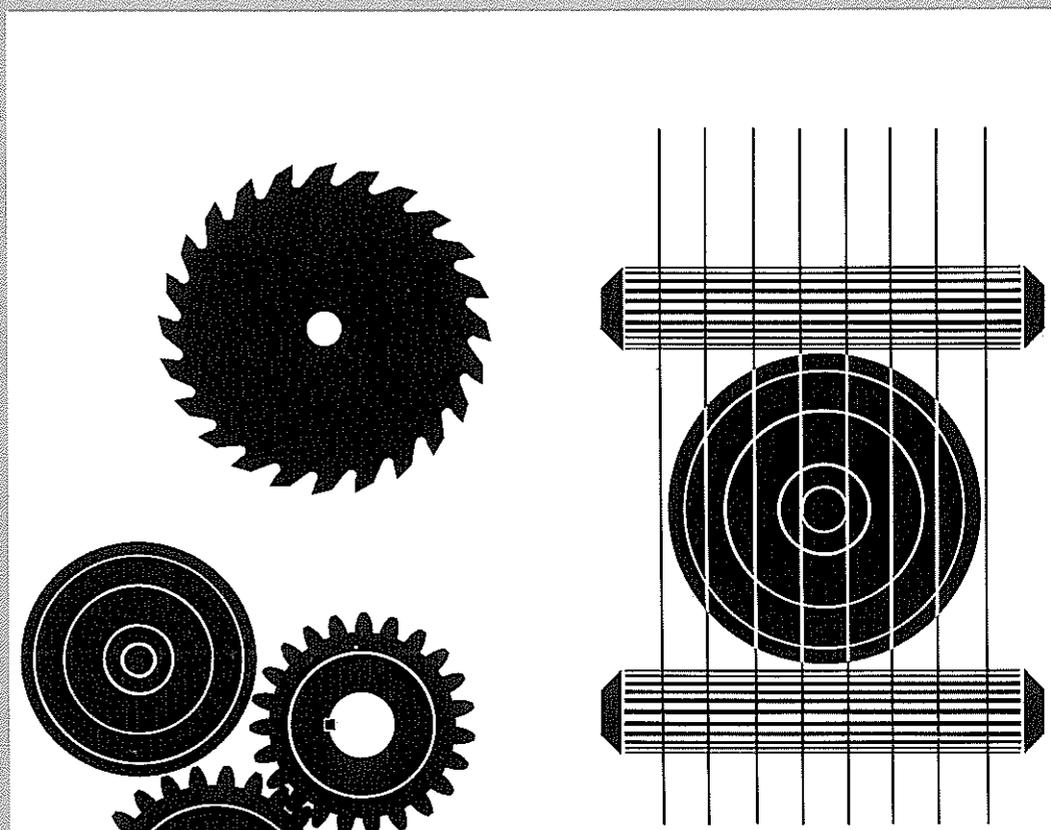


circular saw manual



FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

ROME

fao/sida sawmill manuals

circular saw manual

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INTRODUCTION

This manual, which is the second in a series of sawmill manuals, deals with the construction and operating principles of circular saws of different types. The manual is focussing on the basic, single blade sawbench but also describes modern circular saw equipment.

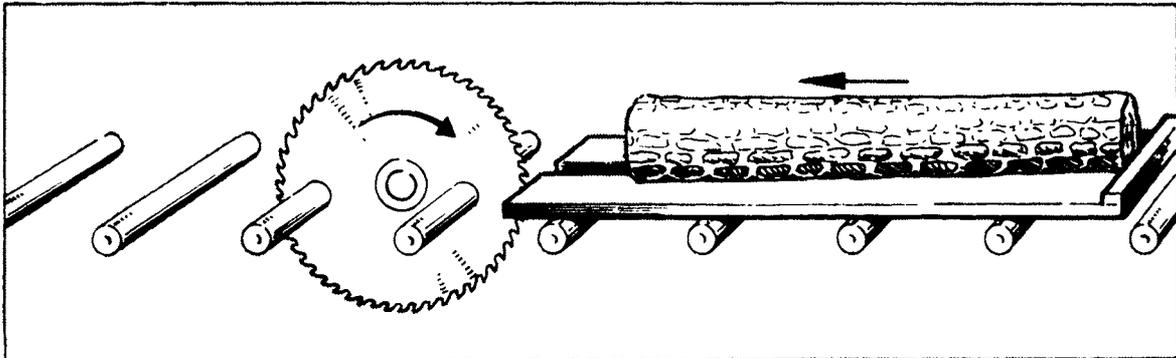
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I CIRCULAR SAWS, GENERAL

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1. Background

Mechanical breakdown saws are mainly of four types: frame saws, circular saws, band saws and reducer saws. Of these the frame saw is the oldest type. In fact, in 1596 frame saws already existed in Holland and Germany. The circular saw was patented in 1777 by the Englishman, S. Miller. This saw was driven by a windmill and had an infeed table which was fed towards the circular saw by means of a cog-wheel shaft driven and geared from the saw shaft. In 1792 the circular saw was manufactured in the U.S.A. by B. Bruce. The blade was of 320 mm diameter and had six radial slots for cooling.

