THE WEAVING OF SINGLE WARPS: BOTANY AND CROSSBRED.

By Professor ALDRED F. BARKER, M.Sc.

THE second Paper on the Friday was delivered by Professor A. F. Barker, of the Textile Department of the University of Leeds, on the above subject. The paper, which was illustrated by means of lantern slides, is presented as follows :—

We have had at least three notable stock-takings of our efficiency so far as the Textile Industries are concerned—in 1851, during 1904-6, and from 1912 to 1914. On stock-taking after the Great Exhibition of 1851, it was agreed that in spinning and manufacturing the finer wool textures, we were markedly behind France.

In 1904, Continental competition was so acute that the Bradford Chamber of Commerce appointed a Special Committee to investigate the difficulties Yorkshire manufacturers were experiencing. The chief fabrics then coming under review were Amazons, Voiles and Crêpe de Chines.

Latterly, from 1913 to the declaration of War, our markets were captured by certain twill fabrics—mostly single crossbred warps—which not only France, but more particularly Germany had placed on our home markets.

I had the privilege of sitting on the Bradford Chamber of Commerce Committee of 1904, and therefore have had at least ten years' experience of Continental fabrics. These circumstances resulted in my delivering a lecture in Bradford last Autumn which evoked much interest and which has possibly helped Bradford to go further in the matter. Further than this, I have put the ten years' experiences referred to into a series of articles appearing in the *Textile Mercury* with the idea of carefully discussing the many important points in manufacturing the various fabrics in which our Continental rivals excelled us. Amazons formed nine-tenths of the imports in 1905; in 1913-14 twills and serges formed nine-tenths; but it is by no means certain that on the declaration of Peace, either of these styles will so dominate. It is, therefore, obviously desirable that a broad review such as I have attempted, should be made the basis of our study of Continental, and particularly German, competition.

But I have another object—a main object—in view in lecturing this morning on the special subject chosen. Although the results of the experiments about to be discussed may have a far-reaching effect upon the weaving of single warps, I more particularly wished to offer them as an example of a typical University Research—of research such as should be multiplied ten-fold if we are to maintain our industrial supremacy against German aggressiveness. We may thankfully accept such classic fabrics as Damasks from Damascus, and Gauze from Gaza; we may even accept Orleans or plain lustre fabrics from our friends across the Channel. But what can we say of a manufacturing community which was so ignorant of the work of its own countryman,

John Mercer, that the French were able for months, if not years, to ship mercerised goods before we were able to discover the method of production ?

In view of the blindness of many of us to our own shortcomings, I must again emphasise the fact that Germany has made and is making goods upon which we cannot improve. There is not the slightest reason why Germany should not make as good fabrics as we can make. It is perhaps some consolation to realise that the historical development of the Textile Industries would lead us to expect both France and Germany to be our masters in Cloth Construction. That they are not so in every variety of fabric is simply attributable to our control of industry during the early days of the evolution of the power loom. During this period, we played our part well. Are we going to play up as well in the near future ?

Before strictly limiting my remarks to the subject in hand, I would refer briefly to the two allied subjects of Finishing and Sizing. Certain difficulties in Finishing have already formed the subject of research at Leeds University, and I can say without hesitation that, given the right fabric—say Nun's Veiling or Amazon—we can equal any German or French finish. Notwithstanding this, I would also add that no subject so much as Finishing apparently offers such a fruitful field for investigation on truly scientific lines.

With reference to Sizing, I could wish that the exhaustive experiments carried out by Monsieur Masurel, of Roubaix, were published. Fortunately, the results of these experiments, in the shape of a sizing machine, are available. So far as sizing for the particular style of weaving I am about to discuss is concerned, I would only suggest that more of the binding, plastic agent should be used, and that not only should the yarn go into the loom beam the same way that it went on to the spinning bobbin, but a stroking or brushing of the fibres in Crossbred warps should be tried, the warp being reversed on to the loom beam after the stroking or brushing.

Passing on to Tappet Shedding, I ask : Why have the possibilities of Centre, and Top or Bottom Tappet Shedding motions been overlooked ? It really seems another case of Columbus and the egg. We have all stood round having no idea of the solution of the difficulty. As soon as the idea came to me, I began to discover that we had all sorts of wrong ideas about centre-shedding.

