
Egypt ...	0·19	76	88	6	30	25	45	0·60	40	Q
—	0·19	78	77	6	20	32	48	0·71	42	R
—	0·15	96	97	4	21	33	46	0·69	43	S
—	0·12	119	131	4	22	36	42	0·66	47	T
—	0·08	112	117	4	17	44	39	0·70	53	U

A Duck.
B Acid-treated drill. A semi-parchmentised fabric, produced according to a patented process using strong sulphuric acid.
C Weft sateen.
D Cellular woven fabric.
E Drill. A little starch and calendered.
F Plain weave. Back filled, china clay and starch. Calendered.
G Drill.
H Plain weave. Back filled, china clay and starch. Calendered.
I Drill. Calendered.
J Ramie fibre fabric. Unbleached. Plain weave.
K Plain weave. Back filled, china clay and starch. Calendered.
L Ramie fibre fabric. Bleached. Plain weave.
M Plain weave. Filled, starch, clay and Epsom salts. Calendered.
N Twill. Calendered. Beetled.
O Plain weave. Beetled.
P Plain weave. Slight running of starch. Beetled.
Q Plain weave. Filled, starch and clay. Heavy calender.
R, S, T and U Plain weave. No filling.

degree of filling on the fabric, removal of which would result in a considerable decrease in reflecting power.

A column of figures is given in Tables I and II showing the values of $\frac{1}{2}A+T$ for the various fabrics. This value, which is a measure of the "hotness" or unsuitability of the fabric, is readily seen to be a minimum on making R a maximum and T a minimum. This figure only refers to garments not in contact with the skin. For garments in contact with the skin, the criterion of unsuitability is the value of $A+T$, so that in general a measure of unsuitability is given by T plus a fraction of A varying between one half and unity.

The position of the fabric C (weft sateen) is very marked in the table of relative values of $\frac{1}{2}A+T$, indicating that of all the fabrics tested, this is most suitable from the point of view of protection in general against the sun's heat. Next in order come the fabric A (duck) and B (acid-treated drill), which are in turn followed by the heavily filled fabrics F, H and K, which in proportion to their weight afford a high degree of protection. Of the remaining fabrics, E and I (drills) and N (twill) are the best, but the unsuitability of the ramie fibre fabrics J and L is most marked, this being due most probably to the open type of weave of these fabrics.

Table II

Fabric	Description of Fabric	Surface Receiving Radiation	Weight in lb. per sq. yard	No. of Samples Tested	$A\%$	$T\%$	$R\%$	$\left(\frac{R}{100-T}\right)$	$(\frac{1}{2}A+T)$ %
V	Celanese self-stripe knitted fabric Acetate silk	Both surfaces alike	0·23	4	23	40	37	0·62	52
W	Crêpe satin Woven fabric Viscose weft Cotton warp	Viscose weft	0·20	4	27	31	42	0·61	44
W	Ditto	Cotton warp	—	4	29	29	42	0·59	44
X	Woven fabric Acetate weft Viscose warp	Viscose warp	0·17	4	35	30	35	0·50	48
X	Ditto	Acetate weft	—	4	33	31	35	0·51	48
Y	Knitted fabric Hollow viscose yarn	Both surfaces alike	0·17	4	23	43	33	0·58	55
Z	"Ninon" Acetate silk Woven fabric	Both surfaces alike	0·06	3	6·5	78	15	0·67	81

Emissivity of Fabrics

On theoretical grounds the emissive powers of fabrics cannot be expected to vary to any great extent. A simple method for measuring the relative emissive powers of fabrics was employed, and consisted in fastening the fabric to a copper surface (6 inches square) maintained at a temperature of 100° C. by boiling water. The surface on which the fabric was laid down was polished, so that for a transparent fabric little heat would be radiated from the background through the interstices in the fabric. A thermopile suitably fitted with shield and water-cooled shutter maintained at a temperature of 20° C. was used to measure the heat radiated by the fabric. The results (Table III) show that there is little variation in emissive power between the different fabrics, which include one which was lamp-blacked. The maximum variation encountered is approximately 13 per cent.

Table III

E.M.F. Generated by Thermopile (millivolts); Corresponds to Heat Received.

Polished copper ...	26	Lamp-blacked fabric	285
A (duck)	299	C (sateen)	263
G (drill)	288	T (plain weave) ...	260
B (acid-treated drill)	286	U (plain weave) ...	260

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5—THE TRANSFER OF MOISTURE THROUGH FABRICS

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CONTENTS

INTRODUCTION AND SUMMARY

In connection with the work on thermal properties of fabrics described in the preceding communication, it was stated that, among other desiderata of fabrics used for clothing in the tropics, a high value of permeability to water vapour was essential. The present work was undertaken with the object of examining the means by which water vapour evaporated from the body reaches the outside atmosphere, and of determining the resistance opposed to this transfer of moisture by fabrics of varying construction.

A method of test simulating those conditions of moisture transfer in which a layer of air is enclosed between the fabric and the body, showed a surprisingly small variation in moisture transferring powers for fabrics of widely differing construction. In order to account for this result, an examination of the mechanism of the moisture transfer under the conditions of experiment was undertaken.

The passage of moisture from the liquid surface to the outside atmosphere may be divided into three stages—(*a*) between liquid surface and the underside of the fabric; (*b*) through the fabric; and (*c*) between the upper surface of the fabric and the free atmosphere which is in contact with it. The passage between the liquid surface and the underside of the fabric is by diffusion, whilst that between the upper surface of the fabric and the atmosphere is by diffusion assisted by convection to an amount depending on the degree of motion of the air. A determination of the concentrations of vapour at various stages in the moisture transfer (of which only the concentrations at the two fabric surfaces were unknown) revealed the fact that although the concentration gradient* for a single layer of fabric may vary by several hundred per cent. from one material to another, it is always small compared with the total concentration difference existing between the liquid surface and the outside atmosphere. This explains why fabrics differing widely in construction have rates of moisture transfer within a comparatively small range.

The mode of passage of vapour through the fabric was examined by constructing a series of fabrics of a material which does not absorb moisture, so that transmission must take place by diffusion only. Both the size of the individual apertures and their number could be varied in a known manner. The conclusion is drawn as a result of tests on this series of fabrics that the

* In connection with moisture vapour concentration, temperature and relative humidity, the term "gradient" has precisely the meaning associated with it in a term like "hill gradient"; it expresses the degree of change in these respective quantities with position.

passage of moisture through a fabric may be accounted for as taking place almost entirely by diffusion, and that the resistance opposed by the fabric is not dependent on the number and size of holes to any appreciable extent. The reasons for this state of affairs are (*a*) as the size of an individual aperture is decreased the flow through unit area of the aperture is accelerated; and (*b*) with many holes in a given area, the flow through any given hole is reduced by the interference of its neighbours, but when there are fewer holes they are obviously farther apart, the mutual interference is less, and each hole passes more vapour than before.

Actually, the layer of air between the fabric and the moist surface may not be enclosed. The conditions of wear may allow of relative motion between fabric and body, which results in displacement of air either through the fabric interstices or through vents in the clothing. This mode of transfer of moisture by which the air under the fabric is constantly desaturated by admixture with air from outside the fabric, is known as ventilation, and is concerned with the passage of moist air as a whole as distinct from passage by diffusion, which is, by comparison, a slower process. The ease of passage of air through a fabric is expressed by its factor of permeability, which is defined as the volume of air passing in unit time through unit area of fabric under unit pressure difference of the air on the two sides of the fabric.

Measurements of permeability to air on the series of fabrics employed in the tests for moisture transfer indicate a variation in this quantity between wide limits (in the ratio of 2,300 to 1). It is shown that, for fabrics of low permeability to air, the pressure difference generated between the two sides of a fabric by even small rates of movement is sufficient to overcome the forces tending to move the fabric relative to the body, so that little ventilation can take place through the fabric. It is obvious that for a fabric of low permeability, ventilation will take place through vents in the clothing, and such a fabric will exert by its movement a more efficient bellows action than a more open fabric. It is a debatable point whether a fabric of high permeability to air will allow of more efficient ventilation than a fabric of low permeability, but in general the former fabric may be preferred, since the air between fabric and body has a choice of passages to the outside air. Assuming that high permeability to air is desirable in a fabric, it is difficult to assess the minimum value of permeability for efficient ventilation beyond stating that a lower permeability factor is permissible for low rates of movement of fabrics in general, and for heavy or stiff fabrics as compared with light or limp fabrics. It is not possible to give any exact figure for this minimum value of permeability owing to the large variation in the forces controlling the stability of fabrics and owing to the dependence of this figure on the degree of motion of the fabric.

Arising out of the measurement of vapour concentration at various stages in the moisture transfer under conditions of test where a layer of air is enclosed between the fabric and the body, an expression was developed for the rate of moisture transfer in terms of partial coefficients of moisture transmission at the different stages. By suitable modification the expression could be applied to other sets of conditions more approximately realised in practice but difficult to simulate experimentally. The following sets of conditions were examined—(*a*) the effect of a moving stream of air over a fabric, (*b*) the effect of placing a fabric in contact with a moist surface, and (*c*) the effect of a moving stream of air over a fabric in contact with a moist surface. The rates of moisture transference increase successively in the three groups of conditions, and ultimately in (*c*) the fabric resistance is the determining factor. A measure of the fabric resistance has been obtained by using a pile method of test developed in connection with some of the work on the determination of concentration differences. A range of variation of several hundred per cent. is shown to exist between extreme types of fabrics. In this connection an interesting result is noted, namely, that the resistance of a weft sateen to moisture transfer is low compared with fabrics such as a duck or an acid-treated drill, to which it is closely allied in weight. A probable explanation of this low resistance is put forward as a result of the conclusions arrived at regarding passage of moisture by diffusion through small holes, and is seen to be due to the slit type of formation of holes in a fabric of this weave. One other general effect of the increase in rate of transfer of moisture under any set of conditions is the extension of the range of variability between fabrics of different construction.

The general conclusions arrived at as a result of this work are—(*a*) when conditions are such that moisture transfer takes place by diffusion through a layer of air enclosed between the fabric and the body, there is little to choose between fabrics, whatever their construction may be; (*b*) it is debatable whether the ventilation afforded by a fabric which is permeable to air is more effective than the alternative method of ventilation due to the bellows action of a non-permeable garment provided with suitable vents; (*c*) under conditions where a fabric is in contact with a moist surface and is fanned by a breeze, the rate of moisture transfer is dependent on the structure of the fabric (a sateen fabric is seen to possess a small resistance compared with fabrics such as duck and acid-treated drill of the same order of weight).

Part I

A STANDARD METHOD OF TEST FOR THE TRANSFERENCE OF MOISTURE

(1) Description

The test conditions chosen are such as might occur in service. The atmosphere in contact with the clothed body has a temperature of approximately 37° C., and a relative humidity which is 100%, or less, according to the rates of production and loss of moisture, the amount of moisture originally present, and, to a less extent, depending on the composition of perspiration. As standard test conditions, the rate of transfer of moisture is measured from a water surface at 37·5° C. through the fabric into free still air at constant temperature and humidity (20·5° C., 63% R.H.), the distance between the fabric and the water surface being maintained constant.

The method of test consists in measuring, by weighing, the rate of escape of water vapour into the air-conditioned room from a shallow glass vessel covered with one layer of fabric, the water in the dish being maintained at the desired temperature by a surrounding water bath. To carry out a test, the sample is fastened by means of seccotine over the mouth (of area equal to 65·5 sq. cm.) of the vessel filled with water to within a distance of one-half inch from the fabric, no definite tension being employed beyond that necessary to prevent the fabric from sagging. The apparatus is arranged to test seven dishes in the same run. The dishes are placed on a wire tray in the water bath, which is thermostatically controlled to within 0·03° C., and the evaporation is determined by removing a vessel after a measured time interval, rapidly drying it and weighing. The vessel is replaced if necessary for continued evaporation, and the period of removal from the bath occupies 2–3 minutes.

The rate of transfer is thought to be somewhat sensitive to stray air currents which exist unavoidably in a room in which movement takes place, and which are also induced by the action of the humidifying plant conditioning the air of the room. For this reason, and in addition, to submit each specimen to exactly the same conditions, the positions occupied by vessels in the bath are changed at regular intervals in a definite sequence. In order to determine the rapidity with which equilibrium is attained, weighings have been made at intervals throughout a day's run, but no evidence has been furnished that the rate determined for the first period differs appreciably from that at any subsequent period, and consequently the test has been made continuous, avoiding the disturbance of conditions which arises on removal of a dish from the bath for weighing. The time of run is limited to not more than four hours, since a longer period would involve an appreciable change in water level, with consequent variations. The rate of moisture transfer is expressed in grams per second per 1,000 square centimetres of surface, which involves the assumption that the rate is proportional to the area of fabric. This assumption is not strictly correct, but the method adopted for the expression of the results is justified, however, on the grounds of convenience, and, since all measurements recorded in this paper have been made on pieces of fabric of the same area and shape, no error is thereby introduced into the figures in this paper, which are purely comparative. A test of the validity of the assumption gave the following results for a given type of fabric.

Rate of Moisture Transfer	Area of Fabric
0·0056 gm./sec./1,000 sq. cm.	18·0 sq. cm.
0·0054 gm./sec./1,000 sq. cm.	65·5 ,,

(2) Discussion of Results

A number of fabrics have been tested, and the results, together with information concerning their structure, are included in Tables I and II.

Table I

Fabric Letter	Description of Fabric (All Fabrics Bleached White)	Mean Rate of Transference in gms./sec./ 1,000 sq. cms.	No. of Tests	Permeability to Air "*P*"	Weight lb. per sq. yd.
U	Plain weave. No filling	0·0055	4	2·2	0·08
R	,, ,, ,, ...	0·0054	4	3·0	0·19
S	,, ,, ,, ...	0·0053	11	—	0·15
A1	,, ,, Back filled. Calendered	0·0052	3	0·03	0·31
H	,, ,, ,, ,, ,,	0·0052	3	0·02	0·29
F	Drill. Starched. Calendered... ...	0·0051	4	0·49	0·30
B1	Plain weave. No filling. Singed ...	0·0051	3	3·5	0·16
C1	,, ,, Back filled. Calendered	0·0050	2	0·07	0·33
Q	,, ,, Filled. Heavy calender	0·0050	3	0·37	0·19
C	Weft sateen	0·0049	5	0·15	0·37
A	Duck	0·0049	6	0·28	0·52
D1	Cellular woven fabric	0·0049	4	—	0·22
B	Acid treated drill. A semi-parchmentised fabric, produced according to a patented process, using strong sulphuric acid	0·0049	1	0·05	0·44

Mean rate for open water surface, 0·0144 gm./sec./1,000 sq. cms.

Table II

Fabric Letter	Description of Fabric (All fabrics bleached white)	Mean Rate of Transference in grms./sec./1,000 sq. cms.	No. of Tests	Weight lb. per sq. yd.
V	Celanese self-stripe knitted. Acetate silk ...	0·0050	2	0·23
Z	Gauze fabric. "Ninon." Acetate silk	0·0054	2	0·06
X	Plain weave. Acetate weft. Viscose warp ...	0·0050	2	0·17
W	Sateen. Viscose weft. Cotton warp	0·0050	2	0·20
Y	Knitted fabric. Hollow viscose yarn.	0·0053	1	0·17

The fabric letters refer to the series of fabrics tested in connection with the determination of absorption, transmission and reflection of radiant heat described in the preceding paper.

The degree of accuracy attainable is indicated by the fact that a deviation of 0·0002 gm./sec./1,000 sq. cms. from the mean rate for any given fabric is exceeded on one occasion only (when 0·0003 gm./sec./1,000 sq. cms. resulted), the mean of all the deviations being slightly less than 0·0001 gm./sec./1,000 sq. cms. Table I includes results of tests on a variety of cotton fabrics which differ widely in construction, and particularly in openness of weave, among the fabrics being some supplied as typical of those exported to the tropics, notably the heavily filled fabrics and the cotton duck. In Table II the results are recorded of a smaller number of tests on some artificial silk and artificial silk and cotton union fabrics. It will be observed that their range of moisture transfer falls within that obtained for cotton fabrics.

A column of figures is included in Table I which gives the value of the permeability to air, "*P*," for most of the fabrics. The details of the measurement are described later, the results being quoted here to emphasise the wide variation from fabric to fabric. Permeability to air is expressed as the volume of air (in litres) passing per unit time (1 sec.) through unit area (1,000 sq. cms.) under unit pressure difference (1 mm. of water) between the two sides of the fabric.

Variations in rates of transfer on different samples of any particular fabric are not thought to be due to a sampling effect, but are inherent in a measurement of this type. Considering the widely different nature of the fabrics tested, the range of rates of transfer is surprisingly small. It is in view of this result that sampling errors are not considered likely to occur, and that the tension under which fabrics are fastened on the dishes is not important. The general tendency of these results is confirmed by previous work from two different sources. A United States Bureau of Standards publication[1] on the transfer of moisture by blankets, employing a method on which the standard method of test adopted in this account was based, states that the range in the rates of moisture transfer of a large assortment of blankets was from 0·0032 to 0·0044 gm./sec./1,000 sq. cm. In a report of the Medical Research Council[2] a few tests are reported on the transfer of moisture to and from a liquid surface at room temperature through fabrics. The conclusion was drawn from tests on five fabrics, including three cotton shirtings, a cellular woven material and flannel, that all these materials allow water vapour to penetrate with almost equal ease. It appears to be established fairly conclusively that there is no large variation in moisture transmitting power of fabrics under the conditions of experiment described above, such as might reasonably be expected to occur.

Part II

THE MECHANISM OF THE TRANSFER OF MOISTURE BY FABRICS UNDER STANDARD CONDITIONS OF TEST

The passage of moisture from the liquid surface to the outside atmosphere may be divided into three stages—(1) between the liquid surface and the under side of the fabric, (2) through the fabric, and (3) between the upper surface of the fabric and the free atmosphere which is in contact with it. It will be assumed that the steady state has been attained, in which moisture is passing at a definite rate, the vapour concentrations being constant at any one point. The investigation is divided into two sections, (1) the determination of vapour concentrations at various stages in the moisture transfer, of which only the concentrations at the two fabric surfaces are unknown, and (2) an examination of the mode of passage of moisture through the fabric and of the extent to which this can be accounted for by diffusion alone.

(1) Determination of Vapour Concentrations at Various Stages in Moisture Transfer

A number of subsidiary determinations are necessary to supply the data for this discussion.

(*a*) *A Pile Method for the Determination of the Concentration Gradient through a Fabric.*—The principle of the method is indicated by a cross-section of the apparatus shown in Fig. 1. The arrangement allows of the passage

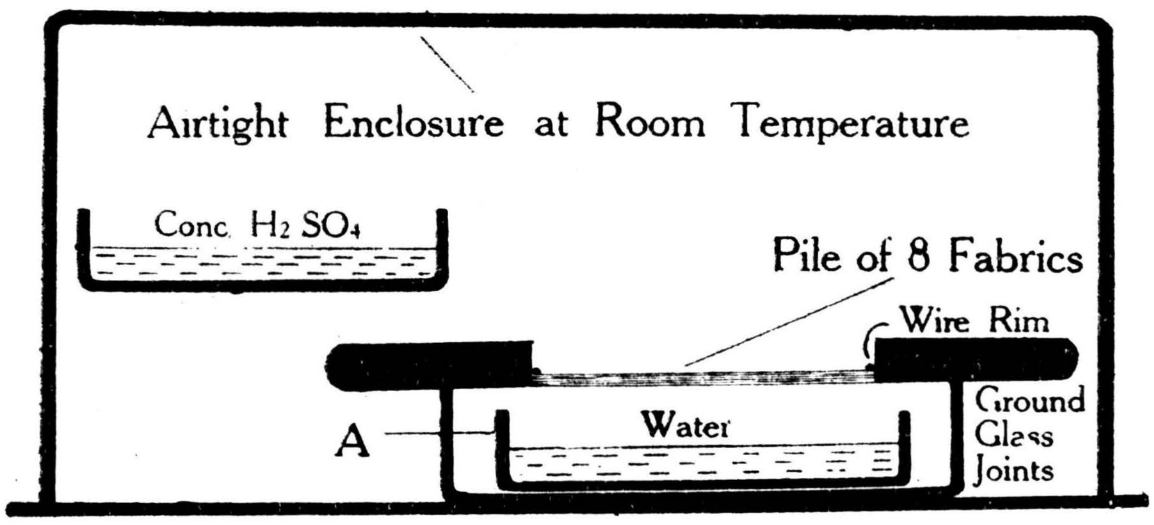

FIG. 1

of moisture from water contained in a dish A (which may be removed for weighing), through a pile consisting of eight layers of the material in contact with each other, into an atmosphere which is maintained at low humidity by means of dishes containing concentrated sulphuric acid placed in an air-tight enclosure. No temperature control has been attempted, the temperature being that of the room. Equilibrium is attained in a period of days, after which the rate of transfer is measured and also the regains of successive layers in the pile. Previous to the test the fabrics were saturated over water, so that reference to the desorption regain-relative humidity relationship (roughly the same for the five fabrics tested) enables the equivalent relative humidity gradient through the pile to be determined. This gradient within the limits of accuracy attainable is linear and proportional to the rate of moisture transfer. The gradients of five types of fabric are expressed in Table III for a constant rate of transfer of 0·0009 gm./sec./1,000 sq. cms., the direction of transfer being upwards.

Table III

Fabric Letter	Description of Fabric	Relative Humidity Gradient per Layer of Fabric
U	Plain weave. No filling	1·0
C	Weft sateen	1·3
R	Plain weave. No filling	1·5
A	Duck	3·2
B	Acid treated drill	6·3

The letters U, C, R, etc., have the meanings previously ascribed. These results show that there is a considerable variation between fabrics in the resistance opposed to the transfer of moisture, but how the magnitude of this effect is related to the total concentration difference between liquid and outside atmosphere will be shown by a second application of this pile method to the actual standard conditions of test.

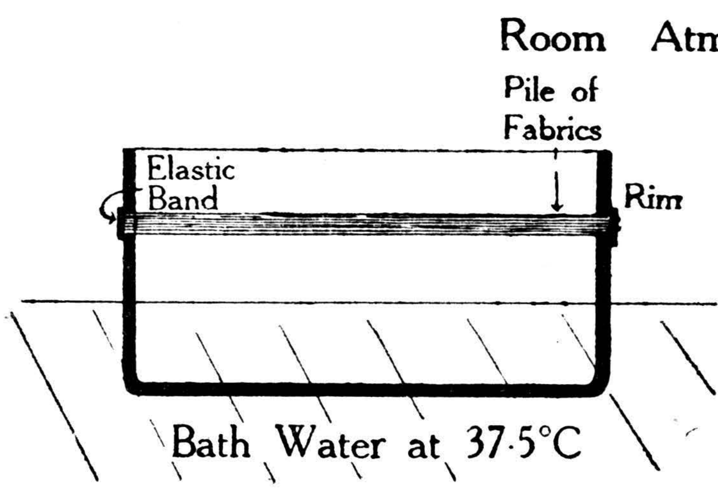

FIG. 2

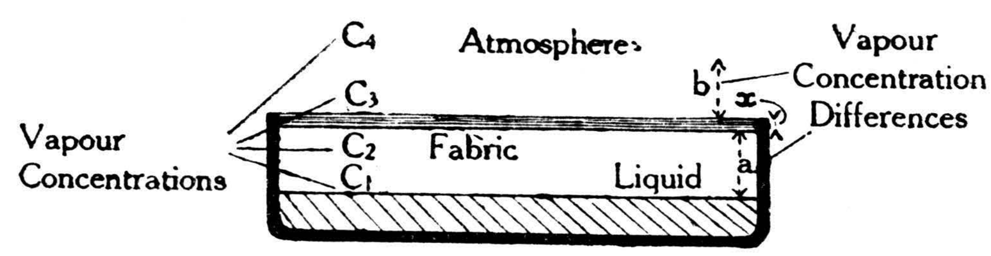

FIG. 3

(*b*) *A Pile Method Applied to Standard Conditions of Test*—A slight modification (shown in Fig. 2) of the standard method of test was found necessary, this involving the application of a rim in order to hold the pile of fabrics in position. In addition to the regain measurements on the attainment of equilibrium, it was necessary to determine the mean temperature of each layer of fabric, which was effected by placing copper-constantan thermojunctions between successive layers of fabric, the normal "cold" junction occupying the thermostatically controlled water bath. The results of temperature measurements are averaged, and, making due allowance for the temperature effect on the regain-relative humidity relationship for the fabric, the mean vapour concentration for each layer of fabric is calculated, being the product of the equivalent relative humidity and the maximum vapour concentration corresponding to the fabric temperature. Five layers of fabric R were tested by this method, the rate of transfer also being measured.

The vapour concentration in immediate contact with the liquid surface may be calculated from a knowledge of its temperature, with the aid of standard tables. The nominal temperature of the water is 37·5° C., but measurements employing a thermocouple between the liquid surface and the bath water indicate that the temperature is less than this, for which two reasons can be ascribed—(*a*) heat loss by radiation, and (*b*) heat loss by moisture evaporation from the water surface. Consequently the lowering of temperature is greater for an open water surface from which increased evaporation takes place. In the test, the temperature of the water surface in the fabric-covered vessel was 36·4° C., and in the open vessel 35·0° C.

The various concentrations of vapour obtained were—

			Concentration.
Atmosphere.	65·8% relative humidity.	21·2° C.	$12{\cdot}1\times10^{-6}$ gm./cc.
Water surface.	100% relative humidity.	36·4° C.	$42{\cdot}2\times10^{-6}$ gm./cc.
Concentration difference per layer of fabric R ...		...	$1{\cdot}85\times10^{-6}$ gm./cc.
Mean concentration of five layers of Fabric R (mean temperature 29·6° C.) ...		...	$23{\cdot}5\times10^{-6}$ gm./cc.

Rate of moisture transfer, 0.0035 gm./sec./1,000 sq. cm. (Height of rim 1·3 cm. Area of cross-section of dish, 56·7 sq. cm.) For one layer of Fabric R tested under the same conditions, the rate of transfer was 0·0045 gm./sec/. 1,000 sq. cm.

Referring to the diagrammatic representation of moisture transfer (Fig. 3), $a=C_1-C_2$; $b=C_3-C_4$; $x=C_2-C_3$. Let $a+b+x=F$, where F is the total concentration difference between the liquid surface and the outside atmosphere. It may be assumed that the transfer of moisture from the water surface is governed by a coefficient of moisture transmission (the "overall" coefficient) M such that rate$=M(C_1-C_4)=M.F$. This is made up of three "partial" coefficients of moisture transmission—

K=coefficient of moisture transmission from liquid surface to fabric.
K_1=coefficient of moisture transmission from fabric to air.
K_2=coefficient of moisture transmission per layer of fabric.

We then have rate$=M.F.=K.a=K_1.b=K_2.\frac{x}{n}$ (equation of continuity)

so that $\frac{1}{M}=\frac{1}{K}+\frac{1}{K_1}+\frac{n}{K_2}$ (equation for resistances in series), where n is the number of layers of cloth R.

K depends on the distance between the fabric and liquid surface and the diffusion constant;

K_1 depends on the diffusion coefficient, on the degree of movement of the air, and on the height of the rim surrounding the fabric;

K_2 depends in some way on the fabric.

Substituting the figures given above, in the equation of continuity, $K=249$, $K_1=517$, $K_2=1891$, cm./1000 sec., so that, under the conditions of experiment the moisture transmission rate will be

$$\text{Rate}=\frac{C_1-C_4}{\frac{1}{249}+\frac{1}{517}+\frac{n}{1891}}\ \text{gm./sec./1000 sq. cm.}\ \ldots\ldots\ldots\ldots\ (1)$$

For the same rate, the concentration difference between the fabric and the outside air is approximately one-half that between the fabric and the liquid surface, that is, there is greater freedom of exchange outside the fabric than under it.

The equation (1) is not valid when $n=0$, since then the conditions will be such as to make K more nearly equal to K_1. The rate of transfer for one layer of fabric R should be

$$\text{Rate}=\frac{(42{\cdot}2-12{\cdot}1)\times10^{-6}}{\frac{1}{249}+\frac{1}{517}+\frac{1}{1891}}=0{\cdot}0046\ \text{gm./sec./1000 sq. cm.}$$

An actual test gives the value of rate=0·0045 gm./sec./1000 sq. cm., which is in good agreement.

When there is no rim to the vessel (i.e. under ordinary standard conditions of test), K_1 assumes an increased value, which, as a result of an experiment now to be described, is shown to be equal to $K \times 3{\cdot}6 = 896$.

(c) *Determination of Mean Concentration of a Single Layer of Fabric under Standard Conditions of Experiment*—A fabric is chosen whose desorption regain-relative humidity relationship is known. Two dishes are prepared in the normal manner, one containing water and the other paraffin oil, both being covered by the same type of fabric C, which was saturated previous to use. After equilibrium has been attained, the fabrics are removed quickly and placed in weighing bottles and their regain determined. The use of the fabric over paraffin oil constitutes an indirect method of measuring the mean temperature of the fabric. Since no water vapour passes to or from the fabric, the concentration of vapour at the fabric is that of the room atmosphere. Making allowance for the influence of temperature on the regain-relative humidity relationship, the relative humidity "H" of the atmosphere with which the fabric is in equilibrium becomes known from the fabric regain. Then, the maximum vapour pressure at the temperature of the fabric is the product, room vapour pressure $\times 100/H$.

The temperature corresponding to this maximum vapour pressure may be read off from standard tables. Similarly for the fabric over water, the relative humidity of the atmosphere with which it is in equilibrium is determined, and, assuming the mean temperature of the fabric is identical with that of the fabric over paraffin oil, the mean concentration of vapour at the fabric can be determined. The various concentrations of vapour were—

Atmosphere—66% relative humidity at 21·1° C. ... $12{\cdot}0 \times 10^{-6}$ gm./cc.
Water surface—100% relative humidity at 36·4° C. ... $42{\cdot}2 \times 10^{-6}$ gm./cc.

Mean concentration of fabric over water corresponds to 85·2% relative humidity at 24·8° C. ... ... $= 19{\cdot}2 \times 10^{-6}$ gm./cc.
Approximate estimation of concentration gradient through fabric for rate of transfer, 0·0050 gm./sec./1000 sq. cm. ... ... $= 2{\cdot}2 \times 10^{-6}$ gm./cc.
From which it follows that $K_1/K = 3{\cdot}6$.

The value $K_1 = 3{\cdot}6 \times K = 3{\cdot}6 \times 249 = 896$ is greater than the value $K_1 = 517$, found when a rim surrounded the fabric, which indicates that there is greater freedom of exchange with the outside atmosphere in the absence of the rim.

We should expect, for one layer of cloth R, under standard conditions of experiment,

$$\frac{1}{M} = \frac{1}{249} + \frac{1}{896} + \frac{1}{1891} \quad \therefore M = 177$$

that is, rate $= 177(42{\cdot}2 - 11{\cdot}1)10^{-6} = 0{\cdot}0055$ gm./sec./1000 sq. cm., calculated as against 0·0054 gm./sec./1000 sq. cm. observed (Table I).

For an open vessel, K_2 does not enter into consideration, and the conditions are such that the diffusion is controlled by a coefficient approximately equal to K_1 (for a vessel with a rim). We then have

Rate $= 517(39{\cdot}2 - 11{\cdot}1)10^{-6} = 0{\cdot}0145$ gm./sec./1000 sq. cm.
calculated as against 0·0144 gm./sec./1000 sq. cm. observed (Table I).

(d) *Influence of Direction and Amount of Flow on the Coefficient of Moisture Transmission between Liquid Surface and Fabric*—The amount of moisture transmission can be reduced by replacing the water by an acid solution to give 50% relative humidity, and the direction of flow reversed by employing concentrated acid in the dish. Some approximate measurements of temperature and regain of fabrics tested over (*a*) water, (*b*) acid solution to give 50% relative humidity, and (*c*) concentrated acid, gave the following values for K—

Water giving 100% R.H. $K=249$, 227, 227, 208.
Acid solution giving 50% R.H. $K=200$.
Concentrated acid giving 0% R.H. $K=222$.

There appears to be no change in the order of the value of K with reduction in rate, or on reversal of the direction of flow of moisture transmission.

(*e*) *Discussion*—The concentration difference for a single layer of fabric is seen to be small compared with the total concentration difference existing between the liquid and the outside atmosphere. A change in fabric concentration difference, which may occur, as reference to Table III shows, still does not bear a serious proportion to the total concentration difference, which explains why fabrics differing widely in construction have rates of moisture transfer within a comparatively small range.