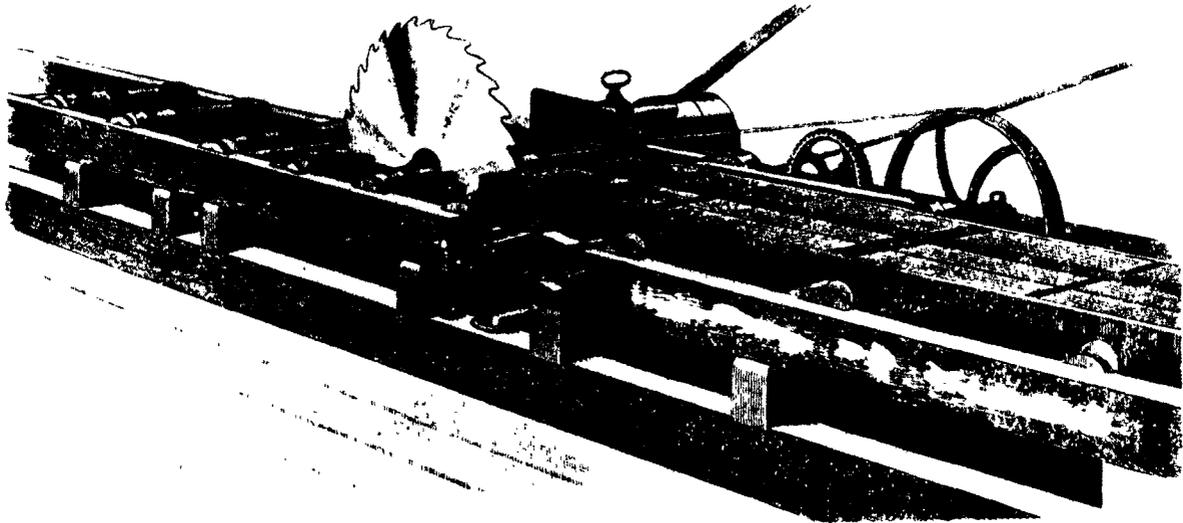


Fig.1

Figure 1. Circular sawmill from the year 1900. Frame, table and rollers are made of wood. Required energy: 6 kW. The mill enabled cutting with four different feeding speeds. Comparison could be made with a modern, single blade cant saw, as shown in Fig.2.