Put briefly, in contrasting Open and Centre-shedding I find that the look of a centre-shed tappet belies its action ; that there is no evidence that slower speed is essential ; that there is no more friction of thread on thread and very little more on heald-band ; that the healds are worn less, not more ; that readings on the Wattmeter showed less, not more power consumed ; that markedly less warp tension is necessary for the same wefting capacity ; that a much cleaner shed is formed in Crossbred weaving ; that ends may be much more readily taken up ; and, from the Tachograph records, that the running is at least as steady as in open-shed tappet weaving.

We have been blinded by our own tradition respecting the open-shed tappet, although most of us have been aware that the centre-shed dobby was a first favourite on the Continent.

In order that these points may be fully appreciated it is desirable to consider the reasons for the employment of a centre-shed tappet and then very carefully its construction.

In Fig. 1 the shedding action of open and centre-shedding tappets are illustrated. In $a\,a^1$ equal lifts above and below the centre line from back-rest to front-rest are illustrated, the tensions on the threads

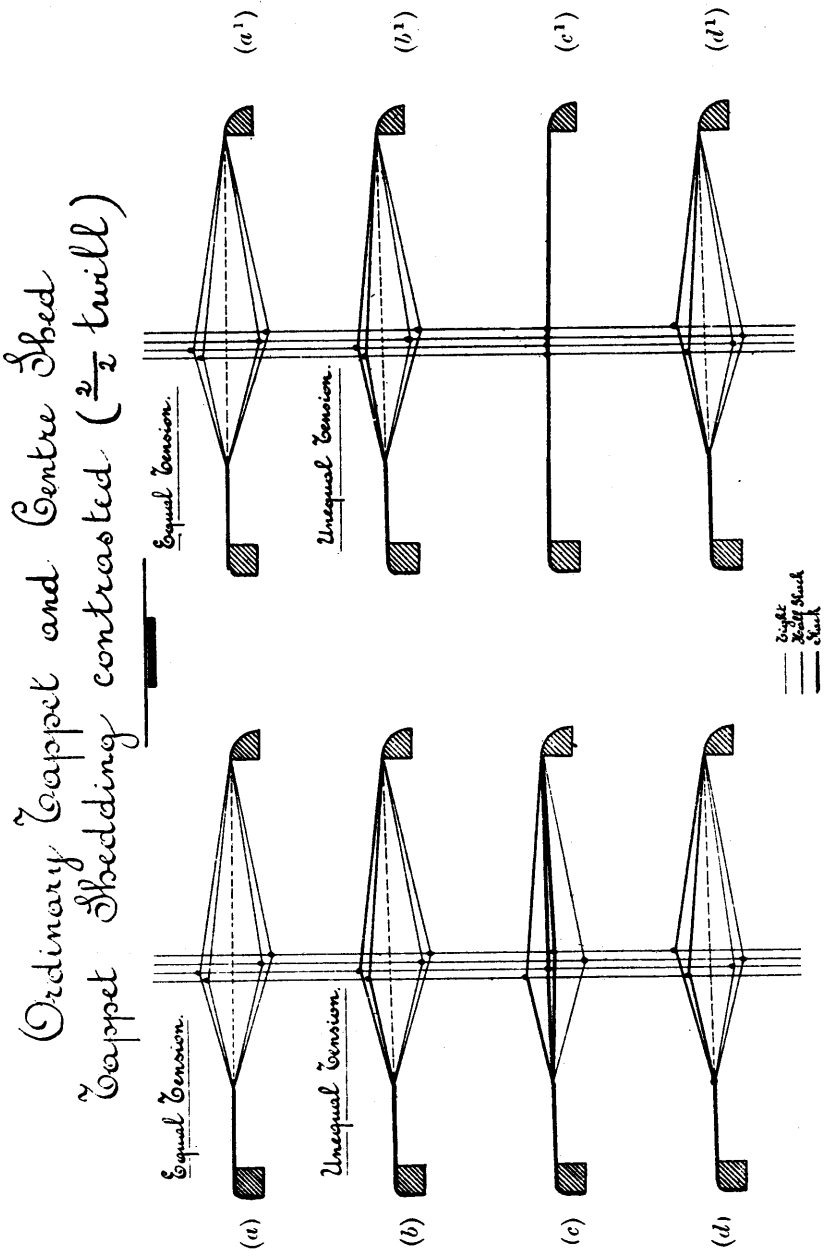


Fig. 1.