Under conditions of still air outside the fabric, a reduction of the concentration difference required to pass moisture through fabrics would not result in an appreciable change, x being already small. It is possible to imagine a fabric constructed in the form of a very fine mesh which does not materially impede the passage of moisture. The effect of such a fabric would be merely to screen the air below it from free exchange with the air above. A large part of the action of a fabric in preventing the normal rate of flow taking place from a water surface is due to this screening effect.

If the degree of saturation at the skin is less than the maximum, or the temperature and relative-humidity of the atmosphere abnormally high, the rate of moisture transfer will be correspondingly reduced, but the range of variation between fabrics should not be affected.

The passage of a rapid stream of air over the outer surface of a fabric would tend to make K_1 large, in which case the rate would approach the value $F/(1/K+1/K_2)$, provided the air under the fabric remained undisturbed. Any such disturbance would increase the rate of moisture transfer. For one layer of fabric R, when $F=30\times10^{-6}$ gm./cc. concentration difference, the rate$=0{\cdot}0066$ gm./sec./1000 sq. cm.

Again, the condition of a garment in contact with a moist skin would make the concentration difference between liquid and fabric equal to zero, and K infinite (since K is inversely proportional to the distance between liquid and fabric). The rate of transfer for one layer of fabric would be $F/(1/K_1+1/K_2)$, which for fabric R ($F=30\times10^{-6}$ gm./cc.) equals 0·0182 gm./sec./1000 sq. cm., which is considerably in excess of the value 0·0054 gm./sec./1000 sq. cm. for the same fabric under standard conditions of test.

If a stream of air passes over a garment in contact with a moist skin, $1/K$ is zero and $1/K_1$ is decreased to an extent depending on the velocity of the air stream. The rate of loss of moisture will then depend very largely on the factor K_2. The relative humidity gradients per layer of fabric (corresponding to constant rate of moisture transfer) given in Table III, are proportional to the values of $1/K_2$ for each fabric, which constitute a measure of the fabric resistances.

One effect of the increase in rate of transfer under any set of conditions is that the proportion of the concentration difference through the fabric to the total concentration difference is increased, thus extending the range of variation in rates of moisture transference.

The figures given in Table III show an interesting result, namely, that the resistance of the weft sateen C to moisture transfer is of the same order as that of fabrics R and U, and is considerably less than that of fabrics A and B, although in weight it is much more closely allied to the latter pair of fabrics. A probable explanation of this comparatively low resistance to moisture transfer will be advanced on p. T81. Under conditions where a fabric is in contact with a moist surface and if fanned by a breeze, fabric C would be definitely superior from the point of view of loss of moisture to fabrics A and B.

(2) An Examination of the Part Played by Diffusion in the Actual Passage of Moisture through the Fabric

An attempt to determine the part played by diffusion alone when moisture passes through a fabric was made by constructing a series of fabrics of a material which does not absorb moisture, so that transmission must take place by diffusion only. Both the size of the individual apertures and their number could be varied in a known manner within limits only restricted by difficulties of fabric construction.

Experimental Details—The material used for constructing the fabrics was ordinary writing paper impregnated with shellac varnish, which in addition to rendering the paper waterproof, provided a means of cementing the strips together. In the majority of cases the method of construction was to cut by means of a razor blade two sheets of paper together, in the manner shown by Fig. 4. After being varnished twice, the papers were

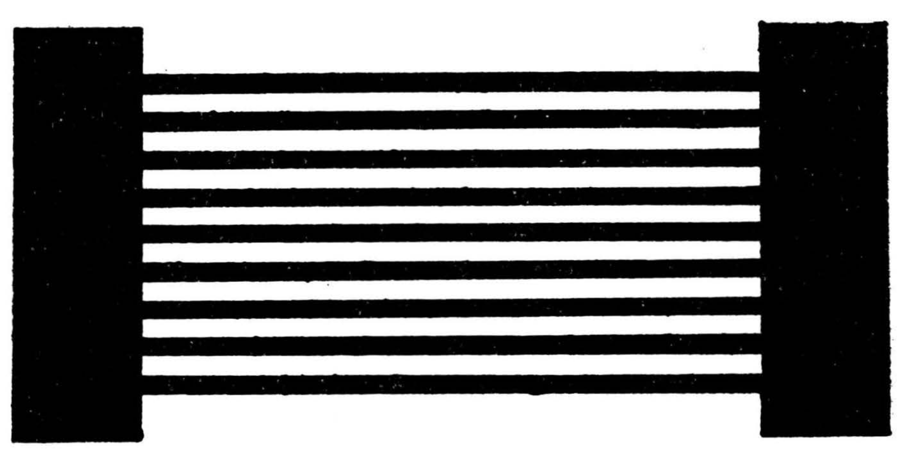

Fig 4.

laid together at right angles, a further coating of shellac binding them. In the following discussion the percentage aperture ($\%A$) is the proportion of free air space expressed as a percentage of the whole area of the fabric. It was desirable to extend the fabric series to holes of smaller area than 0·01 sq. cm., and this was effected by piercing circular holes in copper foil. By enlarging the holes gradually with the tapered portion of a needle, and removing the raised edge with emery paper, a hole whose area could be determined with sufficient accuracy was readily obtained. The fabrics were tested under the standard conditions previously described, namely, loss of moisture from a water surface at 37·5° C., through the fabric into the conditioned atmosphere of the room.

Discussion—Results of tests on these fabrics are given in Table IV, indicating the relationship between the percentage aperture and rate of transmission for four different areas of holes ranging from 0·004 to 0·16 sq. cm. The rates of moisture transfer are expressed in gm./sec./1000 sq. cm.

Table IV

Area 0·004 sq. cm.		Area 0·01 sq. cm.		Area 0·04 sq. cm.		Area 0·16 sq. cm.	
%*A*	Rate	%*A*	Rate	%*A*	Rate	%*A*	Rate
1·1	0·0011	0·9	0·0006	4·0	0·0019	4·0	0·0018
4·3	0·0030	4·0	0·0023	11·1	0·0041	11·1	0·0045
9·6	0·0041	11·1	0·0042	25·0	0·0060	25·0	0·0072
38·5	0·0056	25·0	0·0052	44·4	0·0069	64·0	0·0097
		44·4	0·0057	64·0	0·0086	79·0	0·0109

For each size of hole (0·004, 0·01, 0·04, and 0·16 sq. cm.) the rate of moisture transfer is plotted against percentage aperture in Fig. 5. It may be noted that the smaller the size of the individual apertures the steeper is

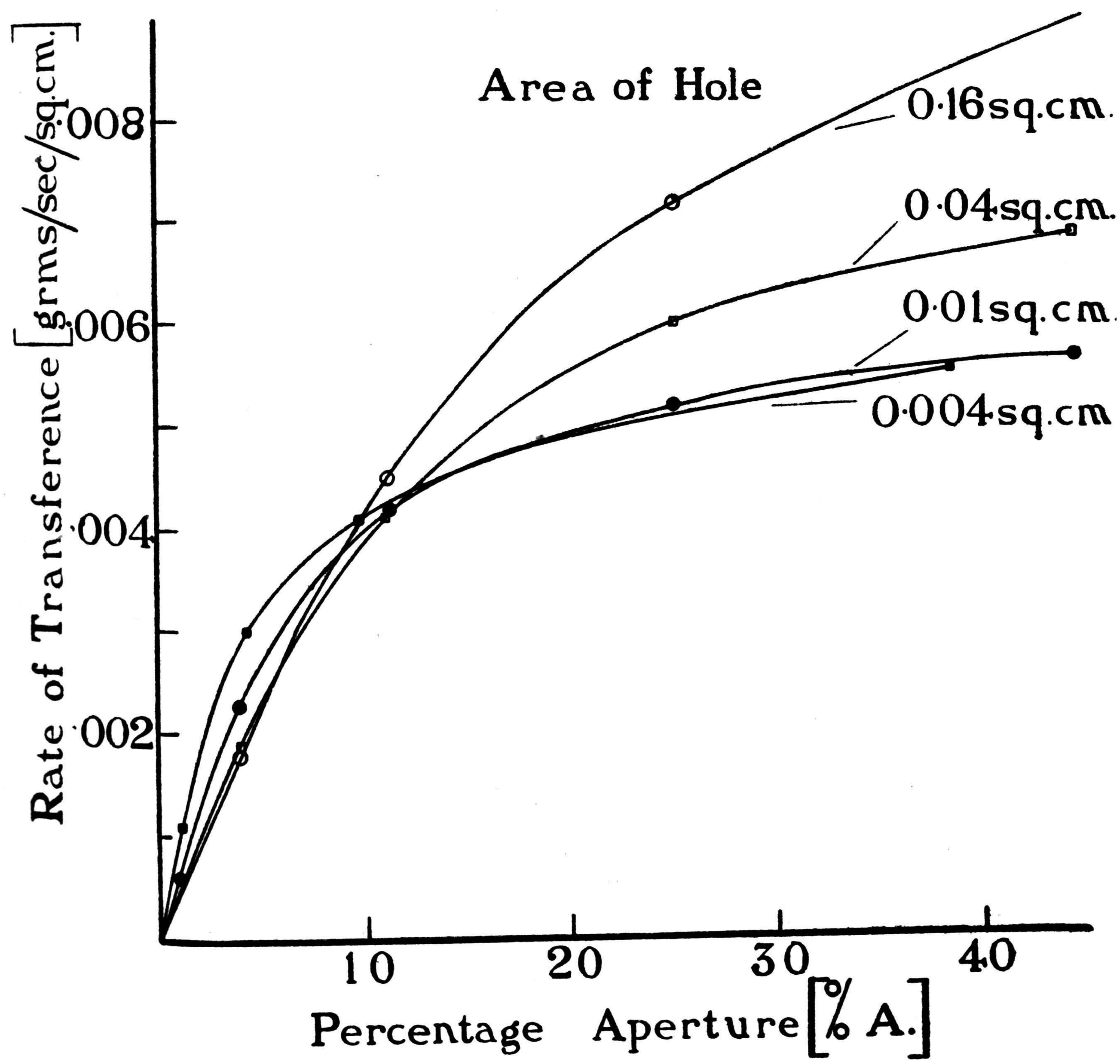

Fig. 5

the initial rise of the curve, which, however, is accompanied at a later stage by a greater flattening out. The results plotted in Fig. 5 admit of greater ease of interpretation if the rate of moisture transfer be plotted against area of hole for a series of constant percentage apertures of 4, 11, 25 and 44% respectively, the data being obtained directly from Fig. 5. These curves (Fig. 6) which are taken to the lowest practical limits of area of hole readily obtainable, appear to converge to a value for the rate of transfer equal to

0·0046 gm./sec./1000 sq. cms., which is not far below the weighted mean value of 0·0051 gm./sec./1000 sq. cms. for all the fabrics examined.

An explanation of the form taken by these curves is forthcoming as a result of some work by Brown and Escombe,[3] who investigated the purely physical processes by which the carbon dioxide of the atmosphere is able

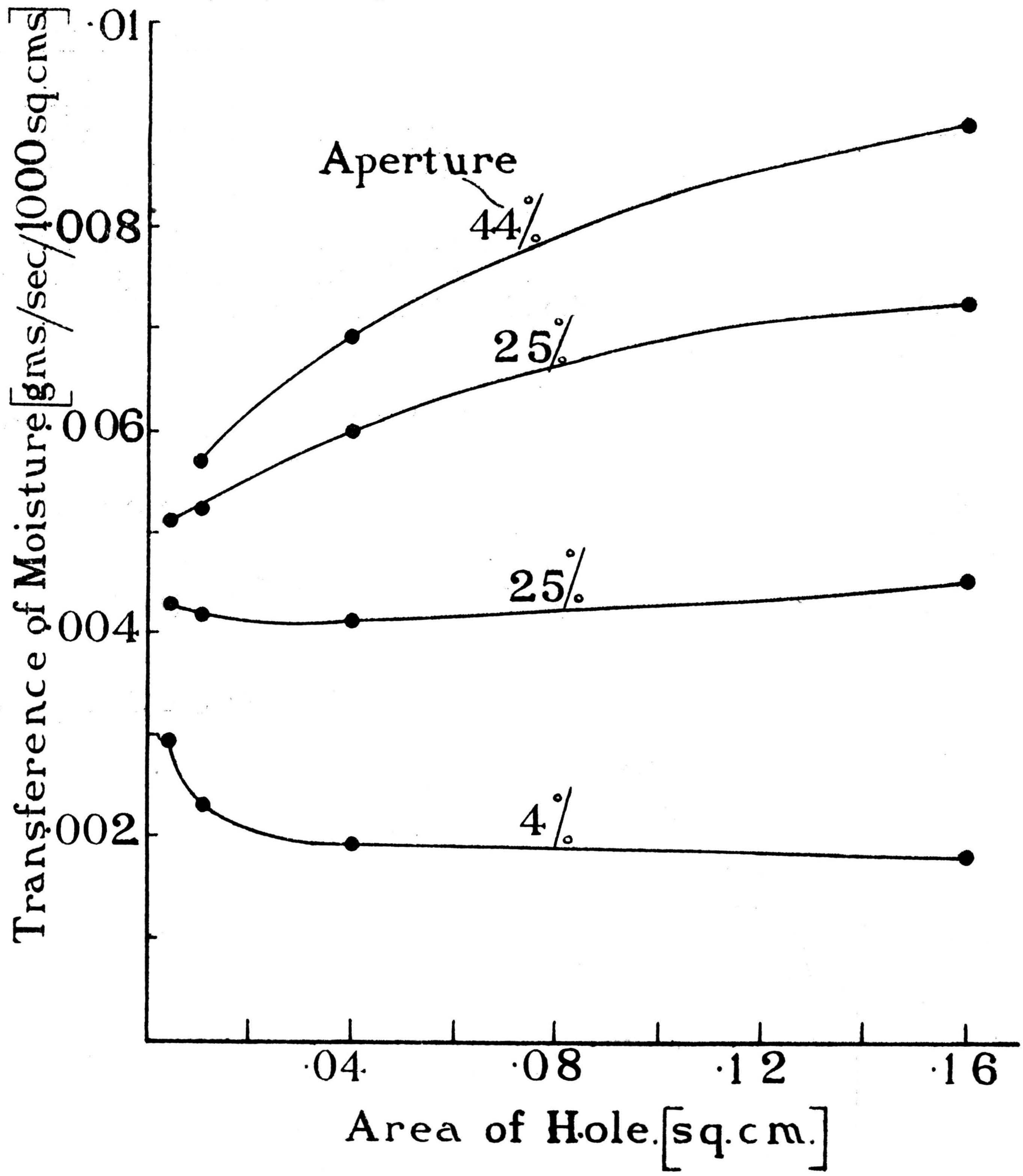

Fig. 6

to gain access to the active centres of assimilation in plants. This necessitated a study of diffusive phenomena generally, and especially of static diffusion, and led to important conclusions as to the remarkable influence exerted by perforated septa on the diffusive flow of gases and liquids generally. Their conclusions will be reviewed briefly.

"When a condition of static equilibrium has been established in a diffusing column of vapour, the amount of diffusion is proportional to the sectional area of the column. If the mouth of the tube be partially obstructed with a septum having a circular aperture, or if such a septum be interposed anywhere in the line of flow, diffusion is modified in a remarkable and unexpected manner. The magnitude of the effect produced is found to be dependent on the linear dimensions of the aperture. It follows from this that the rate of flow through unit area of such an aperture must vary inversely as the diameter."

"All the phenomena of diffusion through apertures in a diaphragm admit of a complete and satisfactory explanation if it be assumed that the converging or diverging lines of flow to or from the aperture result in the production of a system of "shells" of equal density, which locally alter the gradient in the immediate neighbourhood of the septum."

"The problem is analogous to that presented by the electric field in the neighbourhood of a conductor embedded in a surrounding non-conducting surface, and is capable of solution mathematically. For a diaphragm perforated with many small holes, a selection of the right number, size and distribution of the apertures ought to result in causing but little obstruction in the diffusive flow, although the combined areas of the apertures might only represent a comparatively small percentage of that of the obstructing septum. It is observed by experiment that provided the apertures in the septum are set at a minimum distance of ten diameters apart, the flow through the screen approximates closely to that deducible from theory. Any closer setting results in interference taking place which reduces the flow through any given aperture."

A mental picture of the converging and diverging lines of flow to and from the apertures and of the system of shells may be obtained from Fig. 7. The spacing of the holes is assumed to be such that interference takes place; consequently at a comparatively short distance from the diaphragm the density shells are almost parallel to the diaphragm.

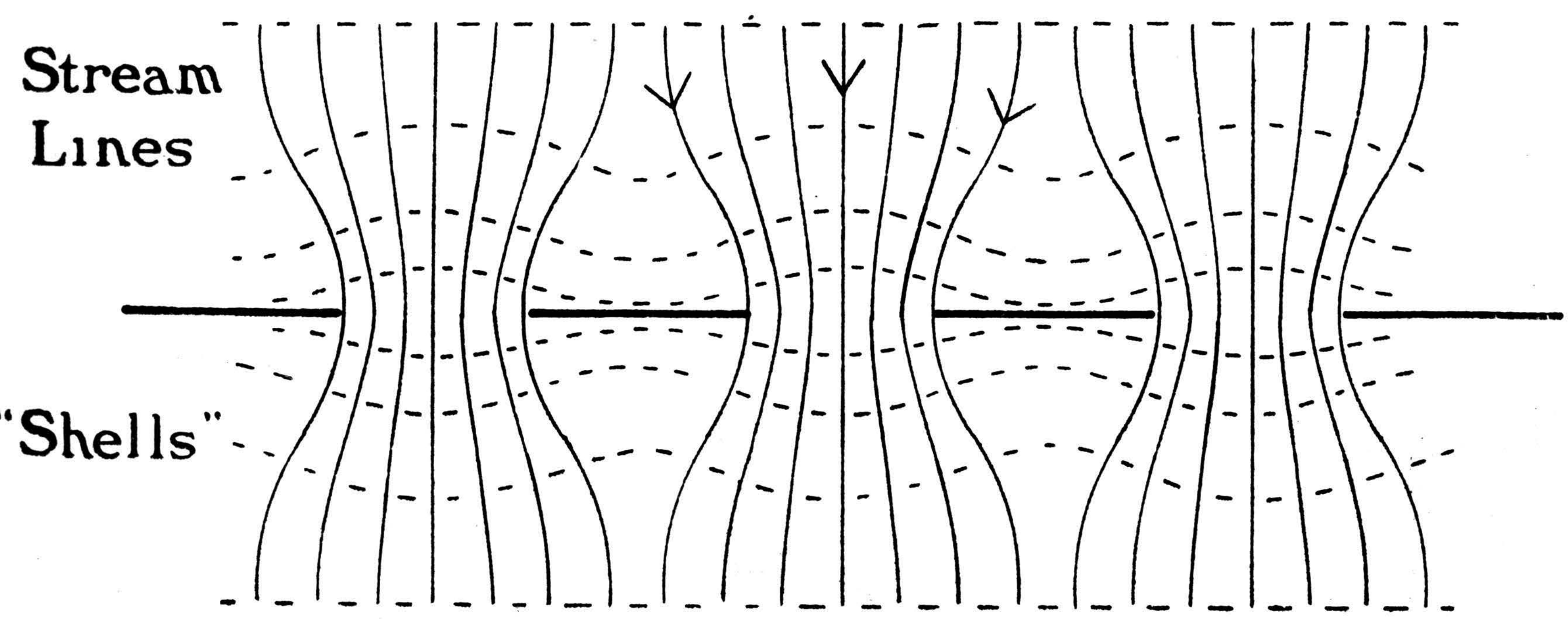

FIG. 7

If the rate of moisture transfer is calculated per unit area of aperture (equals rate $\times 100/A$ for unit area of 1000 sq. cm.), and plotted against spacing ratio (equals minimum distance between centres of holes divided by diameter of circular holes or side of square holes), the resulting curves (Fig. 8) show clearly the effect of mutual interference in reducing the rate per hole as the spacing of the holes is decreased. Again the rate of transfer per unit area of hole (when the interference between neighbouring holes is a minimum) is inversely proportional to the linear dimensions of the holes (of areas 0·004 and 0·01 sq. cm. respectively), although for holes of larger diameter, where the conditions for the production of density shells are not favourable, the rate is more nearly inversely proportional to the area of the holes. The transfer of water vapour by diffusion through a fabric or plate with small holes becomes sensibly independent of the number and size of the holes (i.e. of the percentage aperture). The reason for this state of affairs is that with many holes in a given area the flow through any given hole is reduced by the interference of its neighbours, but when there are fewer holes they are obviously farther apart, the mutual interference is less, and each hole passes more vapour than before. These conditions are seen to be fulfilled by most fabrics.

Some idea of the size of holes in a fabric may be obtained from Table V, which includes the results of some very approximate measurements on fabrics, made under the microscope.

Table V

Fabric	Percentage Aperture (% *A*)	Area of Hole, sq. cm.	Rate of Transfer, gm./sec./1000 sq. cm.
Net	95·5	0·030	0·0106
Z	64·0	0·002	0·0054
Cellular D.1	18·0 minimum	0·006	0·0049
U	23·5 ,,	0·00014	0·0055
S	9·4 ,,	0·00006	0·0053
Copper gauze ...	42·0	0·0025	0·0052
Sheet viscose ...	—	—	0·0050

It is seen that with the exception of the net fabric, which is not classed as an ordinary fabric, the maximum area of hole is 0·006 sq. cm., whilst for most fabrics, especially if closely woven, the area is considerably less.

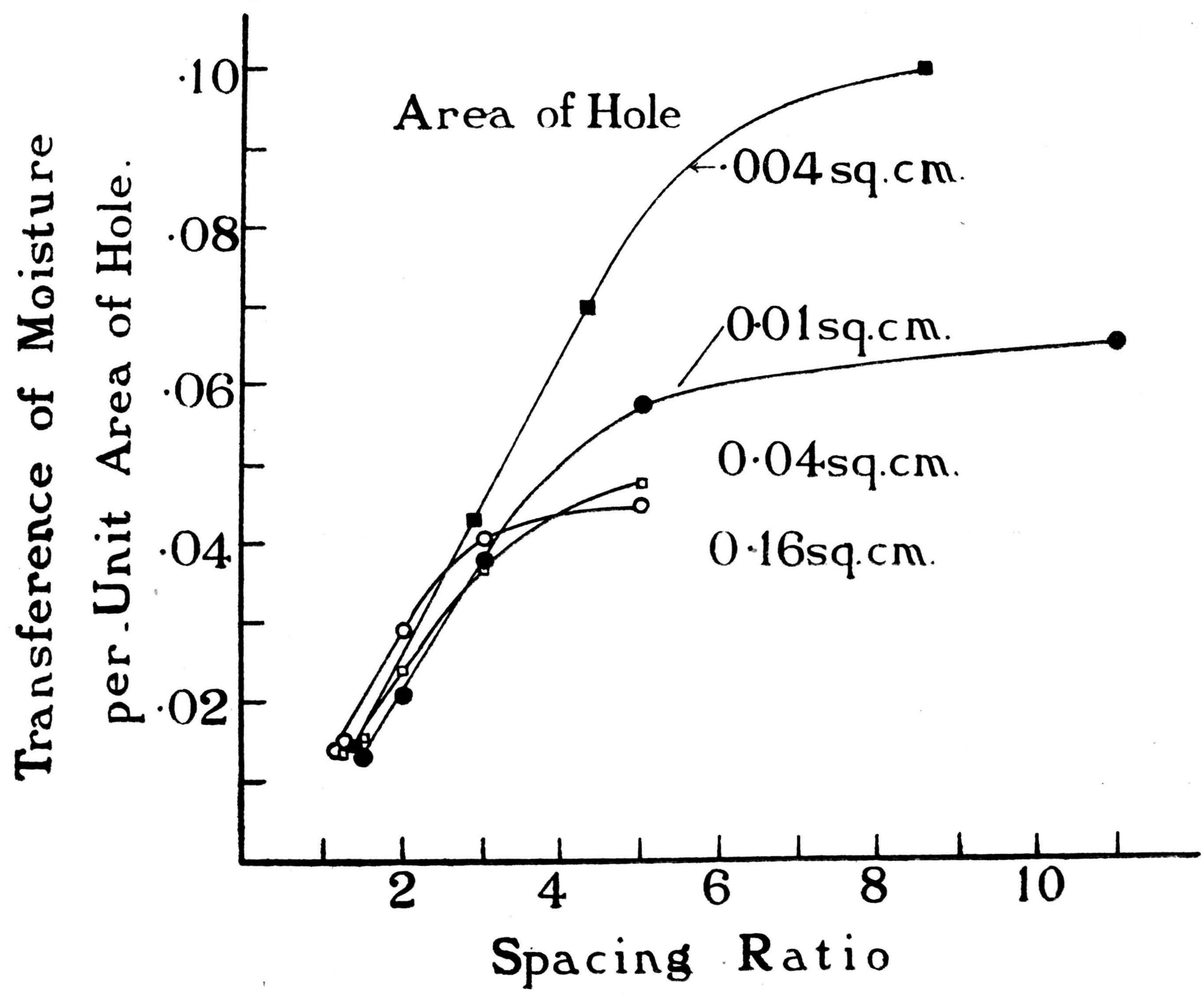

Fig. 8

It was noticed in some of the tests on the series of artificial fabrics that water was condensed under the fabric on the spaces between the holes. Had the material been capable of absorbing water the transmission would have been modified by the process of condensation, transmission through the material, and evaporation from the other side.

A sheet of viscose (which is non-permeable to air, so that diffusion of vapour in the sense previously considered cannot occur) has a rate of transmission of 0·0050 gm./sec./1000 sq. cm., which again is included in the normal fabric range. The sheet viscose when pierced by a large number of small holes did not show more than the slight increase of 0·0002 gm./sec./1000 sq. cm. in rate of moisture transfer.

On varnishing the cellular fabric D1 with shellac, the smaller holes are sealed, and the cotton prevented from taking part in the moisture transference. There is little reduction in rate, the aperture remaining being approximately 18% and the mean area of hole 0·006 sq. cm. Applying these figures to the curves in Fig. 5, the rate of transfer which is shown to be 0·0044 gm./sec./1000 sq. cm. is in very fair agreement with the value of 0·0045 gm./sec./1000 sq. cm. obtained by actual test (value for normal fabric 0·0049 gm./sec./1000 sq. cm.).

A sample of fine copper gauze was tested, and measurements on this, together with the net and fabric W, fit in with the general trend of the curves of Fig. 6.

It may be concluded, then, that the passage of moisture through a fabric may be acounted for as taking place almost entirely by diffusion, and that the resistance opposed by the fabric is not dependent on the number and size of holes to any appreciable extent. If a fabric be sealed by filling, the transmission can still take place by the process of condensation, transmission and evaporation, with little decrease in rate. It follows as a result of this work that the rate of moisture transfer for a fabric cannot be increased above normal unless both the size of the holes and the percentage aperture are increased, which at once goes beyond the field of practical fabric construction. The nature of the particular fibre employed in the fabric construction would also appear to be immaterial.

A probable explanation may be given of the comparatively low resistance to moisture transfer of a sateen fabric, noted on p. T76. A sateen consists largely of floating threads, and consequently, instead of a series of small holes spaced as in a plain woven fabric, there are a large number of narrow slits close together. It has been seen that the resistance to the passage of moisture by diffusion is inversely proportional to the linear dimensions of holes, i.e. to the perimeters of the holes. The resistance therefore of the sateen fabric is comparatively low owing to this slit type of formation.

Part III

PERMEABILITY OF FABRICS TO AIR AND ITS RELATIONSHIP TO THE VENTILATING POWERS OF FABRICS

The conditions of wear allow of relative motion between the fabric and the body, which results in displacement of air either through the fabric interstices or through vents in the clothing. The air under the fabric is therefore in a state of turbulence to a certain degree, and is constantly de-saturated by admixture with air from outside the fabric. The freer the exchange of the air between the body and the clothes with that of the outside atmosphere, the more closely does the vapour tension of the air between the body and the clothes approach that of the outside atmosphere, with a consequent increase in the rate of loss of moisture.

This mode of transfer of moisture is described as ventilation, and is concerned with the passage of moist air as a whole, as distinct from passage by diffusion, which is, in comparison, a slower process. It has been remarked that the displacement of air can take place either through the fabric interstices or through vents in the clothing. It is obvious that for a fabric of very low permeability, ventilation can only take place through the vents, but such a fabric will exert a more efficient bellows action than a more open one. On the whole it is probable that a fabric of high permeability is preferable to one of low permeability, since in the former instance the air between the fabric and the body has greater freedom of exchange with that of the outside atmosphere.

The ease of passage of air through a fabric is expressed by its factor of permeability, which is defined as the volume of air passing in unit time through unit area of fabric under unit pressure difference of the air on the two sides of the fabric.

Measurement of Permeability to Air

Fig. 9 shows the arrangement adopted for this determination. The fabric A is held against the open end of a cylindrical chamber B by means of a ring and spring clamps, to form a junction which is practically air-tight.

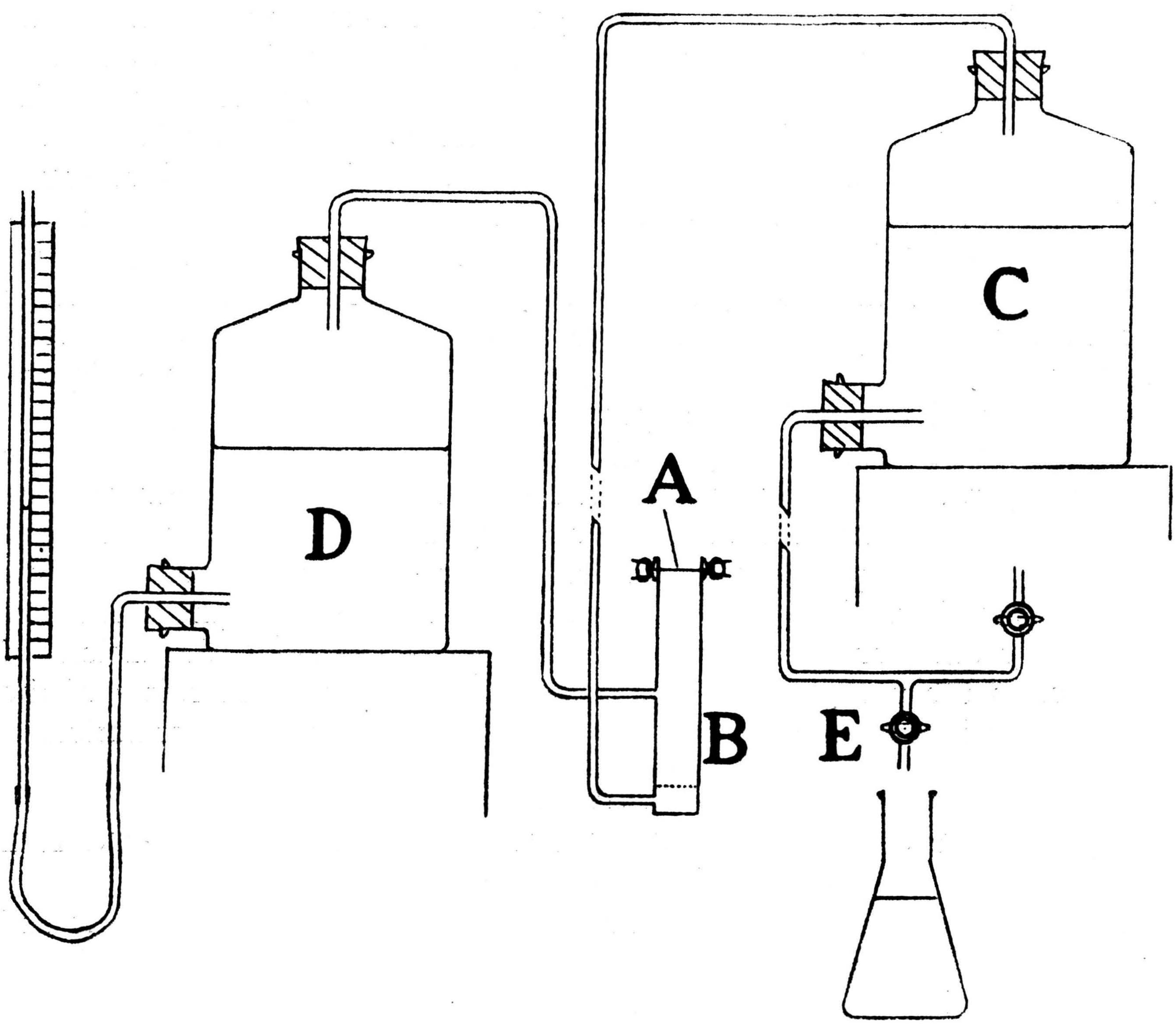

FIG. 9

An aspirator C is connected to an inlet near the base of the cylindrical chamber, a second inlet situated midway in the chamber being connected to a manometer D, which measures the pressure difference of the air on the two sides of the fabric.

