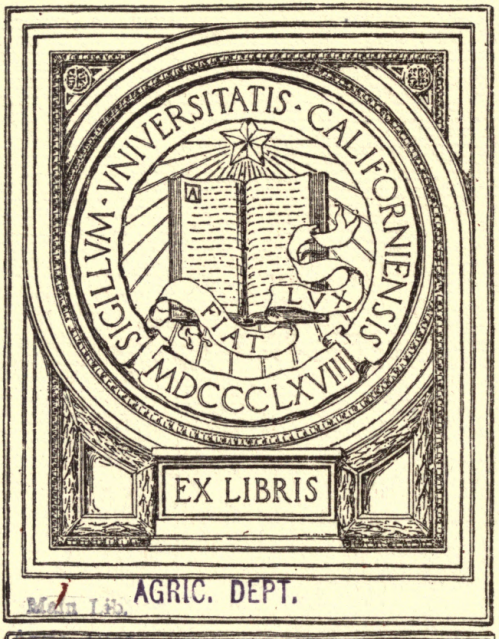
RAMIE, RHEA, CHINA GRASS OR NETTLE FIBRE

BY

THOMAS BARRACLOUGH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I have been deeply interested in the above fibre for many years. It has had a fascination for me. Long acquaintance with its many remarkable qualities, coupled with regret that it has for so long been the victim of unfortunate circumstances and influences, has not diminished either my interest in it or my faith in its ultimate triumph. In March, 1897, by request, I read a paper on "Ramie" at the Imperial Institute, London, under the auspices of the Society of Arts. Some extracts from the paper will be found in the appendix marked "A." They relate mainly to matters which are not included in these notes or are only incidentally referred to. They may be of value to some readers interested in the cultivation of ramie, and therefore I have thought it desirable to reproduce them.

By the kindness of the two leading spinners and manufacturers of ramie, I was enabled to place before the audience a large and very varied assortment of samples of the fibre in various stages of manufacture—in its degummed state, as filasse; in slivers, before and after combing; in the form of top (long fibre) and in the form of noils (short fibre); also in slubbings, rovings, and yarns of many qualities, from coarse to extremely fine counts. Finally, there were samples of a great variety of goods—woven, netted, knitted, made into lace, thread, etc., etc. The samples created very general interest, and being the most complete and representative collection ever placed before the public, an opportunity was given of realising practically the value and beauty of the fibre and its adaptability for being manufactured into a very wide and diversified assortment of goods. The time at my disposal compelling me to keep the paper within narrow limits, I dwelt principally on the cultivation of the plant and the decortication of the stems, as the cheapest and best mode of producing the raw fibre seemed to me at the time to be the most important part of the subject. I dealt but shortly with the manufacturing processes and the general position of ramie in the manufacturing world.

Since the date of my paper considerable progress has been made in the treatment of the fibre and in the manufacture of ramie yarns and goods. Therefore I venture to think that the time is opportune for placing before those who are interested in the fibre some additional information respecting its present position and prospects in the textile world and the progress that has been made in its manufacture. In preparing these notes I have felt it my duty to take cognisance of the following questions frequently asked, especially in England, the United States, Germany, and France:—Why has ramie hitherto failed to come to the front and become one of the leading fibres in the textile manufacturing world? Why is it still viewed with disfavour in certain circles, more especially in financial circles? Why do people shrug their shoulders when ramie is mentioned and attribute to it defects of which it is entirely innocent? Here is a grand fibre under a cloud; there must be some causes for it. Can these causes be explained and removed; if so, by what means? The answer is decidedly in the affirmative, and these notes are intended to show that ramie, with all its valuable qualities, can be manufactured into a great variety of goods with very substantial profit, providing that manufacturers have a full technical knowledge of the fibre, combined with the possession of machinery specially adapted to its treatment.

Before proceeding to give proof of so important a matter, it will be advantageous to first mention some of the reasons for the present prejudices against so valuable a fibre. To detail and explain them is, in my opinion, the best means of refuting them, because they are due to causes and influences mostly outside the fibre and for which the fibre cannot be held responsible. It is only by looking the facts and influences fairly in the face and dispassionately examining the causesof past failures that one can arrive at an impartial estimate of what ought to be the position and the value of ramie in the textile manufacturing world. By carefully pointing out and accurately defining these

causes, a foundation is laid for building up a proper appreciation of the remarkable qualities and the immense value of ramie. Textile manufacturers must of necessity be constantly on the look out for something new. A trade which ministers in so large a degree, not only to the necessities but also to the luxuries and fashions of the world, must undoubtedly be ever prepared to take advantage of new materials, new modes and processes of manufacture, new designs, new colours and dyes, and new styles of finish. Therefore, it would have been strange if the textile manufacturing world had not been moved by the advent of ramie many years ago. It was to them a new fibre; its remarkable qualities were soon ascertained, and many very extravagant hopes and expectations were formed concerning the adaptability of it for an immense variety of manufacturing purposes, both alone and also in combination with other textiles, vegetable and animal.

Paradoxical as it may seem, the exceptionally good qualities of ramie may be said to have been in a small degree the cause of its comparative failure to take its proper place in the textile industry. I enumerate some of these qualities. It has—

(A) A strength very much greater than that of any other fibre—a quality much appreciated in many branches of textile manufacturing, especially where strength of yarn is of the utmost importance.

(B) A lustre almost equal to that of silk—in fact, superior to the lustre of the lower qualities of silk; thus enabling it to be used in conjunction with silk and even to compete with it.

(C) An extraordinary length of filament, amounting to 14 and even to 16 inches, thus enabling it to be spun into very fine yarns with the minimum of twist, so as to preserve its lustre to the fullest extent.

(D) A remarkable facility for taking colours freely and retaining them, thus fitting it admirably for being dyed and printed in all manner of goods.

(E) A non-liability to rot when immersed in water. For this reason it is especially adapted for the manufacture of sailcloth, ropes, cords, fishing lines, etc., etc.

Dealing now with the causes of its failure in past years, I enumerate five principal ones as follows:—

(1) The general absence of knowledge concerning the nature and peculiarities of the fibre.

(2) The difficulties experienced in dealing effectively with these peculiarities.

(3) The fact that several of the manufacturing and other operations are interdependent one on the other, and therefore seriously influence each other.

(4) The impossibility of obtaining in past years large and regular supplies of the fibre.

(5) Financial causes.

Dealing first with the general absence of knowledge that formerly prevailed, I would remark that many manufacturers took up the new fibre with avidity and made it the basis of manufacturing experiments and even speculative enterprises, but the results in nearly all cases were failure, loss of money, and disappointment. They had gone to work very energetically but without discretion, not realising that this fibre, like all others, has its peculiarities, which must be carefully studied and taken into consideration if success is to attend the efforts to manufacture it. An absolutely new fibre naturally needs a new system of treatment and special machinery and plant. Many manufacturers tried to work ramie on their existing machinery, which was designed for flax, cotton, silk, or worsted, etc., all these textiles having qualities differing in many important respects from ramie. Failure and disappointment were the result, because impossibilities were expected.

The preparation and manufacture of cotton, wool, flax, jute, silk, etc., now arrived at so great a state of perfection, are the results of the inventive talent and the practical work of large numbers of men extending over many years. The peculiarities of each textile had to be discovered and studied and the special means (mechanical and otherwise) necessary to deal with it had during many years to be invented, tested, and by degrees brought to relative perfection. The consequence is that the machinery and plant of to-day are thoroughly well adapted to all the various peculiarities of each fibre and the requirements of each trade and class of goods. There existed among the manufacturers interested in these fibres an earnest desire to obtain the best possible machines for manufacturing them; consequently the study of their special qualities, the series of experiments carried out at great cost, the inventive talent applied to the processes, and the determination to succeed, caused the difficulties to disappear, and year after year valuable improvements were made in the machinery with the view of enabling it to produce larger quantities of better and more

varied classes of goods in a given time, at the same time employing the least possible manual labour by making the machines as automatic as possible.