at the open shed being equal. In $b\,b^1$ the effects of raising the back-rest are illustrated, in each case most tension being thrown upon the depressed series of threads. At $c\,c^1$ the change of shed in each case is

illustrated. In *c* it will be noticed that, as at this position the reed is beating up the pick, *practically all the wefting strain is taken by ¼ of the warp*, whereas in c^1 the wefting strain is taken by the whole of the warp. Owing to this, the tension on the warp beam with the centre-shed tappets will be from ⅛ to ¼ that on the warp beam with the open-shed tappets for similar wefting capacity, and an equally clear shed. In *d* d^1 the succeeding shed is illustrated. It should perhaps be noted that in centre-shedding the conditions illustrated at c^1 may be obtained,

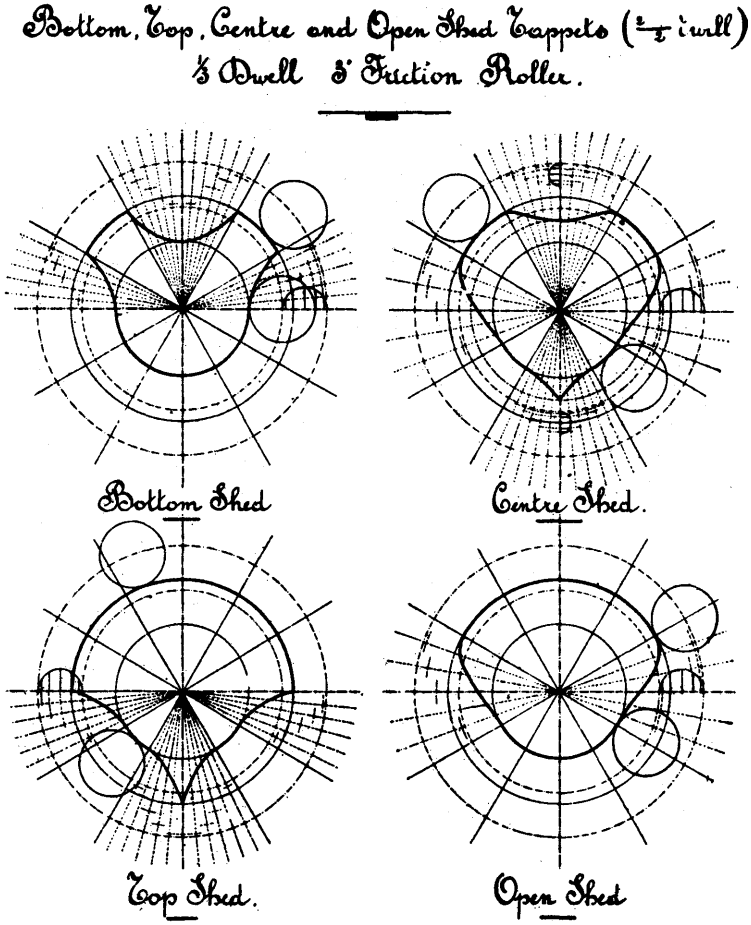
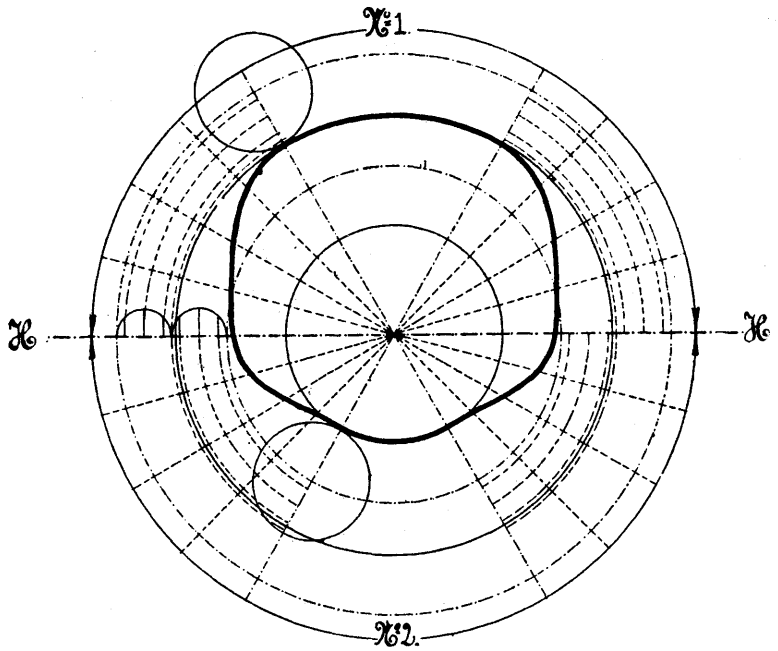