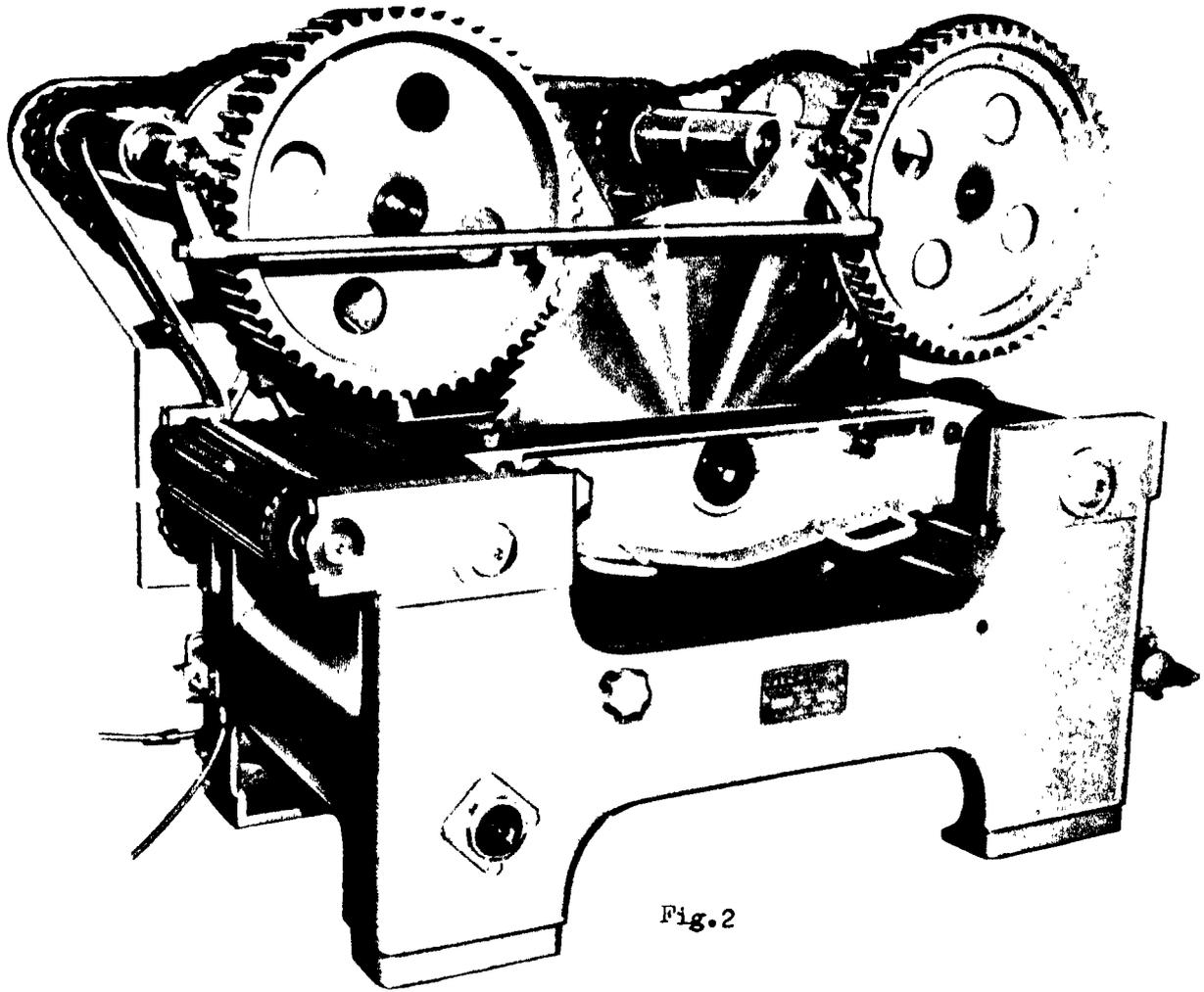


Fig.2

Figure 2. Modern, single blade cant saw made of cast iron and steel. Required energy: main motor 40 kW. Feeding speed varies from 23 to 45 m per minute.

The circular saw is the most common of sawing machines and is used the world over. It is usually cheaper than other types of saws and it also requires less expensive foundations. Maintenance of circular saws is generally easier than for other saws. There are, however, some disadvantages which will be described later in this manual.

2. How a Circular Saw Works

The most common operations of sawing are shown in figure 3 below:

- a) Cross-cutting when the saw teeth cut across or at angles to the grain.
- b) Rip sawing when the saw teeth work along or parallel to the grain. This is also called split sawing.
- c) Edging, which is another form of rip sawing.

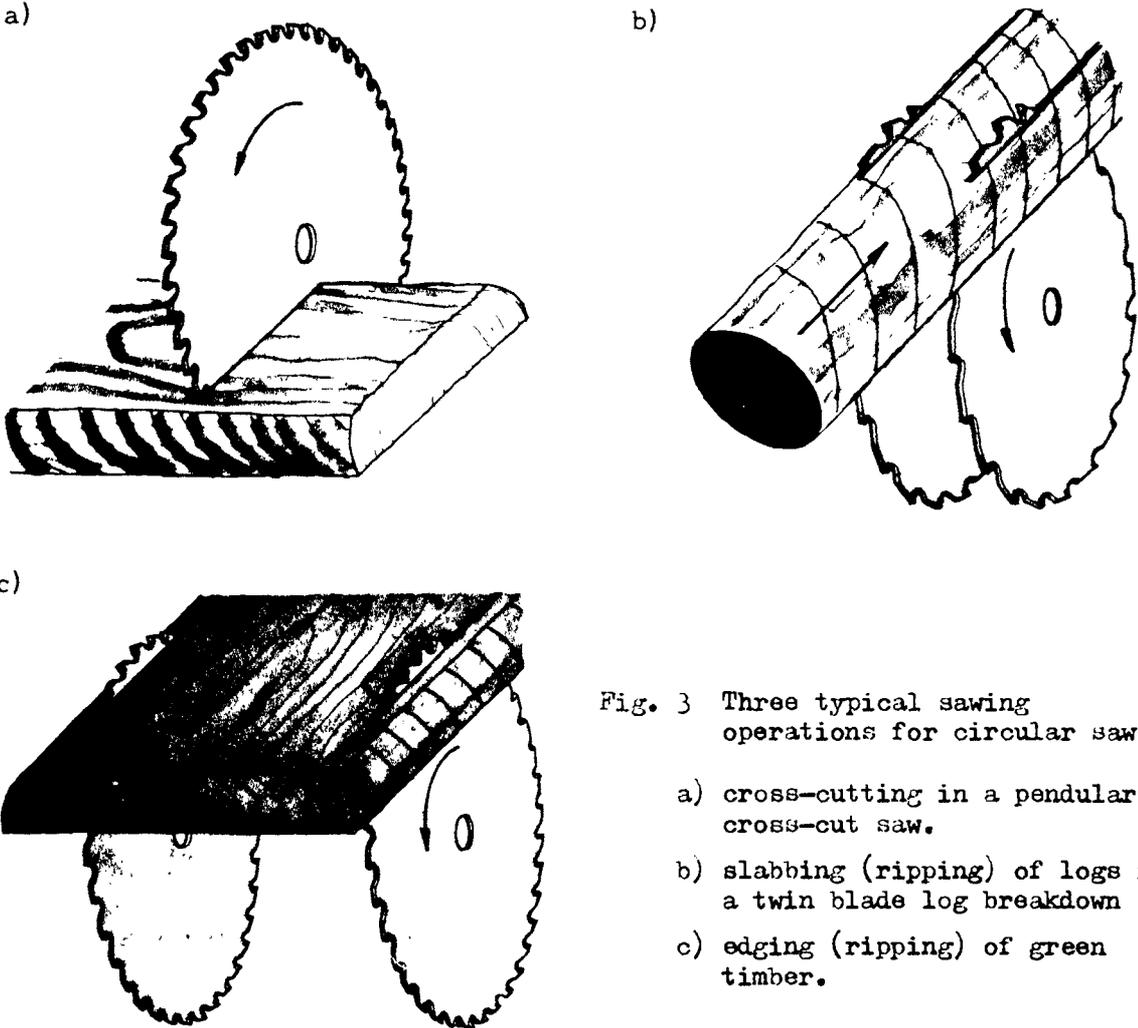


Fig. 3 Three typical sawing operations for circular saws:

- a) cross-cutting in a pendular cross-cut saw.
- b) slabbing (ripping) of logs in a twin blade log breakdown saw.
- c) edging (ripping) of green timber.