It will be evident that the same principle applied to the machinery and apparata for working ramie must of necessity produce like results, and the time has now arrived when one is justified in saying that the ignorance of the past is rapidly disappearing and that a full knowledge of ramie is taking its place. During the last ten or twelve years practical men of experience have been carefully studying ramie both from a scientific and a practical point of view, and by means of experiments, in some cases quietly and unobtrusively carried out, have gained such a knowledge of the fibre and the means of treating it through the various stages of its manufacture that the whole process may now be regarded as being placed on a thoroughly practical footing. There can be no royal road to any manufacturing success. In the case of ramie, by carefully studying the peculiar qualities of the fibre and overcoming the chemical difficulties of the degumming and softening processes, and by studying the mechanical requirements necessary to treat it successfully in all the various stages from the raw material to the finished goods, success has been attained. In the remarks which follow I have endeavoured, speaking generally, to point out difficulties overcome and processes and machinery adapted for the particular purposes in view, and I believe that the successful manufacture of ramie is now an assured fact. Ramie has entered into a new phase and the time is at hand when it may be expected to become a very important and leading fibre in the textile world.

Referring to the second cause, I desire to point out that ramie fibre presented several serious difficulties in the way of its successful treatment. One of these difficulties is the fact that the separate filaments of ramie are, by reason of their form and construction, not congenial to each other: they partake largely of the nature of hairs. The consequence is that the filaments have no natural affinity or tendency to adhere or cling together. Their tendency is rather to go each its own way, hence the serious difficulties experienced in forming the slivers, the rovings, and the yarn. This tendency is liable to be increased by the treatment received during the degumming process, which, if unskilfully carried out, imparts to the fibre a harshness more or less developed. The use of chemicals in the treatment of fibres has generally a tendency to produce brittleness and harshness. This tendency had to be overcome by using with great discretion the very minimum of chemical treatment in degumming and by softening the fibre afterwards. The same remark applies in the case of wool, which, after washing with chemicals, needs the application of oil previous to passing through the machines, in order to soften it and enable it to pass freely and quickly through the various mechanical processes. Another difficulty arose from the fact that ramie fibre is composed of filaments of serious diversities of length—say, from 1½ inch up to 14 and even 16 inches. To pass simultaneously fibres of such varying lengths through the machinery in a practical manner was not possible; therefore means had to be invented for successfully overcoming this difficulty.

The third cause of failure was also serious. For some years I have been endeavouring to lessen the evil effects of it by getting the growers of the fibre, who have also to decorticate it, to meet in conference the manufacturers of ramie, so that each class can point out to the other how to overcome the difficulties experienced (see Appendix B). I have dealt at some length with this matter in describing the manufacturing processes, and therefore I summarise here this cause of failure in past years as due to the isolated and independent action of the persons actively interested in ramie and the absence of combined knowledge and co-operation. Thus the fibre grower failed to realise that he seriously increased the difficulties of the chemist through imperfect decortication, by sending to the market fibre bruised and full of skin, wood, etc., thus rendering the degumming a slow and difficult process and necessitating undue strength of chemicals, in addition to many complicated and expensive operations. Furthermore, the grower entirely ignored the fact that his fibre would have to pass through the combing process, and that if its decortication was defective, the combing machine would inevitably prove it. Properly decorticated ramie—for instance, china grass which has been decorticated by hand labour—ought to give, after combing, about 70 per cent. of long fibre and about 30 per cent. of short fibre (noils); but if the fibre has been bruised and damaged by decorticating machines of imperfect construction, the result is only from 30

per cent. to 50 per cent. of long fibre and 70 per cent. to 50 per cent. of short fibre (noils).

The chemist responsible for the degumming process in like manner ignored the after processes and paid little or no regard to what the fibre had to undergo when it left his hands. If the degummed fibre became harsh and brittle through his defective treatment, it would not pass freely through the preparing and drawing machinery at even one-third of its proper speed; the amount of waste produced was enormous and the combing operation showed only a small percentage of long fibre and an abnormally large percentage of short fibre. Defective degumming has also in many cases led to heavy losses through (A) the use of improper chemicals, or of suitable chemicals, but in unsuitable strength; and (B) the imperfect washing of the fibre and freeing from acid, thereby causing the yarns and goods in a short time to lose their colour and strength and frequently to become rotten and worthless. Imagine the feelings of a merchant who, having bought one hundred pieces of ramie cloth and put them into stock or shipped them to a foreign customer, learned to his dismay in two or three months' time that the goods were discoloured or rotten and valueless. Can anyone be surprised that in past years ramie had many enemies? Imperfect combing has also been the cause of many serious difficulties in the roving and spinning processes.

With regard to the fourth cause of failure, it is obvious that an ample supply of raw materials at all times available is an absolute necessity for all branches of successful manufacture. Unfortunately this has not been the case with ramie. China grass has been available, but the supply has been irregular and intermittent and the prices have been, as a rule, much too high and subject to great and irregular variations. Growers of ramie lost heart and gave up the cultivation, partly because of the small demand and partly because they did not send it into the market in a condition to ensure remunerative prices. On the other hand, spinners and manufacturers interested in ramie were not encouraged to make large outlays on new machinery because of the uncertainty of obtaining a sufficient and regular supply of the fibre at a moderate price. This difficulty has required time and publicity for its removal.

The fifth cause of failure, and by no means the least important, must be justly attributed to financial reasons. A large number of capitalists and others have unfortunately sustained serious losses by embarking in erratic schemes prepared by persons imperfectly acquainted with, and often quite ignorant of the nature of the fibre—its peculiarities and good qualities. Many of these persons have been mainly, if not solely, animated by the desire to sell at enormous prices patents, processes, machines, etc., to capitalists and companies. The fair reputation of ramie has also often been injuriously affected by well-meaning persons who, having failed to thoroughly study all its characteristics and peculiarities, have invented processes or machines for dealing with isolated portions only of the treatment, irrespective of the remainder. Thus the inventor or owner of a patent for a ramie decorticating machine has entirely ignored the fact that the ramie must, after decortication, be degummed, softened, combed, etc. In like manner the inventor or owner of a patented degumming process has introduced his patent, entirely failing or not being willing to see that the combing, manufacturing, and dyeing processes stand in intimate relationship to the degumming process, and are in a measure dependent on its efficacy for success.

Ramie has indeed been the victim of enemies who were rarely heard of in the days when machines were being invented for manufacturing flax, cotton, jute, etc. These enemies are the speculative inventor, the professional director, the company promoter, and their allies, whose action in forming companies and asking the public to subscribe large sums in order to carry out what in most cases can justly be termed ignorant visionary schemes involving immense losses, has undoubtedly been one of the main causes of the public viewing with disfavour ramie manufacturing enterprises.

Having thus described the leading causes of failure and some of the remedies already applied and being applied, I now pass on to the manufacturing operations, but before doing so I will devote a few lines to the ramie plant and the decorticating process. I do not propose to describe the plant botanically or to dwell on its cultivation, but desire to draw attention to the relative qualities of the two leading ramie fibre producing species—Boehmeria tenacissima and Boehmeria nivea. These two descriptions of ramie are frequently distinguished by the terms "green" and "white." The fibre is known under four designations—namely, rhea, ramie, china grass, and nettle

fibre, the latter principally in the United States. Rhea is generally considered to be the green-leaved member of the Boehmeria family and ramie the white-leaved description. China grass was formerly supposed to consist only of the white-leaved description, but a more intimate knowledge of the growth of the plant in China has proved that both Boehmeria tenacissima (green-leaved ramie) and Boehmeria nivea (white-leaved ramie) grow in China, and the fibre extracted from them is indiscriminately known as China grass.