FIG. 2.

under which circumstances the whole of the strain of beating-up is taken from the healds and transmitted through the mails—if desirable somewhat long—clearly to the back-rest; or the back-rest may be elevated, under which circumstances the warp line, on beating-up taking place, will not be straight but slightly depressed at the healds; hence the strain of beating-up will fall on to all the warp threads and slightly on to all the healds.

In Fig. 2, the design of a $\frac{2}{2}$ twill centre-shed tappet is shown The manner in which it raises the shaft which it actuates from the lowest position to the centre and lowers the shaft from the highest position to the centre for the beating-up will be realised by comparison with the open-shed tappet for $\frac{2}{2}$ twill underneath.

If the tappet loom may be so readily converted into a centre-shedding mechanism, the thought naturally occurs : Why not a " bottom " or " top "-shed mechanism ? The $\frac{2}{2}$ twill tappets for both these styles are here illustrated. It may be remarked, however, that while the time for forming the shed is the same in the open and centre-shed tappets and no difference in speed or likelihood of trapping the shuttle in



evidence, the bottom or top-shedding tappets give a most uncomfortable " gigging " motion suggesting catastrophe unless the speed of the loom is markedly reduced. For special purposes, however, either or both these tappets may be useful.

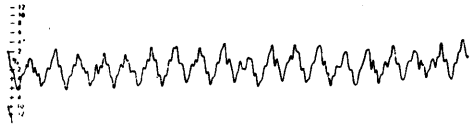
An additional and important point in the construction of a true centre-shed tappet must now be noted. It may be urged that an ordinary, plain tappet is a centre-shed tappet. So far as our definition has gone, so it is. But now an important distinction must be drawn. If the plain tappet in Fig. 3 be carefully examined, it will be noted that instead of the rise and fall curves being each based on a full harmonic motion, each is based upon two harmonic motions. Thus, a rising heald-shaft rises with a true harmonic motion *to the centre* and

again with a true harmonic motion from the centre to the highest position. Similarly with a falling heald-shaft. Thus, a true centre-shed tappet not only brings all the warp threads to the centre, but it also slows them down to the centre so that the thread speed is at its slowest just as beating-up takes place. This seems to have a marked effect on thread-breakage, most materially reducing it.

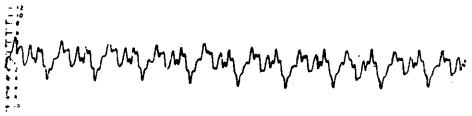
Speed Records from Tappet Loom
fitted with (a) Open Shed (b) Centre Shed Tappets.

(*a*) Open Shed.

(*b*) Centre Shed.



(*c*) Open Shed.



(*d*) Centre Shed.

FIG. 3.