For cross-cutting and edging circular saws are almost exclusively used in saw-mills. Circular saws are also used for splitting (ripping) logs as well as dry timber.

3. Circular Sawing Principles

Figure 4 shows basic principles for circular sawing. It shows the principle of breaking down logs by using a single sawblade. The sawblade is a thin, circular, tough, hardened metal sheet, in which teeth have been punched. Figure 4 gives a schematic picture of rip sawing with a single sawblade.

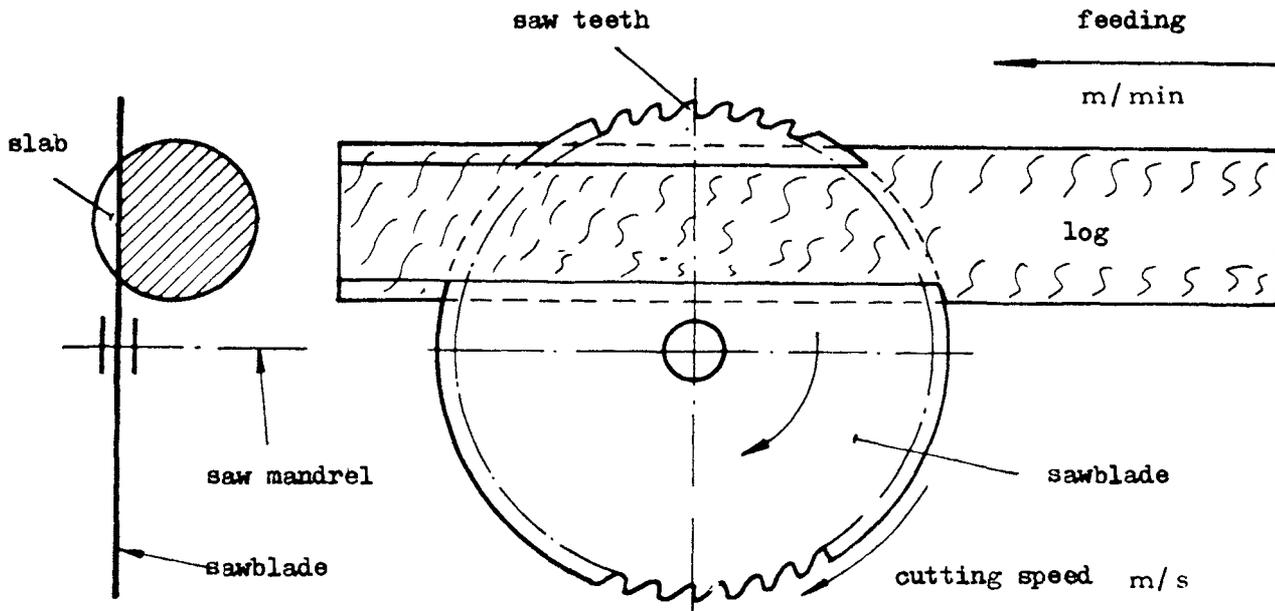


Figure 4 Schematic picture of rip sawing
(in this case log breakdown) with a
single saw blade

The rotating sawblade is mounted on a saw mandrel driving the sawblade with a certain rotation speed. The rotation speed is normally expressed in revolutions per minute, r/min. The saw teeth have a certain cutting speed; the cutting speed is expressed in metres per second, m/s. A common cutting speed for a standard sawblade is 45 - 50 m/s, corresponding to 160 - 180 km/hour. Materials to be cut in this case (Fig.4, a sawlog) is fed towards the rotating sawblade with a certain feeding speed; feeding speed is expressed in metres per minute, m/min. The amount of sawdust that every saw tooth is able to cut regulates the feeding speed. Common feeding speeds are 10 - 50 m/min.