The fibre of Boehmeria tenacissima is, generally speaking, not quite as fine as that of Boehmeria nivea; it is, however, somewhat stronger. It spins well into yarn, but, as the filaments are not so fine, the yarns cannot be spun quite as fine as those of the white variety. On the other hand, the Boehmeria nivea (or white description) although not quite so strong as the Boehmeria tenacissima, has the advantage of being able to be spun into somewhat finer yarn, necessitating a little more careful treating in the manufacturing operations. It is generally considered to have a better colour than Boehmeria tenacissima. The difference in the relative filament length of the two descriptions is not great, and it may truly be said of both that no fibre can compare with them in strength. Both fibres have the same degree of lustre. Some manufacturers prefer the one, some the other description, partly from choice and partly from habit, this arising from the fact that they have become more familiar with and perhaps more successful in the treatment of the one than the other.

DECORTICATING.

The first process which the green stems undergo when cut down is decortication, and although this does not strictly belong to the manufacturing branch, it being in reality an agricultural operation, it needs mention here because of its intimate connection with and influence on the subsequent manufacturing operations. A large number of decorticating machines have been invented and tried, some of them with very disappointing results, arising from the fact that most of the inventors, either from ignorance or disregard of the facts, have treated decortication as an independent process, whereas it has a very intimate relation to and influence on the subsequent degumming and combing processes. A really practical ramie decorticating machine ought—

(A) To decorticate the green stems and produce from them fibre fully equal to that produced by the best hand labour in China. The fibre must be free from shieve or woody parts: the outer skin of the stem must be entirely removed and the minimum of gum left in the fibre. China grass (ramie decorticated by hand in China) usually contains gum equal to about 30 per cent. of its weight, but a good decorticating machine ought not to leave more than about 20 per cent. of gum in the fibre. This freeing from the shieve or wood and the skin and the reduction in the percentage of gum are of the utmost importance, because the subsequent degumming operations are thereby greatly facilitated, shortened, and cheapened.

(B) To avoid bruising the fibre. China grass, as already stated, produces, with a really good combing machine, 70 per cent. of long fibre (top) and 30 per cent. of short fibre (noils), but in many cases the fibre, resulting from treatment by unpractical and imperfect decorticating machines, has shown after the combing process only about from 30 to 50 per cent. of long fibre and about from 50 to 70 per cent. of short fibre—a sure test of the lamentable results of being bruised, broken, and shortened by bad decortication.

It will thus be seen how intimate ought to be the relations between the decorticating, degumming, and combing processes, and how impossible it is to judge of the efficiency or otherwise of any decorticating machine solely by the appearance of the fibre it produces. Not until the decorticated fibre has passed through the degumming and combing processes can an accurate and reliable opinion be formed concerning the efficiency of the decorticating machine that has been used. This is a matter of primary importance, and yet it has too frequently been ignored by inventors and introducers of ramie decorticating machines.

MANUFACTURE.

I now pass on to manufacturing operations, commencing with the fibre in the condition in which it is generally sent to market under the name of "China grass" and "ramie," as produced by the best decorticating machines, free from skin, wood, and extraneous matters.

DEGUMMING.

After the bales of ramie or China grass are opened, the filasse is carefully sorted, generally by female labour, into batches, according to the various qualities of length, colour, and freedom from extraneous matters. The batches

of like quality are then placed in the degumming kiers or vats, in which the filasse is treated by steam, water, and chemicals in such a way that the gum is dissolved and removed, leaving the fibre free from gum, skin, dirt, chemicals, etc. The essentials for a successful degumming operation are:—Plenty of pure water and steam and a set of machines and apparata constructed so as to enable the filasse to be thoroughly treated in the most economical manner, and with the least possible handling. Under no circumstances must the fibre be seriously affected by the treatment. Its enormous strength, its splendid lustre and softness, must remain the same after the degumming process as before it; consequently the chemicals used must be of such a nature and of so slight a degree of strength as to accomplish the removal of the gum without deterioration of the filasse in any respect. The process, when properly understood, is neither complicated nor difficult, and needs principally care and a practical mode of treatment. The machinery used, in addition to the kiers or vats, comprises washing machines, hydro-extractors, squeezers, pumps, etc. These need not be of very special construction.

The main art of successfully degumming ramie lies in the use of suitable chemicals in very weak solution and in the thorough washing of the filasse in the last stage of the degumming process. The filasse then usually undergoes bleaching, for which no special plant is required: it may be bleached in the same way as cotton or flax. There is a diversity of opinion as to the degree of chemical bleaching to be applied to ramie and the stage at which it is best carried out. Some manufacturers prefer to complete the process immediately the filasse is degummed; others prefer to half bleach the filasse and to complete the bleaching on the grass in the same way as linen goods are bleached. Others again prefer to leave the bleaching process to a later stage—say, when the filasse has been spun into yarn and made up into goods. For a great variety of purposes no bleaching whatever is required, because some goods are generally sold and used in the grey state: for instance, many kinds of linings, canvas, sailcloths, etc., also ropes, cords, lines, twine, etc.

One very important matter to be observed in connection with the bleaching of ramie filasse, yarn, and goods is to free them absolutely from chemicals by efficient neutralising and by copious washings, etc. A very large number of processes for degumming ramie have been invented and patented, and the names of the chemicals suggested are legion. Many of these processes have proved to be failures, being mainly the result of laboratory experiments.

In degumming ramie the following important conditions must of necessity be observed:

(A) The process must not attack the strength of the fibre.

(B) The fibre has naturally a beautiful lustre, almost if not quite equal to silk; this lustre must be retained, and nothing in the process which the filasse undergoes must affect its lustre or render it harsh and difficult to pass through the machinery.

(C) Ramie, when properly degummed, takes dyes freely (notably all the finer dyes) and lends itself freely to the absorption of the brightest colours quite on an equality with silk, retaining at the same time its beautiful lustre; consequently this quality of receiving and retaining colours must not be affected by the degumming process.

(D) The degumming process must not only be of a nature to cause the fibre to retain its strength, lustre, and colour at the time of manufacture, but also for years afterwards.

An immense amount of unfounded prejudice has been created against ramie and ramie goods through imperfect treatment and defective degumming. Spinners and manufacturers have experienced heavy losses through ramie yarns and goods having, after a few months' time, lost their strength, lustre, and colour and become rotten and worthless. These disastrous results have been in many cases ignorantly attributed to some natural defects of ramie fibre; they were, however, due solely to defective degumming and bleaching. Ramie goods are as lasting as any textile goods, as has been fully proved. For instance, the Chinese have used the fibre for many centuries, and their many hundred years old fabrics exhibit marvellous lasting qualities, quite equal to the flax mummy cloths.

(E) Finally, and this is of great importance, the degumming and bleaching processes used must be capable of being carried out easily, quickly, and in an economical manner, so as to be a commercial success. Some of the patented degumming processes, even if successful in practice, are prohibitive by reason of their enormous cost and complicated treatment.

Preparing and Softening.

Before passing the filasse on to further processes it is very desirable, in fact almost necessary, to thoroughly impregnate it with a substance called in the trade "prepare," by means of which it is rendered more elastic and more capable of passing easily through all the various machines hereinafter referred to. This process has another important object—namely, to prepare the filasse in such a manner that all the machines can be run at their maximum speed, with the view of obtaining the utmost possible production, and at the same time with the minimum of waste. The preparing process has a tendency to slightly stiffen the fibres; consequently the filasse is passed through a special softening machine, the operation of which results in the fibres becoming thoroughly soft, free, and ductile. This is an important stage of the preparation, because, when carried out efficiently by a really good lubricating prepare, it very greatly facilitates the passage of the fibre at full speed through all the subsequent machines, and thereby reduces the amount of waste produced to the very minimum.