Attention may now be directed to the defective shedding of the centre-shed tappet in Fig. 2 as illustrated in Fig. 4. Following out the lifts of the ordinary centre-shed tappet the marked frictioning of the warp threads on one another will be clearly realised. Obviously, an anti-friction centre-shed tappet should be designed to control the threads as illustrated for the anti-friction centre-shed. If the $\frac{2}{2}$ twill tappet

be designed with its rise and fall curves based upon double-harmonic motion and its half rise and half fall curves on single harmonic motion this control of the healds and movement of the threads will be effected. A $\frac{2}{2}$ twill tappet thus designed presents really beautiful curves, and, combined with a suitable working of the heald-shafts from front to back or back to front, *clears the threads at twice and at double speed from the*

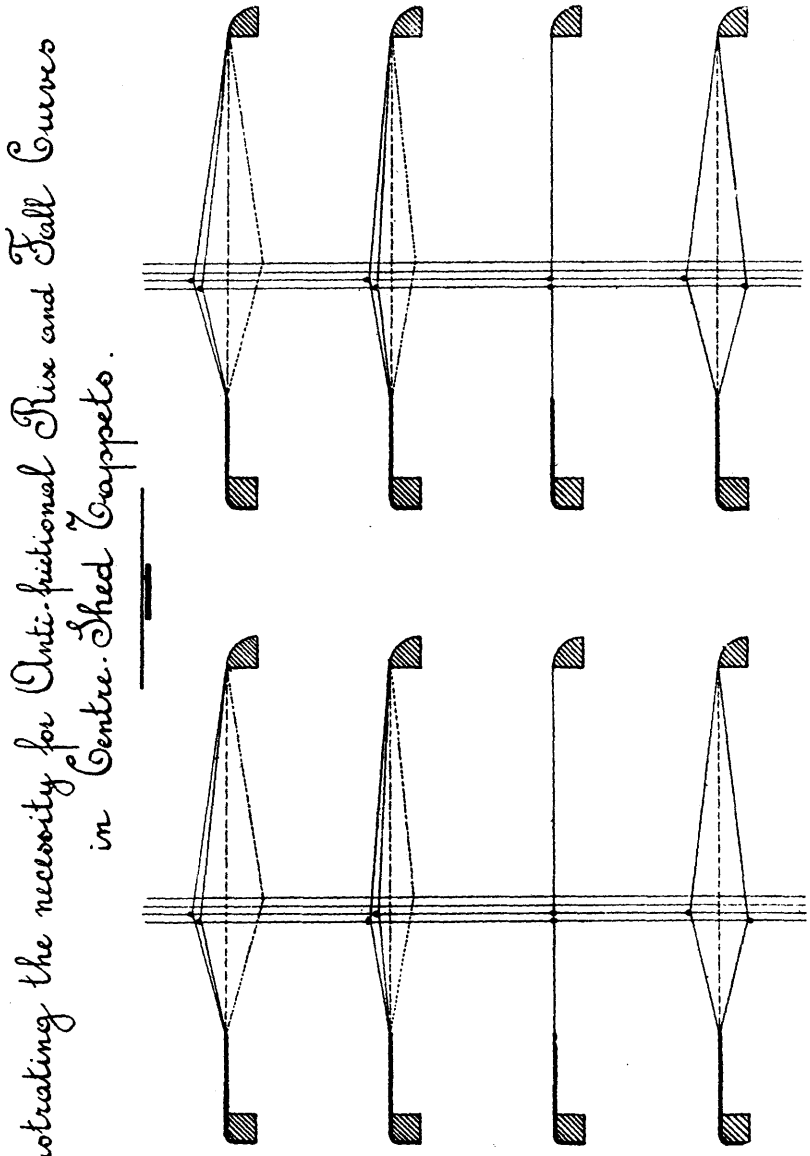


Fig. 4.

centre, or at once if deemed better, and thus conduces to a clearer shed in weaving hairy, crossbred warps than can possibly be hoped for employing open-shed tappets.