When the aspirator is turned on, air of a determined humidity (controlled room atmosphere) is drawn through the specimen, resulting in a decrease in pressure of the air under the fabric. The rate of flow of the air drawn through the fabric is determined by measuring the volume of water run out through the tap E in a given time, a sufficient head of water (approximately 12 ft.) ensuring a constant rate of flow over the brief time occupied by one test. The correction to the volume of air measured in this way, due to the pressure of the air being slightly less than atmospheric, is insignicant and therefore need not be applied. The rate of flow can be controlled by adjustment of the tap E, the aspirator being refilled when necessary from the water supply, tap E then being closed.

In order to obtain a measurable pressure difference, only a small area of fabric can be tested owing to the high value of the factor for permeability of cotton fabrics in general. Two cylinders are used, of areas of cross-section equal to 2·40 and 11·34 sq. cm. respectively, the cylinder of larger area being employed for fabrics of low permeability.

Eddies in the cylinder are avoided by having the fabric cover the entire cross-section of the cylinder, and by introducing a fine metal gauze in the cross-section immediately over the air outlet. The manometer consists of a large reservoir of water connected by means of a short length of rubber tube to a glass tube in contact with a scale. The pressure difference is read off on this scale, or if the movement of the water is small, a cathetometer is used and focussed on the meniscus in the manometer tube.

The apparatus measures the quantity of air forced through a definite area of fabric in a given time under a given pressure difference. The permeability is expressed as a volume of air in litres passing per second through an area of 1,000 sq. cm. under unit pressure difference of 1 mm. of water.

Discussion

A number of fabrics have been tested for permeability to air, *P*., and the results are shown in Table VI.

Table VI

Fabric Letter	Description of Fabric	No. of Tests	"P"	% Mean Deviation	Area of Cross-Section of Cylinder sq. cm.
L	Ramie fibre. Plain weave. Bleached	12	46·2	24·0	2·40
J	Ramie fibre. Plain weave. Unbleached	11	12·7	11·8	2·40
D	Cellular woven fabric	6	11·1	12·6	2·40
B1	Plain weave. No filling. Singed ...	12	3·53	11·3	2·40
R	Plain weave. No filling	11	3·03	6·9	2·40
U	Plain weave. No filling	12	2·21	14·0	2·40
G	Drill	12	0·57	7·4	2·40
E	Drill. Starched. Calendered	10	0·49	8·2	11·34
Q	Plain weave. Filled. Heavy calendar	12	0·37	8·6	11·34
A	Duck	11	0·28	7·1	11·34
C	Weft sateen	11	0·153	8·5	11·34
—	Filter paper	2	0·078	—	11·35
C1	Plain weave. Filled. Calendered ...	8	0·067	6·6	11·34
B	Acid-treated drill	16	0·054	30·7	11·34
A1	Plain weave. Filled. Calendered ...	11	0·026	8·5	11·34
H	Plain weave. Filled. Calendered ...	9	0·019	6·3	11·34

The factor "*P*" is seen to vary between the wide limits of 0·02–46, a ratio of roughly 2,300 to 1. Some idea of the variation from sample to sample in a given fabric can be gained from the column of figures giving the percentage mean deviation. The degree of variability is high, but does not appear to depend on *P* to any marked extent. There is no evidence that the factor *P* depends on the rate of flow (Table VII) within the range of rates of air flow employed.

It is a matter of great difficulty to assess the minimum value of permeability for efficient ventilation, as so many variables are involved. The pressure difference generated by the movement of the fabric acts in such a direction as to restrain the motion, and depends in magnitude on the rate of movement of the fabric relative to the body and on the permeability factor.

Table VII

	Rate of Air Flow, ccs./sec./sq. cm.	"*P*" Litres/sec./1000 sq. cm./mm. Pressure Difference (Water)
Fabric B tested on large cylinder (area of cross-section, 11·34 sq. cm. ...	1·30	0·0201
	0·54	0·0215
	0·16	0·0204
Fabric G tested on small cylinder (area of cross-section, 2·40 sq. cm. ...	16·6	0·573
	4·2	0·605

Repetition of tests on given samples of fabric show the following results.

Fabric B (large variation between different samples)	Permeability "*P*" Test 1	Permeability "*P*" Test 2
Sample 1	0·069	0·070
Sample 2	0·028	0·027

A simple experiment was conducted which illustrates this point. A test dish was prepared, the rim being connected by a short length of camera bellows to a frame on which a fabric could be affixed, so that, on causing the frame to move up and down by mechanical means, air tends to pass through the fabric in alternate directions, there being no other outlet except through the fabric. Fabrics D ($P=11{\cdot}1$) and E ($P=0{\cdot}49$) allowed the frame to move at a rate of more than one complete oscillation per second, but fabric H ($P=0{\cdot}02$) caused the lower dish to be disturbed, although it was of considerable weight. The fabric frame could only be moved relative to the dish at a very low rate under the application of considerable force.

It is apparent, then, that the forces which control the stability of the fabric (due to inertia, tension and stiffness), and which are fairly small, may be overcome by the pressure difference generated by even small rates of movement of fabrics of low permeability, so that the fabric tends to move relative to the body at a very slow rate; consequently, little exchange of moisture by ventilation takes place through the fabric. Beyond stating that a lower permeability factor is permissible for low rates of movement of fabrics in general, and for heavy or stiff fabrics as compared with light or limp fabrics, it is not possible to give any exact figure for the minimum permeability factor for efficient ventilation owing to the large variation in the forces controlling the stability of fabrics and owing to the dependence of this figure on the degree of motion of the fabric.

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THE JOURNAL OF THE TEXTILE INSTITUTE

ABSTRACTS

LIST OF ABSTRACTORS

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Literature relating to the composition and manufacture of dyestuffs is not dealt with in the abstracts of this *Journal*.

1—FIBRES AND THEIR PRODUCTION

(B)—ANIMAL

The Sheep Blow-flies of South Africa. B. Smit. *Union of South Africa, Dept. Agric., Bull.* 47.

A lengthy paper is given dealing with research carried out at the Grootfontein School of Agriculture on the subject of sheep blow-flies. These constitute by far the worst pest the sheep farmer now has to contend with. In spite of constant vigilance, large numbers of sheep are badly infested every season, much wool is destroyed, and many sheep are killed by the maggots. (Some 10% are infested every season, and in some parts of South Africa they are killed by the maggots within 48 hours.) As the result of practical experience much valuable information was obtained from the Farmers' Association by the distribution of printed question sheets. The three species of fly responsible for damage are *Chrysomyia chloropyga*, commonly called the green-and-blue blow-fly; *Lucilia sericata*, the English sheep-fly, and *Chrysomyia albiceps*, the banded blow-fly. The paper gives an illustrated description of these insects, their life histories and distribution. In addition the various methods now in vogue for effecting the control of sheep blow-flies are given. These are as follows—disposal of carcases by burning, by boiling to make meat-meal, by the use of the trough-destructor, spraying with poison, by the "tank method," and by the "big-pit" method. Trapping is a very effective method of destroying flies. An improved form of blow-fly trap which has proved most efficient is described. The trap is baited with meat and set up in damp sheltered places where the flies are most abundant. Sheep should be kept healthy and clean by proper methods of management, including feeding, provision of suitable licks, dosing, dipping, and crutching. Infested sheep should be dressed with substances to kill maggots, heal the skin, and repel the flies. Volatile substances, such as petrol, benzene, chloroform, etc., kill maggots best. Oil and disinfectant help to heal the skin, and pine-tar oil, pyridine creosote, and many other strong-smelling substances repel the flies for a short time. W.

Discovery of a Marking Colour Free from Tar and Red Lead for Sheep. F. Deutsch. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, 59, 608.

A general description is given of the nature of a new marking substance called "Ovilla," which meets all the requirements of the sheep producers for fastness, resistance to water, exposure and sunlight, and all other atmospheric conditions, and yet is easily removed in the scouring process It is being used in Hungary, and the Government is encouraging its use. W.

Observations on the Life History of the Sheep Maggot Fly, *Lucilia Sericata*. B. Smit. *Sci. Bull.*, No. 68, *Union of South Africa, Dept. of Agric.*

A detailed account is given of the life history of *Lucilia sericata*, one of the flies responsible for damage to sheep in South Africa. The technique required to rear the flies and the results of observations made over a period of 15 months are discussed. The work is being continued. W.

Discoloration of New Zealand Sheep by Spores of a Smut Fungus Parasite on Grass. B. Parlane. *Trans. N.Z. Inst.*, 1929, 60.

The wool of sheep in the Nelson district of New Zealand in 1928 was discoloured by the minute bronze-coloured spores of a smut fungus (*Ustilago combureus*) parasitic on grass (*Danthonia pilosa*). These spores, though minute in size, were present in such large numbers that they formed an incrustation on the wool fibres of sheep grazing or lying on infected grass. The animals showed a slight affection of the mucous membrane of the nose due to irritation caused by inhaling the smut spores. W.

Wool of Domesticated Sheep. B. Kaczkowski. *Nature*, 1929, **124**, 66 (from *Bull. Internat. Acad. Polonaise Sci.u.Lettres*, 1929, p. 521).

In recent years the development of apparatus by which wool can be minutely measured has given a stimulus to the investigation of wool qualities as indicating the relationship of domesticated breeds of sheep. In a lengthy paper the author has recorded the results of his application of this method to the races of Polish sheep. The classificatory value of the composition of the fleece as regards the relative proportions of the long, rough, medullated hairs of the under coat of wool is discussed. The Polish races of sheep are divided into three groups. The first contains the most primitive original domesticated races, in which the outer hairy coat tends to predominate in amount and length; the second includes more highly bred and transitional races differing distinctly from the primitive forms; and the third group shows still more clearly the results of breeding and selection in the predominance of fine wool and reduction of medullated hairs. W.

A Skin Disease of Sheep (Mycotic Dermatitis). H. R. Seddon. *Rev. Appl. Mycol.*, 1929, **8**, 643 (from *Agric. Gaz. New South Wales*, 1929, **40**, No. 4, pp. 309-310).

Attention of sheep-breeders is called to the occurrence in Australia of a dermatitis in sheep, which has not been hitherto noticed, probably owing to its comparative rarity. The main symptom is the formation, chiefly on the back, but occasionally also on the sides, of numerous small scabs, strongly reminiscent of a favus, which bind the wool together and finally fall off, leaving a raw area very liable to become fly-blown. The trouble is believed to be caused by an undetermined fungus which was observed in quantity in the scabby crusts, and also penetrating the wool follicles. It was reproduced by rubbing a paste prepared from the crusts on the skin of healthy sheep, especially after scarification, thus demonstrating its contagious nature. Under present conditions in Australia the only means of control economically possible would be the immediate destruction of affected animals, the carcases of which should be burnt. W.

Wool Research in Canada. *Wool Rec.*, 1929, **36**, 1103.

A brief survey is outlined of the programme of the National Research Council of Canada with a view to producing a new type of sheep for Canadian requirements. W.

Experiments with Sheep and Goats at the Oregon Station. *Exper. Sta. Rec.*, 1929, **61**, 59 (from *Oregon Sta. Bien. Rep.*, 1927-28, 50-52, and 117).

Pasture Investigations—A summary of the number of trials and the number of sheep days per acre for permanent, cultivated, and irrigated pastures for winter and spring grazing of hay crops, and for stubble pastures, is given in tabular form. The average results of four years' work have shown that an acre of drilled rape produced 182 sheep days of grazing, rape and clover, 283 days of sheep pasture, and clover 343 sheep days of grazing in addition to yielding 1·4 tons of hay. The drilled rape, in addition to the sheep grazing, replaced 493 lb. of grain as pasture for hogs. In 1926 grazing Hungarian vetch to the extent of

129 sheep days per acre from March 12 to 19 increased slightly the yield of hay, while another lot grazed at the rate of 259 sheep days per acre from March 12 to April 20 reduced the yield beyond the value of the pasturage. In 1927, 172 sheep days per acre as late as May 8 did not reduce the yield.

Lamb Feeding (*at the Umatilla Substation*)—For lambs being fattened for the late winter market three years' results showed that it was profitable to cut and grind alfalfa hay when supplemented with 1 lb. of barley per head per day. While lambs gained but little on alfalfa pasture in the fall, this practice was profitable for holding the lambs to be fattened for the late market. W.

Cashmere. W. von Bergen. *Melliand,* 1929, 1, No. 6, pp. 855-859.

A description is given of the cashmere fibre, a subject sparingly dealt with in the literature. The cashmere goat is kept as a domestic animal, being native in Tibet and N. India. It thrives and grows the downy fibre only at elevation of 10,000-15,000 feet, and attempts to raise the goat in other localities have failed. The fibre is plucked once a year, and is marketed in China. The chief commercial colour is a mixture of greyish-white and brown. Cashmere consists of two kinds of fibres, the soft silky down, the real cashmere wool, with average fibre length of 1¼-3½ inches, and the stiff beard hair 1½-5 inches long. The fibres are contaminted with white scales from the skin of the animal. The appearance of the fibres under the microscope is described, together with a test for distinguishing cashmere from sheep's wool. The average number of scales per unit distance of 100μ (micron) is 6-7, as compared with 10-12 in sheep's wool. The diameter of the hair is extremely regular, the average being about 15μ when mounted in glycerin, but about 17μ in water. The normal cashmere wool hair is thinner towards the root as well as towards the end, and is practically circular in cross-section. The beard hairs contain a brown granular pigment and are medullated. They are very irregular in diameter, but average about 63μ in glycerin. The cross-section is elliptical. W.

Use of Skin Wools. *Wool Rec.*, 1929, 36, 901.

The process of obtaining green skin wool is by sweating the grease wool from the pelts soon after slaughtering the sheep. The wool being fresh—often still warm—the scoured product shows nothing of the so-called dead character inferior skins display. The colour and lustre of green skin washed material therefore do not suffer. As "double cuts" when shearing are absent in skin scoured wools, and the length more even, the combing of such assures a better "tear" than the product of shorn wool, and thereby lowers the conversion cost. The value of the scoured product from skins dried in the sun after killing depends upon the condition, skill, and method in which wool is detached from the pelt. Mixtures of good and indifferent dry-skin and those taken from the carcases of sheep which have died on account of drought, epidemics, or other causes, are much to blame for the antagonism aroused. Since arbitrary and other decisions of individual countries, or trade organisations, on the comparative value of shorn and skin wool products are frequently one-sided, and tend to arrive at conclusions injurious to the skin wool trade, it is advocated that the matter should be regulated by the International Wool Federation. W.

Investigation and Research on Wool. P. Krais. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, 59, 608.

The reports given at the tenth membership meeting of the German Research Institute for the Textile Industry at Dresden include investigations on the finest wool known (unborn Bokhara lambs), on the effects of feeding on wool production, and on the physical properties of wool, such as length, fineness, crimping strength and elasticity. Investigations have been made on scouring and the purification of scouring waters, and scouring by solvents; of the latter it is stated that in spite of the resistance and inertia of the industry toward the use of extraction solvents, the Institute is convinced that a scientifically conducted chemical wool washing will yield better wool and offer closer control than present methods of scouring with soap and soda. Tests have also been carried out on spinning and weaving. In the matter of dyeing it has been shown that dyeing at the boiling point is necessary for truly fast dyeings, and that formic acid cannot completely replace sulphuric acid in such dyeings. The effect of age on elasticity was also investigated, new wool showing an elasticity of 35-50%; wool 150 years old, only 13·5%; 400 years old, 8·8%; and wool 1300-1400 years old, only 4·6%. W.

Classing the Clip: A Handbook on Wool Classing. C. E. Cowley. *J. Text. Science*, 1929, 3, 34.

Review—The subject is treated under such headings as "The Structure of Textile Fibres," "Wool and Its Characteristics," "Preparation of Wool for the Market," "Spinning, Quality, and Yield of Wool," "Wool Pressing," etc. The writer knows his subject from the "field" point of view, and in this respect the work is both interesting and valuable. W.

Properties of Wool. Action of Ultra-Violet Rays on Wool. Meunier and Huys. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, 59, 463 (from *L'Industrie Textile*, 1929, 59-62).

Insolated wool (i.e. exposed to solar light) loses its elasticity, its fluorescence, and its double refraction, but the solubility in water and in alkali increases, and the lability of the sulphur increases. The authors found the iso-electric point to be at pH $=3{\cdot}6$ to $3{\cdot}8$. They also determined the presence and amount of free amino-groups by a modified Van Slyke method. W.

The Chemical and Physical Properties of Wool. A. T. King. *Text. Argus*, 1929, 5, No. 265, p. 17.

A report is given of a lecture at a meeting of the Keighley Textile Society in which the variation of sulphur content and its importance in the formation and properties of wool is discussed at length. W.

Artificial Wool. *See* Section 1C.

(C)—VEGETABLE

Cotton: Cultivation in the Belgian Congo. J. Tilmant. *Revue Text.*, 1929, 27, 1391.

A discussion of difficulties due to taxation, regulations in regard to ginning, and to inefficient and expensive means of transport, which have led to the decline of cotton growing in the Belgian Congo. C.

Cotton: Cultivation in British Empire. British Cotton Growing Association. *Cotton* (Manchester), 1929, 35, No. 1690, pp. 19-20.

A table is given showing the amount, quality, and approximate value of the 1928 cotton crop of various British Colonies and Protectorates and the possibilities of increasing the crop. Information regarding the areas, populations, soil suitability, climatic conditions, and methods of transport of these regions is also supplied. The approximate estimate of cotton produced in Empire fields in 1928 was 359,500 bales, as compared with 374,900 bales in 1927. A résumé is given of the principal work in the several centres during 1928. C.

Cotton: Cultivation in Tanganyika. *Bull. Impl. Inst.*, 1929, 27, 367-374.

The results of time of sowing experiments, spacing experiments, and variety trials at the Morogoro Experiment Station in 1928 are summarised and discussed. The highest yields were given by the earliest planting after the rains had begun, and in cases where rain was unduly late it appeared sound to dry-plant in the latter half of February. Rows 2 ft. apart, with single plants left 9 in. apart in the rows, appeared to give the best results. The local strain of Uganda continued to give the highest yields. The varieties R.M.68 and Foster x Whitehall were the only varieties which appeared likely to challenge the premier position of the local cotton. At the Mpanganya Agricultural Station, experiments were carried out in duplicate plots, representing respectively the light unflooded higher lands of the Rufiji valley, and the loams and black cotton soils of the valley lowlands which are liable to flooding. With the former the period for optimum sowing is from the last week in January to the end of February. In the case of the lowland soils the period is about two months longer. It is important not to wait for rain but to be prepared for it with cotton seed in the ground. Owing to the conditions of rainfall no significance could be attached to the results of spacing experiments and variety trials at this station. The results of ratooning experiments rule out the ratooning of cotton as an economic proposition, even to the farmer who may be out for quantity irrespective of quality. Unusually deep preliminary digging gave no increase in yield over plots dug in a shallow manner and no significant difference in yield was obtained between plots dug in the ordinary manner and plots in which the tall grass and weed growth was merely cut down at the root immediately below the tufts from which tillering occurs and raked into rows 3 ft. apart between which cotton was sown. C.

Cotton: Cultivation in Turkey (Adana). A. Marcus. *Biol. Abs.*, 1929, 3, 244 (from *Tropenpflanzer*, 1927, 30, 426-432).

Cotton is the most important crop in Adana. Varieties of *Gossypium herbaceum* and *G. hirsutum* are mainly grown, using a two-crop rotation of cotton and cereals (wheat and barley). Seed is broadcast. Soil and climate are described. There is an experiment station. C.

New Cotton Wilt. J. J. Taubenhaus, W. N. Ezekiel, and H. E. Rea. *Rev. Appl. Mycol.*, 1929, 8, 501-502 (from *Phytopath*, 1929, 19, 171-173).

A severe wilt disease of cotton, apparently distinct from that caused by *Fusarium vasinfectum*, has been reported from three widely separated counties of Texas, especially from Ellis County. Affected plants are stunted and peculiarly branched, with abnormally short, stout joints; in advanced stages of the disease the plants shed their leaves and the branches become dull in colour. In some cases the plants die from the tops and new growth appears on the lower part of the main stem. Only a few of the diseased individuals are able to produce one or two bolls of cotton. Occasionally the dwarfing and stunting of infected plants is so marked as to give the impression of a rosette. The new disease may be differentiated from *Fusarium* wilt by the splitting of the stems and by black discoloration of the interior cylinder of both roots and stems; in the typical *F. vasinfectum* wilt the latter phenomenon is mostly confined to the outer woody tissue. In the new disease the discoloration is more pronounced in the lower part of the plant, becoming progressively less higher on the stem. Isolations from the Ellis County plants yielded a *Fusarium* apparently distinct from *F. vasinfectum*, besides species of *Alternaria, Sclerotinia, Phoma, Phomopsis*, and *Helminthosporium*. The occurrence of the new wilt in the heavy black lands where root rot (*Phymatotrichum*) [*omnivorum*] is destructive is considered to be specially significant. It has recently been shown that *Fusarium* wilt is mostly confined to soils more acid than *p*H 6·5-7·0, while root rot is destructive under more alkaline conditions. In other words, this is the first occasion on which the two types of disease, root rot and wilt, have been found in a severe form on the same soils. According to Fahmy, there is a certain type of wilt occurring in Upper Egypt on the Ashmouni and Zagoro cotton varieties which is characterised by an apparently harmless discoloration of the central cylinder of the root, hypocotyl, or lower part of the stem. The *Fusarium* isolated from the discoloured regions failed to infect the varieties in question and the fungus is accordingly considered non-parasitic. This type of wilt appears to be very similar to that observed in Texas, except that in the latter region the discoloration is associated with a serious disease of the plants. C.

Pink Bollworm: Control in Egypt. N. W. Barritt. *Rev. Appl. Entomol.*, 1929, 17, 503 (from *Bull. Entomol. Res.*, 1929, 20, 41-43).

The author points out that although the Government has enforced vigorous measures for the control of the pink bollworm (including the compulsory ginning of all seed cotton before May and heat treatment of all seed cotton) throughout Egypt since 1919, no significant change in the extent of attack is shown in the figures given by Williams on the seasonal variation of this pest from 1916 to 1924. These figures show that the attack begins with about 5% infestation at the beginning of July, increases to 15% in the first week of August and then rapidly rises to 60 or 70% in the first week of September, after which every boll is attacked. It seems probable that this is due to the natural rate of increase of the insect when an abundant supply of bolls is available and that the occurrence of only a few moths in each locality in June is sufficient to produce 100% attack in September. Thus, although 98% of the hibernating larvæ may be killed by the control measures, larvæ or pupæ in fallen bolls buried in the soil or in bolls on cotton sticks stored for fuel are quite sufficient to start the outbreak in July. Unfortunately it has not been found practicable to destroy these bolls, and the adoption of some control measure during July and August therefore seemed desirable. Experiments were carried out with a castor oil-resin emulsion used as a deterrent to oviposition. The results were inconclusive, but suggest the feasibility of control along these lines and the possibility of employing a protective belt of sprayed plants in fields that have not recently carried a cotton crop and in which buried bolls are not a source of infestation. C.

Pink Bollworm: Migration. J. A. Todd. *M/cr. Guard. Comm.*, 1929, **19**, 475.

Sporadic outbreaks of the pink bollworm have caused anxiety for several years in Texas. These outbreaks seem to be more of the nature of a new infestation than of the continued presence of the pest carried over from year to year. The prime source of infestation is probably in the Laguna Valley in Mexico where pink bollworm is always present in considerable numbers throughout the whole season. A study of the habits of the moth in Mexico showed that about the beginning of September large numbers are carried up involuntarily by strong convection currents to a maximum of about 3,000 feet. There they meet a "contra-trade" wind which carries them northward till, somewhere north of the United States boundary, they meet contrary winds which cause them to fall to the ground in large numbers, many of them alive. These movements of the moths have been traced by means of traps carried on aeroplanes from Mexico across 200 miles of desert to the nearest outlying points of the cotton belt, which lie in the Big Bend district of the Rio Grande, thence to the isolated irrigated districts in the Pecos Valley, and thence to the western fringes of the main cotton belt in Texas. C.

Pink Bollworm Parasite: Introduction into Egypt. A. Alfieri. *Rev. Appl. Entomol.*, 1929, **17**, 541 (from *Bull. Soc. R. Entomol., Egypte*, 1928, 52-56).

Details are given of the introduction into Egypt of the Braconid, *Microbracon kirkpatricki*, Wilkn., from Kenya where it is an efficient parasite of the pink bollworm. Most of the parasitised bollworms were found to occur in green half-opened bolls; 10-12% of these bolls contained parasitised material, an average of four parasites emerging from each. The bolls were therefore despatched without examination and kept in cold storage on board ship. A temperature of 5-8° C. was the optimum, as it did not affect the parasite larvæ or adults and sufficiently preserved the bolls from decomposition. Altogether, 470 adult parasites were obtained in Egypt from 3,450 cotton bolls. During the preliminary investigations in Kenya, the pink bollworm was found in bolls of *Hibiscus furcatus*, this being the first time it has been recorded in a malvaceous plant other than cotton in Kenya. C.

Yellow Cotton Thrips: Control in Turkestan. S. Fedorov. *Rev. Appl. Entomol.*, 1929, A17, 477 (from *Khlopkovoe Delo*, 1929, 8, 291-293).

Thrips flavus, Schr., is an important pest of cotton in Turkestan, but as its biology was unknown, it was impossible to work out effective measures for its control that would be economically practicable under the conditions of that region. An attempt is, therefore, made to give a general prognosis of the biology of this pest on the basis of a study of *Thrips tabaci*, Lind., on tobacco in the course of four years on the south coast of Crimea, as the conditions in that country and in Turkestan are similar and there exists a close biological relation between the two species. The control measures recommended comprise a rotation system which should include the growing of graminaceous plants, including millet, and sowing these for two consecutive years. Careful destruction of weeds and the removal of trash after the cotton harvest are useful supplementary measures. A single application of soap solution has only a temporary effect, as it kills the larvæ and the adults on the leaves, but does not affect the eggs in the parenchyma, and the plants soon become reinfested. Abundant irrigation, or even flooding of the cotton fields for a short time either late in the autumn or at the end of April, might also be effective. C.

Ginning: Effects on Quality. *M/cr. Guard. Comm.*, 1929, **19**, 425.

The United States Bureau of Agricultural Economics is carrying out an investigation of ginning and the quality of cotton. The relative efficiencies and effects of different mechanical processes of cleaning on the spinning qualities of the ginned lint, the variation of these efficiencies and effects with different machines in various combinations and operations, the nature and extent to which the character of the fibres, the moisture content, and the proportion of foreign matter influence the relative effects of the cleaning and ginning processes and the variation of the relations for different types of gins and different methods of operation are being studied. C.

Blendia. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, **59**, 605.

Blendia is stated to be a vegetable fibre of natural growth which has serrations giving it milling properties. It is recommended for use as a wool adulterant, and can be spun in 50/50 blends to 20's skeins or 2/48's worsted. W.

Artificial Wool. *Text. Merc.*, 1929, **81**, 410.

Two factories in the Roubaix district are producing artificial wool, the basis of which is vegetable fibre such as is used in the manufacture of paper. The product may be carded and woven in the same way as the natural wool. W.

Use of Kenaf as a Substitute for Wool. *See* Section 3G.

(D)—Artificial

Cellulose Acetate: Fractional Precipitation and Properties. J. G. McNally and A. P. Godbout. *J. Amer. Chem. Soc.*, 1929, **51**, 3095-3101.

Two methods of fractionation are described, and the properties of the fractions obtained from a sample of commercial acetone-soluble cellulose acetate are discussed. The fractions have the same chemical composition, but different physical properties; this is attributed to a difference in the state of aggregation of the glucose anhydride units in the micellæ. The solubility of cellulose acetate in organic liquids is a function of its state of aggregation as well as its acetyl content. C.

Nitrocellulose: Fractionation. J. Duclaux and R. Nodzu. *Rev. Gen. Colloïdes*, 1929, **7**, 241-250.

Commercial nitrocellulose may be separated by fractional precipitation into several fractions of different viscosities. The fractions of high viscosity, in general, precipitate spontaneously; those of low viscosity may be isolated by ultrafiltration or by coagulation by the addition of salts. A nitrocellulose may be characterised by its specific viscosity, deduced from the viscosity of a 2% solution in methyl ethyl ketone. The fractions of low specific viscosity are completely soluble in ethyl and methyl alcohols. There is very little difference between the nitrogen contents of the different fractions. The differences in solubility seem to be determined by differences in the sizes of the micellæ. These results confirm the view that there are a great number of degrees of hydration, which implies a very complex molecule. Fractionation may be carried out by the diffusion of a nitrocellulose gel in alcohol or by the ultrafiltration of a dilute nitrocellulose solution. The diffused portion or ultrafiltrate has a low viscosity, and contains only small micellæ. These procedures give very pure products, free from substances in suspension, which give perfectly clear solutions. C.

Viscose Solutions: Decomposition Velocity. O. Faust. *Ber. deut. chem. Ges.*, 1929, **62**, 2567-2573.

Investigations of the rate of decomposition of dilute viscose solutions by various acids are described. An amount of acid sufficient to decompose a given quantity of dilute viscose solution was run into the solution, to which a few drops of phenolphthalein had been added. The mixture was shaken vigorously, and then excess $N/10$ iodine solution added and the residual iodine determined by titration. The time allowed for decomposition is measured by the time between the decoloration of the phenolphthalein and the addition of iodine solution. The results are recorded as percentage xanthate content of the viscose after increasing decomposition periods and curves are constructed. The velocity of decomposition is greater at the beginning of the reaction. Results are given for different acids on viscose with 8·54% xanthate prepared from (1) unripened alkali cellulose, and (2) alkali cellulose which has been ripened for 4 days. The differences in the velocities of decomposition in the two cases are not considerable owing to the fact that the swollen condition in dilute solution renders both the larger and smaller particles easily accessible to the acid. A viscose with 12·8% xanthate content was more readily decomposed by acids than viscose with lower xanthate content. In the preparation of viscose films and filaments the velocity of decomposition by acids is only of secondary importance, the determining factor being the rate of diffusion through the skin of regenerated cellulose formed on the outside by the first action of the acid. In the experiments described skin formation was prevented by the use of dilute solutions and by vigorous shaking. C.

Lilienfeld Rayon: Resistance to Cellulase. P. Karrer and P. Orsi Mangelli. *Helv. Chim. Acta*, 1929, **12**, 989-990.

Lilienfeld rayon is more readily attacked by cellulase than ordinary viscose rayon, but shows more resistance than fine-filament cuprammonium rayon. These results are in agreement with earlier investigations, which showed that the resistance of viscose rayon to attack by cellulase decreased with decreasing salt content and increasing acidity of the precipitation bath. C.

Cellulose Acetate: Swelling in Binary Mixtures. I. Sakurada. *Kolloid Z.*, 1929, 49, 178-184.

The swelling of cellulose acetate in binary mixtures of which both components are polar, is studied. No such simple relation exists here between swelling and polarisation as that found in cases when one component is non-polar. Additions of small amounts of dipolar substances are shown to have a great effect on the swelling. An attempt is made to find a relation between swelling, molecular polarisation, vapour pressure, and viscosity measurements. If at least one component of a binary mixture is non-polar the swelling may be predicted from the molecular polarisation, vapour pressure, and viscosity. C.

Stretched Nitrocellulose and Cellulose Acetate Films: Structure. J. Trillat. *J. Phys. et Radium*, 1929, **10**, 370-384.

An account is given of X-ray investigations of the changes in structure of colloidal films of nitrocellulose and cellulose acetate on stretching. Stretching produces an orientation of molecules in the direction of the tension and reduces the degree of oscillation of the molecules. With increased stretching a pseudo-crystalline state is eventually reached in which the molecules occupy practically the same positions as in the crystalline form, but are not perfectly aligned. The presence of a residual amorphous phase also prevents perfect crystalline formation. These changes are analogous to those observed in stretched rubber. The relation between the structure of colloidal films and the effects of mechanical action on their physical and surface properties is discussed. C.

Alkali Cellulose: Ageing. B. Rassow. *Textilber.*, 1929, **10**, 787-791.