Too much importance cannot be attached to a thoroughly practical treatment of the filasse in the initial stage, because when the treatment is well adapted to the nature and peculiarities of the fibre, all following processes are so facilitated as to make the spinning of ramie a commercial success. If, on the other hand, through lack of practical knowledge of the peculiarities of the fibre, this initial preparing process is ignored or not carefully carried out, all the following operations must of necessity be adversely affected. It may truly be said that this softening operation and the combing operation, concerning which more later on, are the two most important operations in the manufacture of ramie.

After leaving the softening department, the filasse, still in stricks, is fed by hand into a gill-spreading machine of special construction, the object of which is to transform it into slivers, which are then passed through a series of other special gill machines arranged in a set, whereby the slivers, during their passage through the various machines in their proper sequence, are opened out, simultaneously levelled, combined, and made of equal thickness and loftiness, in order to render them capable of being efficiently treated by the combing machines with the least possible waste.

Combing.

These slivers are then fed automatically into the combing machines, the fibres are automatically combed, separated into their various qualities, and delivered by the machines into cans in the form of slivers, which then undergo the further processes of doubling, drawing, and equalising. As already stated, the combing process is of vital importance, because it influences the working of all the following machines both as regards quality and quantity of the yarn produced and economy of production.

The reputation of ramie has unfortunately suffered severely through the employment of defective combing machines, some of which leave a considerable amount of short fibre (noil) and extraneous matter in the finished sliver of long fibre (top), thereby preventing the spinning machines from producing good, clean, and level yarn. Other combing machines damage the fibre during the combing process by breaking and shortening it, thereby reducing its quality and value and increasing the amount of waste. There are also some combing machines to which the previous criticism applies only in a minor degree—their chief defect is the smallness of their production and the costly nature of the attendant labour, rendering them almost prohibitive from a commercial point of view in a ramie mill. A really practical, well designed, and well constructed ramie combing machine ought to possess the following good qualities:—

It must comb and sort the fibres into their various qualities and deliver each quality separate.

It must not break or shorten the fibre during the combing.

It must thoroughly clean and free it from dirt and short fibre (noil).

It must give a large production—about 300 lb. a day.

It must be capable of producing from properly prepared filasse about 70 per cent. of good quality long spinning fibre (top) and 30 per cent. of short fibre (noil).

It must be so designed and constructed that it does not need skilled labour to attend it.

It must not be liable to break down or get out of order; the stoppage of combing machines for repairs involves not only very expensive mechanical labour, but also a great lessening of the production of the mill.

Before passing on to the next process a few words may be desirable respecting the noils or

short fibre separated from the rest of the fibre by the combing machine; these are now exceedingly useful for many purposes, and there is a large demand for them. They can be spun into an excellent serviceable yarn on ordinary tow machinery, and as such their leading qualities are strength and regularity. They are also mixed with other textiles, such as wool, cotton, etc. These mixtures are very advantageous to the manufacturer, as ramie noils impart not only great strength to the yarns and to the fabrics, but they improve the appearance of the goods through their lustre and through the excellent and lasting colours which they take in the dyeing process. In most cases they reduce the cost of the goods, for ramie noils now find a ready sale at about 4d. to 5d. per lb., according to the state of the market. It cannot be called a case of adulteration by bringing into the mixture something that is of inferior quality, but it is rather the effecting of a distinct improvement in the goods by adding a material of excellent value. Noils are also being spun satisfactorily on cotton machinery. They are likewise used in a variety of other trades, such as the manufacture of celluloids, etc.

Drawing.

This is effected by passing the combed slivers through a series of gill-drawing machines of special design, running at very high speeds, in order to give the greatest possible production. The drawing processes require to be carried out with considerable care and judgment. For instance, the relative sizes of the slivers and the relative number of them fed into and combined in each of the drawing machines, must be duly proportioned in such a manner as to cause each machine to deliver a sliver or tape as level as possible for the succeeding machine; this applies to every machine in the set of drawing frames. Want of care at this stage cannot fail to be detrimental to the after stages, because irregular tape of necessity produces irregular rovings, and these in their turn produce irregular yarns of diminished value.

Some descriptions of ramie have a slight natural defect—namely, what are called in the trade "hard ends," these being in some cases fibres which have not developed to their full length, but have grown somewhat thick and short; in other cases two or three fibres that have grown together. In the ordinary process of good combing, these hard ends are to a large extent removed from the slivers, but experience has shown that it is very desirable in the highest qualities of ramie yarn that these hard ends should be entirely removed; otherwise they are liable to form inequalities in the yarns, and the woven and other goods produced from such yarns are liable to show a speckled appearance after dyeing: the hard ends absorb more colour than the rest and are non-lustrous.

In order to do away with this defect, the slivers intended for the very best quality yarns pass through a second combing operation and then through a set of special drawing or re-gilling machines, so as to free them from all the hard ends and make them suitable for spinning into the finest yarns for the highest classes of expensive fancy goods, such as brocades, union silks, imitation silk goods, etc.

Roving and Spinning.

On leaving the drawing frames, the ramie slivers or tapes are transferred to roving frames of special construction, which convert them into rovings. These are then spun into yarns by the spinning frames. The roving and spinning frames for ramie differ in some essential features from the ordinary machines used for cotton, flax, worsted, or silk waste. In their construction are embodied some of the most improved motions of the machines used for the above-mentioned textiles—for instance, quick-running spindles, etc., to ensure a large production of good work. There have been introduced into their design and construction—the result of ten years' experiments—a number of special mechanical improvements, in order to adapt them for the treatment of the peculiar qualities of the fibre, and designed to overcome the difficulties formerly experienced in roving and spinning ramie.

In describing the combing operations I made special mention of the system of sorting or separating the fibre during the combing operation into its various qualities. Experience has shown that the most improved method of dealing with the assorted slivers after combing is for each quality of fibre to be treated by passing it separately through a set of drawing, roving, and spinning machines designed and constructed for that special quality. The result is that ramie is now being spun very economically into the very best yarns of which each quality of fibre is capable, consideration being paid to strength, lustre, uniformity of size, twist, speed of production, etc.

This is a new departure in the manufacture of ramie and has added immensely to its value as a textile, because it has materially enlarged

the field for its employment and goods are now being manufactured from it which a short time ago were thought impossible or unsuitable. It enables the spinning machines to produce a wide range of counts of yarn in various qualities of fibre, and thus allows of the same being manufactured into a great variety of goods, for instance:—

(A) The highest quality of fibre is spun into yarns used in the manufacture of brocades, damasks, fine tapestries, etc., plushes, velvets, lace curtains, ladies' dress goods, silk and ramie mixtures—goods to supersede the highest qualities of linens, etc.

(B) The medium quality of fibre is spun into yarns used in the manufacture of scarves, turbans, pongees, pocket handkerchiefs, velveteens, medium linens, hosiery, wool and ramie mixtures, sewing and other threads, fishing lines, fire engine hose, belting, girths, and many other goods.

(C) The third quality of fibre is spun into yarns used in the manufacture of ordinary woven goods of many descriptions, such as canvas, sailcloth, towelling, and also for cords, lines, and a great variety of other goods.