It may be contended that the movement of the heald-shafts to the

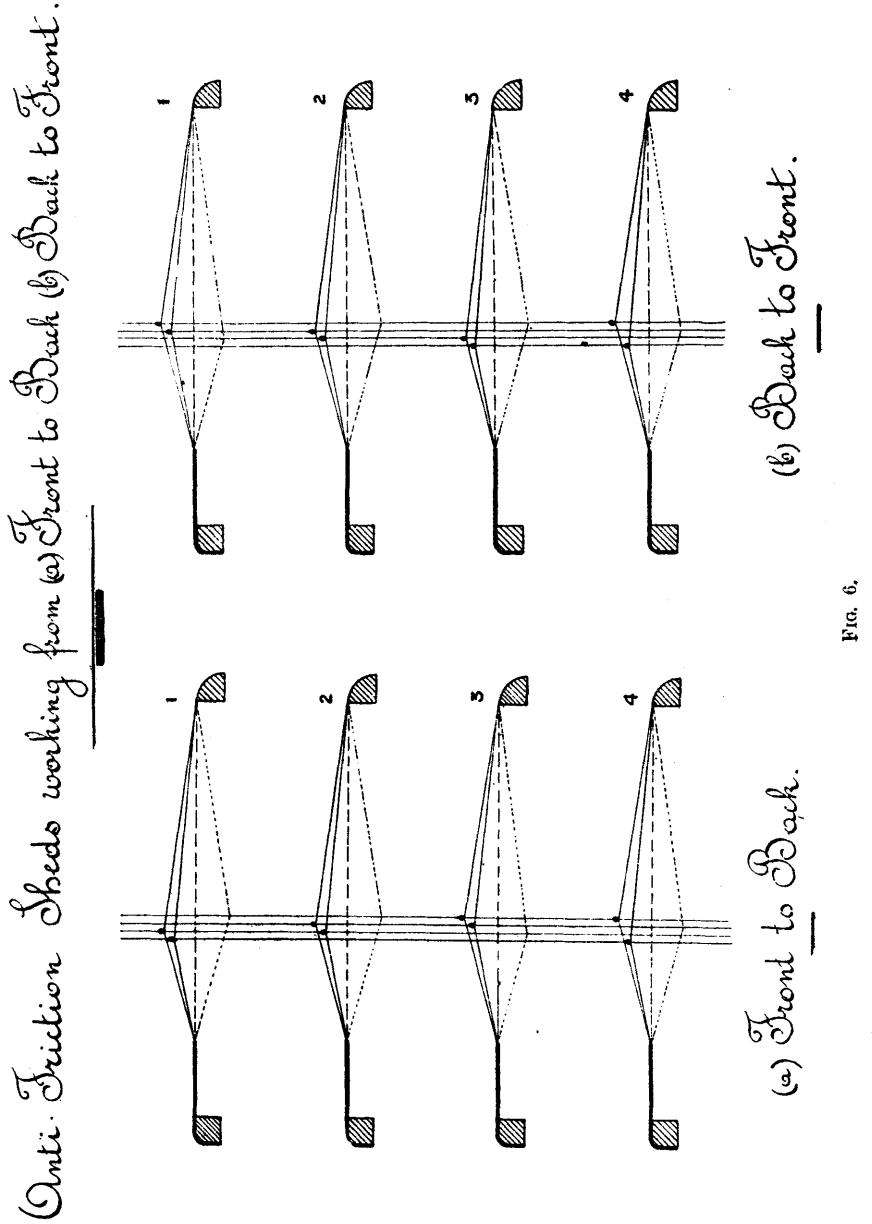


FIG. 6.

centre gives extra friction on both threads and heald-band. But this is not necessarily so, as has been already shown with reference to the warp threads and, possibly, is not so with reference to the heald-back.

If of two healds one goes down and the other remains stationary there is friction on one another, but if both go down there is no friction on one another. Relative movement must be taken into account.

Stocks and bowls or spring under-motions may be employed, and experiments are being tried with balanced tappet treadles as against unbalanced treadles, tension on the healds being thus relieved; with treadles on the top instead of underneath the tappets; with spring, easy-regulating nuts on the streamer rods; with a swinging back-rest to obviate too much backlash from the closing shed; and with a heated back-rest to enable a good start to be made on a Monday morning.

The tests on the Tachograph illustrated in Fig. 6 are very illuminative. In the centre-shed tappets employed there was evidently a defect every two or four picks; but for this the centre-shed tappets would show much steadier running. The power consumed was tested with the following result:—

OPEN v. CENTRE SHED TAPPETS.

