Introduction.—During the last 18 months you have probably noticed a number of references to flax, both in the press and on the radio. Flax is urgently required by the British Government for the manufacture of essential articles, such as:

Shoe Thread for the sewing of boots, canvas, etc.

Manufacture of Canvas, Parachute Tape, Kite Cord, Balloon Cord, and many cords and threads used in aeroplane construction.

Webbing Equipment, and a great variety of other articles.

Flax has been grown in Australia for many years, but not always with financial success. In 1935 a fresh attempt was started in Victoria. Arrangements were made with the Linen Industry Research Association of Northern Ireland for technical advice, and for the supply of the latest types of pedigree flax seed. The latest methods of processing the straw were studied in England and Belgium, and an Automatic Scutcher was imported. In 1936 500 acres were grown and treated, one thousand in 1937, twelve hundred in 1938, and two thousand acres in 1939. By this time three mills were in operation in Victoria, and the first Australian-made automatic scutcher had been produced and was in operation, and all the fibre produced had been used by Australian spinners.

At the outbreak of war, with Baltic, Holland, and Belgian supplies doubtful, arrangements were made to increase the area under cultivation to 12,000 acres in order to provide for the anticipated Australian demand. This was a sixfold increase in one year, and a 24-fold increase over 1936. Just as the organisation of this increased programme was nearing completion, an urgent appeal was received from the British Government. They asked if an additional 13,000 acres could be planted at once. The Federal Government, which had taken control of all flax mills, appointed a Flax Production Committee, and in 1940 a total area of 21,000 acres was planted.

At this time four existing mills were available, with a total of four automatic scutchers. An additional ten mills had to be built. De-seeding machines, winnowing machines, and twenty automatic scutchers had to be manufactured, installed, and ready in just over seven months.
For the 1941 season the United Kingdom made a further appeal for flax, and the present programme, embracing Victoria, Tasmania, South Australia, and Western Australia, covers 60,000 acres, which will produce approximately 100,000 tons of straw. Naturally, additional milling equipment will have to be installed, existing mills enlarged, and new mills erected. Thus, in six years, an industry which was in a very precarious state, has increased 120 times. Such expansion is forced, and does not allow the proper time for the most efficient planning; but it had to be done, and it has not been necessary to import any of the processing machinery so far. It has all been made in Australia.

That is a very brief history of the last few years of flax production in Australia, and as the undertaking should produce fibre and by-products, valued at approximately 1 1/2 million pounds, it is of considerable interest both as a primary and a secondary industry.

**Ancient Methods of Flax Production and Preparing of Fibre and Spinning.**—Here we have a sheaf of flax straw complete with the seed bolls. In early days the seed was removed by pulling the seed head through a coarse comb, and collecting the bolls and seed on a tarpaulin. This is straw which has been dew-retted. After de-seeding, the straw is spread out in paddocks, where, under the action of dew, rain, and sun, fungi act upon the pectines and gums which hold the fibre bundles to the central woody core. This takes from five to eight weeks according to the weather conditions, and during that period the straw must be turned over once. Now that the straw is retted, you will find that the central core is more brittle, and that the fibre can be separated quite easily.

In order to produce the fibre contained in the retted straw, it was usual to beat or break it with a mallet, and when the central core was sufficiently broken to scutch the woody core or shive away from the fibre with a hand blade, until the fibre was quite clean and parallel. The fibre was then made up into bundles, taken to the local market, and sold. You will see that from the growing of the straw to the production of the finished flax fibre practically no equipment was required, and the whole process was well suited for a peasant industry.

The first mechanisation came in the breaking and scutching. Power-driven fluted rollers soon displaced the mallet breaking, and a revolving wheel, with a number of blades secured to the periphery, did away with the hand scutcher. Thus scutch mills were established, and in most centres displaced the peasant
industry. However, this was not the case in Russia and the Baltic States, and it is only during the last few years that the industry has been mechanised in those countries.