Ramie can be spun into exceedingly fine yarn—say, No. 168's, having 50,400 yards to the lb. Fine yarns of this description used for the manufacture of the highest qualities of goods rival silk yarns and are largely used to supplant silk goods or to mix with silk yarns as, for instance, a ramie warp with silk weft or a silk warp with ramie weft. In order to retain the full natural lustre of the fibre these yarns are spun with the very minimum of twist.

Twisting, Etc.

A considerable proportion of ramie yarns are used in the doubled state; the twisting is generally effected on flyer and ring twisting frames, but with some modifications and additions to ensure good work and great production. The same remark applies to the machines for winding, gassing, reeling, and bundling.

Weaving.

The weaving of ramie and of goods made of ramie mixed with silk, flax, wool, worsted, etc., is proving a great success. This branch of the manufacture has not presented the same amount of difficulty as the preparing and spinning branches, nor is the divergence of ramie looms from the ordinary construction of looms very great. Minor but necessary modifications to adapt them for weaving ramie under favourable circumstances have been introduced. It has also been found that sundry modifications in the ordinary warping, winding, sizing, beaming, etc., machinery are necessary.

Dyeing and Finishing.

The processes of dyeing, printing, and finishing ramie goods are very diversified, according to the various classes and qualities of goods. Ramie goods take colour very freely, and consequently are eminently adapted for dyeing and printing. When woven into damasks, house linens, and similar goods, heretofore made of linen, they are finished in a manner similar to that applied to linen goods. When woven into brocades, pongees, dress goods, and similar goods, heretofore made of silk, or when woven with a mixture of silk—for instance, silk warp and ramie weft or silk weft and ramie warp—the goods are finished in much the same manner as silk goods. Between the above two branches many varieties of goods are made of ramie and wool, worsted, flax, and cotton, and they are treated in the finishing process in a manner similar to that employed for the goods they compete with. The manufacture of ramie into hosiery, curtains, sewing and crochet threads, cords of all kinds, fishing and other lines, twines, ropes, and similar goods calls for no special remark, because the ordinary modern machinery for making these goods is well adapted for making them of ramie.

Counts of Yarn.

Various modes of describing the fineness of yarns are in vogue. Some ramie spinners have used the worsted scale, others the silk scale, and others again the cotton scale. The fibre bears a closer resemblance and has a nearer relation in its character to flax than to any other fibre. It has therefore been found desirable, in order to avoid confusion and facilitate business, to adopt the flax scale in describing the counts or sizes of ramie yarns. This scale has the additional advantage of being simple and easily understood by non-technical persons. Ramie yarns are therefore divided into leas or hanks, each containing 300 yards, and the number of hanks per lb. indicates the size of the yarn. Thus No. 60 ramie yarn contains 60 hanks each of 300 yards = 18,000 yards to the lb.

Speaking generally, the preparing, spinning, and weaving machinery for ramie is of such a character that female labour can be very largely employed in most of the manufacturing operations. The manufacture of ramie has in the past been burdened with difficulties arising

from the fact that the mills have not been self-contained—that is to say, the manufacturer has not been in a position to carry out on his own premises the whole of the operations required from the raw ramie to the finished goods ready for the consumer. Some firms have degummed and combed the fibre and offered it to the trade in the form of sliver. Others have carried their operations a little further and have sold it in the form of rovings. Others have offered their yarns for sale to the weavers. In many cases remunerative prices were not obtainable because the buyers were unable or unwilling to purchase really high-class machinery specially adapted for carrying out the further processes required. In all cases the ramie goods have been dyed, printed, and finished by outside firms.

I would therefore strongly advise that, in starting mills for the manufacture of ramie, they should, wherever possible, be self-contained—in other words, that the manufacturing operations should include everything from the raw material to the finished article ready for sale to the consumer. In this way the manufacturer has full control over all the operations, even the seemingly least important, and is not exposed to failure through the ignorance or incapacity of outsiders.

In conclusion, I may add that the signs of progress are unmistakeable. In Yorkshire there is at present a very large demand for ramie yarns of all classes. On the Continent ramie manufacturers are having a very good time and their number is increasing. The Americans are quite alive to the value of ramie. Buyers, especially in England, are to the fore, some because ramie yarns are so exceedingly strong and valuable for special purposes, other because of the beautiful lustre of the yarns, so necessary in many descriptions of fancy goods, and others again because ramie is able to satisfy requirements which no other fibre can. Ramie mills are now being started even in Eastern countries—Japan and China. Prejudice is rapidly giving way to earnest, intelligent desire to give ramie a fair trial and to appreciate it according to its real value. I may instance the case of one manufacturer in this country who informed me a few days ago that he had been for some years on the look out for a special yarn possessed of strength not previously obtainable. Having bought a quantity of ramie roving he had spun it into yarn and found it exactly suited to his purpose. He has just bought ten tons of ramie rovings and purposes spinning ramie yarns on a large scale.

Manufacturers are now in a position to obtain the best ramie machinery as easily as they can obtain cotton or woollen machinery, and to produce ramie goods with the minimum of risk and the maximum of profit. The days of ignorance are gone by, and ramie seems at last to be taking a position in the textile world worthy of its good qualities.

I have been induced to write these notes as a contribution, however slight, to the knowledge and progress of the manufacture of ramie. I earnestly hope they will be found useful and encouraging to the friends of this grand fibre.

APPENDIX A.

The following are extracts from a paper on the "Cultivation and Manufacture of Rhea Fibre," read by me:—

The growth, production, and quality of ramie vary very much, according to climate, soil, mode of cultivation, and treatment of the fibre. There are, therefore, many elements of uncertainty—such, for instance, as the cost and the weight of the crop grown per acre, the number of crops that can be obtained annually, and the percentage of fibre contained in the stems. My figures must be taken as representing a general average, liable to modifications, according to circumstances.

Ramie, called in India "rhea," and when grown and prepared in China known as "China grass," belongs to the family of nettles (Urtica), and to the sub-division Boehmeria. There are many varieties of the plant, but the two which have been proved to be the best fibre-bearing species are B. Tenacissima, often called the green-leaved ramie, and B. Nivea, often called the white-leaved ramie, on account of the silvery appearance of the under side of its leaves. The Nivea species is mostly cultivated in China and Formosa, and the Tenacissima in Java, Sumatra, Borneo, Malacca, India, Mexico, and other tropical countries. Many attempts have been made to successfully cultivate ramie in temperate zones, and at one time great expectations were raised as to the possibility of successfully growing the fibre in France, Holland, and other countries enjoying a similar climate, but these expectations have not been realised, as the plants are not able to resist winter cold, unless protected to such a degree and at such an expense as to cause their cultivation to be too costly. At one time it was expected that the cultivation of rhea in India would prove of immense benefit, but careful study and experience have shown that something more than a merely tropical climate is required.

Warm moisture is the first requisite to the soil for cultivation, but anything approaching stagnation of water on the land, even for a short period, is the ruin of an estate. Plenty of water always in the soil and yet ready absorption of all that falls are true essentials in ramie land. This implies friability of surface soil to soak in the moisture and porosity of the subsoil to absorb the excess of water or heavy rains. The land must be sufficiently elevated to run no risk from floods. Moisture and warmth in the land depend largely upon moisture and warmth in the atmosphere. Therefore, a plentiful rainfall is indispensable, coupled with a high and even temperature. The rainfall must not only be plentiful but it must be well distributed throughout the year. The greatest enemy of ramie after stagnant water is drought. Dry heat burns it up; drought kills it outright. What ramie requires is a naturally rich deep soil, plenty of rain, and no extremes of temperature.