Power Consumption.

	Open Shed.	Centre Shed.
Power consumption to run Motor.....	325 Watts.	325 Watts.
,, ,, with Loom added .	550 Watts.	485 Watts.
,, ,, of Loom alone	225 Watts.	160 Watts.

Note:—746 Watts per H.P.

Results confirmed by three independent observers.

The University tests of the various styles of tappets upon a very tender, hairy, crossbred warp have suggested that the threads down may be in the proportion of 40 : 1, but probably in practice 4 : 1 is nearer the mark. In the mill, the only tests so far made have been with a $\frac{3}{3}$ twill centre-shed tappet as against the ordinary $\frac{3}{3}$ twill open-shed tappet with the following mending result:—

OPEN v. CENTRE SHED TAPPETS.

*Mending Costs of Cloths.**

Open Shed.	Centre Shed.
10 pieces costing £2 5s. 8d.	7 pieces costing £1 5s. 7d.
Average 4/6·8	Average 3/7·8

Difference in favour of Centre Shed—20 %

* Slipping knots were the difficulty here.

This centre-shed tappet was of altogether inferior design as compared with those now being turned out, so that a very much better result with the newly-designed tappet may be expected.

I claim for the special tappets and for the fine single-warp gearing —which has taken some months to work out at the University—25 per cent greater production in delicate warps; 25 per cent less mending of fabric produced; 10 per cent saving in power; 25 per cent saving in life of healds; a cleaner shed, and, consequently, a more perfect fabric

without "stitches"; a better balanced, non-curling, less reedy cloth; much greater ease in taking up ends; and the possibility of weaving at present unweavable yarns, if sized, and certain other yarns without sizing at all.

I wish cordially to acknowledge the assistance of Mr. Yewdall and Mr. Wadsworth, both of the Staff of the University, and of Mr. A. Balsaert, from L'Ecole Industrielle Supérieure de Ghent, and Cloth-workers' Scholar in the University, in carrying out the experiments and in preparing the illustrations.

DISCUSSION.

Mr. GARNETT said he believed Professor Barker's conclusions were perfectly right when he spoke of the prejudices we had had against the centre-shed motion—at any rate in the coating trade. He thought the fear—quite groundless—which had been in their minds, was that production would go down. They had been under the impression that the centre-shed loom would naturally go slower, and they felt that they must not have the production less, and therefore they had not tested these things to see whether the conclusions were obtained in practical experience.

Mr. THOMAS PICKLES (Burnley) said he would like to know what the idea of the centre-shed tappet was. Was it to obviate the ends breaking, or what?

Professor BARKER replied that it was for ends breaking down. He thought he was quite justified in saying also that there was greater capacity for clearing the shed and thus preventing stitching.

Mr. PICKLES, referring to foreign productions and English-manufactured goods, said that Professor Barker had been very good to him and had offered him every facility for trying to weave the kind of cloth which had been referred to. He had had a warp from Leeds and had woven that, and he had brought a piece with him for the inspection of anyone who cared to see it. To his mind, that piece did not require any mending at all. It had woven all right, and would give every satisfaction, to his mind. Moreover, they had had few ends down, and it had woven in less time. He thought there would not be much difficulty in weaving that kind of cloth. With regard to the tappet, he thought it was very good, but there were other parts of the loom that wanted looking at besides the tappet. Meetings and Congresses such as those of the Textile Institute were exceedingly valuable, bringing, as they did, the practical men in the textile industries into closer touch with the textile experts. One other question he would like to ask, and that was, what the difference was in breakages between the Continental and the English makes?

Professor BARKER said it was contended that the Continental weavers would weave pieces with more ends down than ours, but they would stand worse warps than our weavers. Probably some others present could answer the question better than he could.

Mr. A. M. BELL (Halifax) asked if Professor Barker did not think that the tappets would be better if they were made to indicate only, and the arrangements for shedding—giving the depth of shed—were effected by

an auxiliary appliance. It appeared to him that the ½ rise in the tappet shown was very small and delicate.