Air-dry cotton was treated with 9%, 18%, and 36% solutions of sodium hydroxide, squeezed out to three times its original weight and aged in thermostats at 20° C. in diffused daylight. Aged alkali cellulose has always a characteristic odour; visible change is only clearly apparent at high alkali concentrations and under the microscope. The mechanical properties of cellulose regenerated by washing out the alkali are never as good as those of the original material and less cellulose is always obtained than was originally taken. Aged alkali celluloses have a pure cellulose content of nearly 100%. Their reducing power is only a little greater than that of the untreated cotton, the slight increase being due to oxidation by atmospheric oxygen. The degree of swelling is only a little greater than that of the untreated cellulose if the material is not washed free of alkali before treating with acid. If the alkali is first washed out, the degree of swelling increases with increasing concentration of the lye used in the preparation of the alkali cellulose. The pentosans are only slightly attacked in ageing; if the alkali is washed out they are to a considerable extent dissolved. The hygroscopicity of aged alkali cellulose is higher than that of non-aged lyes which have no mercerising effect and cause an increase in hygroscopicity, which is independent of the time of ageing. With the commencement of the mercerising effect the hygroscopicity increases with increasing concentration of the alkali and with the duration of ageing. The ageing increases with increasing ultra-violet light. Strong bases other than sodium hydroxide, e.g. tetramethylammonium hydroxide, show similar ageing effects. The nitric acid esters of aged alkali celluloses have the same nitrogen content as esters of untreated cellulose nitrated under the same conditions, but the yields fall very considerably with increased ageing. The solubility of the nitric acid esters in ethyl acetate is good. The mechanical properties of the films prepared from the solutions fall off with increasing ageing, the films becoming more brittle. The viscosity of the solutions falls to a very low value with increasing intensity and duration of ageing. There is, therefore, considerable breaking up of the cellulose molecular complex in ageing. The hygroscopicity of the esters from aged alkali cellulose is greater, and the explosion temperature is lower than of those from untreated cotton. Aged alkali cellulose washed and quickly dried shows a decreased reactivity towards acetylating agents which is due to a "hornification" of the fibre. The reactivity decreases with increasing ageing. The hornification can be avoided by displacing the water by glacial acetic acid, the dehydrated cellulose then esterifying more rapidly with increasing ageing. The triacetates in chloroform solution give films which decrease in quality with increasing ageing. The optical rotation of the cellulose acetates from aged alkali cellulose is the same as that of the acetates from cellulose. Methylation is facilitated only in the most highly aged alkali celluloses; for intermediate and lower stages a methoxyl number of about 27% was found for the methyl derivatives and the untreated cotton. After the fifth methylation no further effect was detectable. Aged alkali cellulose is a degraded cellulose intermediate between freshly prepared alkali cellulose and hydrocellulose. C.

Viscose Rayon: Manufacture. E. Köhler. *Leipziger Monats. Text. Ind.*, 1929, 44, 345-348 and 393-395.

A report of a lecture describing the manufacture of viscose rayon; illustrations of typical machinery are reproduced. C.

Viscose Rayon Alkali Recovery Dialyser. G. W. van Barneveld Kooy. *Rayon Record*, 1929, 3, 463-469.

The application of dialysis is the only feasible method of recovery of sodium hydroxide from the press lye obtained from the preparation of alkali-cellulose. An efficient dialyser must have a large membrane surface, be capable of using replaceable membranes, and must work on the counter-current principle. Difficulties met with in the design of dialysers, particularly those in connection with the prevention of idle flow of the liquids on both sides of the membranes, are discussed. The construction, use, and performance of a modern type of dialyser are described. C.

Cuprammonium Solution, its Preparation, Analysis, and Use in the Microscopic Investigation of Fibres. A. P. Sakostschikoff. *Textilber.*, 1929, 10, No. 12, pp. 947-950.

The preparation of cuprammonium solution by passing purified air through a solution of ammonia (25%) containing metallic copper is described. Methods of estimating the copper and ammonia content of the solution are given. The copper content suitable for the examination of different vegetable fibres is discussed, and the behaviour of the various fibres is described. L.

Tasmanian Wood Pulp for Rayon. *Text. Argus*, 1929, 5, No. 248, p. 13.

According to the annual report of the Imperial Institute, chemical tests have shown that Tasmanian stringy-bark pulp is suitable for the manufacture of artificial silk, manufacturers of which believe that Tasmanian pulp would be a satisfactory substitute for other pulps costing £23 a ton. Arrangements are being made for a factory trial with a ton lot from Tasmania. W.

Patents

Artificial Threads and Rubber Substitutes: Preparation. I.G. Farbenindustrie A.-G. (Frankfort). E.P.318,967 of 13/9/1928.

Elastic products are prepared from derivatives of polymeric carbohydrates which contain one or more saturated or unsaturated fatty acid radicles and one or more saturated or unsaturated cyclic substituted fatty acid radicles by working them up by any process suitable for working rubber, gutta-percha, or balata, particularly by calendering and vulcanising. The products are particularly suitable for making films, threads, insulating masses, etc. In examples, cellulose naphthenate-oleate, cellulose phenyl-acetate-oleate-laurate, and starch naphthenate-oleate-stearate are specified carbohydrate derivatives. C.

Artificial Threads: Manufacture. I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.319,371 of 22/9/1928.

Artificial threads, films, etc., are made by dispersing with water a water-insoluble or sparingly soluble binding agent, such as cellulose derivatives, rubber, natural or artificial resins, drying oils, etc., or a mixture of them, and treating the dispersion after bringing it into a desired form as by spreading, spraying, or kneading, and, if desired, after wholly or partially drying it, with an agent capable of dissolving or swelling the binding agent. C.

Viscose Rayon: Desulphurising. O. Y. Imray (London) (Herminghaus & Co. Ges., Elberfeld, Germany). E.P.319,098 of 18/7/1928.

A desulphurising agent is employed which is either free from water or contains a proportion of water insufficient to have any swelling action on the product, e.g. not more than 10% of water. Suitable reagents are specified, and some details of the process are given. C.

Viscose Rayon: Manufacture. I.G. Farbenindustrie A.-G. (Frankfort). E.P. 319,243 of 18/9/1928.

Viscose rayon of high tensile strength is obtained, whilst employing ordinary precipitation baths, by using an unripened viscose prepared from unripened alkali cellulose, the viscosity of the solution being such that it has to be diluted to a cellulose content of 5-2% or even less in order to give for spinning a solution of normal viscosity. C.

Viscose Rayon: Manufacture. L. Lilienfeld (Vienna). E.P.319,291 of 14/4/1928.
Viscose of improved qualities is obtained by treating the cellulose, before conversion into alkali cellulose, one or more times with an alkali solution containing not less than 18% of caustic soda or an equivalent of another caustic alkali, and subsequently washing the treated cellulose, if required after removal of any excess alkali solution, by pressing or centrifuging, either with water, or first with dilute alkali of, for example, not more than 12% strength or with alkali solution of decreasing concentrations, and finally with water. The cellulose may be subjected to a preliminary treatment with dilute alkali solution. Before conversion into alkali cellulose the material may be dried, or it may be used in the wet state, the caustic alkali being added either in the solid state or in the form of a concentrated solution. C.

Viscose Rayon: Manufacture. L. Lilienfeld (Vienna). E.P.319,293 of 11/6/1928.
Caustic alkali solutions containing 2-5% of alkali hydroxide are used as the shrinking agent in the process described in E.P.281,352 for increasing the extensibility of viscose filaments of more than 2 grams per denier dry tenacity, as produced by the processes of E.P.264,161, 274,521, and 274,690. C.

Alkali Cellulose: Preparation. L. Lilienfeld (Vienna). E.P.319,378 of 22/3/1928.
Alkali cellulose to be used in the manufacture of viscose is prepared in such a way that the temperature exceeds 80° C. or even 100° C. during at least part of the preparation. Details are given. C.

Cellulose Ester Rayon Waste: Utilisation. H. P. Bassett. *Chem. Abs.*, 1929, 23, 4571 (from U.S.P.1,722,171 of 23/7/1929).
The waste is subjected to the action of a 1% aqueous solution of sodium acetate, sodium sulphite, sodium sulphide, or a similar compound, in order to render it more suitable for use. Soap and caustic soda may be used to produce a crinkled product. C.

Hollow Rayon Filaments: Manufacture. Soc. des Usines Chimiques Rhone-Poulenc. (Paris). E.P.318,970 of 13/9/1928.
Bodies which are hollow, contain gaseous bubbles, or have a tubular structure, are obtained by the evaporation of solutions of cellulose esters, gelatin, colloidal cellulose, indiarubber, etc., applied as a coating to a thread, a number of threads, or to a solid film, and then causing, either by the application of heat or reduction of pressure, development of gas to take place whilst the material is on the support. The support thread may be allowed to remain in the finished article or be separated from it. C.

Cellulose Acetate Rayon: Manufacture. I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.319,014 of 14/9/1928.
Rayon possessing high stability to boiling is prepared from acetone-soluble secondary cellulose acetates which on heating in dilute, for example, 70% alcohol, do not dissolve or dissolve incompletely, and have an acetyl content calculated as acetic acid of about 54-56%. C.

Non-inflammable Cellulose Ester and Ether Materials. British Celanese Ltd. (London) and A. J. Daly. E.P.319,073 of 19/6/1928.
Artificial fibres and other products having a basis of cellulose esters and ethers are rendered less or non-inflammable by incorporating in them, at any stage in the manufacture, a bromine derivative of an acidylated aromatic amine, such, for example, as acetyl-4-bromomethylanilide. C.

Mixed Acetate and Viscose Rayon: Manufacture. C. H. Field and D. Haslett (London). E.P.319,294 of 13/6/1928.
Artificial silk is prepared from a mixture of cellulose xanthate with cellulose acetate and/or cellulose nitrate dissolved or dispersed in a solvent or solvent mixture comprising mono-, di-, or epichlorhydrin, one of the acetins or like esters of glycerine, or glycerine itself, or mixtures of any two or more of these compounds. A solution so constituted may be extruded, for example, into a bath comprising hydrochloric acid and ammonium chloride. C.

Mixed Wool and Cellulose Ester Fibre: Production. Aceta Ges. (Berlin). E.P. 319,354 of 22/9/1928.

Wool is mixed with nitro-acetyl-cellulose, a suitable mixture having 70 parts of wool and 30 parts of mixed esters containing 1-2% of nitrogen and acid equivalent to about 54% of acetic acid. The mixture may be subjected to the ordinary hot vat treatments such as are used in wool dyeing, and to carbonisation, as with aluminium chloride, without damage. C.

Rubber-coated Rayon Spools: Coating. Anode Rubber Co. Ltd. (St. Peter's Port, Guernsey). E.P.301,300 of 26/11/27.

Perforated metal sheets or articles, e.g. reels or spools for the rayon industry, are covered with a protective seamless layer of rubber, which also rounds off any sharp edges, by dipping or by electro-phoretic deposition, using aqueous dispersions containing rubber. According to the composition of the deposit produced the layer, after drying and vulcanisation, may be either of soft rubber or vulcanite. C.

Rayon Stretch Spinning Apparatus. O. Kohorn & Co. and A. Perl (Vienna). E.P.319,658 of 25/9/1928.

The apparatus of E.P.317,442 is modified by interposing a diverting or reversing device between the spinning apparatus and the positively driven roller which conducts the thread into the bath. C.

Nitrated Cellulose Ester or Ether Rayons. British Celanese Ltd. (London). E.P.319,691 of 26/9/1928.

Cotton linters are treated with strong or dilute nitric acid, with or without the addition of acetic acid, then washed and/or dried, and then acetylated. The clear products are suitable for rayon, films, etc. (This is part of a wider claim for the treatment of cellulose derivatives with nitric acid.) C.

Viscose Rayon: Manufacture. British Enka Artificial Silk Co. Ltd. (London). E.P.319,766 of 28/9/1928.

Cakes or cheeses of viscose rayon are freed from noxious gases by passing air or other innocuous gas through them at a temperature of at least 50° C. C.

Gas-absorbing Apparatus. British Enka Artificial Silk Co. Ltd. (London). E.P. 319,780 of 28/9/1928.

Apparatus applicable to the removal of hydrogen sulphide from air in the viscose industry is described. C.

Rayon Coagulant Aerating Apparatus. Brysilka Ltd. and F. W. Schubert (Apperley Bridge). E.P.319,841 of 4/7/1928.

The liquid used as coagulant in the stretch-spinning process of rayon manufacture is flashed at ordinary temperature through a vacuum to remove free oxygen, and a definite amount of oxygen depending on the size and number of the filaments being spun is reintroduced just before the liquid enters the spinning vessel. The aerating apparatus is described. C.

Rayon Yarns: Treating with Fluids. J. Brandwood (Manchester). E.P.319,848 of 6/7/1928.

Rayon threads may be treated with fluids when wound on a perforated cylinder, by simultaneously winding on a length of permeable fabric so that the coils of thread and fabric alternate. C.

Viscose Rayon: Manufacture. J. C. Hartogs (Arnhem, Holland). E.P.319,887 of 20/8/1928.

Finely divided sulphur is added to the xanthate solution, in an amount not exceeding 0·8%, at any stage in the manufacture prior to spinning. In this way the corroding action of the viscose on the iron parts of the apparatus is reduced. C.

Rayon Spinning Machine Thread Guide. H. Wade (London) (Naamlooze Vennootschap Bouwonderneming, Soerabaja, Java). E.P.320,009 of 5/2/1929.

Spindles carrying the funnels or guides for the filaments in spinning rayon threads into boxes are supported on the traverse rail by means of nuts and are provided with a thickened portion of such cross section that when the spindle is raised manually from the rail and turned through an angle it may be supported on the lower of two stationary bearings whereby the traverse of any guide may be arrested independently of the others. The rail is operated by heart cam mechanism, and the nut rests on a sleeve screwed into the rail so that each guide may be independently adjusted relatively to the spinning box whilst the machine is running. C.

Rayon Yarn Liquid-treatment Apparatus. J. Brandwood (Manchester). E.P. 320,025 of 22/3/1928.

Rayon threads coming from the spinner are wound on a perforated spool into a soft resilient package with an open wind and are then treated with liquids by spraying the liquid on to the inner or outer face of the package and simultaneously drawing the liquid radially through the package by regulated suction. C.

Cuprammonium Rayon: Manufacture. A. Carpmael (London), I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.320,069 of 28/6/1928.

Commercial cellulose is dissolved in the cuprammonium solution without previous chemical or swelling treatment. C.

Rayon Spinning Apparatus. British Celanese Ltd. (London) and W. I. Taylor. E.P.320,106 of 5/7/1928.

The starting up of spinning jets in the manufacture of artificial silk, more particularly by the dry spinning process, is effected by applying a vacuum to the jet until uninterrupted extension is obtained. Two forms of apparatus are shown. C.

Viscose Rayon: Manufacture. S. Dunlop (London), E. H. Morse (Nutley, U.S.A.). E.P.320,161 of 24/7/1928.

Films, threads, or bands of viscose are passed through an acidified coagulating solution and then subjected to dilute acid under such conditions that the acidity increases as the treatment proceeds, the use of conveying bands or the like being avoided. C.

Rayon Spinning Machine Electric Driving Mechanism. General Electric Co. Ltd. (London) and H. J. Eley. E.P.320,197 of 1/9/1928.

In spinning machines, particularly for spinning rayon, a number of spindles and controlling means for them whereby one spindle may be rendered operative and another inoperative, are mounted on the frame of an electric motor so that they form with it a unitary structure. C.

Opaque Rayon Filaments: Preparation. J. A. Singmaster. *Chem. Abs.*, 1929, **23**, 4820 (from U.S.P.1,725,742 of 20/8/1929).

In order to produce rayon filaments of good opacity and covering power, a solution to be spun has incorporated with it a small quantity of inorganic pigment-like material such as carbon or barium sulphate such as will not materially impair the continuity of the filaments formed from the solution by the use of small orifices. C.

Cellulose Esters; Reducing Viscosity of——. B. N. Lougovoy. *Chem. Abs.*, 1929, **23**, 5041 (from U.S.P.1,726,357 of 27/8/1929).

A cellulose ester such as nitrocellulose, the viscosity of which is to be reduced, is dissolved in acetone or other solvent of high dispersing power; separation of the ester is then effected by gradual dilution of the solution with a mixture of the solvent and a non-solvent such as water, which is miscible with the solvent. C.

Viscose Filaments and Films; Improving Elasticity of——. L. A. van Bergen. *Chem. Abs.*, 1929, **23**, 5041 (from G.P.480,519 of 7/5/1929).

Products of improved elasticity are obtained by using an acid precipitating bath containing a salt of a bivalent metal (e.g. magnesium sulphate), together with a small quantity of a zinc salt (e.g. the sulphate). C.

Pure Cellulose: Preparation. E. Orioli. *Chem. Zentr.*, 1929, **ii**, 2397 (from F.P.659,021 of 14/8/1928).

Plant cellulose is treated repeatedly with 18% caustic soda and washed with sodium carbonate. The product may be used in place of cotton for the preparation of rayon, guncotton, cellulose acetate, films, etc. C.

Viscose Rayon: Preparation. I. Frenkel. *Chem. Zentr.*, 1929, **ii**, 1992-1993 (from F.P.660,535 of 17/9/1928).

Small amounts of nitrites are added to the viscose when preparing the solution in order to avoid the development of irritating gases. C.

2—CONVERSION OF FIBRES INTO FINISHED YARNS

(A)—Preparatory Processes

Roving Frame Steel Tube Creel. Woonsocket Machine and Press Co. Inc. *Text. World*, 1929, 76, 2301.

A new creel for cotton roving frames is made with steel tubes with inserted porcelain steps for the skewers. The creel is stiff and is vibrationless within itself. The tubes and supporting brackets are coated with aluminium and the reflected light from this surface is claimed to brighten the room to a considerable extent. The eye for holding the top of the skewer is not a screw eye, but is a loop of wire which is inserted into the tube in such a manner that it cannot be turned around or displaced. The top of the creel is of ample width for receiving two rows of 12 ×6 in. bobbins without crowding. The round tubing is not so likely to collect lint as were the wooden bars in the old model. Since headless set screws are used in all brackets, there are no projections on which the roving is likely to catch. C.

Roving Frame Traverse Motion. S. J. Bishop. *Text. World*, 1929, 76, 2301 and 2303.

The new traverse motion for roving frames has few parts and is simple in operation. It may be adjusted for travel full length of the rollers and for double travel on the ends of the rollers in keeping with the reversing or lifting shaft, thus providing even wear on the roller coverings. A diagram is given showing the arrangement which consists of a cam mounted on a revolving shaft driven by gearing from the driving shaft of the roving frame. A rod is made to rise and fall by the action of the cam, so that it moves an L-shaped rocker arm which is pivoted on the machine and imparts a right and left traverse to the roving guide bar. To adjust the length of the traverse, the cam may be slid in either direction along the shaft, thus lengthening or shortening the operating horizontal portion of the rocker arm. C.

Merino Wool Preparation. *Text. Expt.*, 1929, 3, No. 31, p. 25.

Methods of wool sorting and classing are described. W.

Static Electricity in Woollen Carding. *Text. World*, 1929, 76, 2443.

To prevent trouble in condensing the roving through friction caused by rub aprons or condensers, a small percentage of alum may be used in the oiling emulsion. Too much alum will injure the card clothing. A better way to deal with the static electricity is to instal an electric neutraliser. W.

Woollen Carding. J. B. Wilson. *J. Huddersfield Text. Soc.*, 1928-9, p. 9-22.

The author considers that too little attention is given to the preparatory processes of willeying, mixing, and teasing of the blends. The action of various parts of a card, suitable card clothing, and the grinding of the cards are discussed, together with factors conducive to successful working of the card. W.

Worsted Carding. "Pecten." *Wool Rec.*, 1929, 36, 919-921, 989-991, and 1063-1065.

A detailed description is given of the functions of various parts of a worsted card, types of suitable card clothing, and the construction of rollers. W.

Management of Cone Drawing and Roving. *Wool Rec.*, 1929, 36, 777.

The manner of doffing cone rovers varies chiefly in the removal of the flyers and full bobbins. Each flyer should be returned to the correct spindle, and so prevent badly shaped bobbins and consequently strained portions of roving. Each roving box should be tested and recorded daily, or at least three times a week, for the dram weight of roving produced. An advantage of cone drawing is the use of large bobbins, so that the longest possible length should be placed on them consistent with good work. In the star wheel pawls adjustment, very careful setting of the moving pawl is necessary. It is possible in setting the moving pawl to make a slightly uneven traverse of the cone belt in the direction of making all layers alike in drag and overcoming the defect of the swing frame. W.

Porcupine Drawing. "Tex." *Wool Rec.*, 1929, 36, 775.

The principles and advantages of the porcupine drawing system of Hall and Stells, Ltd., are discussed. W.

(B)—Spinning and Doubling

Ring Spinning Frame. R. Threlfall. *Text. Merc.*, 1929, **81**, 412 and 416.

A new ring spinning frame, designed for both twist and weft, on tubes, pirns and bobbins for cotton, and also for silk, wool, and other textile fibres, is described. Brass bushings are provided for many important bearings and oil baths are used wherever possible. Lifting pokers, rocking levers, and cap bars have been improved. Any individual cap bar may be removed without unduly interfering with its neighbours and improved methods of fitting the cap bars and cap nebs together make top roller setting easier. Patent roller weights are used which extend half way across the frame. They are shaped in order to supply the requisite downward pull on the weight hooks from the fulcrumed position. The loose ends of the weights rest and swivel upon a round rod running from end to end down the centre of the frame underneath the creel bottom board. The pig's foot of the new frame is described as a jaw lever and is placed in such a position that it is easy of operation and access. The arrangement of the lifting pokers tends to steady the strain or the pull on the chain, and the strong flat bar connecting rods from end to end of the frame help to complete a very efficient copping motion. The cam for the copping motion is designed to give a rapid upward movement of the ring rail, so as to lay binding threads upon each chase. It also has a cut away or depression just on the point of the cam, which gives the ring rail a slight drop or quick reverse. A double copping lever may be used. Automatic stop motion for full cop position and a brake motion are provided, and adjustable stop brackets are fixed to carry ring rails during doffing time. C.

Fine Yarns and Woollen Spinning. *Textilber.*, 1929, **10**, No. 4E, 253 (from *Dtsch. Wollengew.*, 1928, Oct. Jubilee No. 37).

Woollen spinning cannot be indifferent to the efforts of the spinners of other textile fibres to produce still finer and finer yarns. For this purpose the machinery at present in use must be reconstructed. The use of flat cards prevents difficulties owing to their narrowness. The Gilljam card appears to be particularly well adapted, and its special advantages are briefly described. Special attention must be paid to the production of a uniform roving, since this alone permits of spinning fine yarn of perfect quality. A few hints are given as to how the twist can be uniformly distributed over the whole length of the yarn on the mule between the delivery rollers and the spindle. W.

The Spinning of Camel Hair. *Melliand*, 1929, **1**, No. 7, 1121 (from *Z. ges. Text. Ind.*, 1928, **31**, 767).

Camel hair is rather difficult to spin because it is very light and long. The author explains the important points which have to be taken into consideration during the course of manufacturing. Special attention should be given to a thorough and well penetrating oiling. When carding, attention should be given to the feed of the card, as it is essential that no excessive material is delivered to the apron. Suggestions are given of how this can be obtained. The author discusses further the setting of breaker and finishing cards as well as the wire sizes which should be used for the clothing. The article is concluded with general suggestions concerning the performance of the mule. W.

Patents

Spindle Driving Mechanism. C. Hamel A.-G., and E. Hamel (Schönau, Germany). E.P.318,804 of 5/12/1928.

In spindle driving arrangements in which two pulleys for each belt are mounted on pivoted arms arranged on opposite sides of the tin roller and connected by a spring so that the belt is tensioned thereby, irrespective of the direction of the drive, the arms carrying the pulleys and connected by a resilient element, such as a spring, are mounted in supports provided with abutments so that, when the tin roller rotates in a given direction, one of the arms is maintained by the tension of the belt against its abutment, the corresponding pulley acts as a guide, and the slack portion of the belt is tensioned by the other pulley under the control of the spring. When the tin roller rotates in the opposite direction, the tension of the belt moves the arms over, and the functions of the pulleys are automatically reversed. C.

Mule Brakes Operating Mechanism. Soc. Alsacienne de Constructions Mécaniques and R. Roth (Mulhouse, France). E.P.319,154 of 19/10/1928.

The patent relates to a mule in which the tin roller shaft is driven by a differential gearing controlled by brakes which are applied to effect the drive for twisting and the reverse drive for backing off, and describes the mounting and operation of the brakes. C.

Roller Drawing Head. R. Riley (Burnley). E.P.319,518 of 16/10/1928.

In ring and flyer frames separate weights pivoted on a shaft or on separate shafts running the full length of the frame are used for the rollers on each side of the frame in lieu of the usual single cross weight serving both sides of the frame. More than one line of rollers may be weighted by means of stirrups and saddles. C.

Scutcher Guard. C. Shuttleworth (Middleton). E.P.318,710 of 18/7/1928.

In guarding arrangements for scutchers and similar textile machines, of the kind in which the beater cover and driving pulley are alternatively locked by a sliding pin which, when engaging the cover, also passes through a lever having a slot to engage a bolt carried by a lug on the desk door, this bolt, which hitherto has been releasably secured in the slot by a nut in order to allow independent opening of the door, is screwed into or secured by a nut to a fixed bracket, and is held against unauthorised removal by locking means such as a padlock, or, according to the provisional specification, a locked pin. C.

Combing Machine Feeding Device. C. Schleifer (Novara, Italy). E.P.319,773 of 29/9/1928.

In a device in which the sliver is fed through a duct and held by a reciprocating flat comb which penetrates through holes in the duct, the flat comb is arranged below the duct to pass upward through the holes in the duct, and the upper part of the duct is formed as a movable cover which can be lifted to facilitate the introduction of sliver. C.

Roller Drawing Head. R. Nigrin and Vereenigde Textiel Maatschappijen Mautner Naamlooze Vennootschap (Rotterdam, Holland). E.P.319,596 of 16/6/1928.

A number of slubbings are drawn in separate heads on a slubing frame, and are united in a common drawing head as described in E.P.274,356 and 297,302. The roving is spun on a frame comprising a drawing head provided with a condenser constructed as in E.P.292,954, and situated preferably in front of the delivery rollers. C.

Spinning Frame Bar Travellers. R. Riley (Burnley). E.P.319,952 of 16/10/1928.

To facilitate threading, bar travellers are provided on their top edge with a yarn conductor in the form of a flange, lip, or projection, which, when the traveller is formed of two hinged parts, is formed in two parts provided with stops to limit the hinge-movement of the traveller. The yarn conductor and traveller may be formed from a single piece of wire, and a connecting strip or plate may, in addition, be provided. The provisional specification describes also guide surfaces of the traveller bent or doubled over to afford a smooth passage for the yarn, or eyelets provided for the same purpose. C.

Ring Rail Guard. H. Baron (Bolton). E.P.320,178 of 15/8/1928.

To prevent a broken end from splashing or throwing oil from the ring rail on to adjacent intact yarns, sheet metal guards are mounted on the ring rail to engage and deflect a broken end, and are bifurcated so that they may be slid on to and grip the rail, projections engaging the bases of adjacent rings and flanges engaging the rail being provided to ensure accurate positioning. C.

Twist Tube Coupling Devices. Sächsische Maschinenfabrik vorm. R. Hartmann A.G. (Chemnitz, Germany). E.P.319,608 of 24/9/1928.

Twist tubes are coupled to their driving members by springs or any other devices used in free wheel drives, so that they may readily be stopped for inserting the roving without stopping the driving members. C.

Thread Oiling Device. Universal Winding Co. (Boston, U.S.A.). E.P.318,820 of 22/8/1928.

A device for oiling thread comprises an angularly adjustable plug located above a reservoir, the plug being slotted to accommodate the thread, which engages a wick, the wick-bearing surface of the plug being of progressively increasing radius, so that the thread may be made to engage a greater or less length of the wick by altering the angular adjustment of the plug. The plug is fixed in a given position by a set screw, and its angular adjustment may be indicated on a graduated dial. To obtain uniform oiling when winding on a bobbin, a lever system is provided by which the spindle of the plug is automatically adjusted as the bobbin grows to present a greater wick surface to the thread, and thus compensate for the increased speed of winding on the outer layers. C.

Skein Holder. G. Casalis (Turin, Italy). E.P.318,827 of 6/3/1929.

The patent covers an adjustable reel comprising two symmetrical hubs and arms consisting of pairs of spokes pivoted at their inner ends to the respective hubs and connected to each other at their outer ends through a skein supporting member. The spread of the reel is adjusted by relative rotation of the hubs. C.

Spool Cleaning Machine. Amoskeag Manufacturing Co. (Manchester, U.S.A.). E.P.318,961 of 13/9/1928.

The mass of yarn remaining on spools is cleaned off by the cutting action of a jet of water under a pressure of some 2,000 lb. per sq. in. C.

Bobbins. J. C. Hartogs (Arnhem, Holland). E.P.319,888 of 20/8/1928.

A bobbin particularly for use with rayon and having a yarn-bearing surface which may be reduced after the package has been wound, comprises a barrel having disposed on its surface a number of rods removable in a longitudinal direction and arranged in paper, straw, or like yielding covers. On removal of the rods the covers collapse, leaving the package loose. The rods are formed of wood, glass, ebonite, or other acid-resisting material, whilst the covers are fixed in recesses in the barrel or are glued to it. C.

Skein Holder. R. Haddan, London (F. Gegauf's Söhne, Steckborn, Switzerland). E.P.320,012 of 18/2/1929.

In a reel or skein holder for supporting yarns, the yarn-bearing surfaces of wooden crossbars extending transversely of the arms are protected by self-fixing members of rust-proof steel, the longitudinal edges being bent inwardly to engage grooves. One or both ends may be formed to overlap the end of the crossbar. C.

Yarn Baling Press. J. Hetherington & Sons, Ltd., L. Hemsley, and W. Cordwell (Manchester). E.P.320,042 of 29/3/1928.

Baling presses for bundling yarn hanks and the like are provided with means for braking the platen automatically at each end of the stroke simultaneously with the declutching of the press driving shaft. C.

Preparing Fibres for Spinning. York St. Flax. Spg. Co. Ltd. and J. G. Crawford. E.P.319,117 of 18/8/1928.

Apparatus for severing flax and like fibres into lengths comprises one or more rotary abrasive cutting discs and travelling belts, by which the fibres are gripped and carried forward to the cutting discs. The cutting discs, which may be of carborundum, are mounted in a fixed frame and a sliding frame adjusted by screws and a handwheel. Supporting belts, to carry the flax, etc., are supported on pulleys. The pulleys are mounted one each side of the disc, and other pulleys are mounted to slide on the shaft and are positioned one to each side of the disc. The pulleys are connected by lazy-tongs and slide on the shaft. Belts running over pulleys hold the flax on the belts as it is being cut. The central cut portion falls on to belts supported on pulleys and running in the reverse direction. The end portions are carried away by belts running over pulleys. L.

Preparing Fibres for Spinning. P. E. G. Swynghedauw (Berlin). E.P.319,353 of 4/9/1929.

In a machine for breaking and scutching flax, hemp, etc., the material held between travelling chains is carried along a slot between the halves of a curved table carrying on the under surface blades A roller with blades is mounted on arms centred on a shaft below the slot, and is rocked to cause the roller to move over the surface of the table, the blades intermeshing. The material hanging through the slot is engaged on one side by the roller and broken by the blades. The roller passes far enough to free the material and allow it to fall back into a vertical position. The roller then returns and engages the other side of the material, breaking it, in its motion over the other side of the table. The arms carry blades, and coating blades are mounted on arms centred on the shaft. The material is engaged by these blades, and bent as they are moved along its length. The arms carry stops which engage the arms and push them over in front of the roller. The arms are provided with counterweights to return them into position. Combs are adjustably mounted on the arms to dress the ends of the material. The arms are operated by a crank driven from a shaft which also operates through chain gearing the feeding chains. Wires or blades carried by arms rocked by cams on the shaft are moved at the end of each movement of the roller to free the material from the table. The material may be passed through one machine and then transferred to the grip of another pair of chains to enable the other end to be treated. The second pair of chains are arranged at the opposite side of the second slot, which is in line with the first. A rotary disc bends the material down between the two sets of chains as they are running side by side to position the material before it is finally gripped by the second pair of chains. L.

Preparing Fibres for Spinning. I.G. Farbenindustrie Akt.-Ges. (Frankfort-on-Main). E.P.319,653 of 11/6/1929.