4. Circular Sawbench

Compared with a frame saw a circular saw is a relatively young type of sawing machine. Production of sawblades of acceptable quality commenced about 1850 when rolled laminated steel was first available. The circular sawbench was and still is technically fairly simple. It consists of the following main components:

1. Frame with infeed table
2. Saw mandrel with bearings, driving device and motor
3. A circular sawblade
4. Feeding device

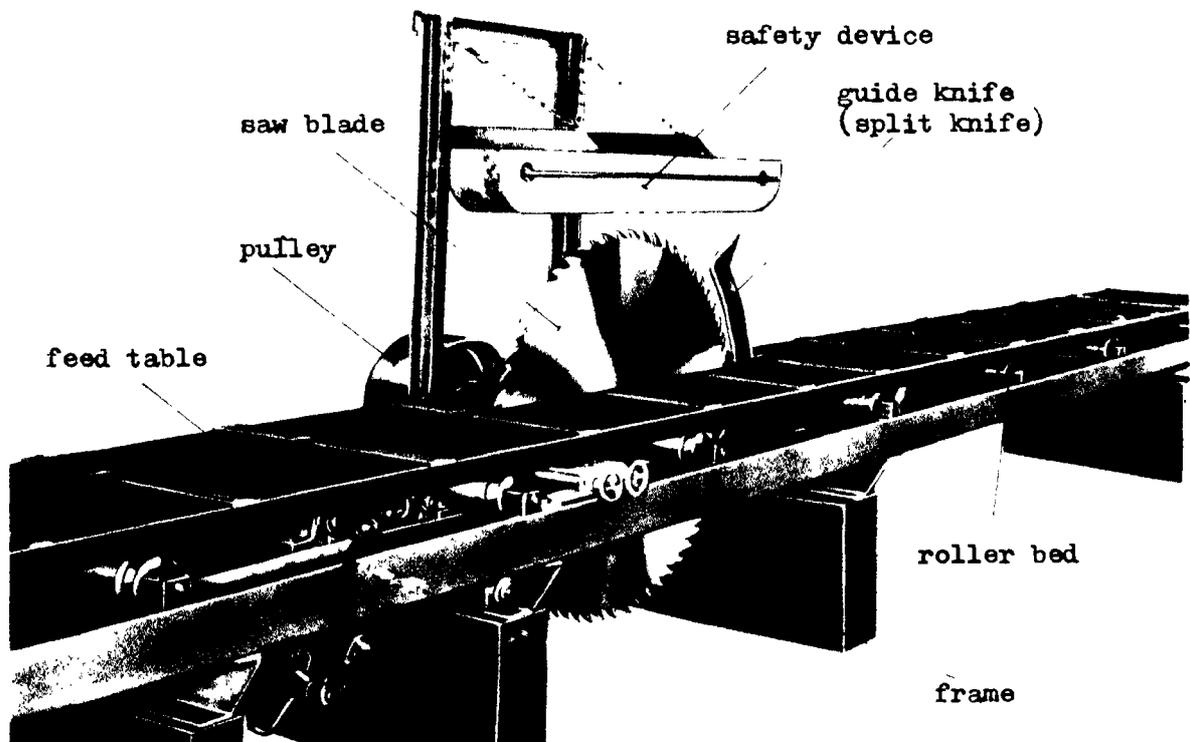


Figure 5 Circular sawbench with a single sawblade and hydraulic table feed. Some technical data:
maximum diameter of sawblade, 1.5 m
Speed of saw mandrel: 750 revolutions per min.
r/min. Infeed table length by width
10 000 x 720 mm. Required energy 30 - 40 kW.

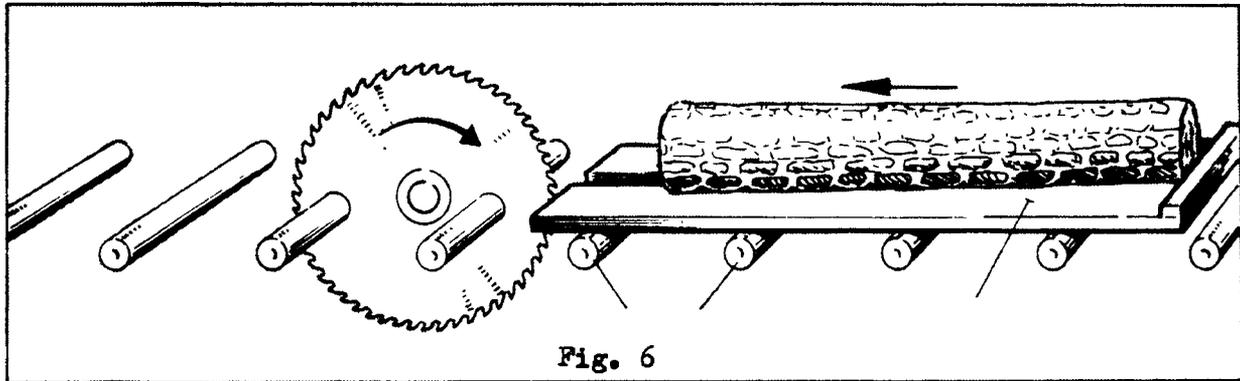
Figure 5 shows a circular sawbench with a single blade. This machine can be used for ripping and edging but not for cross-cutting. The frame of the machine is built of welded steel profiles; the total length of the frame is about 17 m. The infeed table, which is slotted to let the blade pass, moves on a roller bed. It is driven forward and backward by a chain from a hydraulic motor. Feeding speed varies from 0 - 82 m per minute.

Special attention should be given to the guide knife whose function is:

- a) To prevent the log or cant from turning over.
- b) To open the saw out to prevent extensive friction between the sawblade and the wooden materials which may result in overheating of the blade and in dangerous 'kickbacks'.