It was at one time generally supposed that the whole of India is suitable for growing rhea. Such, however, is not the case. Districts in India, the climate and soil of which are in accordance with the above requirements, can produce any quantity of rhea, and if the authorities will foster and protect the cultivation, India will doubtless become one of the most important producers of rhea fibre. It is a perennial, giving from two to five crops annually, and when well established on the land yields its crops for a succession of years. The roots became stronger and stronger each year as they spread through the soil, and the plant becomes more and more productive. It yields a crop the first year, if grown from seed. If planted from root-cuttings it can give two crops in the first year. Owing to the quantity of tannin in the bark it is singularly free from insect pests and fungoid diseases. An estate of 500 acres of ramie under good cultivation and favourable circumstances ought to produce yearly from 7,000 to 9,000 tons of green stems, calculating four crops per year, of which about 5 per cent. is fibre.

The leading qualities of ramie fibre may be summarised thus:—

(*a*) It is the strongest fibre known. The comparative tensile strength of some of the leading fibres may be known as follows:—Assuming the strength of ramie to be 100, the strength of hemp is 36; flax, 25; silk, 13; and cotton, 12.

(*b*) It is the longest of all textile fibres. Its filaments range in length from $2\frac{1}{2}$ in. up to 18 in. The filaments of flax vary in length from $\frac{1}{6}$ in. to $2\frac{1}{2}$ in.

(*c*) Ramie fibre has a brilliancy or lustre superior to that of all other textile fibres. In this respect it may be compared with silk, which it almost equals. In certain classes of goods only an expert can distinguish between silk and ramie. When properly degummed, prepared, spun, and woven, this lustre is not affected by the processes, but shines forth as brightly in the woven piece as in the fibre.

(*d*) Ramie resists atmospheric influences better than any other fibre. Air and water have little influence on it, however long a time exposed. This has been amply proved in the case of fishing nets made of ramie, which have lasted far beyond any other material that has ever been used for the purpose.

(*e*) It mixes easily and freely with silk, wool, cotton, and flax, and the combinations thus obtained are very valuable in point of colour, durability, and economy.

(*f*) It takes colours freely in dyeing, and the very best effects of colour are obtained without affecting the lustre.

One of the difficulties that has impeded the spread of the cultivation of ramie has been the planting. It has been assumed for many years that the best way to propagate ramie was by means of stem or root cuttings. In order to obtain these cuttings, plants have been procured with great difficulty and risk, and at great expense. Many people have been discouraged by the difficulties and the expense, and in many cases it has not been possible to obtain plants. Sowing has been tried in a few cases, but has resulted mostly in failure; hence the idea that ramie is best propagated by cuttings.

From a friend of large experience in the East, I have quite recently obtained special information, which points to the fact that propagation by sowing has been rejected through ignorance of the proper method of sowing. I cannot do better than make known the result of his practical knowledge and experience:—

"It is commonly said that an ounce of practice is worth pounds of theory, and it may not be amiss to give here the results of my own experience in ramie propagation by seed.

"It requires great care, but if the seed be good, the results obtained are an ample reward for the trouble taken. My first attempt ended in failure. One month later I sowed some seed on a bed made of fine sifted earth with a slight admixture of well rotted cow dung: the bed was well sheltered by a lallang roofing, and, in fine, every precaution was taken to ensure success. The result was far from satisfactory; little patches of green here and there showed that germination had partially taken place, but the sowing was practically a failure. I then referred to the precepts given by 'The Imperial Treatise of Chinese Agriculture' on the subject of the rearing of the plant. This work says:—

"'For the purpose of sowing, a light sandy soil is preferred. The seeds are sown in a garden near a river or well. The ground is dug once or twice, then beds are made, and after that the earth is again dug. The ground is then pressed down with the back of a spade. When it is a little firm it is slightly raked, the beds are watered, and again loosened with a fine rake, and finally levelled. After that a ching (a measure) of moist earth and a ho (a measure) of seeds are taken and well mixed together. After having sown the seed it should not be covered with earth; indeed, earth on the top prevents germination. Cover with a slanting roof of matting. Before the seed begins to germinate, or when the young leaves first appear, the beds must not be watered. By means of a broom dipped in water the roof of matting is wetted so as to keep the ground underneath moist. When the plants are about two inches high the roof may be laid aside. If the earth is dry it must be slightly moistened to a depth of about 3 inches. A stiffer soil is now chosen and formed into beds, to which the young plants are to be transferred.'

"I followed the Chinese method in all its minuteness, with the most gratifying results. I have, therefore, no hesitation in stating that of the three modes of propagation open to the ramie planter—seed, stem, or root cuttings—the first appears to me to be the most practical, the cheapest, and probably the quickest in the case of a large estate."

Although one cannot go far wrong in adhering closely to the Chinese text, I think, for the sake of conciseness, the following may be substituted for it:—Germinate the ramie seed in open boxes in a roofed house. Fill the boxes with earth; for top soil take a light loam, and pulverise it thoroughly by passing it through a $\frac{1}{4}$ in. sieve; a slight admixture of burnt earth or dung will keep it moist without its being necessary to water it for some days. Mix a small quantity of the seed with one basketful of the prepared soil. Sprinkle this soil over the earth in the boxes. Do not water until after five or six days (sometimes ten days), when the seminal leaves begin to appear. When watering, use a very fine rose. When the young seedlings are from 2 in. to $2\frac{1}{2}$ in. high,

transfer them to the nursery in specially-prepared beds, planting them 3 in. apart. If taken out with a ball of earth round their roots they bear transplanting well, and from that time need only the usual amount of attention and care which all young plants require—shading, watering, and weeding.

Propagation by stem or root cuttings is generally assumed to be the most expeditious, producing a crop more quickly than by sowing. It may be so in the case of a small acreage—say, 500 acres. If 10,000 cuttings are procured for purposes of propagation, one may, after six months (it is not advisable to do so before) obtain a supply of root and stem cuttings—say, twenty from each original stool—which will bring the number of cuttings up to 200,000, capable of planting sixteen acres. Six months later, 4,000,000 cuttings may be obtained, capable of stocking, under favourable circumstances, about 315 acres. It will be fully eighteen months before the full acreage of 500 acres will be supplied. During that time there will have been but few, if any, stems available for crop, as they will have been cut up for purposes of propagation.

It is well known that propagation by cuttings is apt to bring degeneration, and it is necessary from time to time to revert to seed to obtain a healthy stock of plants; plants grown from seed possess the tap root, and are not so liable to spread their roots laterally to an undue degree. This is shown by the practice followed by the Chinese themselves in the cultivation of ramie: they reserve some of the best stems for seeding purposes. Notwithstanding the widespread opinion to the contrary, it appears that planting from seed is the right method, and that every effort should be made to follow it. In the few cases where good seed is not procurable, but only cuttings, it will undoubtedly be advantageous to reserve some of the best plants thus raised exclusively for seeding. When propagating from seed, a small crop of fibre may be available for sale the first year, the planting will be more systematic, and the growth of the stems more uniform, a great desideratum in view of obtaining fibre of one standard and one quality. The work of uprooting the stock plants grown from cuttings is a laborious one, which is dispensed with in the case of propagation by seed.

Plantations raised from seed are longer lived than those raised from cuttings. The Ram Ragh estate, planted in 1878, is still giving crop, notwithstanding the abandonment of cultivation consequent on the death of its owner in 1880. Of this I have most precise and conclusive evidence recently given me by the present occupier of the estate. Mr. C. Riviere, director of Hamma Garden, Algiers, says:—"Our trial to raise ramie from seed proved successful; 250,000 fine plants were obtained, remarkable mostly for their vigour, the size of the foliage, the height of the stems, and the fine development of their roots."

Experience has shown that former ideas respecting the space required for plants need modification. These were planted too far apart, and as a consequence the stems freely threw out branches. Each branch breaks the continuity of the fibres, and causes a larger proportion of short fibres. Too much space between the plants also favours growth of weeds.