An arrangement for feeding fibre-containing leaves to a decorticating machine, in which the leaves are taken from a supply and are separated and straightened as they are passed forward in small numbers, comprises a series of fingers or claws, swinging about pivots in a frame, adjacent fingers being alternately in their raised and lowered positions. The leaves slide from the supply on to the fingers when in their lowered position. The fingers, rising, take some of the leaves from the fingers and pass them on to the lowered fingers. During their passage forward the leaves are straightened against the depending curved portions of the fingers. The plane of the fingers may be inclined to cause the butt end of the leaves to be aligned against one side of the frame. The fingers or claws may be arranged to rise and fall alternately through a sloping table. A series of upright claws may be mounted on a bar given a circular movement and projecting through a table comprising a series of parallel bars. L.

Winding Yarns. W. P. Dreaper (London). E.P.320,100 of 6/6/1928.

Dry spun artificial silk yarn which has been collected in a centrifugal spinning box is wound off the cake after its removal from the spinning box directly on to pirns, bottle bobbins, or a beam, the yarn in its passage from the cake being treated with a solution of a sizing material or a soluble oil. Gelatine may be added to the treating solution. The yarn may also be given an additional twist, by ring or like spinning device, and if already moist may be dried by contact with a hot surface or with heated air. T.

3—CONVERSION OF YARNS INTO FABRICS

(A)—Preparatory Processes

Bottle Bobbin Winding Frame. W. Schlafhorst & Co. *Rayon Record*, 1929, 3, 479-481.

A new bottle bobbin winding frame for artificial silk is described. On this frame excessive tension or friction is avoided. Variations in the speed of the bottle bobbin take place in accordance with the varying winding diameter of the conical-shaped thread layer in such a way that the speed of the thread remains approximately uniform, in spite of the variation in winding diameter. The variable spindle speed is achieved by completely positive means and the friction wheels used in earlier winding mechanisms are not employed. C.

Foster Cone Winding Frame. Thos. Holt Ltd. *Text. Merc.*, 1929, 81, 411.

Cones weighing 12 lb. may be wound on the Improved Foster Cone Winder for tyre yarns. Noticeable improvements have been made in the unwinding process. By the simple arrangement of reversing the position of the cone upon the drum the new frame is converted from what may be termed a twist wind to a weft wind. In ordinary cone winding frames the small end of the cone points in the left-hand direction of an observer, who stands facing the frame. In the new winder, the small end of the cone points in the opposite direction. The drums upon which the cones rest, revolve with their upper periphery receding from the observer, and the contact causes the bottom or lower periphery of the cone to recede with it. The yarn being wound passes between the two peripheries, and the fact of revising the position of the cones alters the direction of the spiral. In place of one large cam operating the traverse for both sides of a frame, there are two cam shafts in the new frame. Thus each drum is provided with its own traverse cam. The new frame contains all the salient features of the ordinary Foster cone winder. There are two swifts to each drum, one being fixed overhead on the creel top and the other in the usual position low down on the frame front. When piecing 15/23's the ends are split into three strands, each consisting of five threads, and joined by three small knots with intervening spaces. A suitable stop motion is supplied to each cone. C.

Winding Frame Bobbin Support. J. Desvignes. *RUSSA*, 1929, 4, 1543-1545.

The arrangement consists of two parallel arms with forks at their upper ends in which the shaft carrying the bobbin turns freely. The shaft is driven by means of friction discs. The arrangement is inclined at an angle to permit the thread to unroll normally from the reel and to enable the support to be raised automatically and the bobbin stopped when the tension exceeds a certain limit. An eccentric roller is arranged in such a way that when the yarn on the bobbin has reached a definite volume it is set in motion and stops the bobbin. C.

(B)—SIZING

Rayon Yarn: Sizing. P. Krais and H. Böhringer. *Deutschen Forschungsinstitut für Textilindustrie in Dresden, Forschungsheft* 10, 1929, 50 pp.

The pamphlet gives an account of extensive experiments on the sizing of rayon, but the results are of a negative character. It was found extremely difficult to distribute colloidal solutions of sizing agents uniformly on viscose rayon threads. The accurate estimation of the amount of size on rayon requires special precautions, since the last traces of moisture are very difficult to remove. Rubbing tests and tests of breaking load and extension of sized rayon as compared with the unsized material, even when carried out with all precautions, and the optimum experimental conditions give no reliable basis for judging the different sizes or the best amounts to use. Since sizing undeniably has a beneficial effect in practice, conditions must prevail which find expression first of all only in the weaving trial itself. C.

Rayon Warp Sizing Machine. Maschinenfabrik Zell., J. Krükels. *Textilber.*, 1929, 10, 772-773.

A special hot air sizing machine for rayon warps employs indirect heating in the size box, the inside of which is of copper. The box has a single pure copper size roller of 240 mm. diameter, and the two upper rollers have a solid rubber covering. Between the size box and the drying chamber is an automatic tension device which compensates for changes in length of yarn in the drying chamber. The rotary fans in the drying cylinders are so built that the air is thrown against the warp at a constant speed across the whole width of the warp, and the reels are not rotated by the pull of the warp, since the fans have a driving action in the direction of travel of the warp. The air heater on the roof of the chamber works in conjunction with an automatic temperature regulator. The warp rests on rods covered with hard rubber and therefore does not dry quicker at the point of contact than in the surrounding parts. Rayon should be treated at temperatures not above 70-75° C. On steam-heated copper cylinders parts of the warp are exposed to temperatures of 100-110° C., hence the superiority of air drying to cylinder drying. After leaving the drying chamber the warp passes over lease rods and in the usual way to the beaming machine. C.

Size: Storing Overnight. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, 93, 1425-1426.

A discussion by various tapers. Size has been stored overnight at 200° F. in a closed storage kettle, heated with an open coil, without giving any bad results. Experience seems to show that it is best to hold the size at approximately the same temperature as that at which it is run. In one mill the size is held overnight in a kettle with a closed coil with the paddle not kept going, but started up about 45 minutes before starting time. The level of size in an open kettle stored at 195° overnight was found to fall more than when the kettle was closed. The amount and hardness of skin formed on storing is greater the lower the temperature. This skin cannot be broken up into a usable form. Skin does not stay on the size at 195°. In a case where the paddle is turned very slowly, about 14 turns a minute, during storing, on starting up in the morning the first three or four warps are said to be easier to dry. C.

Sizeometer: Application. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, 93, 1425.

The sizeometer is attached to the slasher, taking the place of the big lease rod, for the purpose of indicating on a dial the force necessary to separate the warp.

This force changes with changes in the viscosity of the size applied, with differences in drying, etc. C.

Sizing; Invisible Loss in——. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, 93, 1414 and 1419.

Tests were carried out in order to determine the difference between the weight of starch and compound put into the size mixture and the weight added to the yarn. In one test this invisible loss amounted to 3%, based on the amount of the net raw yarn. In another series of tests the lowest value obtained was 0·64%, based on the total soft yarn, representing a loss of 5·1% of the size materials used. C.

Warps: Retaining Elasticity in Sizing. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, 93, 1421 and 1425.

Satisfactory results are obtained with positively driven tape frames when the gearing is correct. In a trial with the positive drive on the small cylinder there was a slack tension between the small cylinder and the take-up roller. The amount of tension necessary to split at the main splitting rod is enough to turn the small cylinder with ball bearings. The condition of the friction disc on the beam motion is important. There is no slipping on the big cylinder because the yarn is wet and sticks. C.

Warps: Leasing on the Tape Frame. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, 93, 1419 and 1421.

Methods of leasing warps on the back and on the front or head end of the tape frame are briefly described. C.

Sizing. Southern Textile Association. *Cotton* (U.S.), 1929, 93, 1368.

A discussion of various points in connection with tape frames. A temperature of 235° F. on the big cylinder is advocated when running 30's at 40 yards a minute. A temperature of 208° is used in one mill running 15's at 26 yards a minute. Steam pressures up to 7 or 8 lb. are reported. The importance of controls on the tape frame is emphasised. Without controls the sized yarn frequently shows a lower percentage of moisture than the raw yarn. In one mill the moisture content of the yarn was studied by means of a conditioning oven and it was found that mildew appeared on yarns with 10% moisture and that these yarns did not run as well on the looms as yarns with 7 or 8%. C.

Tape Frames; Speed of——. Southern Textile Association. *Cotton* (U.S.), 1929, 93, 1366.

Tape frames on 30's, with up to 4,000 ends are being run successfully at speeds of 27 to 40 yards a minute, according to the boiler room and steam arrangements. On 18's to 29's an average of 47 yards a minute is reported in one case. C.

Starches and Their Stiffening Qualities. W. F. A. Ermen. *Text. Mfr.*, 1929, 55, No. 658, p. 35.

The American Bureau of Home Economics have been investigating the properties of different starches of commerce as an aid to the choice of the best sizing agents for fabrics. As the qualities of the same kind of starch may be influenced by the method employed for its isolation and purification, they prepared specimens of the different commercial starches to serve as standards of comparison, avoiding any reagents likely to affect the final properties of the purified substances. A stiffness figure was determined for wheat starch 42·8; rice and corn starch, 42·9 and 42·7; and farina, 36·7. In the case of rice, corn, and wheat starch, the stiffness of the sized cloth was reduced proportionately to the value of water added. In the case of farina, however, there was no drop in stiffness until from 90 to 100 c.c. of water had been added. The addition of borax to a certain sample of corn starch was investigated. It was found that up to an addition of 3 grams of borax the stiffening value rose from 42·2 to 46·5, but after that began to fall again. The addition of salt, beeswax, paraffin, or vegetable oil up to a proportion of 4 drams for 15 grams of starch was found to have no influence on the stiffness, as tested by the method employed, and this is a somewhat surprising result to the mind of the ordinary finisher or sizer, who invariably adds a certain proportion of tallow, paraffin, or other fatty mixtures with the object of reducing the stiffness of the finished article. L.

Starch: Composition and Zymolysis. *See* Section 9.

Starch: Estimation by Iodine Method. *See* Section 9.

Flour-water Suspensions: Plasticity. *See* Section 9.

(C)—WEAVING

Draper Looms; Speed of——. Southern Textile Association. *Cotton* (U.S.), 1929, 93, 1366-1367.

A speed of 160 picks per minute has been found best for a 40-inch loom and also found to give greater production than 150 picks per minute on 72 × 100, 60's warp. C.

Warp Tensometer. Crompton and Knowles. *Text. World*, 1929, 76, 2301.

The warp tensometer is used for comparing the adjustments of a number of looms and for checking the tension of the warp on one loom at various intervals during the weaving. In applying the instrument a number of warp threads are separated by hand or by the use of a divider. For 13/15-denier silk, 100 ends should be used and for 75-denier artificial silk, approximately 150 ends should be used. The frame on which the instrument stands is slipped under these threads and the long "foot" located immediately under the dial is allowed to rest on top of them. The reading of the dial depends on how far the threads are depressed by the weight of the foot. The lay is placed in a position which can be accurately duplicated on the other looms, and a few seconds are allowed to elapse for the warp ends to settle slightly. The dial is then read. The graduation of this dial is arbitrary and should not be taken to mean pounds or ounces. C.

Science in Weaving. M. P. Gregg. *Text. Rec.*, 1929, 47, No. 560, pp. 33-34.

The article gives a brief account of a lecture before the Blackburn Textile Society by Mr. M. Proctor Gregg, a director of the British Northrop Loom Co. Ltd. He emphasised that the automatic loom is a special purpose machine, and is employed to the best advantage in weaving bulk quantities of the same quality of fabric. Automatic high speed machinery that is being introduced in the preparation process is assisting this ideal of uniformity, because not only does it tend to produce more even warp or weft itself, but it also requires more uniform yarn itself to function efficiently. Also an automatic loom must be supplied with uniform yarns if it is to weave well. A good layout is also essential for success. This means grouping for weavers and sections for overlookers, and with wide passages round each group, for beams, cloth, and weft to be kept moving. It also means organisation for the supply of warp and weft and the removal of cloth and empty pirns. The question of comparison between ordinary and automatic looms was discussed in detail, and some interesting data relating to times occupied by weavers in various operations were recorded. L.

An Electro-Pneumatic Warp Stop-Motion. Wm. Shirley & Co. Ltd. *Text. Rec.*, 1929, 47, No. 560, p. 41.

Describes a patent warp stop-motion operating on the electro-pneumatic principle for use on looms and warping mills. No drop wires are used, and the system is combined with an ingenious method of local humidification of the warp. The principal feature of the invention is the fitting of six rows of teeth, mounted on an adjustable stand, whereby the rows of teeth can be adjusted in a position just below, but not touching, the warp threads, about midway between the healds and the back-rest. The six rows of teeth all extend the full width of the warp; the first, third, and fifth rows are mounted in a manner so that they can be given a sideways reciprocating motion by means of a cam and appropriate gearing. The second, fourth, and sixth rows of teeth are divided into small sections, each of which is pivotally mounted. These three rows of teeth are stationary. Immediately over the rows of teeth is a pipe furnished with a slit on its underside. When a warp thread breaks, that portion of the thread which lies directly under the pipe is blown between the teeth of the stop-motion by a blast of air issuing from the slit in the pipe. The broken thread is caught between the movable and stationary teeth, and is carried by the movable teeth in the direction in which they are travelling. The resistance of the thread, however slight it may be, is sufficient to move the small section of stationary teeth on its pivot, whereby a flap is released and an electric circuit closed. Simultaneously a small signal lamp is lit showing the exact position in the warp where an end is broken, and at the same time the loom is stopped by an electro-magnet. The air current necessary to blow down the broken end is closed automatically during the stoppage of the loom. Also it can be regulated to carry any degree of moisture required to humidify the warp. It is claimed that this manner of humidification alone prevents 10% to 20% of the usual warp breakages. L.

Correction of Mistakes in the Arrangement of Jacquard Machines. *Textilber.*, 1929, **10**, No. 4E, 257 (from *Z. ges. Text. Ind.*, **32**, 1929, 4).

The knives are generally adjusted in relation to the hooks as a matter of "feel," and the adjustment depends upon the system, but the hooks must be turned back so far that the noses do not rub on the knives and the cylinder should come quite up to the needle board. If a jacquard needle becomes bent or crooked, it can cause some of the warp threads to be kept back (needle aligner, needle pliers should be used to correct this fault). In order to avoid unequal card lengths new and used cards should not be used promiscuously, and the cards should be stored as far as possible at the temperature of the weaving shed. Card holes that have become too big can be repaired by gumming on bits of cardboard. W.

(D)—Knitting

Flat Knitting Machine Locks. C. Heininger. *Leipziger Monats. Text. Ind.*, 1929, **44**, 381-383.

Lock constructions of the ordinary flat knitting machine are discussed, and a "combined" lock, which enables the different kinds of knitting required for sports and fancy goods to be accomplished on one machine in a simple manner is illustrated. C.

Full-fashioned Hosiery: Improvemets. F. K. Fogleman. *Text. World*, 1929, **76**, 2295-2296.

A splicing-block mechanism for the production of "block in sole" and "toe guard" reinforcements and a reinforcing attachment for the production of the "stepped sole" and pointed and French heels are briefly described. The new reinforcements are designed to follow the curve of the low-cut shoe and to give increased resistance to the cutting action of the shoe and of the toe nails. In stockings made with an all-cotton sole and a silk instep the two are joined together by an open seam by means of a split-sole attachment which is operated automatically in such a manner as to cause the formation of cross loops and thus interlock the cotton yarn of the sole with the silk of the instep. C.

Warp Knitting Machine Yarn Tension Devices. M. C. Miller. *Text. World*, 1929, **76**, 2292-2294 and 2319.

A method of operating knock-over bits, which permits high speeds without vibration, is shown in diagrams and various methods of applying tension between the yarn source, the eye needles, and the knitting needles are described. C.

Principles of Knitted Fabrics. W. Davis. *Text. Mfr.*, 1929, **55**, 300.

During recent years great progress has been made in machine mechanisms for the production of pattern effects where the number of colours used and the size of the patterns possible have been greatly extended in scope. In producing designs on circular knitting machines there is a severe limit to the number of pattern areas which can be operated on. The difficulties in designing and in meeting the demand for fully trained designers are considered. Many of the principles of designing in the weaving industry can be applied to the knitting industry, e.g. the building up of ground and figure patterns by such means as the satin system of transposition, crêpe designs, etc. The author has used many designs from books of weaves with excellent results in the knitting machine. W.

Survey of the Knitting Industries. W. Davis. *Text. Rec.*, 1929, **47**, No. 559, pp. 73-77.

A general survey of the knitting industries is given. W.

(G)—Fabrics

Rayon-Wool Fabrics: Production. S. Kershaw. *Text. Weekly*, 1929, **4**, 220 and 250.

The development of rayon and other new fibres and their uses in association with wool and cotton are discussed. Methods of blending rayon with wool are briefly described and reference is made to experiments on worsted and woollen machines. Precautions to be taken in spinning and drawing rayon, the twisting of yarns of two colours, the selection of twists suitable for the particular weave, and the possibilities of cross-dyeing mixtures are briefly discussed. C.

American Research on Textiles. H. D. Hubbard. *Amer. Dyestuff Rep.*, 1929, 18, No. 17, pp. 662-663.

The Bureau of Standards (U.S.A.), with its experimental cotton and knitting mills, is equipped to produce many kinds of woven fabrics, and is engaged in researches in which desired characteristics are being designed into types of fabric of great diversity and utility. Research is transforming the textile industry. We are learning how to build any desired quality or characteristic into fabric. This is done by measuring the characteristic, then building the measures into the yarn spin and weave. The Bureau built a cotton fabric as a substitute for linen for use as aeroplane wing cloth when the world's linen supply was cut off. Each of the endless varieties of textile products presents problems for the technician, the solution of which enhances their utility, creates new uses, and promotes comfort and well-being of the user. Other examples are given illustrating the use of measurements of slip quality and resiliency, air permeability, heat retaining properties, and wear by abrasion. L.

Simple Wave Effects on Coloured Shirting Fabrics. R. Sansone. *Text. Amer.*, 1929, 52, No. 5, pp. 20-22.

Describes several new wave effects which have been used recently to enhance the appearance of shirting materials, in cotton, cotton and rayon, and rayon. several different types are illustrated and discussed in detail. Generally a mixture of white and coloured warps is used, with a white weft, the consistence of the articles being varied by changing the number of ends and picks. These fabrics have interesting characteristics, and vary very much in appearance, according to the way in which they are viewed. L.

Use of Kenaf as a Substitute for Wool. S. S. Soworoff. *Leipzig. Monats. Text. Ind.*, 1928, 43, 279.

The author describes an attempt made to substitute the Russian vegetable fibre Kenaf for wool in a union cloth. For this purpose 20% Kenaf was spun as filling on the worsted principle, together with 40% of different kinds of wool, and 40% of waste, and lubricated with 6% of oleic acid. The result was 68% of yarn and 32% of waste. A cloth was woven with this yarn, using a cotton warp; it had a good appearance, and hardly showed the presence of Kenaf. The addition of Kenaf makes the cloth much cheaper, while it does not unfavourably affect the process of manufacture. As much as 40% can be added. W.

Types of Backed Cloths and Their Relative Settings. A. Yewdall. *Text. Mfr.*, 1929, 55, 298-299.

Compound cloth structures are employed when it is required to imitate the surface appearance of a cloth and yet obtain a considerable increase of weight, solidity, and strength. In order to conserve the original fineness of appearance on the face at least another series of yarns must be attached to the underside of the single cloth which forms the basic style. The types of fabrics made on this principle may be classed as backed double and treble structures. There are three types of backed fabrics—(1) weft backed structures made with one warp and two wefts, the second weft priming the back of the texture; (2) warp backed structures, composed of two warps and one weft, the additional warp forming the back; (3) wadded warp backed structures, made with 2 warps and 2 wefts. In this type one warp and one weft form the face of the cloth, the second warp forms the back, and the second weft, called "wadding," lies between the face of cloth and the backing warp. Diagrams are given of typical backed structures contrasted with a single 2-and-2 twill. Compared with the 1-and-1 system the use of the 2-and-1 system affords considerable economic advantages in production for the thicker backing yarn is cheaper than the finer yarn composing the face. The backing yarn may be of low quality or entirely different material, and in weft and warp backed cloth there is reduction in the number of backing threads, thus reducing the cost of weaving. Four methods of constructing a backed fabric are described. A general characteristic of backed cloths is that the back is usually different from the face. The commonest forms of structures in which the back and face are alike are termed "weft reversibles." W.

Compound Cloth Structure in Relation to Woollens and Worsteds. A. Yewdall. *Text. Mfr.*, 1929, 55, 330-332.

Weft backed structures find a common application in worsted coatings, especially for the building up of bulky fabrics with more lofty handle than can be obtained with backing warp. Backing with weft is usually more expensive than backing with warp, but a cheaper material can be used for the backing weft. Applied to worsted coatings, weft-backed structures usually consist of common twills, mats, and sateen derivatives, such as twills or sateens, the backing, however, largely depending upon the type of weave used for the face. Examples of some of these are given. In practice the face weave is marked first on its own series of picks, and then the backing weave is inserted on its series, but with particular regard to the positions that the stitches will occupy. To form a perfect stitch each backing pick must be raised over a warp thread so that if possible it is covered by two face picks. Particulars of suitable counts and settings for cloth are given. Care must be taken to select a suitable backing weave for a wrong one may interfere with the surface effect on the face of the cloth. Many face weaves offer a choice of position for the backing stitches, and for obtaining the best results these stitches must be placed in position where they are most covered by the face picks. Figures are given showing different forms of stitching, and their resultant effects on the back of the structure contrasted by means of end sections. W.

Patents

Patterned Textile Fabrics: Manufacture. British Celanese Ltd. (London). E.P. 318,840 of 8/9/1928.

Fabrics having coloured pattern effects are produced from a warp comprising yarns made of or containing organic derivatives of cellulose which is printed with the desired pattern and converted into a fabric by weaving or knitting with other threads, which may be of the same cellulose derivative, or of silk, cotton, etc. C.

Photo-Electric Jacquard Operating Mechanism. G. Haebler (Breslau, Germany). E.P.318,972 of 13/9/1928.

A current controlled by a light-sensitive cell affected by light points on a pattern arranged on a drum is amplified, and operates a relay for energising an electromagnet for controlling a cord, the circuit through the relay being completed by a slider moving with the cell. The cell may travel axially of the drum or the drum may be rotated for each pick. After each pick the relays and magnets are returned to normal position through a circuit breaker. Instead of using a pattern having light and dark points to operate the jacquard, the pattern may act in conjunction with a light-sensitive cell and an amplifier to cause a travelling steel band to be magnetised by electromagnets in parts corresponding to the points of the pattern, the band then being passed in proximity to magnet systems in which currents are induced. The induced currents are amplified, and, through relays and electromagnets, control the heald cords. C.

Shuttleless Loom Continuous Weft Supply Device. W. Gledhill (Holmfirth). E.P.319,134 of 10/9/1928.

In shuttleless looms or other machines in which yarn is drawn from stationary supplies, the yarn cheeses or masses are mounted on holders carried by bands or chains, so that on exhaustion of an active mass the band is traversed, by hand or automatically, to remove the empty tube and present a new cheese. The yarn passes through a conical guide to an eye on a guide rod. The end of the weft on one cheese is connected to the beginning of the weft on the next, so that when a cheese becomes exhausted the direction of the weft is changed, and causes a pivoted member, through which it passes, to be rocked, and thereby to effect the traversing of the chain to present a fresh cheese. C.

Circular Knitting Machine Feeder Control Device. A. Kirkland and F. Hillard (Leicester). E.P.318,799 of 21/11/1928.

A circular knitting machine of the type having a number of thread feeders at each of a number of positions round the machine is provided with a separate control device for each of the feeders, or for each of the groups of feeders, and means for determining the rotation of the several control devices. C.

Circular Knitting Machines. R. Haddan, London (Scott & Williams Inc., New York). E.P.318,878/9 and 318,910 of 9/6/1928.

The first two patents describe web transferring mechanism, and the third describes automatically operated mechanism, provided on the knitting machine, for turning the web inside out. C.

Fashioned Hosiery Knitting Machine. E. Brooksby (Leicester). E.P.319,109 of 4/8/1928.

The patent covers a method of knitting fashioned hosiery and the circular machine employed. C.

Stocking Toes: Knitting. R. Haddan, London (Scott & Williams Inc., New York). E.P.319,417 of 26/6/1928.

A method of forming the toe in "split foot" or other hosiery is described. C.

Loom Take-up Motion. B. and C. Marsden (Ahmedabad, India). E.P.319,846 of 5/7/1928.

The finger lever on the cloth rod is arranged in a horizontal instead of the usual vertical position and is operated on the breakage or exhaustion of the weft by a lever connected by a link with the brake lever. The finger, lever, and brake lever are arranged at one end of the loom, the cloth rod carrying a pawl at the other end of the loom which when raised also lifts the take-up pawl, allowing the take-up shaft to turn backwards an amount determined by a pawl which can move on a pivoted slide up to an adjustable stop. C.

Shuttle Tensioning and Threading Device. H. Whalley (Haslingden). E.P. 319,890 of 22/8/1928.

A tensioning and hand threading device comprises a flat base, a vertical flange or web carried by the base, and a flat horizontal plate arranged across the top of the flange and formed with rounded shoulders to guide the yarn to an eyelet in the shuttle side, the whole being pinned to the nose of the shuttle. The flange is divided down the centre vertically to receive a tongue adjustable on a screw to vary the tension of the yarn. The device may have a slotted plate formed on the rear end of the web to act as a guide for the yarn. In another modification, the device has an inclined plate projecting downwardly to guide the yarn through an inclined slot in the side of the shuttle to the eye. C.

Shuttleless Loom. A. Davis, F. Walters, and T. B. Worth & Sons Ltd. (Stourport). E.P.319,916 of 14/9/1928.

The weft-inserting needle or needles are guided to ensure their correct engagement with the selvedge thread by one or more vertically movable guides adapted to rise and fall in front of and behind the needles. C.

Shuttle Changing Mechanism. J. Bright & Bros. and J. W. Lord (Rochdale). E.P.320,090 of 4/7/1928.

The lowest weft carrier in a gravity feed magazine is held by resilient means and is pushed into the shuttle by a pivoted hammer when its catch is lifted into the path of the bunter on the slay. The catch is lifted by a sliding rod connected by a lever and link to an arm on a shaft which at the other end of the loom carries an arm and pawl to engage the weft fork hammer when the cranked rod is turned by the weft feeler mechanism on exhaustion of the weft. If the shuttle is not properly boxed a sliding feeler through a lever and link moves the rod sideways out of the path of the bunter. C.

Narrow Loom Warp Let-off Motion. H. Haywood (Wirksworth). E.P.320,139 of 11/7/1928.

A warp let-off motion for narrow fabric looms comprises a rod carried by rocking arms, over which the warp yarn passes, and a lever for releasing the tension on the boss of the warp reel or bobbin. The rocking arms and the lever are connected by a cord carrying a weighted rod or may be directly connected by a light steel rod. Adjusting screws for the release lever and for the spring of the rocking arms are provided. C.

Circular Knitting Machine. R. Haddan (London). E.P.319,676 of 23/6/1928.

A splicing yarn is led to the needles at a point substantially diametrically opposite the knitting point and is laid against the outer faces of the needle shanks until the needles reach the knitting cams, so that the yarn is definitely looped in the same wale of the knitted fabric. C.

Tufted Fabrics. H. Smalley (Lincoln) and G. Haworth (Stockport). E.P.319,422 of 29/6/1928.

A machine for making carpets bends the foundation material over a slotted plate, and inserts through the slots a row of tufts to form pile. Locking mechanism is provided to prevent movement under the strain of inserting the tufts. T.

Looms: Starting and Stopping Arrangements. R. H. Smith and G. W. Shackleton (Keighley). E.P.319,434 of 11/7/1928.

Relates to locking devices for retaining gear positively in operative and inoperative positions. T.

Knitting: Straight Bar Machines. W. Nebel (Charlotte, N.C.). E.P.320,059 of 2/7/1928.

For knitting stocking feet with extended tapered insteps, the stops at each end of the machine between which the carrier rods work are connected to other stops, so that they all move simultaneously in the same direction. The tapering of the instep portion is produced by the narrowing operation, and the toe portion is knitted by a special carrier. T.

Warp Knitting Machines. E. E. Preston and W. H. Stringer (Leicester). E.P. 320,189 of 25/8/1928.

Warp machines of the circular type are provided with one or more deflectors which travel around the machine and engage the yarns from the guide rings and cause them to move from the front to the rear of the needles or vice versa, The sequence of the knitted loops may be varied by movement of the cams. T

Circular Knitting Machines. W. Gibson & Son Ltd., and T. H. Jones (Nottingham). E.P.320,164 of 27/7/1928.

Patterns are produced by the action in turn of two or more sets of elements carried by or associated with one or more rotating or travelling members, such as drums or chains upon the yarn guides. T.

4—CHEMICAL AND FINISHING PROCESSES

(A)—Preparatory Processes

Wool Lubrication. J. H. *Text. Mfr.*, 1929, 55, 337.

Wool oiling with emulsions and "simple" oils is discussed, and details of the calculations for "plunger" type oilers for back-washers are given. W.

(B)—Boiling, Scouring, Degumming, and Washing

Adipic Acid. W. Obst. *The Melliand*, 1929, 1, 442-444.

Adipic acid, $C_4H_8(COOH)_2$, and its derivatives, are likely to prove of considerable use for the preparation of finishing, wetting-out, and emulsifying agents. The neutral esters are known in commerce as Sipalins. Sipalin MOM, e.g. is a neutral ester of methyladipic acid and a cyclic alcohol. Wax-like products are obtained by the interaction of adipic acid, glycerine, and the higher fatty acids. The glycol ester has a tallow-like consistency. L.

Wetting-out Agents. A. Haller and A. Landolt. *The Melliand*, 1929, 1, 96-98 and 243-247.

The technically important wetting-out agents may be classified as follows—I (*a*) Soaps, including resin soaps; (*b*) soaps and fat solvents. II (*a*) Sulphoricinoleates; (*b*) sulphoricinoleates and fat solvents. III (*a*) Alkylated naphthalene sulphonic acids; (*b*) alkylated naphthalene sulphonic acids and fat solvents. IV—Miscellaneous, including (*a*) pyridine derivatives; (*b*) cholic acid derivatives; (*c*) cresol with fat solvents; (*d*) derivatives of ethylenediamine; and (*e*) mixtures of members of Group IV. Colloidal dispersion is a characteristic of the wetting-out agents most commonly used. When soaps are mixed with chlorinated hydrocarbons, etc., the products dissolve fats directly, and the following belong to this group—Lanadin (tetrachloroethylene), Hydraphtal (Tetralin), Cycloran, Solventol, etc. The free acids of Group II are soluble in water, hence the indifference of these compounds to acids and even calcium salts, a property which is enhanced by addition of hydrogenated phenols. The chemical compositions of a number of products of this type are as follows—

	Total Fatty Acids %	Ricinoleic Sulphuric Acid %
Turkey red oil	44·2	22
Monopol soap	71·5	39
Avirol KM extra	37·0	51
Appret Avirol E	35·8	54
Flerhenol M	31·7	61
Præstabit oil V	36·0	93

Other highly sulphonated castor oils are Tuerkon oil, Universal oil, Solapol oil, Monopol Brilliant oil, etc. Mixtures of the foregoing with fat solvents are known in commerce as Tetrapol (with carbon tetrachloride), Perturkol (with trichlorethylene), Penterpol (with turpentine oil), Hexoran (with carbon tetrachloride), Brilliant Avirol SM 100 (with tetrahydronaphthalene). Also Præstabil oil G and K spec. (with sulphoricinoleate and a little fat solvent). The first member of Group III, viz. 1-iso-propylnaphthalene-2-sulphonic acid, was introduced about ten years ago by the B.A.S.F. Other members have been added from time to time. They are characterised by high wetting-out properties and resistance to acids and lime. Nekal A and BX, Leonil S and SB, Oranit, Neomerpin N are commercial products. If certain amounts of suitable fat solvents are added, such products as the following are obtained—Neomerpin (methyl-cyclohexanol), Floranit M (amyl) acetate, Eucarnit (trichloroethylene), Flerhenol PF (trichloronethane), and Laventi BL (terpene). In Group IV the "Carnites" of Bohme (pyridine derivatives) are of considerable interest. Tetracarnit has no great wetting power, but it increases the dispersion of dyes. Oleacarnit (pyridine bases sulphoricinoleate) and Novacarnit (pyridine Nekal) are also used in dyeing. Eucarnit does not belong chemically to this group. A product of the cholic acid type is known as Curazite soda, which can only be used in natural or alkaline baths. Mercerol is a product the use of which renders it possible to mercerise raw cotton goods without previous treatment. A substance known as Sapamin CH is used as a wetting-out and emulsifying agent; it is said to be diethylaminoethyloleamide, and is used in carbonising. Various chemical tests, wetting tests, etc., are discussed. L.