5. How the Circular Sawbench Works

The operation of the circular sawbench is illustrated in figure 6. In the middle of the bench and perpendicular to its longitudinal direction a shaft is placed in a machine frame. On this shaft a circular sawblade is mounted and rotated.

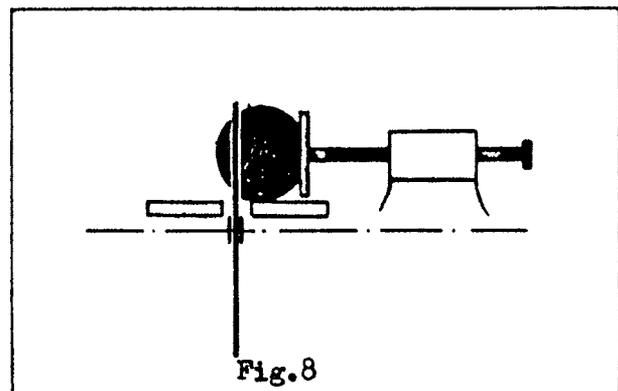
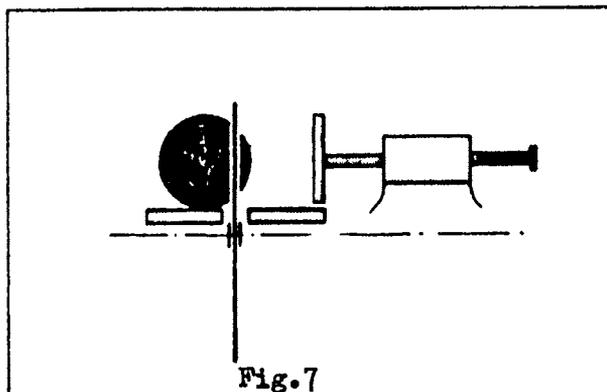


In front of and behind the circular sawblade there are roller beds on which a saw table, divided into two parts, can be moved to and fro. Each part is situated on either side of the longitudinal direction of the circular sawblade.

The log to be sawn is placed on the table, where it is properly positioned and clamped. The saw table, or saw bench, is then moved forward so that the sawblade cuts the log longitudinally. Before the next cut can be applied the saw table must be reversed to the starting position for the remaining part of the log to be re-positioned.

In principle, the positioning of the log is done in two ways:

- a) While the log is still round it is positioned to cut off a wing to best advantage. (Figure 7).
- b) When one or two cuts have been sawn and one wishes to saw a cant or a piece of wood of a certain size, it must be measured. An adjustable plate called a fence is used so that the flat side of the log is supported by it during the forward movement of the table. (Figure 8).



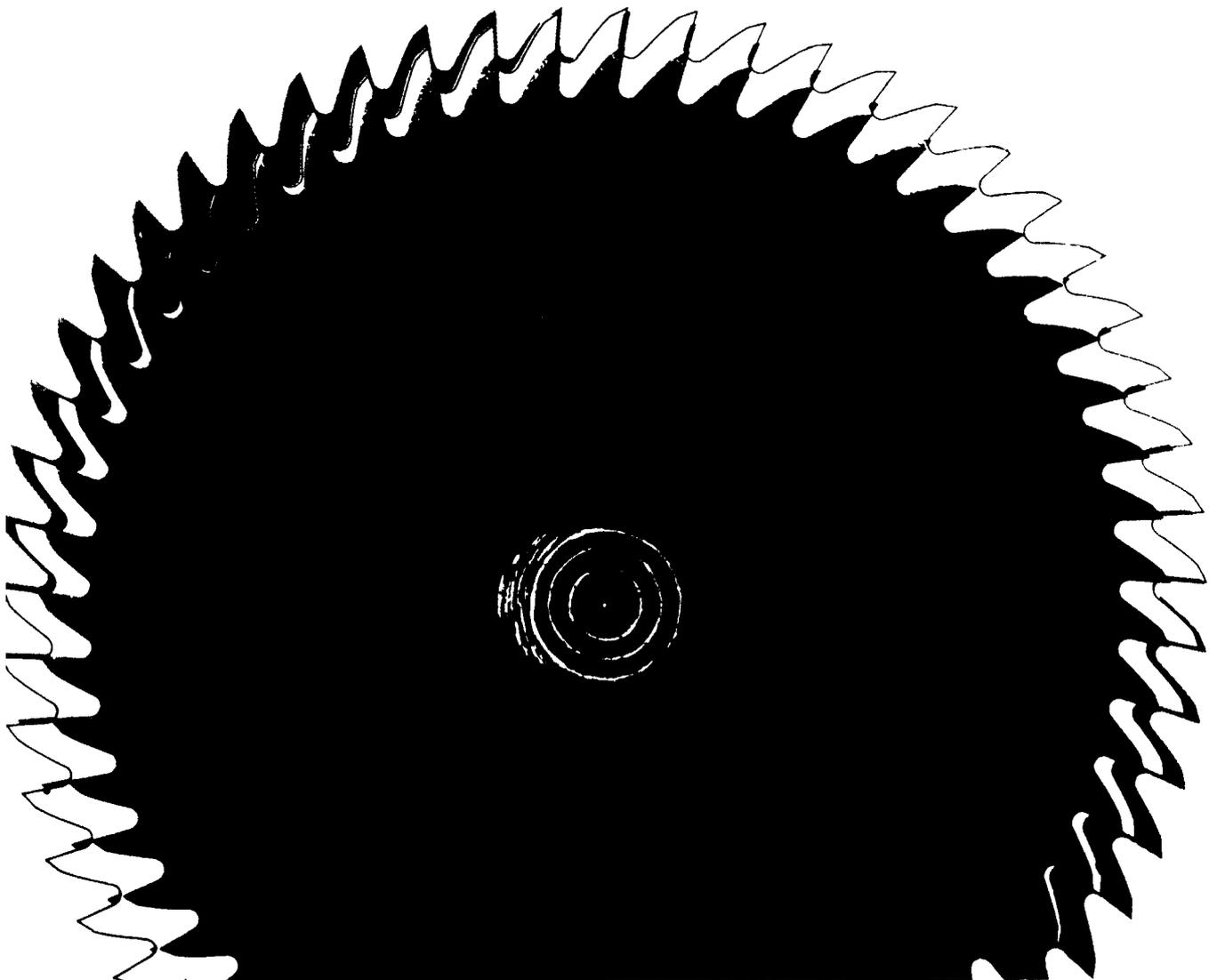
As we have seen the circular sawbench has three important parts that must each work correctly together to ensure a good result.