Many enterprising men have put forth great endeavours to grow this fibre, and to bring it into practical use, and their experience has added materially to the general knowledge; but the growth of practical knowledge has been slow and the resulting failures many. One of the principal causes of this has been that each man in his department has been working with limited ideas, ignoring the fact that there must be a combined working together in order to ensure success. The planter has in many cases planted ramie without understanding its nature and requirements. The climate and the soil have been unsuitable, the treatment of the plants mistaken, the means of turning the proceeds of the crop into a marketable article have been wanting; hence failure and disaster.

For many years there existed a strong opinion—especially in France—that the most practical way to treat ramie stems was to dry them, and afterwards to decorticate them. The idea was good so far as it went, because, as in the case of flax and hemp, there are many advantages to be gained by cutting the crop, letting it dry, storing it, and extracting the fibre later on, when the labour of the farm is not otherwise occupied. It allows also of the possibility of sending the dried stems in quantities to central works to be treated on a large and economical scale. In tropical countries the drying process was a failure, because the stems fermented instead of drying in the humid climate, and artificial drying was too expensive to be adopted. This opinion undoubtedly retarded seriously the manufacture of ramie for many years, because it was based on two serious mistakes that have needed years to expose and overcome. Each stem of ramie is

surrounded with a skin or pellicle. This skin, if allowed to dry on the stem, assumes a brown colour, clings to the fibre with remarkable tenacity, and has been the cause of the major portion of the degumming patents that have been taken out. The chemists only partially succeeded in their treatment, because in removing the brown skin they too often attacked the strength of the fibre, destroyed its lustre, made it harsh and brittle, affected its character for receiving dyes, and matted it, causing great loss in combing.

The problem, commercially considered, has been to obtain a decorticating machine which can carry out economically the following processes without damaging the fibre:—(*a*) Remove all the woody parts from the green stems; (*b*) remove the outer skin or cuticle which has so long baffled all mechanical efforts to remove it; and (*c*) extract as much as possible of the juice of the stems so as to simplify and cheapen the degumming process. The two former processes are effectively carried out by hand-labour in China, where women and children scrape every stem and remove the skin and the wood, but leave most of the juice in the fibre.

All inventors of ramie decorticators have concentrated their efforts on machines to produce ribbons. Needless to say, the object aimed at fell far short of the real necessities of the case; hence some of the long delays and numerous disappointments with which this fibre is associated. Ramie ribbons or strips must always be considered unsatisfactory, and will, no doubt, in time disappear. The buyer has no means of readily testing their value, the quality and percentage of the fibre, and whether it has been damaged or not by the decorticating machine; hence his objection to an unknown article, in addition to which they cannot be highly compressed and packed into proper bales as other fibres are, because the large quantity of pieces of wood in them cut the fibre. They also contain a very large percentage of useless material on which freight has to be paid.

It has been reserved for a Frenchman, M. Faure, to construct a machine capable of producing, not ribbons, but fibre in one operation, free from woody matter and skin, and with the least possible amount of juice in it. The product is equivalent to China grass. A skilled engineer and machine maker, with every facility at his own works and ample means for carrying out his ideas, he had the benefit of another important advantage—namely, the growing of ramie on his own estate—which enabled him to practically test his ideas by actual experiments on the raw material—a combination of advantages probably not enjoyed by any other inventor of decorticators. Patiently and scientifically he has, step by step, worked out the problem, and the machine represents the result of his several years' labour. It is simple, inexpensive, and does its work admirably. It is fed by the insertion of lots of about ten stems. The stems are used in the same condition as cut, with the leaves on. The operation of feeding is as follows:—The stems are passed in twice. They enter the machine butt ends first, and having been treated about six inches of their length, they are withdrawn (an operation easily carried out) and fed in a second time, the leaf ends first, so as to complete the operation. It frees the stems from all woody matter and from the outer skin or cuticle, and extracts a large portion of the juice, thus producing fibre retaining all its valuable qualities.

The machine, which weighs 11 cwt., is very strong and not liable to get out of order. It consists mainly of the framework and driving gear, the decorticating drum carrying beaters and the feed bed. This latter is the important feature of the machine, by reason of its special contour, which varies at different parts to suit the various descriptions of work which the machine has to perform. The first part of the bed is curved outwards, the second is straight, and the third is curved inwards. The ramie stems are fed into the machine over the first part of the bed, where the woody portion becomes immediately broken and partly removed; the strip passes on to the second part, and as the speed of the beaters is considerably greater than that at which the stems are fed into the machine, a scraping effect is produced on the strips, seeing that the distance between the beaters and the surface of the bed is less than the thickness of the strip. This scraping action effects a double purpose: it attacks the outer skin and also all matters extraneous to the fibre. The strips or stricks of filaments then pass down vertically into the machine, and the separated matters—namely, most of the woody parts, the skin, and gummy substances—are thrown out to a distance by the centrifugal force of the beater drum. When the stems have entered to within a short distance of their end, the return movement is effected and they are withdrawn. During the withdrawal the following action takes place:—At the inward curve, or third part of the bed, the fila-

ments are slightly and gradually grazed by the beater blades, which throw out the coarser of the debris still adhering. The operation is performed with great delicacy; the fibres assume the position of the chord of the curve, and are constantly agitated by the beaters. When the fibres arrive at the second part of the bed, as the space between it and the beaters is infinitely reduced, the entire removal of matters still adhering to the fibres is effected, and these latter leave the machine white, parallel, and free from woody matter, from skin, and from the major portion of the juice. The concave bed or breast is mounted in such a way that its position to the action of the beaters is easily regulated. The brackets which carry the bed are supported by spiral spring cushions and flexible legs, the object being to obtain a rubbing action between the beaters and the fibre, having for its special object the loosening and removal of the skin or outer cuticle. The elastic bed gives way or vibrates an enormous number of times per minute, and this produces the described rubbing or "knuckle-joint" action between the beaters and the fibres on the bed. The shape of the feed bed causes it to remain clean and free from extraneous matter through the action of the beaters. Choking is thus rendered impossible. All abnormal strains are avoided, and the machine can be kept at work from morning till night without stoppages for cleaning. The refuse falls underneath the machine, and is removed from time to time. In the case of a number of machines working together, an endless band or conveyor, passing under the machines, removes the refuse continually, and so keeps the neighbourhood of the machines perfectly free from it.

The machine is capable of being easily worked by native labour in the ramie plantations, or in works connected therewith. Although simple, it needs to be constructed with the greatest accuracy in order to ensure effective working. The cylinder, carrying the steel beaters, is perfectly balanced and accurate in its action; it runs at 250 revolutions per minute; the surface of the beaters is perfectly parallel with the setting of the feed-bed, and capable of working close up to it, say within a distance equal to the thickness of a piece of writing paper. The feed bed, the varying profile of which is of such enormous importance in the efficacy of the machine, is made with the greatest of accuracy by special machinery.

With regard to the production, practical experience shows that one machine, worked by two men, can treat 360 lb. of fresh green stems per hour, or about 32 cwt. per day of ten hours. The amount of dry fibre produced depends largely on the nature of the stems; the percentage of fibre contained in green stems varies very much according to circumstances. On a 5 per cent. basis the net production of dry fibre of each machine per day of ten hours is 180 lb. When the stems are specially good, 200 lb. of dry fibre have been produced per machine in ten hours. Under ordinary circumstances, a production varying from 160 to 200 lb. of dry fibre in ten hours per machine may be expected. Each machine requires about 1 indicated horse-power to drive it. When a number of machines are working together less power will suffice; thus, 8 horse-power will drive ten machines. The machines produce a fibre which ranks in the market with China grass, by reason of its regularity in condition and quality. The buyer can easily see and test what he is buying. He is therefore able to give it its proper classification and pay its full market value; in addition to which, by reason of the bales being well pressed and containing little else than ramie fibre, the freight and expenses per ton are reduced to a minimum.