To-day with the automatic scutcher the retted straw is fed on to a conveyor belt, passes through a series of fluted rollers to break the straw, and then to a pair of turbine scutchers which scutch first one end and then the other, so that scutched fibre is delivered at the far end, a process taking about 30 seconds. The fibre is then graded, made up into bales, and marketed. Recently we received a film from England which will give some idea of the growing and processing of flax. In Australia we do not follow out exactly similar methods. Our areas are larger and our finances smaller than those overseas. We have had to devise methods to suit our own conditions, just as others before have had to evolve an entirely new technique for the growing and harvesting of wheat. In this we are co-operating with the manufacturers of agricultural machinery in order to develop machines particularly suited to Australian conditions.

[An interesting film was then shown. It covered the whole process from the preparation of the land to the spinning of the flax.—Editor.]

Mechanical Spinning.—We know that a yarn can be produced by twisting the fibres together with the fingers, and no doubt that method was practised. The first mechanical spinning employed as aids the distaff and the spindle. The distaff holds the flax so that the spinner can draw off the fibres required, and the spindle which has imparted the twist and stored up the yarn already spun.

To illustrate this method I am using a pencil and a potato. The potato is only a fly wheel, and in the earliest days it was made of baked clay, a drilled stone, or ornamented pottery. The distaff is held under the left arm with the flax hanging down, a few fibres are drawn off, twisted, and attached to the spindle, the spindle is given a sharp twist with the right hand, and more fibre is drawn away from the main bunch with the right hand. During this time the potato has been rotating the spindle, and twist is put into the fibres that were drawn off. This is spinning, and has not changed from that day to this. When the yarn has become so long that it nears the ground, the operation is stopped. The yarn spun is wound around the spindle and the cycle started again. You will appreciate the magnitude of the spinner’s task. This method was carried on for centuries, and some of the finest fabrics ever woven were
made from yarns spun in this manner. In India cotton was spun to 500's in this manner. Thus if one pound of cotton was spun to 500's it would become a yarn over 230 miles long. To do this a very fine spindle was used, and its bottom end was supported on the concave side of a shell resting on the ground.

As you see, this was an intermittent process, and the next step was to first, increase the speed, and second, reduce the stops. This was achieved by the spinning wheel (incidentally, we have jumped a few hundred years, but as I say it quickly, it will not bother you).

In this machine—(for if you doubted the mechanical aids I spoke of in the last demonstration you must admit that this is a machine, and as you will see if you examine it, a machine in which the maker has taken great pride to show his skilled craftsmanship)—we have the same distaff, but held mechanically, not manually. This gives us our supply of fibre. Now comes the big improvement, a flyer and bobbin. The flyer is driven by foot power through the medium of a treadle and a rope-driving wheel. This imparts the twist to the yarn, and instead of stopping periodically to wind the yarn on the spindle, a bobbin is provided to receive the yarn continuously.

In principle this method is in use to-day in the spinning of all types of fibres, although spinners differ in various respects. However, the mule as used in the woollen trade is more closely related to the first and older method.

Slides were then shown with the following comments:

This slide shows one of the earliest types of containers for sliver, and was in vogue for over one hundred years in the flax, hemp, and jute trade. The container was made of sheet iron, and the sliver was packed in by a juvenile operator. When it was full it was changed. As it held a comparatively small amount, the number of changes per hour was approximately twenty-five. From that we go to the first of the more modern types of containers, a larger can, lighter as it was made of fibre with steel reinforcing at top and bottom, but being larger in each direction, it was necessary to traverse the can sideways and traverse the sliver back and forth. It was still packed by hand, and when the can was full it was changed by the operator. From this the next step was to pack and change the can mechanically, so we come to this type which in its day was considered very efficient. The next improvement was entirely different, for instead of trying to improve on the existing methods, an entirely different line was explored. The main idea was to dispense with this can or container, and a roll
was evolved. This roll started itself off, rolled to its predeter-
mined size, was ejected and a new roll commenced automatically. Then the operator rolled this large package to the next machine. At first a roll of sliver was produced weighing 45 lbs. To-day this roll has increased to 150 lbs. So while we started off with an effective package of 25 lbs., plus a container of 18 lbs. and one operator, to-day we have a package of 150 lbs., but no container and one-fifth of one operator.