- a) The circular sawblade must rotate in the right way and must be correctly located in the sawbench.
- b) The saw table on which the log rests must move correctly in relation to the sawblade.
- c) The fence must be correctly positioned in relation to the sawblade and the saw table.

In this manual some common faults in rotation and centring of the circular sawblade are described.

II CIRCULAR SAWBLADES (MANUFACTURING)

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1. General

The economy of the woodworking industry relies to a large extent on the production capacity and the endurance of the cutting tools. It is, therefore, of the greatest importance to choose circular sawblades of the highest quality. When buying a cutting tool the basic rule should always be to choose quality and not consider only the price. There is normally a standard sawblade for every type of woodworking.

There are standard sawblades of different dimensions and with different tooth shapes for a large range of cuttings, as for example:

- a) Ripping, cross-cutting and edging of softwood, green or dry.
- b) Ripping and cross-cutting of different hardwoods, plywood and veneer.
- c) Block sawing and panel sawing of particle boards and fibreboards.

Figure 1 shows two different types of sawblades.

2. Steel Qualities

The basic material for manufacturing sawblades is hot or cold rolled steel, which is purchased as rounds, i.e. round steel plates. The rounds are punched with or without centre hole, within the following dimensions: diameter 100 - 3 000mm; thicknesses 1.0 - 18.0 mm. Rounds for diameters up to 400 mm and with thicknesses up to 5 mm are normally made of cold roll steel strips. When larger diameters or thicknesses are required, hot rolled steel is used.

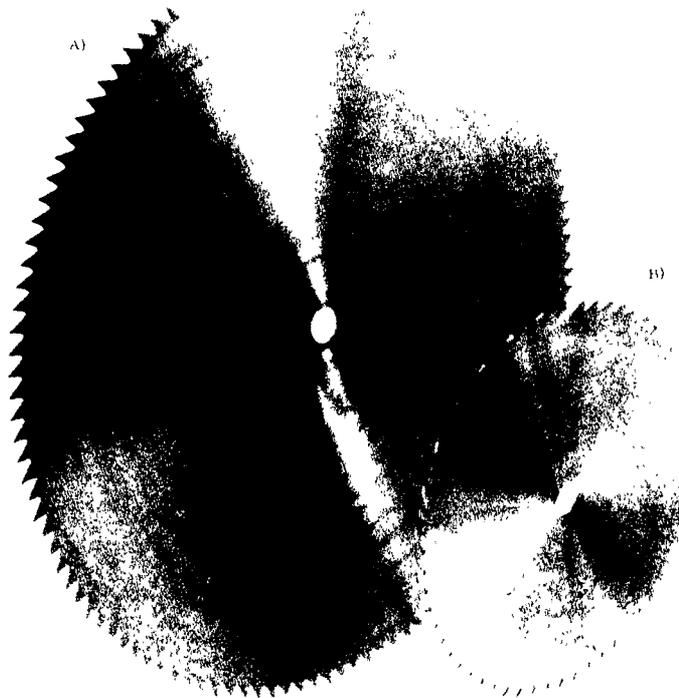


Fig. 1 Standard sawblades

- A) Double conical sawblade with spring setting for cross-cutting. Diameter 1200 mm; thickness 4.0/3.0 mm; number of teeth: 120.
- B) Plane sawblade with swaged teeth for ripping of green timber. Diameter 600 mm; thickness 2.4 mm; number of teeth: 60.