The Use of Dispensing Agents for Precipitates Produced by Hard Water. F. Munz. *Textilber.*, 1929, **10**, No. 12, pp. 962-963.

It is pointed out that the deposition of lime-soaps on fabrics is more liable to occur during rinsing than during actual washing. The reason for this is that while excess of soap is present it acts as a protective colloid, and prevents the precipitation of the lime soaps on the fabric. Other substances have a similar protective action, and it is claimed that "Intrasol" (Stockhausen) prevents the flocculation of lime soaps when used in quantities as small as 0·2 to 0·3 gm. per litre. L.

New Process for Degreasing Wool. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, **59**, 608.

A description is given of a Dutch process for degreasing by means of organic solvents. W.

Uses of Nitre Cake. *Wool Rec.*, 1929, **36**, 773.

Nitre cake may be used as a substitute for H_2SO_4 in cracking scouring liquors, refining grease, stripping colour from rags, dyeing rags, and extracting cotton from mixed fabrics in the shoddy trades. The chief disadvantage is that the cake stains the wool yellow. W.

Action of Highly Sulphonated Oils on Wool Fibres. H. Friedrich. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, **59**, 609.

The article shows that the behaviour of wool as a base towards all acids is paralleled by its behaviour when treated with the highly sulphonated oil, Praestabitol V. The wool takes up 3-12% of the oil, which is then not removed by rinsing or by extraction with organic solvents, but only by scouring with ammonia water or similar alkaline reagents. W.

Investigation and Research on Wool. *See* Section 1B.

(E)—Drying and Conditioning

"Hygrolit" Yarn and Fabric Conditioning Machines. Hygrolit Inc. *Text World*, 1929, **76**, 2439.

The new conditioning process employs a rapidly penetrating solution known as Hygrolit, which is guaranteed to prevent mildew up to 12% moisture for cotton yarns and said to kill mildew spores. The solution does not have any objectionable effect on yarn subjected to such processes as dyeing, bleaching, or mercerising, whether applied before or after these treatments, and the conditioned yarn shows an improved texture. Complete moistening is obtained immediately. The solution is applied cold and has no damaging effect on the bobbins. The yarn packages are lifted and dumped on slat conveyors, where they are distributed evenly by a spreading attachment. The yarn passes on the conveyors under four sets of sprays. Between each set the packages are turned over, insuring moistening on all sides. At the end of conveyor travel they are elevated and dropped into a waiting container. The time required for the operation is approximately 1½ minutes and the yarn is immediately ready for weaving, winding, etc. Controls on the side of the machine regulate the sprays from a mist to a heavy precipitation, depending on the size of the yarn package and the percentage of moisture required. The moisture applied may be varied from 1% to 21%. A fabric conditioning machine for conditioning, cooling, and softening hot and brittle piece goods uses Hygrolit solution and has similar control features. C.

A Rapid Sample Dryer. J. Withnell. *Text. Rec.*, 1929, **47**, No. 561, p. 49.

A small compact drying apparatus is described and illustrated. It comprises a small electric motor, an electric heating unit, and a motor-driven fan which blows hot air upwards through an inverted pyramid-like chamber. The opening at the top of the apparatus is about 12 inches square, and is furnished with two wire grids, the lower one being fixed while the top one is mounted in a hinged lid The apparatus has been designed for the rapid drying of trial samples or swatches of yarn cloth or other fibrous materials, or for the quick drying of samples of material where it is desired to ascertain the amount of moisture. The samples are dried in a few minutes, whence it can be seen at once if the correct shade has been attained or whether more colour or other additions are necessary. L.

Influence of Atmospheric Humidity upon the Moisture Content of Textile Fibres. H. Sommer. *Textilber.*, 1929, **10**, No. 4E, 242-244.

The amount of moisture contained in a fibre depends on the relative atmospheric humidity, the hygroscopic capacity, the length of time exposed to the atmospheric humidity, and the state of the material, e.g. the presence of hygroscopic bodies, the degree to which the fibre has been advanced in manufacture, etc. Formulæ and curves are given expressing the moisture content as a function of the relative humidity, together with tables showing the moisture contents of wool, silk, artificial silk, cotton and bast fibres at various humidities. W.

Conditioning Worsted Yarn. E. N. S. *Text. World*, 1929, **76**, 2158-2159.

Yarn sets quicker when conditioned than when dry. The added moisture gives to the yarn elasticity and flexibility, and makes it better able to withstand sudden strains of tension. It kills any tendency to curliness or liveliness caused by excessive twist, and gives a fuller appearance. A description is given of a machine, made for adding moisture to the yarn, which requires very little room, power, and attention, and in which 80 lb. of yarn can be conditioned in a few minutes. Other systems of conditioning are briefly described. W.

(F)—Carbonising

Carbonising. B. H. *Text. Mfr.*, 1929, **55**, 314-315 and 350-351.

Burry materials in fabrics may be dealt with in three ways—(1) burling or picking out, (2) inking or burl-dyeing, and (3) carbonising. Burling consists of the removal of burrs by hand-picking with burling irons. Burl-dyeing is a process of staining, and therefore disguising the vegetable matter. The vegetable matter is usually mordanted with tannin and then fixed with sulphate of iron. This method is only applicable on dark goods, as the wool portion tends to be stained to some extent by the process; it is unsatisfactory in that iron salts tend to deteriorate the handle to some extent, and as the burrs still remain in the goods they tend to be prickly. In place of iron salts it is a fairly common practice to employ small quantities of direct cotton dyes to stain to the necessary shade during the milling operation. Carbonising is more effective and more economical than burl-dyeing. It depends on the fact that certain mineral acids will abstract water from the vegetable matter, rendering it friable, so that it is easily broken up and removed as dust. The following six stages in piece-carbonising are discussed in detail—(1) cleansing the cloth, (2) saturation with acid (or salts in solution), (3) whizzing to remove superfluous acid, (4) drying and baking, (5) dry milling and beating, and (6) neutralising and rinsing. Factors on which the process is dependent to a great extent for its success are discussed, together with defects in, and machinery for carbonising. W.

Leonil S in Carbonising. *Wool Rec.*, 1929, **36**, 773.

Leonil S, a brown powder soluble in water and acid, is used during carbonising to assist the penetration of H_2SO_4 into the vegetable matter during steeping, and so facilitate the use of a lower concentration of acid, the makers recommending 3° Tw; 2½ lb. of Leonil S dissolved in water are added to every 100 gallons of a 3° Tw. H_2SO_4 bath, and the carbonising proceeds in the usual manner. The advantages claimed by the makers, owing to the small amount of acid used, are (1) better preservation of the wool, (2) omission of the neutralising bath in many cases where goods are dyed immediately after carbonising, (3) level dyeing and good penetration when the dry goods are entered into the cold dyebath immediately after carbonising, (4) possible carbonising in the grease, and (5) in carbonising dyed wool goods the acid bath of 3° Tw. only slightly alters the dyes susceptible to acid, so that it should be possible to do away with the use of aluminium chloride. W.

Carbonising of Loose Wool. *Wool Rec.*, 1929, **35**, 729.

Two methods for removing vegetable matter from wool are described. In one the material is treated in cages, and in the other in continuous treatment vessels. The use of a sulphuric acid bath is advised for efficiency in loose wool carbonising. Tar or paint marking stains cause considerable trouble with carbonised material, and treatment for their removal is shown. W.

(G)—Bleaching

A Simple Bleaching Process, Employing Chlorine and Peroxide (Osmeter Process). G. H. Dahlenvord. *Leipzig Monats. Text. Ind.*, 1929, **44**, No. 6, p. 262.

Describes an attempt towards the simplification of the plant required in so-called "cold" bleaching processes for cotton in which the goods are treated successively with sodium hypochlorite and hydrogen peroxide. It is proposed to carry out the treatment in open vessels in which the goods are sprinkled with the definitely alkaline hypochlorite solution instead of being immersed as usual. After trickling down through the cloth (or yarn), the liquor flows away freely at the bottom. It is claimed to obtain very level bleaching by this method. After this treatment the sprinkling apparatus is removed, and the goods are treated in a circulating peroxide bath in the same vessel. The exhausted bath may be used, preferably in conjunction with a wetting agent, for wetting out the grey goods. L.

Bleaching without Chlorination. C. Sunder. *Chem. Abs.*, 1929, **23**, 4577 (from *Bull. Soc. Ind. Mulhouse*, 1929, **95**, 225-229).

Report on Sealed Note 2178, deposited by A. Dondain, 21st May 1912. According to R. Müller's D.R.P.240,037, Cl bleaching can be eliminated by prolonging the NaOH boil and injecting air until the solution is almost decolorised. Dondain proposes improving the process by substituting nascent O generated electrolytically in the liquor for atmosphere O_2, and claims the process thus accelerated without using catalysts. In order to do without Cl bleaching, the goods must be perfectly white when they come out of the NaOH; if all the gums, sugars, and pectins have been dissolved, they can be oxidised in solution without attacking the fibre, but if some of them remain on the fibre, they cannot be satisfactorily oxidised without at the same time attacking the fibre. On the other hand, if part of the incrustants remain on the fibre when it comes out of the NaOH liquor, bleaching with acid or $NaHSO_3$, as suggested by Müller, does not give a permanent white. Sunder concludes that the process cannot give a perfect white, but that it can give a sufficiently good colour for many purposes. W.

Bleaching by Hydrogen Peroxide. *Wool Rec.*, 1929, **36**, 1273.

The advantage of hydrogen peroxide over other bleaching agents are discussed. Methods for its use are described. W.

The Greening of Vat Blues on Bleaching. T. Scholefield. *Text. Mfr.*, 1929, **55**, 241.

In order to avoid greening troubles the following points should be noted—(1) in no case should the temperature of vatting or dyeing be allowed to rise above 120° F., and the yarn should be entered as soon as possible after reduction. The quantities of hydrosulphite and caustic soda should be carefully controlled. (2) A quantity of dextrine equal to the amount of caustic soda reduces the danger from inadvertent increase in temperature or prolonged standing of the vat. (3) It is advantageous to add glucose to the soap solution, thus reducing the time required to complete this process. Goodyear and the author have found that when two different samples of a similar blue of British manufacture are subjected to the same conditions of drastic reduction, the dyeings produced show very different degrees of fastness to chlorine when bleached in the same bath, and this result could be accurately reproduced. W.

Potassium Permanganate and Its Uses in the Textile Industry. *TIBA*, 1929, 7, 141-145.

Tables are given of solubility, methods of analysis, price comparisons with other oxygen-liberating substances, chemical reactions, uses in the bleaching of wool in the yarn, or in the piece, and the after-treatment with sulphurous acid, as well as the blueing for perfect whites. W.

(H)—MERCERISING

Mercerising Plant Automatic Acidity Control Apparatus. The Integra Co. Ltd. *Text. Rec.*, 1929, **47**, No. 559, 69-70.

The Leeds and Northrop automatic control apparatus will hold the strength of dilute acid baths constant within the narrow limits of one-tenth of a degree above or below the desired concentration. It can be applied to a mercerising equipment already in operation without interfering with production. The method of control is based on the fact that the conductivity of the solution varies with the concentration of the acid. A conductivity cell in the bath is made to form a part of the electrical circuit in an instrument which is sensitive to changes of conductivity. In responding to the conductivity changes the instrument puts in operation a valve mechanism which regulates the flow of acid to the bath. The variations in acid concentration are recorded continuously on a chart. The recorder is calibrated so as to show the ratio of the actual bath strength to the desired strength. The concentration of the sulphuric acid bath is approximately 3%, and the bath is discarded at the end of each day's run in order to avoid accumulations of sulphates. The acid added by the controlling device is approximately 40 to 50%. Continuous agitation is important. C.

(I)—DYEING

Black Cellulose Acetate Rayon: Dyeing. A. J. Hall. *Amer. Dyestuff Rep.*, 1929, **18**, 671-674.

The following are the chief methods for producing a black on cellulose acetate rayon—(1) Dyeing with an amine, diazotising, and coupling with a suitable naphthol. (2) Dyeing with a dyestuff capable of producing directly a black shade. (3) Dyeing with a substance capable of being oxidised to black on the fibre. (4) Dyeing with a mixture of yellow, red, and blue dyes which can be directly applied. (5) First hydrolysing the cellulose acetate rayon and then dyeing it by methods suitable for viscose or other regenerated cellulose rayons. The first of these methods is the most largely used. The author discusses each method. C.

Knitted Tubular Fabrics: Dyeing and Finishing. *Rayon Record*, 1929, 3, 471-477.

In knitted fabrics, barred effects are liable to show up after dyeing owing to different degrees of tension in the artificial silk yarn. Examination of the fabric before dyeing for tightness in the wale, is therefore advisable in order to ascertain the desirability of using only those dyes which yield even dyeings on different grades of regenerated cellulose silks. Scouring and dyeing may be carried out on the winch machine. In the case of cellulose acetate knitted fabric the scouring temperature must be kept below 80° C. since the material, being slack in the soap liquor is more liable to become delustred than in a jig machine, where the tension acts as a protection against delustring. Regenerated cellulose knitted goods are dyed at a temperature as near to the boil as possible to avoid barred effects, but in the case of cellulose acetate fabrics, temperatures not exceeding 80° C. are used. Regenerated cellulose materials may be dyed in a machine of the Longclose type in which the dye liquor and textiles are circulated by means of steam and air. The knitted fabric is placed in large-mesh bags and need not be removed until it has been scoured, dyed, and whizzed. Before finishing it is advisable to dry the dyed fabrics to a certain degree of moistness. The finishing process consists of passing the knitted tubular fabric over a stretcher and immediately leading it between a travelling blanket and the surface of a tinned iron cylinder rotating in the same direction of travel as the blanket. The finishing must generally be effected so as to yield a material having a very soft silky handle, good draping qualities, and a subdued lustre. To obtain this the pressure between the blanket and cylinder should be very light and the blanket and cylinder should travel at the same speeds. Softness of handle and subdued lustre can be assisted by the use of finishing oils. C.

Adsorption on Wool Fibre of Organic Dyes Suspended in Water. M. Il'Inskii and R. Burstein. *Chem. Abs.*, 1929, **23**, 4574 (from *Papers Pure and Appl. Chem. Karpov-Inst.* (Moscow), 1928, No. 8, 85-95; *Chem. Zentr.*, 1929, **I**, 698).

Adsorption of indigo on wool fibre in acid solution increases with increasing quantities of adsorbed acid. Endosmotic experiments show that the adsorbed H ions reduce the negative charge of the wool fibre, and thus annul the repelling action on the dye particles, likewise charged negative. The rapidity of cataphoresis is diminished, and the sedimentation is accelerated with increasing concentration of the acid. In order to effect the coagulation on the fibre only it is advisable to have the acid first adsorbed by the fibre and not to acidify the suspension. The presence of methyl orange facilitates the quantitative adsorption of the dye. The homogenization of the adsorption layer occurs only in the second phase of the dyeing process. W.

Dyeing Wool with Direct Cotton Dyes. A. E. Porai-Koshitz. *Chem. Abs.*, 1929, **23**, 4345 (from *Zhur. Prikladnoi Khim.*, 1928, **I**, 11-20.)

Wool was dyed in a neutral bath with NH_4 salts of Benzopurpurin 4B and Diamine Violet N, which were prepared from Na salts by precipitating free acids with HCl or H_2SO_4, washing the precipitate with distilled water (dialysis was resorted to for the complete removal of sulphate and chlorine ions from Diamine Violet N as the dye is soluble in water), dissolving the precipitate in 30% NH_3 solution, and evaporating the resulting solution to dryness. The NH_4 salt of Diamine Violet N thus prepared contained 57% of Na salt as impurity, while the NH_4 salt of Benzopurpurin 4B was practically pure. On boiling these salts with water they are hydrolysed. Experiments are described from which it was found that some NH_3 was retained by wool. When wool was boiled with aqueous NH_3, some NH_3 was also adsorbed. When wool thus saturated with NH_3 was boiled in distilled water or dyed in the manner described above, part of the NH_3 was liberated. Cotton adsorbed NH_3 salts (also Na salts) of these dyes as such. Conclusions—unlike cotton, wool adsorbs only sulpho acids. W.

Dyeing of Woollen Muslin. *Wool Rec.*, 1929, **36**, 915.

A description is given of the Continental method of dyeing muslin. The material is prepared in a similar method to that employed in England, but is far more rapid, and produces bright colour effects. The method is not so efficient however, since it causes the deposition of the dyestuff acid to take place within and on the fibre without actual combination, and therefore the colour is not so permanent to washing and scouring. W.

Action of Light on Diazo Derivatives and on Azo Dyes. A. Seyewetz and D. Mounier. *Chem. Abs.*, 1929, **23**, 4075 (from *Chimie and Industrie Special*, No. 1929, February, 513-518; cf. *Chem. Abs.*, **22**, 2373).

Previously reported work on diazo derivatives is given in greater detail. The action of light on chrysoidine (yellow, basic monoazo dye), diamine pure blue 2B (diamino acid dye), and roccellin (hydroxyazo acid dye) was studied under the same conditions as for the diazo derivatives, leading to the following conclusions—(1) Decolorising of azo dyes by ultra-violet light is apparently due to an oxidation, as it is increased in presence of oxidising agents and decreased in presence of reducing agents. (2) The oxidation products obtained by the action of H_2O_2 give various colour reactions comparable to those given by the decomposition products of the dyes under the action of ultra-violet light. (3) The decomposition products of azo dyes under the action of ultra-violet light act as stabilisers toward the same dyes. (4) The decomposition products obtained by the action of ultra-violet light are apparently the same as those obtained by the action of oxidising agents on the same dyes. W.

The Dyeing of Low Woollen Piece Goods. J. Newsome. *Dyer and Cal. Printer*, 1929, **62**, 495.

Practical methods and hints in dyeing low woollen piece goods are described in detail. W.

Researches on Dyeing Baths. F. C. Jacoby. *Textilber.*, 1929, **10**, 121-124.

Several physical chemical studies were made of dyeing baths containing some of the newer dyeing assistants, such as Neomerpin, Tetracarnite, etc. But little measurable effect on viscosity was noted. The drop numbers varied greatly, as did the solvent of the dyestuff. Filtration studies showed remarkably high dispersing power for tetracarnite and other pyridine derivatives. In general, a retarding effect on the rate of dyeing was noted, believed to be beneficial. W.

Investigation and Research on Wool. *See* Section 1B.

(J)—PRINTING

New Process for Printing Vat Dyes. M. Jeanmaire and L. Ebersol. *Chem. Abs.*, 1929, 23, 4076 (from *Chimie and Industrie Special* No. 1929, February, 493-494).

The dye (indanthrene, algol, etc.) is merely thickened and printed on the white fabric, which is jigged in a solution of Na_2CO_3 or NaOH containing a suitable reducer, preferably rongalite. Finishing is carried out as usual. The advantages of the process are—the use of strongly alkaline colours is avoided; after printing the goods can be allowed to stand indefinitely before jigging with NaOH or Na_2CO_3; multicoloured designs can be printed with these dyes in conjunction with oxidation colours. The process can be modified by printing on fabric which has been previously prepared with Na_2CO_3 and reducer. The I.G. has recently described a process which is identical, except that the use of "colloresin D" is said to be indispensable to obtain a sharply defined design. Jeanmaire and Ebersol have found, however, that its use is not essential. Very good results have also been obtained by using the following "lysogum" thickener—wheat starch, 1,500 g; 5% lysogum thickener, 35 l.; glycerol, 1 kg.; H_2O, 12·5 l.; the presence of lysogum facilitating penetration, both during jigging and during steaming, and also helping to eliminate by washing the small quantity of starch incorporated with the colour. W.

Spray Printing on Fabrics. S. R. Nelson. *Dyer and Cal. Printer*, 1929, **62**, 356-357.

The method of arranging the cloth on the table, cutting stencils, spray gun, etc., are described. W.

New Use for Tetracarnit in Wool Printing. H. Perndanner and J. Hackl. *Textilber.*, 1929, 310-312.

Certain direct and acid dyestuffs are unsuited for printing because on steaming they partially decompose and alter in shade, giving uneven or spotted prints, and also in many cases large percentages of dyestuffs are necessary to give deep shades. The damage by steaming can be avoided, and colours 100% deeper for a given quantity of dyestuff obtained by adding tetracarnit to the printing paste. The sample prints attached to the article bring out these facts. The method seems universally applicable, and depends on dispersion and capillary phenomena. W.

(K)—FINISHING

Rayon Finishing Machines. *Textilber.*, 1929, **10**, 797-801.

A number of machines for finishing rayon fabrics and mixed fabrics are described, and the article is well illustrated. The machines dealt with include a gas singeing machine, various calenders, a tentering and drying machine, a machine for rolling cloth in heated paper, and a breaking machine for improving the handle of goods too stiffly sized. C.

Shearing Machine Cutters: Standardisation. *Textilber.*, 1929, **10**, 833-834.

Tentative standards and specifications for the rollers and spirals, and the under blades of shearing machines are put forward for comment. C.

Effect of Finishing on Light Fastness. *Text. Weekly*, 1929, **4**, No. 92, p. 398.

The effect of the presence of finishing substances on the fastness to light of dyed material is of practical interest to both dyers and the various committees at home and abroad which are endeavouring to establish standards of fastness. From time to time contributions to this subject have been made by various investigators, and are to be found in the *Journal of the Society of Dyers and Colourists.* A further such contribution may be noted (*Amer. Dyestuff Rep.*, 1929, **18**, 700) dealing particularly with the effect of such finishing substances as sulphonated castor and mineral oils, sulphonated tallow, glycerine, and glucose used as finishing agents on the fastness to light of cotton fabric dyed with about 22 direct dyes. In these investigations the voile cotton fabric was first padded (once only) with a solution of the dye ($\frac{1}{4}$ lb. of dye per 100 gallons of liquor), such that the fabric carried with its own weight of the dye liquor, then dried, and similarly padded with the various finishing solutions of a concentration comparable to those used in practice. The resulting fabrics were then exposed in a fadeometer of the improved type (provided with humidifier and voltage control), and the times noted at which perceptible fading occurred. The results are expressed in tabular form, and those interested should refer to these in the original paper, but some interesting points may be noted. Thus, unfinished fabric dyed with Pontamine Fast Red 8 BL required for perceptible fading 16 hours, when finished with solutions containing 5 lb. of sulphonated castor oil per 100 gallons, 2 lb. of similar oil, together with mineral oil per 100 gallons, 5 lb. of glycerine per 100 gallons, 10 lb. of glucose, and 100 lb. of glucose per 100 gallons, the corresponding periods were 14, 16, 20, 10, and 40 hours respectively. It is evident that the addition of a mineral oil to a sulphonated castor oil tends to counteract the decreased fastness to light caused by the presence of sulphonated oil alone, the large beneficial effect of glucose is clearly shown. With all the dyes used, sulphonated castor oil (Turkey red oil) decreased the light fastness. The effect of glucose varied, but in no case did it reduce the fastness. With Solantine Orange G, Solantine Pink 4B1, Benzo Fast Grey B1, and Pontamine Fast Blue 4GL the fastness was nearly doubled, but in the case of Erie Green MT, Niagara Blue 6B, Diphenyl Catechine G, Pontamine Black extra concentration, and Pontamine Fast Green G1, the beneficial effect was quite small. The effect of glycerine was generally in the same direction as glucose, but usually of considerably less effect. L.

Crêping Wool Muslin. C. Favre. *Chem. Abs.*, 1929, **23**, 4825 (from *Bull. Soc. Ind. Mulhouse*, 1929, **95**, 359-360; cf. *Chem. Abs.*, **20**, 827).

When a large number of pieces are crêped simultaneously by the process of Sealed Note 2266, the results are somewhat uneven, and best results are obtained by treating each piece separately for about 20 minutes. The crêpe may be reserved by printing the wool muslin with 40° Bé. water-glass, drying, and then treating with acid. By dissolving a direct dye in the water-glass, a coloured reserve is obtained. *Report*—A. Wolf. Ibid 360. The claims of Favre were confirmed. Similar results can be obtained by printing with a solution of albumin or of sericose, but not with British gum and $BaCl_2$. W.

Knitted Tubular Fabrics: Dyeing and Finishing. *See* Section 4I.

(L)—Proofing

Shower Proofing. "Consultant." *Text. Mfr.*, 1929, **55**, 318.

Shower proofing is most readily produced by coating the fibres with a thin layer of paraffin wax. In practice the cloth must be "mordanted" with aluminium hydroxide, and whilst still hot it is run through a dilute solution of paraffin wax in benzol or light naphtha, and the solvent evaporated by passing over the drying cylinders. Owing to the injurious and inflammable character of the escaping vapours this method is being replaced by a kind of printing process. The cloth is run over a suitably engraved iron roller which revolves in a trough of molten wax. Excess of wax is removed by a doctor-blade applied to the surface of the roller after it leaves the trough and before it reaches the cloth. The cloth, which has thus been printed on one side only with wax, is finally run over a series of drying cylinders, to allow the wax to penetrate into the cloth. I.G. Farbenind. A.-G. have introduced a wax emulsion Ramesit I, which consists of a low melting-point paraffin wax dispersed in a solution of Nekal. The goods to be proofed are padded in the diluted Ramesit and then dried. The water-repelling powers of the goods may be improved by the addition of a small proportion of a soluble aluminium salt to the liquor. Both aluminium and basic aluminium sulphate give a certain degree of water resistance to the cloth. A description is given of the "drop," "trough," "funnel," and hydrostatic tests for measuring the degree of proofing process. W.

Patents

Wetting Agents: Preparation. Soc. of Chemical Industry in Basle (Basle, Switzerland). E.P.319,249 of 18/9/1928.

Condensation products are obtained by the interaction of benzoin, an aromatic or carboxylic acid, and an aliphatic, cyclic, or aromatic-aliphatic alcohol, simultaneously or in any order, in the presence of a condensing agent. The products, which are resinous, may be used as wetting agents, as dispersing agents for dyestuffs, and as assistants when precipitating lakes. C.

Bleach Liquor Distributing Apparatus. J. M. Voith (Heidenheim). *Zellstoff u. Papier*, 1929, 9, 755 (from Fr.P.658,975).

A device for the bleaching of wood pulp and cellulose is described in which the bleaching agent is distributed evenly, in a fine state of division, over the material by means of a current of air. The amount of bleaching agent used is at the same time varied according to the amount of material to be bleached. C.

Chromium Azo Dye Compounds: Application. Soc. of Chemical Industry in Basle (Basle, Switzerland). E.P.318,832/3 of 7/9/1928.

(1) Level dyeings, fast to light, water, and washing, are obtained on rayons other than cellulose esters and ethers by the use of chromium compounds of dyestuffs obtainable by coupling *o*-oxydiazo or *o*-carboxydiazo compounds with 2:5:7-aminonaphtholsulphonic acid or its *N*-acidyl, *N*-alkyl, *N*-aralkyl, or *N*-aryl derivatives. (2) Fast tints are produced on materials by coupling a diazo compound with a leuco compound of a dyestuff or intermediate product capable of being absorbed, in its reduced form, by the material to be dyed. The leuco-compounds of vat dyestuffs of the anthraquinone and indigoid series, and of sulphur dyestuffs are specified. C.

Substantive Dyes: Application. E. I. du Pont de Nemours & Co. (Wilmington, U.S.A.). E.P.318,891/2 of 11/9/1928.

Certain types of disazo dyes which dye regenerated cellulose materials in level shades are specified. C.

Vat Dye Pastes: Dehydration. J. W. C. Crawford, G. E. Scharff, and Imperial Chemical Industries Ltd. (London). E.P.318,937 of 9/3/1928.

A method of dehydrating vat dye pastes which yields products suitable for dyeing and printing textile fibres is described. The pastes are heated and agitated with an inert liquid non-miscible with water. C.

Vat Dyes: Application. Soc. of Chemical Industry in Basle (Basle, Switzerland). E.P.318,978 of 13/9/1928.

In printing with vat dyestuffs, particularly those requiring considerable quantities of glycerine to fix them, urea is added to the paste. C.

Dye-resistant Metal Bobbins. Felten and Guilleaume Carlswerk A.-G. (Cologne, Germany). E.P.319,204 of 17/9/1928.

Light metal-bobbins are coated with nickel. C.

Azo Dyes: Application. I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.319,247 of 18/9/1928.

Azo dyes are made in substance or on the fibre by coupling a diazotised alkyl ester of 5-halogen-2-amino-1-benzoic acid with a naphthylamide of 2:3-oxy-naphthoic acid. C.

Cellulose Ester and Ether Fabrics: Dyeing. British Celanese Ltd. (London), D. H. Mosby, H. C. Olpin, and G. H. Ellis. E.P.319,390 of 18/6/1928.

Unsulphonated (including unsulphated) azo dyestuffs obtained by coupling a diazotised 2:4-dinitro-6-alkoxy- or alkyl-aniline, or derivatives, with suitable coupling components are employed. Suitable components are specified. C.

Fabric Dyeing Apparatus. T. Parkinson (Manchester). E.P.319,432 of 6/7/1928.

In a dyebath employing pairs of submerged nip rollers and upper and lower rollers for guiding the fabric, additional rollers are provided at the bottom for diverting the material when more than one piece is to be treated at a time. C.

Vat Dye Ester Salts: Application. Durand et Huguenin Soc. Anon. (Basle, Switzerland). E.P.319,021 of 15/9/1928.

An iron alum is used as oxidising agent in developing dyeings and printings with ester salts of leuco vat dyes. C.

Yarn Conditioning Box. H. Tattersall (Oldham). E.P.320,260 of 8/11/1928.

A yarn conditioning box of the open-topped and partly open-fronted type, and suitable for conditioning Egyptian yarn, has a water tank in which dip cloths hung from rods and replenished with liquid from an additional tank, a cloth serving to cover the top and front opening. The cloths are held in position by vertical guide rails. In use, the bath cloth is first placed in position, then cops are piled up until they reach to the top, or nearly. Positioning slabs or strips are inserted in slots in the rails, the next cloth is placed in position, and the operation repeated until the box is filled. The cloths may be mounted on spring rollers, or pulleys and counterbalance weights may be used. C.

Hypochlorite Bleaching Compound: Manufacture. Mathieson Alkali Works (New York). E.P.319,727 of 27/9/1928.

A method is described for preparing the triple salt $Ca(OCl)_2 \cdot NaOCl \cdot NaCl \cdot 12H_2O$ which may be used for bleaching. C.

Peroxide Bleaching Apparatus. H. Wade (London), Deutsche Gold-und Silber Scheideanstalt vorm. Roessler (Frankfort, Germany). E.P.320,072 of 3/7/1928.

Peroxide bleaching in which liquid currents pass in different directions is carried out in vessels made of, or lined with, cement or like hydraulic mortars. An iron vessel may be coated with a suspension of cement in water to which a binder such as waterglass has been added, and, after setting, the coating may be treated with a silicate such as waterglass solution. The invention is particularly applicable to apparatus shown, in which currents from within outwards are produced by pipes, and from above downwards by a coil pipe, the liquid being withdrawn for circulation by a pump through a heater. Further supply pipes may be arranged on the walls of the vessel, and the directions of the currents may be reversed. C.

Vegetable Textile Materials: Immunisation to Direct Dyes. Soc. of Chemical Industry in Basle (Basle, Switzerland). E.P.319,584 of 21/9/1928.

The material is treated with an anhydride or chloride of an organic carboxylic acid, such as phthalic, maleic, or succinic anhydride, or benzoyl or phthaly' chloride, in the presence of a tertiary base such as pyridine, quinoline, triethyl amine, or diethylaniline. C

Dyeing Apparatus. Tissage Dewitte-Lietaer Lauwe (Courtrai, Belgium). E.P 319,672 of 25/9/1929.

In the longitudinal walls of a vat, or of a removable frame to be supported in it, superposed grooves are formed to receive rods or tubes which carry the goods. The rods are pushed in from an open end of the frame. A frame may be carried by a crane to successive vats or successive treatments may take place in one vat. Two filled frames may be superposed in a single vat. C.

Cotton-Acetate Rayon Mixed Fabric: Dyeing. J. Y. Johnson (London), I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.320,027 of 30/4/1928.

The cotton is dyed by means of a sulphur dyestuff in a bath containing an alkali metal sulphide, or other reducing agent of a lower alkalinity, such as a hydrosulphite, and a faintly alkaline salt, such as borax or sodium bicarbonate, of which the cation is the same as that of the alkali metal sulphide if such is employed. The use of baths containing sulphite cellulose waste liquor or soap is excepted. C.