Professor BARKER said it gave a beautiful rise that could not be improved upon. He was surprised when he put it on the loom. The movement was steady and quite the opposite from what might have been expected before it was on the loom. We were too much given to looking at a thing and saying it was no good, instead of thinking closely about it and trying it in actual practice.

Mr. H. HALLIDAY (Bradford) asked what was a suitable under-motion for the centre shed?

Professor BARKER replied that the only spring required was a spring to draw the heald down or to make the threads pass to the low position across the warp. All that was wanted was a spring sufficient to control the heald in weaving, and not a spring to work right away round and draw the treadle against the tappet—a most ridiculous thing, when one came to think of it. Under the arrangements he had referred to, he did not think it mattered whether they had the Kenyon spring motion or the ordinary spring. The ordinary spring gave them, within certain limits, a regular pull on the heald shaft.

Mr. R. W. GODDARD (Bradford) said that Professor Barker and himself had had this subject constantly before them for ten or fifteen years. The question was how to make single warps weave well. They felt there was a great opening for the trade, and that if they put their heads together something might be achieved. They had worked very hard indeed, and had made the single-warp trade in Bradford "go." There was no doubt that manufacturers could weave warps to-day that it would have been deemed impossible to weave in Bradford ten or fifteen years ago. They could now weave any cloth that the German or French manufacturers had woven, and they were making cloths in Bradford that had never been manufactured in this country before, but the manufacture of which had been confined to Germany. The manufacturers said they could not do it, but now they knew that they could. Now that Professor Barker had shown them a tappet arrangement which would relieve the tension of the warp and save the ends from being broken, he felt that most manufacturers would weave even crossbreds well and would never grumble in future. They could make yarns that would weave as well as any. He knew they could do it, but people were so frightened of saying anything. He would like to express his personal thanks to Professor Barker for his work on this question. He had spent an enormous amount of time on the subject.

Mr. EBER MIDGLEY (Bradford) said there was no question about the fact that the principle was quite correct. The feature was the weaving of delicate single-twist warps. Originally this matter came up, he believed, regarding the production of single-warp poplin and Amazon cloths. In both cases there was a fine warp and a much thicker weft. In open shedding there was a strain on the warp during the beating up, and the beating up of the thick pick created increased strain on that warp, and it was at that point where the breakage usually happened. With the centre shedding, at that point of the beating up, the tension was relaxed from the warp thread and a certain amount of elasticity given to the warp. Naturally, this would facilitate greatly the production of these goods.

Professor Barker had dealt with the manufacture of Continental cloths. The feature of these cloths appeared to be their fulness. A number of factors had to be considered, too, in the production of those cloths. Twist was very important, as was also sizing; and spinning the yarn was a factor to be considered. The Continental method of spinning worsted yarn was different to the ordinary or British method of spinning, and it might be claimed on the part of the Continental yarns that they were more manipulative. Then there was the question of finishing. Chemical analyses of over 130 different makes of German fabrics had revealed the fact that in addition to ordinary mechanical finishes most of them had been chemicalised. The amount of foreign matter on those cloths in no case amounted to over 3 per cent. In a number of them, three different agents were employed. The chemical finish was to obtain appearance, in some cases to develop softness in handle, in other cases to obtain permanency. Therefore, the matter of chemical finish was a most important one. He thought that what was wanted was more observation on our part. In the past we had been too prone to take it for granted that things were all right. What was wanted was a spirit of observation—to observe what competitors were doing, and, if it was considered to be worth while, to adopt fresh methods. There was also necessary the spirit of inquiry. With more of the spirit of observation and of inquiry, he thought there was no doubt that we could produce here anything produced elsewhere by textile manufacturers.

Mr. C. W. KEIGHLEY (Huddersfield) moved a vote of thanks to Professor Barker for a lecture which, he said, had been most instructive.

Mr. OSCAR S. HALL seconded.

The vote was heartily accorded.

The Congress proceedings closed with afternoon visits of inspection to the engineering works of Messrs. David Brown & Sons (Huddersfield) Ltd., and Messrs. William Whiteley & Sons Ltd., Prospect Ironworks, Lockwood, by kind permission of the firms named.