**Electrical Application.**—The original method of driving the various machines was by means of line shafting from a central engine house. An early innovation introduced individual motor drives fitted to each machine. This opened a very large field for electrical ingenuity.

First, choke signals were fitted. These indicated by means of Klaxons that all was not right. The operator should then stop the machine and attend to the trouble. This was a great improvement, but the next step was to arrange the stop motion so that the motor was stopped without relying on the human element—i.e., the operator. In general the forces that are available to operate these stop motions are very small, and the method used to amplify this small force is both effective and simple. A bob weight is balanced just off the vertical (just enough to be stable with the usual machine vibration), but when a small force is applied it is enough to move the bob weight to an unstable position, it falls, and after passing through 90° operates a switch. It is English practice to arrange this switch to actuate a solenoid which throws off the belt. In Australia we find that our Star-Delta starters and contactors are so robust that we use the switch to actuate the no volt release. This has been applied to all types of drawing frames and gillspinners.

**Flyer Balancing.**—A flyer is a deformable body, its deformation depending upon its speed, and therefore balancing must be effected by trial and error. This is a monotonous job, and only certain types of people are suitable for it.

**Roller Grinding.**—For certain high grade types of flax yarn the main drawing roller must be round and parallel. When the roller becomes worn more than eight to ten thousandths inch, it is necessary to true up the roller. As this roller is made of high carbon steel, and is ground by the makers, it must be ground to recondition it.

These rollers are up to 18 ft. long, with smaller journals at approximately 3 ft. 9 in. centres. As far as I know there are
no machines in Australia that will do this work. The centreless grinder is not of any use, as the journals are of smaller diameter than the portion to be ground, and also the ground portion must be absolutely concentric with the journals. After a good deal of experimentation a method was evolved using a 12 ft. stroke planing machine. The underlying principle of this operation being that a 4 ft. movement on a 12 ft. bed gave a most accurate traverse. The roller was mounted on plain bearings, and its axis aligned by shims to be parallel with the line of travel of the table. At the commencement of each grinding this was done by a dial gauge held in the tool holder, and as the table traversed back and forth the readings were taken, but when grinding had taken off most of the high spots the parallelism was corrected by measuring the diameter of each end, and making corrections accordingly. For grinding, a suitable wheel was mounted on the tool holder and driven by a 2 h.p. motor. To get a fine adjustment to the wheel, the feed screw of 8 thread per inch was replaced by a feed screw 20 threads per inch. The feed screw hand wheel of 8 in. diameter was replaced by a hand wheel one 24 in. diameter (actually one from a laundry mangle). By this means an increase of one thousandth per inch of feed on the grinder was comparatively easy (about 1 1/2 in. on the circumference of the large hand wheel). The roller to be ground was rotated by a separate 1/2 h.p. motor, which with suitable reduction gear was mounted on the table itself. This motor was fed by a flexible cable. Naturally, the grinding wheel speed, roller rotation, traverse speed, and grain of wheel had to be found and adjusted to get good results. The whole arrangement was an improvisation of existing plant, and after quite a few errors, the results achieved were really satisfactory.

It will be interesting to note one detail in this comparison. Flax yarn has a definite abrasive action, and cuts through the flyer eyes very quickly. In the first type of modern spinning frames it was found advantageous to stellite the eye of the flyer. This was better than mild steel, but a further improvement was effected when replaceable hardened steel inserts were fitted. This was good practice until tungsten carbide inserts were moulded to the correct shape and brazed in, and that is the most advanced current practice.

After all that, are we so far ahead of the old craftsmanship of 400 years ago? If you examine the flyer eye in the 15th Century wheel you see before you, you will see that it is fitted with an agate insert. I do not know what the Brinell number is for agate, but it is fairly high.