Textile Fabrics: Printing. J. Y. Johnson (London), I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.319,457 of 7/8/1928.

Pastes for printing on vegetable fibres comprise complex chromium compounds of azo dyestuffs, free organic acids, and metallic cotton mordants. The prints are, for the most part, well fixed by a short steaming. C.

Fabric Coating Machine. J. Downham & Co. (1927) Ltd., and S. Platt (Bury). E.P.319,064 of 26/3/1928.

A machine is described for coating fabrics by applying an adhesive and dusting or sifting powdered cotton, wool, etc., on to the material. C.

Cloth Shrinking Machine. A. A. Lindqvist (Stockholm). E.P.319,236 of 18/9/1928.

The cloth is fed by a permeable travelling band, which may be of metal cloth or gauze, between a steam box and an impermeable travelling band of felt or closely woven material. C.

Gig Mill Teazle. A. C. Scholaert (Tourcoing, France). E.P.319,358 of 22/9/1928.

To prevent damage to the fabric due to slipping between a rotary teazle of a gig mill and the fabric under treatment, the teazle is provided with end rings secured by washers and nuts and covered with wires or emery cloth, the diameter of the covered rings exceeding the diameter of the teazle proper, whereby rotation of the teazle is effected before the hooks of the teazle make operative contact with the fabric. C.

Polymerised Vinyl Ester Stiffening and Waterproofing Agents: Application. I.G. Farbenindustrie A.-G. (Frankfort, Germany). E.P.319,364 of 22/9/1928.

Impregnation with a solution of a polyvinyl ester renders textile materials stiff, waterproof, and capable of being shaped and pressed at a raised temperature. C.

Cellulose Ester Rayon Fabrics: Hydrolysis and Weighting. British Celanese Ltd. (London), and G. H. Ellis. E.P.319,420 of 26/6/1928.

Materials made of or containing organic esters of cellulose are subjected separately to partial or superficial hydrolysis and to weighting treatments. The treated materials have an increased resistance to hot treatments such as ironing, and possess affinity for a very wide range of colouring matters. They are also very suitable for the production of discharge effects. C.

Rayon Yarns: Dressing. Oranienburger Chemische Fabrik A.-G. (Berlin). E.P.320,018 of 29/9/1928.

The yarns are treated with an aqueous emulsion of a drying oil, such as linseed or wood oil, or a varnish made therefrom. C.

Viscose Solutions for Finishing Vegetable Textiles. L. Lilienfeld (Vienna). E.P. 320,062 of 2/7/1928.

Yarns or fabrics are treated with a cellulose derivative containing the CSS group and from which the cellulose can be regenerated, the material being treated with at least one shrinking agent for the fibres before, during, or after the deposition of the cellulose. The treated material has the feel and elasticity of wool or linen, increased resistance to washing, rubbing, and sharp bending, and may acquire a high lustre and a silky appearance. C.

Rayon Filaments: Strengthening. P. Joliot. *Chem. Zentr.*, 1929, **ii**, 2523 (from F.P.639,196 of 14/1/1927).

Rayons are treated in a bath containing 750 parts water, 20 parts sodium borate, 80 parts albumin, 40 parts gelatin, 10 parts glycerin, 40 parts aluminium acetate, and 60 parts acetic acid; a trace of nitric acid may be added as catalyst. The rayon is then treated with formaldehyde to render the gelatin insoluble. The product has increased strength, spins easily, and may be weighted with tin salts. C.

Rayon Fabrics: Softening. A. Vergé. *Chem. Zentr.*, 1929, **ii**, 2523 (from F.P. 651,166 of 24/8/1927).

Rayon fabrics are wound on perforated tubes and treated with steam under high pressure (about 10 kg.) and then cooled suddenly in order to improve the softness. Rayon fabrics so treated do not crease. C.

Pile Fabric Pile Raising Machine. J. Montforts (Gladbach, Germany). E.P. 319,759 of 29/9/1928.

In apparatus of the kind in which the fabric travels through a large adjustable trough in contact with a rotating cylinder having finishing appliances at its circumference, the trough is adjustable along supporting bars and the bars are movable for moving the trough to and from the cylinder into its operative and inoperative position. C.

Yarn Brushing and Polishing Machine. A. H. Junkers (Rheydt, Germany). E.P.319,793 of 29/9/1928.

Apparatus for brushing, polishing, or otherwise treating yarns extended freely between two parallel drums is described. C.

Degumming, Washing, and Drying Fibres. R. L. Pritchard (London). E.P. 319,594.

A process for degumming, washing, and drying fibres consists in maintaining the fibres in a separated or segregated condition while subjected to the action of a liquid or of air caused to move in a direction more or less parallel to the length of the fibres. The fibres are supported vertically in a series of trays, secured by ties between frames in a degumming vat. The trays are perforated and flanged, the fibres being supported and segregated by pins. The series of trays is supported on brackets, so that the fibres are vertical, and the treating liquid circulated downwardly through the fibres by a pump. The fibres are washed in a similar vat, and then dried up by an upwardly moving stream of warm air while lying loosely and vertically in a chamber, the trays clamped between plates being slowly rotated in opposite directions to separate the fibres intermittently between the drying periods. Specification 161,219 is referred to. L.

5—ANALYSIS, TESTING, GRADING, AND DEFECTS

(A)—Fibres

Textile Fibres: Fineness Measurement with Lanameter Automatic Registering Apparatus. H. Döhner. *Textilber.*, 1929, 10, 781-782.

The apparatus consists essentially of a series of 20 vertical glass tubes, a series of numbered celluloid discs, and means for controlling a magazine of small metal balls so that a ball is introduced into the appropriate tube each time a measurement is made. The numbers on the celluloid discs form a scale of "fineness classes" differing by two microns. Sheets of horizontally ruled paper, on which the distance between the lines is equal to the diameter of the balls, are placed behind the tubes for recording the curves obtained. C.

Nitrogen in Cotton and Linen. M. M. Tschilikin. *Textilber.*, 1929, 10, No. 11, pp. 883-885.

The effect of various treatments on the nitrogen content of flax fibre was determined. Each treatment was for 15 minutes at 55° C.

	Nitrogen Content (per cent.)
Original fibre	0·89
Water	0·55
Caustic soda (1% solution)	0·50
Biolase (0·2% solution)	0·53
Novofermasol (0·2% solution)	0·59
Biolase followed by caustic soda	0·17
Novofermasol followed by caustic soda	0·49

L.

Scientific Measurement of the Attributes of the Wool Fibre. S. G. Barker. *Wool Rec.*, 1929, 36, 245.

A synopsis is given of the paper read by the author at a meeting of the B.A. at Cape Town, 25th July 1929. In it the author enumerates some of the dimensional characteristics of the wool fibre which affect the spinning value such as staple length, crimp, cross-sectional contour, and area, and stresses the fact that in any proposed scheme of classification these will have to be linked up to some physical or chemical factor which shall be expressive of the constitutional factors which exert an influence on the reactions during the manufacturing processes. The chemical and biochemical aspects of wool composition are briefly discussed, and special reference is made to the sulphur content of wool. The influence of fibre contour is mentioned, and the question of crimp in wool is discussed in some detail. The different forms of crimp encountered are defined, and it is shown that any of these may be produced by the composition of two simple harmonic motions at right angles. The article concludes by putting forward suggestions for the improvement of South African wool. W.

Use of the Microscope in Textile Industry. J. M. Preston. *Text. Mfr.*, 1929, 55, 295 and 335-336.

A review is given emphasising the basic principle of textile microscopy under the headings of appliances required, technique involved, and the application and tests practised. W.

New Method for the Determination of Neutral Fat in Sulphonated Oils. R. Hart. *J. Amer. Leather Chem. Assoc.*, 1929, 24, 576-582.

A new method is suggested for the estimation of neutral fat in sulphonated oils. The method is based upon saponification tests, and full details, together with formulæ, are given. W.

Suitable Twines for Tying Wool Fleeces. *Bull. Natl. Assoc. Wool Mfrs.*, 1929, 59, 606.

Several American wool organisations have agreed that paper twine is the most suitable material for tying wool fleeces in order to avoid vegetable fibre contamination, and details are given of their circular to wool growers, etc. W.

(B)—Yarns

Dietz Yarn Tester: Application. —. Dietz. *Leipziger Monats. Text.-Ind.*, 1929, 44, 325-328 and 373-374.

It is shown by reference to a series of experiments that the results of tensile strength tests on yarns do not always agree with their performance in practice, but that strength tests on the Dietz yarn tester, in which the yarn is put under a tension approximating to the strain to which it will be exposed in manufacture, do give the same results as are obtained in practice. For example, two lots of 2/10's cotton yarn from different mills were tested. One lot was quite satisfactory in weaving, whilst the other broke frequently. Tensile strength tests indicated no great difference between the two; the mean and sub-mean for the poor yarn were only 1·6% and 3·1% lower than for the good yarn. The Dietz tester indicated a very considerable difference between the yarns, the good one showing an average of one break in 350 m. and the poor one an average of one break in 35 m. C.

Oil Stains on Wool. *Text. Merc.*, 1929, **81**, 298.

The cause of yellowing of wool yarn is due to oxidation of oils which is favoured by heat and humidity, and which becomes accentuated in time. The effect of this oxidation is a hardening of the oil, making its removal by washing more difficult. The amount of oxidation of the oils increases with the increase of iodine index. A table is given showing iodine figures of some drying, semi-drying, and non-drying oils. Mineral oils added to mixtures of fatty acids to reduce the cost of production of fine carded woollens, oxidise under the influence of light, and the brownish ground of a cloth containing an oiling of this nature may persist after washing. It is the general opinion that when the yellow stripes are very much accentuated they may be lessened by energetic washing, but not completely eliminated. W.

The English Yarn Balance. Wolle. *Wollen-, Leinen-Ind.*, 1928, p. 299.

The English count expresses the number of hanks that go to the pound, and therefore is calculated from the formula—number of hanks divided by the number of pounds avoirdupois. Two instruments are needed to determine the yarn count, namely, the sorting reel for finding the length (measurement of a hank) and the yarn balance. The article describes by the aid of a number of illustrations the usual construction of this balance, and the theory of the division of the scale. The yarn balance can also be employed for ordinary weighing purposes, e.g., for weighing the doffing of a single spinning machine, and this application also is described. W.

Water and the Textile Industry. W. H. Mitchell. *Amer. Dyes Rep.*, 1929, **18**, 611-619.

A general account is given of faults in textiles caused by impure water, with notes on filtration and softening plants. W.

(C)—Fabrics

Weaving. Textile Operating Executives of Georgia. *Cotton* (U.S.), 1929, **93**, 1362-1364.

Discussions on faults in weaving are reported. (1) A case is reported in which 56-inch cloth and 28-in. cloth of the same construction were produced on the same type of loom with the wide looms running at lower speeds than the narrow looms. The wide cloth seconds were about twice the narrow cloth seconds. Reasons for differences in the seconds produced on wide and narrow looms and the importance of determining the cause to which the seconds are due are discussed. (2) Causes of drop threads on dobbies include starting the looms with the harness not level, stretching of the cords, improper setting of harness; harness springs stretching and failing to pull harness down, pegs loose in harness pattern chain, fingers in dobby picking up due to too much oil and being out of line and failing to drop at the proper time, too heavy warp counts per inch for the air space in the reed dents per inch, running with the breast beam and whip roll too high, too much difference in the top shed and the bottom shed, having the harness wide open when the shuttle is passing through, and worn dobby hooks. C.

Lustrous Fabrics: Photomicrography. H. vom Hove. *Textilber.*, 1928, **10**, 779-781.

Photomicrographs in transmitted and direct light of a silk crêpe-de-chine, a cotton fabric made from fine, mercerised Egyptian yarn, and a coarse, lustreless cotton fabric before and after calendering are reproduced. The photographs were taken with a metallographic projection apparatus. The pieces of cloth were stretched between two metal rings fixed to a glass plate. In making the photographs by transmitted light a layer of cedar oil was placed above and below the fabric, and a mirror above the whole. C.

Magnifying Glass Spectacles. O. Schürz. *Textilber.*, 1929, **10**, 784-785.

A nickel spectacle frame carries a holder with two spherical prismatic magnifying lenses adjustable for the convergence of the eyes. The device is such that the fabric under examination can be viewed as desired, either with the naked eye or magnified and the observer's hands are both left free for manipulation. The spectacles are made by the firm of Emil Busch A.-G., Rathenau. C.

Scientific Testing and Buying of Textiles. J. G. Williams. *Text. Rec.*, 1929, **47**, No. 559, pp. 33-34.

An essential feature in the testing of merchandise is to secure information concerning the qualities in the merchandise that will help to make sure the customer is satisfied with the service given by her purchase. There are three principal causes of failure of fabrics. The first and most important is defective colour fastness. This probably accounts for at least 70% of the reasonable complaints against merchandise. The fact that a colour is fast to one factor does not mean it is fast to other factors. Colour may be fast to light but fugitive to washing. The second is concerned with shrinkage which is due to the cloth recovery from the stretchings it has received in manufacture. If a fabric is washed and smoothed while still evenly damp, the shrinkage may be very considerably decreased. The third defect is found in fabrics that are too weak to resist the strains of normal use. L.

Faults in Black Dyed Worsteds. *Wool Rec.*, 1929, **36**, 916-917.

The most common fault in black-dyed worsted goods is that of poor fastness to perspiration. Dyeing of Logwood black, using either Fustic of Quercitron Bark, as the yellow component, gives a good "bloomy" full black, but if good fastness to light is required as well as fastness to perspiration, the material should be dyed with a mordant dyestuff of the type Diamond Black F along with Logwood black, approximately equal colour values of each dyestuff being employed. Care must be taken in dyeing or unsatisfactory results are obtained. Poor fastness to rubbing may be caused through imperfect preparation of the material, such as soap or oil being left on the material by the scourer, and imperfect exhaustion of the dyebath before fixing the dyestuff and converting it into a black. The combination of these two faulty treatments is occasionally met in grey materials produced by blending wool black with white wool. If the black dyed wool has been faultily treated it will cause trouble during scouring by some of the black colouring matter being mechanically carried on to the white wool. Such goods have also been spoilt by the use of unsuitable oils, such as nut oil, for spinning purposes applied to the black dyed wool. W.

Testing Laboratories. W. F. Edward. *Amer. Wool and Cotton Rep.*, 1929, **43**, 2968.

The author discusses some of the reasons and suggestions as to the importance of textile tests. Beginning with a reference to the somewhat primitive standards for buying and selling fabrics in China, he points to the need of specifications and tests for textiles in this country. The various kinds of tests for strength and fastness to light and washing are dealt with briefly, and the work of the Society for Testing Materials Committee D-13 described in this connection. Finally, the value of the tests and specifications to the manufacturer and ultimate consumer is pointed out. W.

Testing Knitted Fabrics. W. Davis. *Wool Rec.*, 1929, **36**, 749-751.

Testing standards for knitted fabrics have not been established. The horizontal cloth testing machine used for woven fabrics is unsuitable for testing knitted fabrics, the chief reason being that such a large compass of breaking strains is not required, and the standard type of machine does not register sufficient elongation when tests are taken width-way. Goodbrand's vertical testing machine is described. The above difficulties are to a large extent overcome. Samples of fabric should be at least 4 inches wide to prevent the collapsing effect. Tests are given comparing the breaking strains and elongation of normal knitted fabrics and the woven variety. W.

Removal of Damage Due to Calcium Soap. *Text. Merc.*, 1929, **81**, 297.

Two methods of treating calcium soap spots on woollen material are given—(1) The goods are treated with 2-3% HCl, 0·4-0·6% tetracarnite (for knitting yarns), or 0·4-0·6% oleocarnite (for worsted yarns), for 15 minutes at 30°-40° C., on the hank or the wide washing machine, and then well rinsed. This application is made if it may be assured with fair certainty that the calcium soap deposits ensued in the dyeing or rinsing bath. (2) If the usually light and dark ringed spots are attributed to the fulling, spinning, or washing processes, the goods should be treated in the vat for 45 minutes at the boil in a bath containing 3-4% HCl, 0·5-0·8% tetra- or oleo-carnite. Using method (1) the properties of the goods are not harmed, and the shade of the dyed goods does not alter at the temperature of 30°-40° C. In method (2) the shade may alter a little at the boil, but shading may be effected in the same bath with the known good levelling colours. The total value of the goods improved in this manner is considerably increased. W.

Analysis of Mixture Goods. "Tester." *Hosiery Tr. J.*, 1929, **36**, 104.

Detailed methods are given for the analysis of many mixtures of textile fibre materials, and examples are worked out for cotton wool fabrics, with or without tinsel trimmings. W.

White Woollens. G. White. *Text. Col.*, 1929, **51**, 443).

The loss of whiteness in spots during the hot pressing of some white woollens was traced to the fact that the raw material was made from skin wool which had been subjected to irregular temperature in the sweat box W.

Water and the Textile Industry. *See* Section 5B.

(D)—Other Materials

Hydrosulphometer. R. Feibelmann and W. Meves. *Textilber.*, 1929, **10**, 804-805.

The apparatus enables the reducing value of hydrosulphite preparations such as Candit V, Rongalite, Blankite, Burmol, and Decrolin, whether in powder, paste, or liquid form, to be determined quickly and easily. It consists of a stoppered cylinder graduated, by 5% intervals, from 0-115%, and with a free space below the 0% mark for the reception and solution, if a paste or powder, of the preparation. A standard solution of ferric thiocyanate is added until the blood red colour no longer disappears. If then, for example, the reading on the cylinder is 80%, the reducing power of the preparation is the same as if the preparation contained 80% of pure dry sodium hydrosulphite. Pure, undecomposed Rongalite, on this basis, shows a value of 113% and for Candit V paste the result is generally 36-38%. Control analyses by the indigo method gave results which showed the method to be sufficiently good for technical purposes. For example, a commercial hydrosulphite gave 93% by the indigo method and 90% by the Hydrosulphometer. Commercial Rongalite in 5% solution gave 5·2% and 5·5% and Candit V paste 39% and 37% respectively by the two methods. C.

Interpretation of Testing Results. E. R. Schwarz. *Melliand*, 1929, **1**, No. 7, pp. 1063-1072.

A simplified explanation is given of statistical methods applied to results obtained in textile testing. W.

7—LAUNDERING AND DRY-CLEANING

Patent

Washing Machines. British Launderers' Research Association, R. G. Parker, D. N. Jackman, and R. E. V. Hampson (Hendon, London). E.P.320,102 of 3/7/1928.

The drive to the agitating means of a washing, bleaching, or dyeing machine which is automatically reversed at predetermined intervals is automatically and periodically interrupted at specified times for lengthy periods, so that during such periods articles under treatment lie quietly in the treating fluid. T.

8—BUILDING AND ENGINEERING

(C)—Steam Raising and Power Supply

The Heat Conductivity of Boiler Scale. C. Eberle and C. Holzhauer. *Arch. Wärmewirtsch*, 9, 171; and *Chem. Zbl.*, 1928, **2**, 1248.

Tests were made with synthetic boiler scales to find what alteration took place in heat conductivity with alterations in temperature, density, and composition. Temperature changes had little effect, but density had much, and composition affected density. At lower densities the different kinds of scale (gypsum, carbonate, silicate) showed little difference, but at higher densities the silica compounds were better conductors than gypsum, which was slightly better than lime. As gypsum scale is always formed in a state of high density, it is the least dangerous for boiler work. Silicate scales form at low densities, and then have little conductivity and are most dangerous. The structure and crystallisation of the different scales are discussed. D.

Rational Steam Economy in the Textile Industry. *Bull. Natl. Soc. Wool Mfrs.*, 1929, 59, 608.

A description is given of the advantages accruing from the use of the Ruths storage system or ecomoniser, which has now 400 units built or under construction throughout the world, 90 of which are for the textile industry. By running the boilers at a uniform rate and storing the steam produced at periods when the requirements are least, boilers of smaller peak load capacity can be used, and the costs of steam and hot water production lowered. W.

(D)—Power Transmission

Textile Plant Electrification. C. Carter. *Sci. Abs.*, 1929, **32**, Pt. 9, No. 381 (from *Elec. Rev.*, 1929, **104**, pp. 958-961).

Various aspects of textile mill and factory drives are reviewed, and the advantages of the electric motor are pointed out, especially as regards its constancy of speed, which results in improved output and quality of product. The advantages of individual over group drive are insisted upon with provision for a wide variation of speed to suit starting, finishing, and yarn changes. In weaving sheds individual drive is of as great advantage as in spinning machinery, as it renders the speed of the loom quite independent of the starting and stopping of other looms. As much as 13% increased output has been obtained by converting looms from mechanical to individual electric drive, with improvement of the evenness of the product. In addition to the drive of spinning frames, looms and other machines, electrical methods are used for the separation of fragments of iron from raw material, yarn testing, and warp and weft stop motions; and electric baling presses, cloth cutters, conditioning ovens, hydro-extractors, pumps, cranes, winches, and hoists are other examples of electrically-operated mechanisms now in use in modern textile mills. L.

Short-Centre Drives. B. A. Briggs. *Sci. Abs.*, 1929, **32**, No. 7, p. 392 (from *Power*, 1929, **69**, pp. 302-305)

Discusses the advantages of direct belt drive for speed reduction. Long centre drives are usually preferable, but under suitable conditions a short centre drive can be made satisfactory. The chief difficulty is to get a good grip on the driving pulleys, and it is with these that the paper is concerned. One method of increasing the grip is to use a suitably disposed idle pulley, placed so as to obtain the minimum possible contact arc, as in the figure. In this case the belt should be continuous, and have no metallic fastening, on account of the sharpness of the bend. If such an idle pulley is not permissible, belting having an abnormally high coefficient of friction must be chosen. L.

(E)—Transport

Pneumatic Transportation in the Textile Industry. C. Klinger. *Melliand*, 1929, **1**, No. 6, pp. 898-903.

Pneumatic transportation can be divided into three groups—(1) by compression, (2) by suction, and (3) by suction and compression. In the compressed system the speed of the air for good transportation must be 26-39 feet per second. Next in importance to speed is the diameter of the pipe. A great deal of difficulty is encountered in this system in the feeding of the material and the proper construction of the hopper. The second method is used only in the textile industry, and its main work is the conveying of waste dust and card waste. The compound method is used, particularly in the cotton industry, where the fibres suffer no injury when passing through the fan. This process is simplest, and, from the economic view, the best. W.

(G)—HEATING, VENTILATION, AND HUMIDIFICATION

A Design for a Humidity Slide Rule. G. F. Davidson. *J. Sci. Instr.*, 1929, **6**, No. 10, pp. 318-320.

A slide rule is described by means of which the dew-point, the pressure of water vapour, and the relative humidity may be rapidly and accurately obtained fron the readings of the ventilated wet and dry bulb hygrometer. L.

New Forms of Wet and Dry Bulb Thermometers. A. McAdie. *Science*, 1929, **70**, 172.

A new short-cut method has been devised for the approximate values of relative humidity at places where tables are not available. The method is approved of by the Royal Meteorological Society, and is explained in the article. On the new instruments saturation *weights* as well as pressures can be read. W.

(H)—WATER PURIFICATION

Rayon Factory Water Supplies and Effluents: Treatment. P. W. Uhlmann. *Textilber.*, 1929, **10**, 827-829.

A general article dealing with the purification and softening of water for the rayon industry, and the treatment and disposal of effluents from the different processes of manufacture. C.

Influence of Atmospheric Humidity upon the Moisture Content of Textile Fibres. H. Sommer. *The Melliand*, 1929, **1**, 242.

The amount of moisture contained in the fibre at any given time depends not only on the relative atmospheric humidity, but also on the hygroscopic capacity of the fibre. The latter differs not only for different kinds of fibres, but even for fibres of the same kind but different origin. Other factors, e.g. the presence of waxes or finishing agents, the state of manufacture and time of exposure to the atmosphere, affect the moisture content. Equilibrium with the atmosphere is reached after 4-5 hours, the rate being rather more rapid with wool, viscose, and jute, and rather slow with linen, cotton, and cellulose acetate silk. L.

(I) WASTE DISPOSAL

The Composition of Waste Water from Flax Retting and Experiments on Its Purification by Biological Treatment. A. V. Evlanova. *Trans. Central Comm. for Protection of Water Reservoirs from being Polluted by Ind. Waste Water* (Moscow), 1928, No. 8, p. 29; and *Chem. Abs.*, U.S., 1929, **23**, 3766.

The method of treatment is described in detail. After lime treatment, the water is subjected to the action of anaerobic bacteria belonging to the *Plectridium* type. The water subjected to this treatment, however, is still below the Health Department standards. D.

Waste Waters from Flax Retting. A. I. Rossolimo. *Trans. Central Comm. for Protection of Water Reservoirs from being Polluted by Industrial Waste Water* (Moscow), 1928, No. 8, p. 7, and *Chem. Abs.*, U.S., 1929, **23**, 3766.

The waste waters from flax retting are coagulated with lime, which causes a removal of 50-60% of the dissolved organic matter. The most satisfactory proportions for coagulation are 4·5 gm. of lime per litre and 2·5 gm. of alum per litre. The precipitate can be used as a fertiliser. The wastes are further treated by biological purification and dilution with equal parts of water. D.

PATENTS

Base Exchanging Substances: Adsorbents. F. B. Dehn (London). E.P.313,206 of 9/3/1928.

Base-exchanging substances may be produced by the reaction of sodium aluminate with sodium silicate with the addition of acid, which can be added to the reaction mixture or to the final product any time before complete drying. Sufficient acid should be added to neutralise most or all of the free alkali present, and the reaction mixture should be neutral to phenolphthalein and alkaline to methyl orange. The solution employed should have the consistency of a gel. The porosity of the product renders it useful also as an adsorbent. D.

Base-Exchange Substances. Reymersholms Gamba Industrie Aktiebolag. E.P. 313,522 of 11/6/1929.

Hydrated base-exchanging substances can be prepared by boiling under pressure the residue of "waste clay," consisting of silicic acid and iron and aluminium oxides with oxides, hydroxides, or carbonates of the alkali or alkaline earth metals. "Waste clay" is obtained when natural silicates, such as kaolin, bauxite, or refractory clays are decomposed with acid. If lime is used as the alkaline agent, hard products are obtained. Prior to use, the product may be washed with a solution of common salt until free from lime. D.

9—PURE SCIENCE

***Aspergillus Niger:* Effect of Zinc and Manganese Salts on Growth.** A. Niethammer. *Bot. Centr.*, 1929, **15**, 170 (from *Beitr. Biol. Pflanzen*, 1929, **17**, 51-71).

By inoculation from very old cultures the growth of new cultures is very slow and incomplete. In such cases metal compounds exert a favourable influence, perhaps owing to the lack of natural activators, which may be replaced by metal compounds. When zinc is used much smaller amounts are necessary than in the case of other nutritive substances. Zinc thus occupies a special position in the metabolism of the mould. The crop weight is considerably increased by additions of zinc. The duration of the test and the concentration of the usual nutritive substances are important factors. The action of the zinc is greatest when optimum concentrations of all the usual nutritive substances are used. Manganese compounds increase the growth, their influence being dependent on the time and on the concentrations of other nutritive substances. The addition of manganese produces a greater sugar consumption than that corresponding to the increase in the crop. There is here possibly an increase in the intensity of respiration. C.

***Aspergillus Niger;* Degradation of Fatty Acids by——.** H. B. Stent, V. Subramaniam, and T. K. Walker. *J. Chem. Soc.*, 1929, 1987-1993.

Small yields of succinic acid were obtained from cultures of *Aspergillus niger* on calcium *n*-butyrate. This product may arise either (i) by oxidation of the butyric acid at the γ-carbon atom, or (ii) by oxidation at the β-carbon atom with ultimate formation of acetic acid, followed by dehydrogenation of the latter according to the Thunberg-Wieland hypothesis. The mould grew rapidly when introduced into a solution of succinic acid half neutralised with calcium carbonate, but no products of degradation could be detected. Malic acid, consisting of a mixture of the *d.l.*- and *l.*-forms, was isolated from cultures on the normal calcium salt. *l.*-Malic acid is not racemised by the treatment adopted for the extraction of the malic acid from the culture and no evidence of racemisation of either the *d.*- or *l.*-acid under enzymic influence was found. Consequently, it is to be inferred that the *d.l.*-malic acid owed its formation to the direct hydroxylation of succinic acid, a process which presumably could be effected by an aerobic oxydase system. When the mould was cultivated on the racemic acid the media developed dextrorotatory properties and in two cases the formation of fumaric acid was noted. It would appear probable that, whilst the development of dextrorotatory properties in cultures of *Aspergillus niger* on solutions of *d.l.*-malic acid was due partly to the conversion of a portion of the *l.*-isomeride to fumaric acid, it was occasioned also by the preferential utilisation of this isomeride for protoplasmic synthesis. Hence it follows that the *l.*-malic acid, which was produced when the mould was grown on calcium succinate media, must have arisen through preliminary conversion of the substrate to fumaric acid. C.

***Penicillium;* Production of Anti-bacterial Substance by——.** A. Fleming. *Brit. J. Exp. Path.*, 1929, **10**, 226.

A species of *Penicillium*, allied to *Pen. rubrum*, when grown on broth produces an anti-bacterial substance to which the name "*Penicillin*" is given. The preparation can be filtered and even boiled for several minutes without loss of activity. By evaporation at low temperatures and extraction with absolute alcohol, it may be obtained in a more concentrated form. "Penicillin" inhibits the growth of pyogenic cocci and the diphtheria group of bacteria. The coli-typhoid and influenza groups are unaffected, and its selective action is of use in the isolation of such types. It is non-toxic and non-irritant to animals, and is suggested for use as an injection or for external application. C.

Wheat Flour: Sulphur and Chlorine Contents. B. Sullivan and M. Howe. *Cereal Chem.*, 1929, 6, 396-400.

Determinations of sulphur and chlorine in a wheat and products milled from it, and also in bread baked from the patent flour, are described, and the results are tabulated. The higher the protein content of the samples analysed the higher was the sulphur content. Sulphur is combined organically as a component of cystine. Comparisons of the results with determinations of sulphur and chlorine in the ash of the products showed that sulphur and chlorine were almost completely lost upon ignition of the samples at 590°-600° C. C.

Starch: Composition and Zymolysis. F. Polak and A. Tychowski. *Biochem. Z.*, 1929, **214**, 216-228

Investigations of the action of α- and β-diastases on starch show that starch consists of two different substances, amylopectin and amylose. The first is split into reducing limiting-dextrin I by β-diastase. α-Diastase splits amylose to maltose, and β-diastase gives limiting-dextrin II by its action on amylose. Hence it is concluded that amylopectin is built up from reducing limiting-dextrin I, which contains six maltose units. Amylose is built up from limiting-dextrin II (molecular weight three times that of maltose). β-Diastase breaks the bindings between these units, and α-diastase breaks all the bindings between the individual maltose molecules. The relation of these results to methods of preparing amylose, the influence of alcohol and drying processes on amylose, the fractionation of starch, and the testing of amylose and amylopectin products are studied. C.

Starch: Estimation by Iodine Method. E. Lepik. *Chem. Abs.*, 1929, **23**, 4166 (from *Mitt. Lebensm. Hyg.*, 1929, **20**, 79-88).

The size of the starch particles in the disperse stage depends upon the warming temperature, the time of heating, and the pressure. The precipitation of the starch-iodide is greater when the particles are small. At higher temperatures this precipitation is accelerated if the starch is pure. Impurities hinder the reaction. A pressure over 3 atm. has an inhibitory effect. Certain growths, such as that of *Phytophthora infestans*, in potato tubers, will lessen the precipitation. It has been found best to use iodine in calcium iodide solution as the precipitant. C.

Sodium Hypochlorite Solution: Decomposition in Hot Weather. R. Poigat. *TIBA*, 1929, 7, 1135.

Variations with the time of delivery in the hypochlorite titre of Eau de Javel, guaranteed at 47°-50°, are shown graphically for the period of a year. In the hot months of June, July, and August the hypochlorite value fell below 40°, reaching a minimum of 34·5°. For September and October the figures lay between 40° and 45°. From November to May transport scarcely affected the hypochlorite value. In the June to August period storing caused a further decrease in hypochlorite amounting to about 1° reduction in 8 to 10 days. In September-October the rate of decrease was 1° in 12-15 days. C.

***Aspergillus Niger* Diastase: Reaction Velocity.** Elizabeth Luippold. *Chem. Abs.*, 1929, **23**; 3728 (from *Jahrb. wiss. Botan.*, 1929, **70**, 26-54).