Green stems grown in a tropical or sub-tropical climate give the best results. The growth being quick, the stems carry plenty of fresh green juice, which assists the decortication very much by leaving the fibre freely and carrying with it in its downward course from the beating point of the machine large quantities of extraneous matter. The condition of the stems at the time of treatment also plays an important part. In order to ensure the best possible fibre, the stems should be treated within a few hours of being cut. They should not be over-ripe, as the fibre deteriorates after the stems have arrived at maturity. The best plan is to cut them either just at full maturity or slightly before. The fibre thus obtained excels in whiteness and ductility, retains its full lustre, and shows to the best advantage during subsequent manufacturing operations, such as preparing, combing, spinning, dyeing, etc.

The machine has worked during all the seasons since 1894 in the presence of experts and fibre growers. In each season it has treated two crops, and the fibre obtained has proved, after degumming and combing, to be equal to the best China grass. It is claimed for this

machine that it has solved the question which has heretofore been one of the chief difficulties in connection with ramie.

The grower can now produce ramie fibre from his stems in such a condition that it needs only drying, packing, and sending to market in order to turn it into money, and as the margin of profit is large, there can be no doubt that the cultivation of ramie will henceforth increase each season. The position of the manufacturer is entirely changed. His raw material will come into the market in regular quantities in a condition in which he can easily utilise it, so as to enable him to be sure of an ample supply. The cost of extracting the fibre from the green stems, drying, and packing it into bales, amounts to about 3s. 9d. per ton of stems treated, or £3 15s. per ton of dry fibre obtained— when working with ten machines and native labour at 1s. per day— including motive power, stores, etc. If the labour is calculated at 2s. per day, the cost will be 5s. 1½d. per ton of green stems, or £5 2s. 6d. per ton of dry fibre obtained, assuming that the stems give 5 per cent. of fibre. The cost of extraction is, of course, liable to be much affected by the price of labour, the cost of motive power, and by various local circumstances.

The way is now clear and open for great progress in this industry, but it must not be too readily assumed that there is going to be an immediate boom in ramie; the very nature of the circumstances attending its cultivation prevent such an occurrence. Everything points to a certain but gradual development. I do not anticipate that the cultivator will proceed otherwise than cautiously in planting and producing fibre. As soon as he has thorouhgly realised that there is a ready sale for his fibre at good and profitable prices, he will doubtless increase his production methodically and energetically. The progress will be steady, and in the proportion in which the increased supplies of the fibre come into the market will be the enlargement of existing mills, the starting of new mills, and the increased use of the fibre in all manner of goods for which it is adapted.

The trade is now on a sound and practical basis as far as immediate requirements are concerned. The supplies of China grass, though at times irregular in quantity and quality, and subject to considerable fluctuations in price, have enabled spinners to attain their present position in the market and to show to the manufacturing world what can be accomplished with the fibre. There can be no doubt that the present situation warrants and justifies the encouragement and immediate development of ramie cultivation in all the countries the climate and soil of which are favourable to the growth of the plant. This will ensure regular, ample, and cheap supplies of the fibre from a variety of sources, and free the spinner from dependence upon one channel of supply only—namely, China. Visionary schemes have been swept away by hard experience; our knowledge of the splendid qualities of this fibre and the mode of treating it has grown enormously, and we may, therefore, look forward to its manufacture being rapidly increased and freed from speculation and costly experiments.

In a recent letter received from a large spinner of ramie, I was much struck with an expression he used in relation to this fibre— namely, that it is the "noblest" of all fibres. I thoroughly agree with him. It is a true description, and I have endeavoured to show that it is indeed superior in so many respects as to justify its being placed at the head of all textile fibres.

APPENDIX B.

The following is an extract from an article in the "British Trade Journal" of May 1st, 1898:—

IMPORTANT PROGRESS WITH RAMIE FIBRE: IT ENTERS A PRACTICAL PHASE.

In a paper read by Mr. Thos. Barraclough at the Imperial Institute, London, W., under the auspices of the Society of Arts, on the cultivation and manufacture of the above fibre, which is printed in the "Journal" of the Society of Arts for April 2nd, 1897, he laid stress on the fact that one of the principal reasons why this fibre has not yet taken its proper place in the textile market is, that in its various stages, beginning with the cultivation of the fibre and ending with its manufacture into textile goods, there has been an entire absence of sympathy and co-operation between the various parties whose interests are involved—the grower, the merchant, the spinner, the manufacturer, and others.

When the 1897 crop of ramie grown on M. Faure's estate in France (first cutting) was almost ready for decortication, Mr. Barraclough invited a number of gentlemen interested in the cultivation of ramie to meet together at Limoges in order to personally inspect the Faure decorticating machines at work extracting the fibre from the green stems, and to carefully test the fibre produced. These gentlemen represented firms and planters of ramie in the Straits Settlements, South India, Southern Russia, and other countries. With the view of securing the personal sympathy and the active co-operation of ramie spinners and manufacturers with ramie growers, and of bringing about an interchange of ideas so as to ensure a community of interests, Mr. Barraclough also specially invited some ramie spinners to be present during the trials, to test the Faure machine and the fibre it produces, so as to assure themselves that the fibre is thoroughly well adapted for their manufacturing requirements. The invitations were cordially accepted, and the presence of the invited guests at Limoges during the tests was a signal proof of the importance they attached to a full consideration by both the growers and manufacturers of ramie of the many questions involved in its production and utilisation. One of the gentlemen present, who had personally worked the Faure decorticating machine in Sumatra, was pleased to inform the other visitors that the Faure machine had been tested on a plantation in Sumatra, owned by a company of which he is managing director, and the results obtained were thoroughly satisfactory; that he was then in Europe with the view of completing arrangements to enter largely into the cultivation of ramie and of purchasing a considerable number of Faure machines.

The crop of ramie stems at Limoges was cut, the fibre extracted by the Faure machines in the presence of all the gentlemen who had accepted the invitation, and on July 27th, 1897, an important conference and discussion was held at Limoges, in which every one of the visitors took part. The discussion referred mainly to three points:—(1) Are the visitors satisfied with the construction and working of the Faure machines? (2) Is the fibre produced by the machines equal to ramie fibre decorticated by hand, as in China, and known in the trade as China grass? (3) Is the mechanical decortication of ramie a success?

After full discussion of the various points, a resolution in French was proposed, of which the following is a literal translation, unanimously adopted and signed:—"Limoges, July 27th, 1897. The undersigned, present at the trials made by M. Faure with his new machine for decorticating ramie, are pleased to declare that the results obtained have completely satisfied them. Their opinion is that the decortication of ramie by the Faure machine is quite equal to that done by hand. They express their opinion that the problem of mechanical decortication is now solved under conditions absolutely satisfactory."

This testimonial, emanating as it did from men practical in the cultivation, preparation, and spinning of the fibre, cannot fail to be regarded as a distinct step forward in the direction of success for ramie. China grass, being ramie prepared by female labour in China at a mere nominal cost, is virtually the only ramie fibre that is at present on the market [1897] and the few important spinners of the fibre in France and Germany have been practically limited to China grass as their raw material. The supply of this fibre is variable, and the price is generally considered much too high for an extensive use from the manufacturer's point of view. The result of the conference has a very important bearing on the trade, because it asserts that ramie decorticated by Faure's machines is equal to China grass, and it necessarily follows that the supply of the fibre will be virtually unlimited, seeing that any quantity of decorticating machines can be set to work.