The reaction velocity for the digestion of starch by diastase was determined at 15° and 35° The temperature quotient for this reaction was not altered, providing the nutrients and the *p*H of the medium were the same at both temperatures. When, however, either the *p*H or the nutrients was altered, the value of the temperature quotient was changed. Since the *p*H of the medium was altered by a change in temperatures, it follows that temperature exerts an indirect but not a direct influence on the temperature quotient. The maximum value for the quotient (5·1) was obtained at *p*H 5·2-5·4 in solutions containing carbohydrates as a source of carbon. C.

Flour-water Suspensions: Plasticity. J. L. St. John. *Cereal Chem.*, 1929, 6, 400-410.

A method of measuring the plasticity of flour-water suspensions, using the capillary tube plastometer previously described, is studied. Measurements expressed in terms of mobility, show that results may be closely duplicated. The mobility may be determined from the measurements either graphically or by calculation. The results of tests of ten different flours are recorded. An increase of mobility was evident on standing. Mobility varied with the concentration of the suspension, but only varied slightly with the pressures used. The results do not show any change in mobility due to ageing of the flours. Eight of the flours used showed an increase in plasticity from flour to flour as the load volume increased. The yield values for all the flours were practically the same. C.

Toxic Vapours: Adsorption by Fibres. E. V. Alexseevskii. *Chem. Abs.*, 1929, **23**, 4346 (from *Zhur. Prikladnoi Khim.*, 1928, **1**, 184-189).

Chloropicrin is best adsorbed by dyed new wool and dyed used silk, while linen is the poorest adsorbent. It does not affect the fibre strength. Arsenic chloride is best adsorbed by wool, hairs, and rubber. Paper is the poorest adsorbent, but disintegrates quickly, while the strength of wool fibres is not affected. Most of the adsorbents darken on exposure because of deposition of arsenic. Methyl sulphate is slowly adsorbed by wool and quickly by cotton, but cotton and silk retain it tenaciously while wool loses it quickly through ventilation. It does not affect the fibre strength. Benzyl chloride is adsorbed more quickly by animal than by vegetable fibres. Its adsorption is increased by moisture. Ventilation is not effective for its renewal. Bromoacetone is better adsorbed by animal than by vegetable fibres. Moisture also favours its adsorption. Strength and colour of fabrics are affected to a considerable extent. C.

Microbalance. J. W. McBain and H. G. Tanner. *Proc. Roy. Soc.*, A, 1929, **125**, 579-586.

Details of construction are given of a robust and compact balance which is sensitive to 4×10^{-9} g. Its essential features are the use of carborundum crystal points for the points of support, and the magnetic control arrangement. The carborundum points are attached to the fused quartz balance beam by means of fused pyrex. The magnetic arrangement consists of a short piece of soft iron wire sealed in a tube of fused quartz and attached vertically to the centre of the beam. A horizontal disc-shaped coil of wire is placed above and a little to one side of this vertical pin. When an alternating current (60 cycles) is passed through the coil, the iron pin on the beam is inclined towards the centre of the coil, and this inclination is proportional to the current flowing through the coil. When a weight causes the pin to be inclined away from the coil, adjustment of the current in the coil can bring the pin back to its former position. C.

Textile Micrometric Apparatus. E. R. Schwarz. *Text. World*, 1929, **76**, 2430-2434 and 2445.

An account is given of the methods and equipment needed for carrying out micrometric examinations of textiles. Stage micrometers, eyepiece micrometer discs, filar micrometers, and protractor eyepieces are described. Projection methods and the use of the *camera lucida* are discussed and methods of measuring angles and areas, the counting of objects, the calibration of scales, and the use of special scales and accessories are described. C.

Parallel Reactions of Starch and Cellulose. P. Wengraf. *Textilber.*, 1929, **10**, No. 10, p. 805.

In a short article dealing with the behaviour of starch when subjected to a number of treatments which are very important in the case of cellulose, the author suggests that it is desirable to investigate further the possible uses of "starch viscose" in the textile industry. Reference is also made to acetyl starch, nitro starch, and "formalin-starch." It is suggested that the action of cuprammonium solution on starch has not been carefully studied. L.

The Rates of Saponification of Various Commercial Oils, Fats, and Waxes and Pure Tri-Glycerides by Aqueous Alkali. J. W. McBain, C. W. Humphreys, and Y. Kawakami. *J. Chem. Soc.*, 1929, pp. 2185-2197.

Summary—(1) The rates of saponification by aqueous alkali of 25 oils and tri-glycerides have been studied under strictly comparable conditions at 90°, the reaction being followed by means of the hydrogen electrode. (2) The rates differ for different oils by as much as 200-fold. The results are explained as being due to the various degrees of emulsification of the different oils, some being wholly and others only partially emulsified. (3) The results are directly applicable to all such related processes as fat-splitting, hydrolysis, and "fermentation." (4) The emulsifying power of the soaps is wholly unrelated to the case of emulsification of the corresponding oils; nor is there any relation between molecular weight and rate of saponification. In general, the time required for saponification increases with degree of unsaturation. L.

The Mildew Problem in the Cotton Industry. G. Smith. *Text. Merc.*, 1929, **81**, No. 2122, p. 452, and No. 2123, p. 472.

Mildew is caused by the growth of microscopic living organisms which in many ways are very similar to plants. The moulds which attack cotton are closely akin to the microscopic organisms which cause rusts, smuts, mildews, wilts, etc. The initial development of a mould consists of mycelium which is a network of exceedingly fine filaments. If conditions are favourable this spreads rapidly and throws out the special filaments which bear the reproductive organs. The fruit bodies are known as spores which germinate and produce a mass of growth. The spores are very often coloured, and they usually give to a mildew growth its characteristic colour and appearance. The mycelium, on the other hand, is frequently colourless, and it is quite easy to have extensive mildew infection of cotton cloth without there being anything at all visible to the naked eye. The main points which must be taken into consideration in attempting to prevent mildew in cotton goods are—(1) Both cotton itself and various sizing and finishing materials are excellent foods for various mould species. (2) Mildew cannot develop except in presence of moisture, but the amount of water required by many common species is extraordinarily small, provided other conditions are favourable. (3) Mould spores occur everywhere, and are ready to germinate as soon as they reach a suitable environment. The author believes that the final elimination of loss by mildew will have to come through more factory conditions to ensure that no cloth is packed containing sufficient moisture to cause the development of very humid conditions inside the bale. If the practice of storing the cloth to the last possible moment in a warm and airy room were adopted, the amount of damage would be very much decreased. L.

Predominating Influence of Moisture and Electrolytic Material upon Textiles as Insulators. R. R. Williams and E. J. Murphy. *Sci. Abs.*, 1929, **32**, No. 8, p. 447 (from *Bell System Tech. J.*, 1929, 8, pp. 225-242).

The insulating qualities of textiles vary with the amount of moisture present in them from hour to hour, and are also strongly influenced by the amount of electrolytic material (salts, etc.) which the textiles contain. Electrolytic material may be washed out, producing a commercially realisable increase in insulation resistance of the order of 50 times the original value. The resistance of the animal fibres, silk and wool, is far greater for a given moisture content than that of cotton or of cellulose acetate, a derivative of cotton. It appears probable that the distribution of water as well as the quantity is important, and that the two classes of fibres are characterised by different space patterns according to which the water is distributed. It is suggested that the space distribution patterns are associated with the colloidal structures of the materials, and in turn with their chemical classification as proteins and celluloses respectively. Cellulose acetate absorbs little water as compared with cotton, and is correspondingly superior electrically. However, its resistance varies with the moisture content in the same way as that of cotton. L.

The Problem of Aerobic Cellulose Decomposition in High Concentrations of Salt. L. Rubentschik. *Cbl. für Bakt., Parasitenk, und Infektionskrankh.*, Abt. II, 1928, 76, 305.

The author gives the results of investigations of the process of aerobic cellulose decomposition in sludges from the Kujalnizki-Liman, which were observed in the van Iterson medium with varying concentrations of salt. The decomposing action was observed on strips of filter paper in flasks. The first tests were made with sludge from the southern part of the Kujalnizki-Liman, and it appeared that the process was halo-tolerant while samples from other parts were definitely halophilo. This is explained by the amount of soil which reaches the southern part in the spring, containing bacteria which do not completely lose their original characteristics, and are more energetic in low salt concentrations. In all tests the decomposition was definitely aerophile. Certain of the bacteria were isolated and examined, and are fully described, but those which caused the halophile character of the decomposition in sludges from the north-east parts have not yet been isolated. A number of references to the literature, including work on the chemical side of the problem, are given. D.

Glasses Transparent to Ultra-Violet Radiation. *Nature*, 1929, **124**, 441-442.

Investigation has been carried out upon the transparency of various ultra-violet transmitting glasses under different conditions. The mercury arc produces a greater loss of U.V. transmission "solarisation" in these glasses than does sunlight. This is considered an unfair test, since arc-solarised glass actually increases in transmission, when placed in sunlight, to the value given by glass solarised directly by sunlight. W.

10—ECONOMICS

Italian Rayon Industry: Distribution and Production. *Rayon Record*, 1929, **3**, 460-461.

A table is given showing the production capacity of the various Italian factories. The distribution of the factories, and also that of the Italian rayon manufacturing industries, are indicated on a map. C.

Industries and Fashions. *Text. Amer.*, 1929, **52**, No. 4, p. 19.

Since important changes occur in fashions, expecially in women's wear, from time to time at almost stated periods, the writer considers it a lack of foresight on the part of the allied textile industries that the dictation of such vital changes should be allowed to be controlled by Parisian designers, whose interest in the textile industries is nothing. Scientific experimentation in producing synthetic fibres and fabrics was known to be going on, but nothing was done until Rayon actually became a worthy competition of the older fibres. If the allied textile industries would assume to plan the fashions for the next decade, providing for logical and natural changes through research, the mills would be busy indefinitely. L.

The Russian Textile Industries—Prospects for British Textile Machinery Makers. F. Utley. *Brit. Russian Gazette and Trade Outlook*, 1929, **6**, No. 2, p. 29.

Up to 1925-26 the U.S.S.R. was purchasing the greater part of her textile machinery imports from Lancashire, which in that year supplied orders amounting to 14 million roubles. Germany then only supplied some half a million roubles' worth, but in 1926-27 Germany supplied orders for 6·3 million roubles as against our six million, the U.S.A. being the source of most of the remainder of the orders. Since then large orders have again been placed in this country, and it would appear probable now that relations are to be resumed that British textile machinery manufacturers will be able to regain some of the trade lost to Germany and the U.S.A. The five years' plan of industrial development in Russia provides for a large expansion of productive capacity in the textile industry, the estimated capital investment between 1928-29 and 1932-33 amounting to 1,235·6 million roubles. This is to be divided up as follows amongst the various branches of the industry—

	In Millions of Roubles.
Cotton	901·6
Woollen	211·1
Flax	158·6
Hemp and jute	31·9
Felt	11·3
Silk	11·1

Of the total, 1,325·6 million roubles, above 41·3%, is to go for reconstruction of old factories, and 46·5% for new erections. The principal expansion is evidently to be in the cotton industry; in all there are to be 26 new spinning and 24 new weaving mills, with a total of 1·7 million spindles and 62,000 looms. L.

Linens in Canada. Dept. of Trade and Commerce, Ottawa. *Belfast Ch. of Comm. J.*, 1929, **7**, No. 7, p. 23.

The condensed preliminary report on the trade of Canada, 1929, just issued by the Department of Trade and Commerce, Ottawa, gives the following figures of interest to the linen industry—

Imports from the United Kingdom.

		1928	1929
Linen thread for sewing	lb.	248,742 ...	244,878
	dollars	325,935 ...	311,534
Fabrics, flax, not bleached	yards	3,326,228 ...	2,176,796
	dollars	484,652 ...	366,005
Fabrics, flax, printed, dyed, or coloured	yards	380,316 ...	3,091,048
	dollars	120,125 ...	575,529
Fabrics, flax, bleached or mercerised	yards	475,371 ...	523,244
	dollars	152,358 ...	140,532
Handkerchiefs	,,	449,307 ...	531,192
Sheets, pillowcases, etc.	,,	193,031 ...	213,058
Tablecloths, napkins	,,	1,115,950 ...	835,313
Towels	,,	439,520 ...	212,882

The total imports of flax, hemp, and jute manufactures for 1929 were valued at 15,854,434 dollars, of which 7,153,973 dollars were imports from the United Kingdom. L.

Structural Alterations in the Textile Industry. A. Niemeyer. *Text. Rec.*, 1929, **47**, No. 561, p. 30.

Structural alterations are among those important outside influences which finally determine the extension and development of trade in general. There are in the first place the important international economic structural alterations which have so greatly influenced textile trade during the last 15 years. In the case of the supply of raw materials, there is the question of the flax crisis, which will compel Central and West European consumers to develop this raw material. Some notable changes have been introduced by rationalisation, and a further variety of structural alterations takes place when a previously flourishing branch of industry is compelled to change over to new methods of production owing to continual marketing difficulties or adverse fashion phenomena. A further aspect of the subject is that connected with the growing popularity of other fibre-stuffs. Rayon is now used in the place of cotton, linen, and silk, or it is combined with them to produce a new textile article. The industries which have been built on a definite raw material are now tending more or less to become mixture industries. Examples accumulate on every hand to show how the new chemical product, rayon, is making breaches in the old industries calling for entirely new methods of production or making mechanical alterations necessary in the old producing branches. There is in this case a genuine structural alteration under which the pure cotton and linen industries have already suffered considerably, whilst the silk industry has made a virtue of necessity of taking up the production of this article so similar in many respects to its own product. L.

Rationalisation and Standard Costing. *The Accountant*, 1929, **81**, No. 2853, p. 183.

One of the resultants of rationalisation will be the comparing of efficiencies as between the various plants with a view to concentrating production in the one considered to be the most economical, and in all probability the basis of such comparisons will be the relative costs of production. It is very important to know what each side means when it speaks of its cost, so that in all their varied details they may be truly comparable. In other words a standard method of costing should be adopted. A second aspect of this question of standardising is the development of the idea of publishing accounts and costs relative to particular industries, much more of which is done in the United States than in this country. With a common basis much useful information could be secured which not only would assist the management of firms in the various industries, provide the Government with reliable information, but would act as a guide to the investor in his financial dealings. L.

Flax. *Belfast Ch. of Comm. J.*, 1929, 7, No. 7, p. 19. (from *Deutsche Leinen Industrielle*).

According to figures recently published in *Der. Deutsche Leinen Industrielle*, the acreage under flax in Middle and Western Europe was as follows—Germany, 13,200 hectares; Czechoslovakia, 20,100; Holland, 19,200; Belgium, 27,300; France, 33,700; and Northern Ireland, 13,700. L.

Flax. *Internat. Rev. of Agric.*, Pt. III—Monthly Crop Rep. and Agric. Statistics, 1929, **20**, No. 11, pp. 470-472.

Northern Ireland communicates that the quality of fibre is good, and yields are above the average in quantity. In the U.S.S.R. dry weather during autumn delayed the processing of flax with very considerable effects on the purchases by State and co-operative associations, which in the period October 1-24 reached only about 15% of the quantity anticipated in the Government programme. The price situation on the principal markets during the latter half of October and the first ten days of November remained calm, with a tendency to a final slight fall in prices. The quotations for the quality "Riga Z.K." on the London market, in fact, fell from £63 per long ton on 18th October to £62 on 25th October, and to £60 on 8th November. They are notably lower than last year; in the first ten days of November 1928, prices fluctuated between £87 and £85 per ton. The tendency to fall is largely attributed to the considerable quantities of Russian fibre sold recently, and in general to the political economy of the Government of the U.S.S.R., which has the intention to increase its exports. L.

Latvian Flax. Latvia Consulate-General, London, Bulletin No. 12 (from *Belfast Ch. of Comm. J.*, 1929, 7, No. 8, p. 17).

This bulletin states that the area under flax was as follows, in 1,000 hectares (2,500 acres)—1909-13, 69·6; 1920-25, 49·6; 1926, 63·8; 1927, 63·2; 1928, 68·7; and 1929, 55·8. L.

11—INDUSTRIAL WELFARE, INDUSTRIAL PSYCHOLOGY, AND EDUCATION

Methods of Research in Industrial Relations. G. H. Miles. *J. Nat. Inst. Ind. Psychol.*, 1929, 4, No. 7, pp. 373-378.

The difficulty of evaluating the relative importance of material and mental factors in industrial relations is emphasised. The formation of group attitudes is instanced as a mental factor too often neglected, and research methods capable of taking such elements into account are outlined. L.

Colour Vision. J. N. Morris. *J. Soc. Dyers and Col.*, 1929, 45, No. 12, pp. 349-350.

The author suggests that any employer who doubts that imperfect colour perception on the part of his employees affects the quality and quantity of work they perform, should make a test examination of a small section of them. For this the Holmgreen Colour Test is suitable. The test employs skeins of coloured wool, and may be obtained from Messrs. Raphall's Ltd., Hatton Garden, E.C.1. L.

Studies on the Disinfection of Anthrax-Infected Hides. II—The Sodium Sulphide Method. G. Brotzu. *Chem. Abs.*, 1929, **23**, 4364 (from *Boll. Soc. Ital. Biol. Sper.*, 1929, **4**, 154-156; cf. *Chem. Abs.*, 1928, **22**, 2289).

Normal solutions of various inorganic salts were added to equal parts of N.NaOH and Na_2S, and the mixture was tested for germicidal activity on anthrax-infected hides and on filter-paper saturated with a strain of anthrax of medium resistance. K_3AsO_3 was the most effective in strengthening the germicidal power of NaOH and Na_2S. Anthrax-infected hides were completely freed of spores when treated by this mixture. The results with filter-paper were irregular. W.

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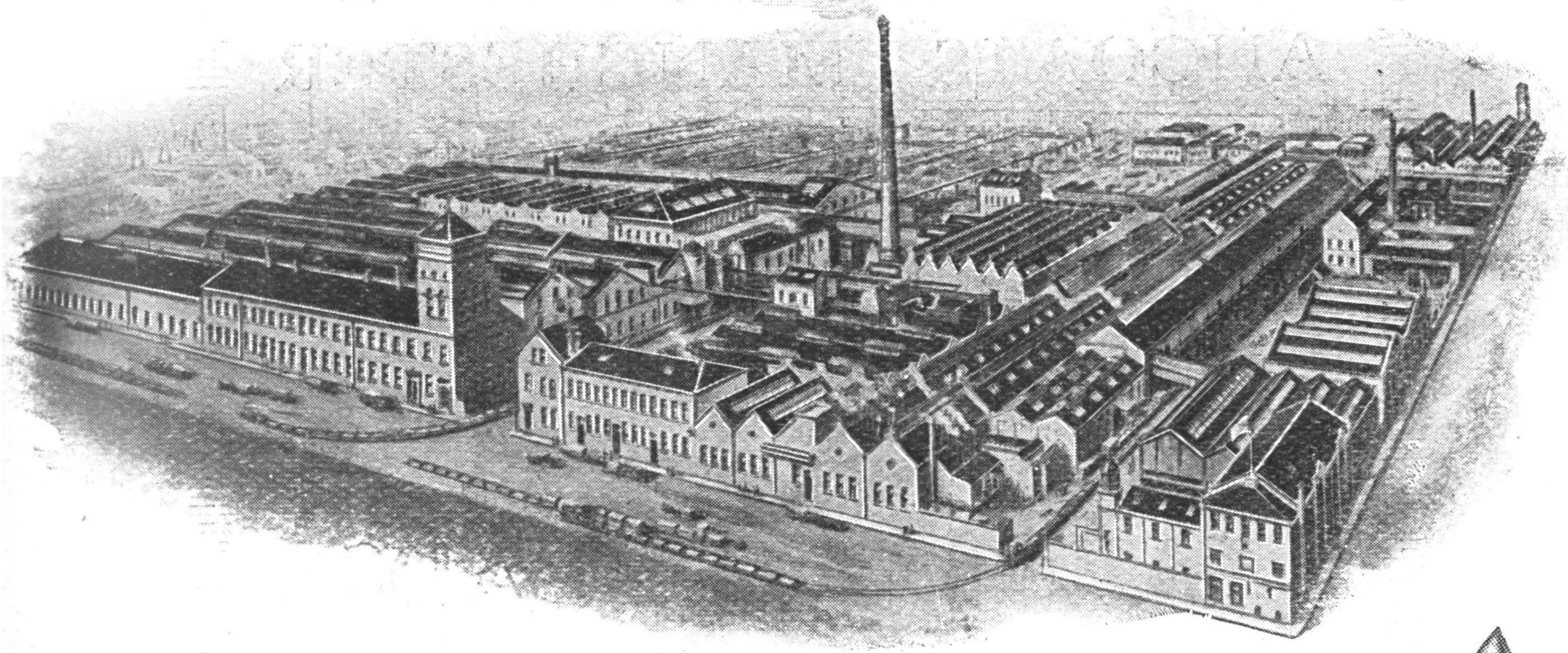

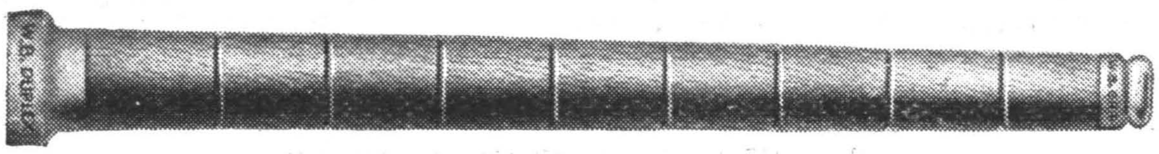

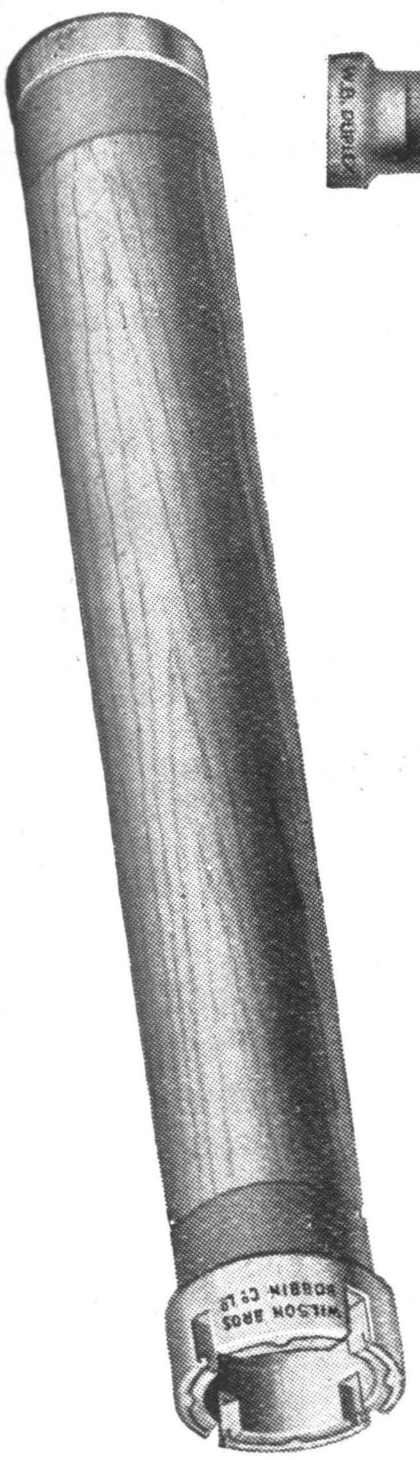

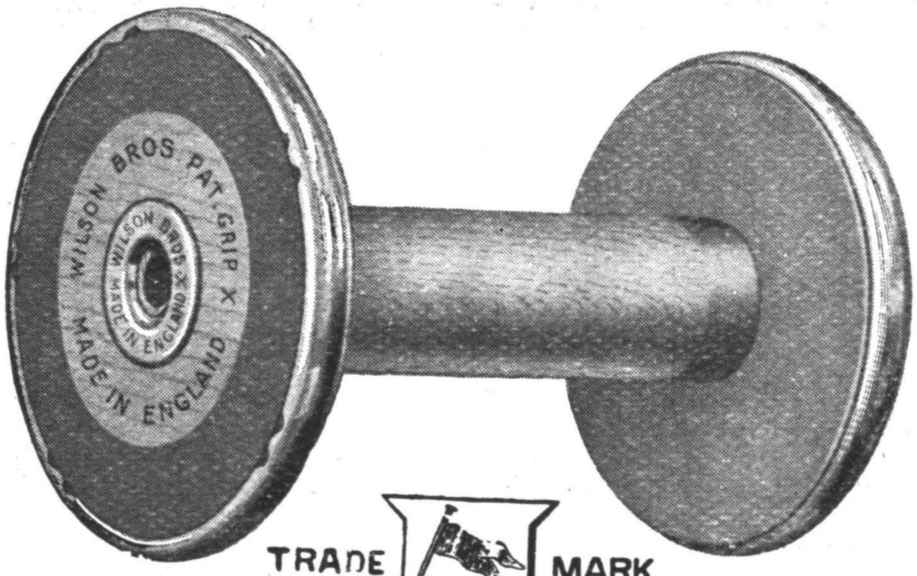

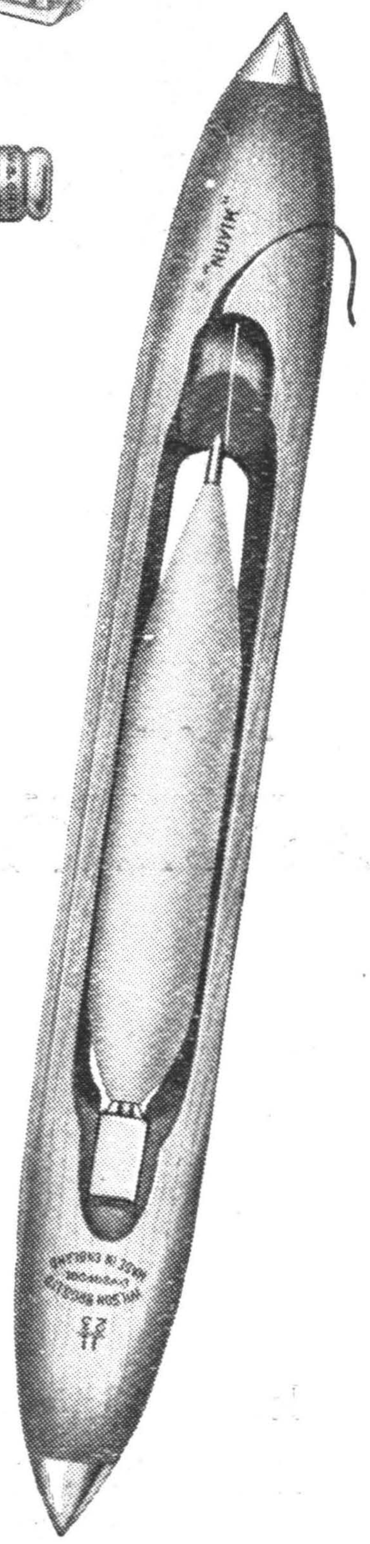

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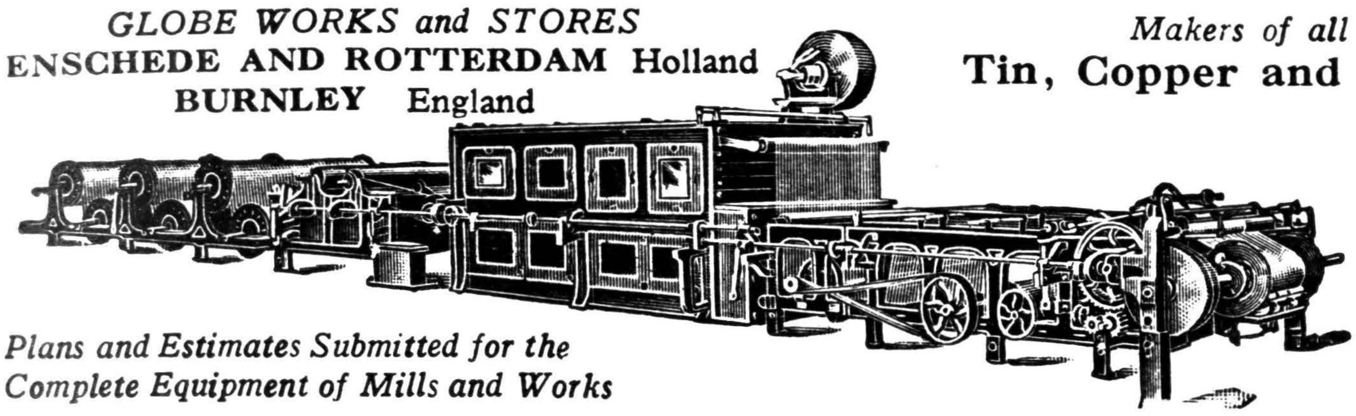

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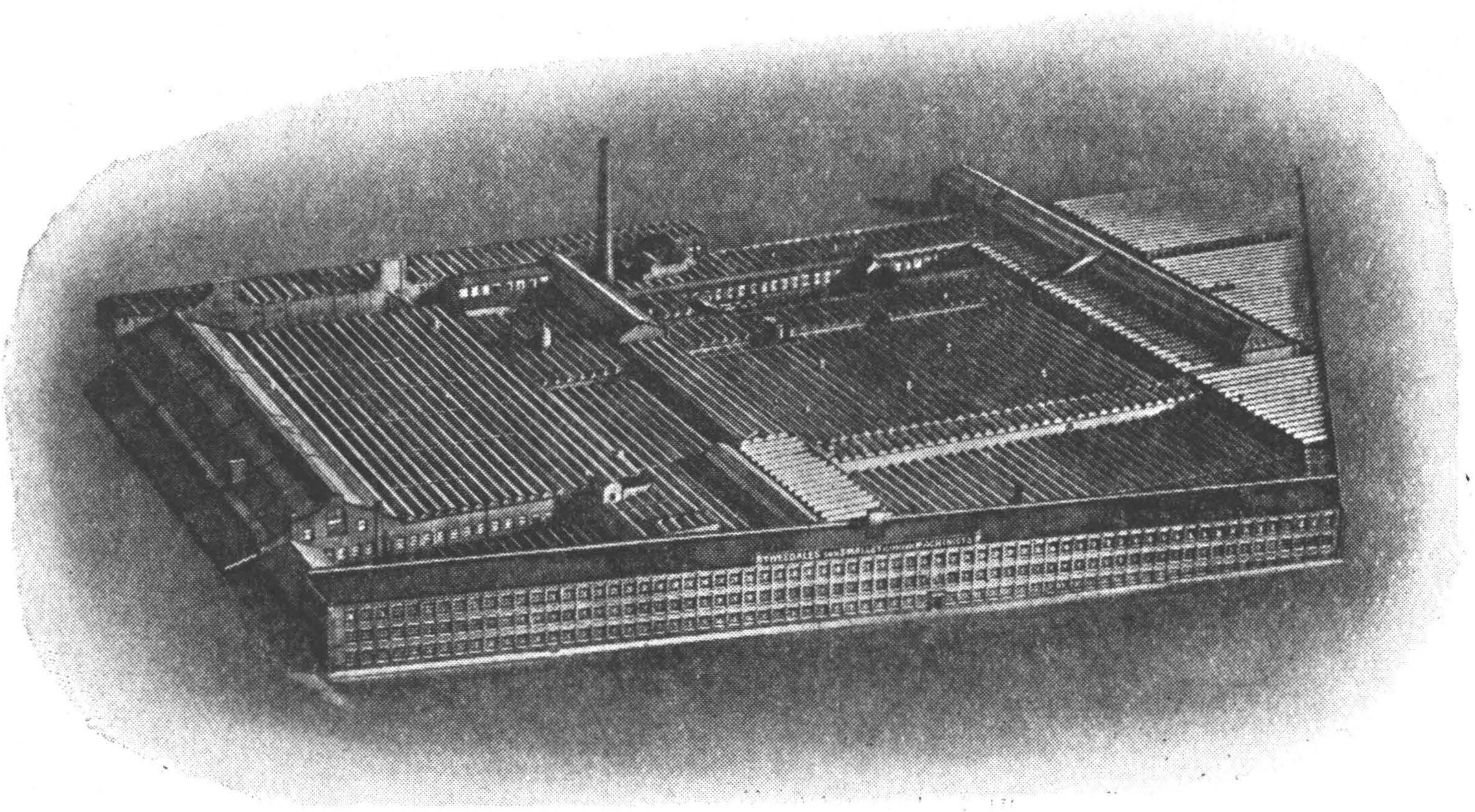

GENERAL VIEW OF WORKS

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