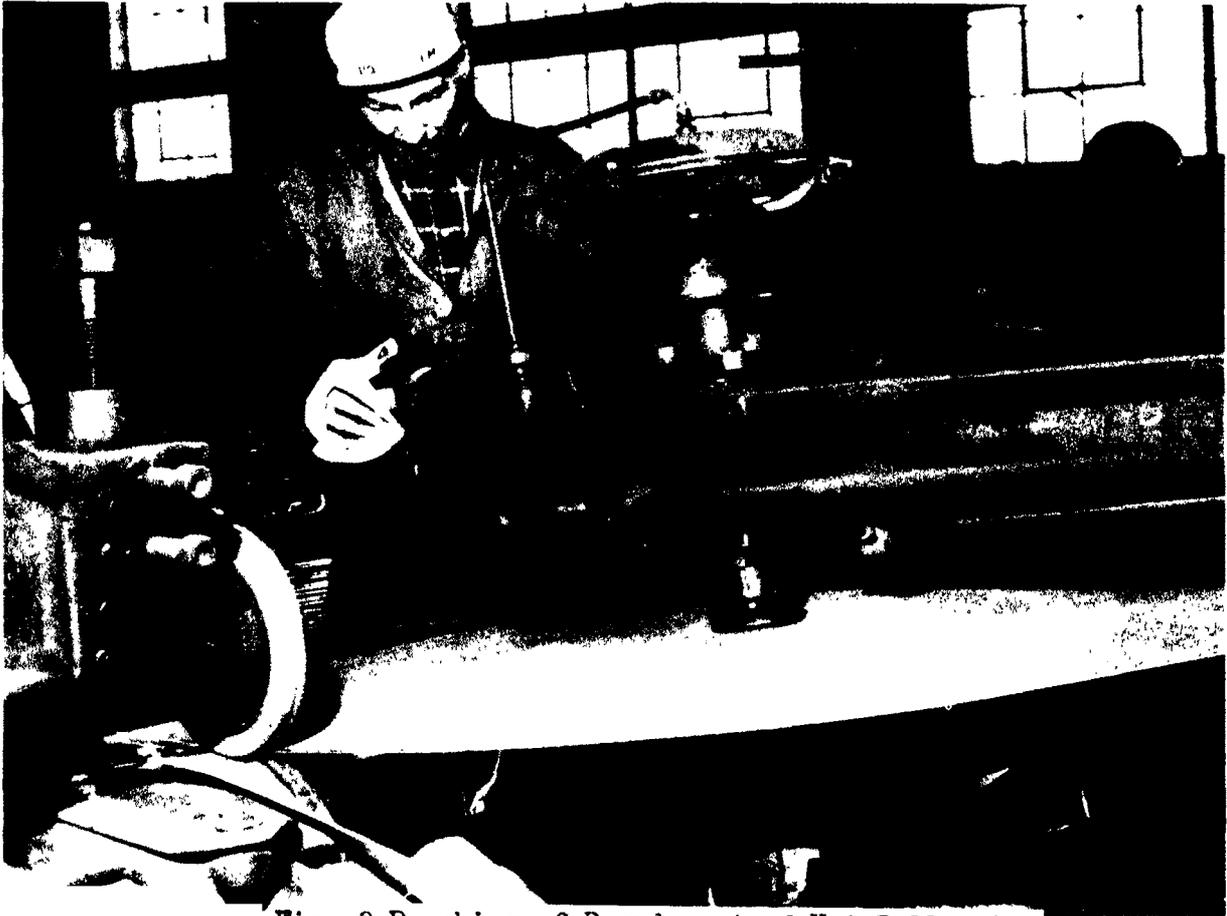


Fig. 2 Punching of Rounds out of Hot Rolled Steel

3. Punching of Rounds out of Hot Rolled Steel

The chemical composition of the steel affects, to a large extent, the properties and quality of the sawblade. For circular sawblades usually alloyed steel with a carbon content of 0.7 to one percent is used. Higher carbon content increases the hardness and wearability of the steel but reduces its toughness. Alloys as magnesium (Mn), silicone (Si), chrome (Cr), vanadium (V), and nickel (Ni), increase the wearability of the steel and maintain its toughness. In order to reduce costs a sawblade should maintain its sharpness as long as possible. To achieve this the sawblade must be made of hard and durable steel. On the other hand, it should be possible to carry out setting and swaging of saw teeth without developing cracks in the teeth. Therefore, the steel in the blade must have a certain toughness. For some sawblades, the final choice of quality is a compromise between hardness and toughness.

4. Manufacturing Steps

The main manufacturing steps required to process a steel round to a plane solid sawblade are mainly as follows:

- a) Punching of centre hole
- b) Hardening and tempering
- c) Hardness control
- d) Punching of teeth
- e) Pre-levelling
- f) Surface grinding to achieve correct thickness
- g) Levelling and polishing
- h) Setting or swaging of the teeth
- i) Sharpening of the teeth
- j) Tensioning
- k) Testing and control.

5. Methods to Increase Durability of the Saw Teeth

The most important factor affecting the durability of a sawblade is the wearability of the tooth tips. There are mainly three methods to increase their wearability:

- a) Hardening of the tooth tips
- b) Stellite welding of the tooth tips
- c) Applying hard metal tooth tips.

a) Hardening of the Tooth Tips

Hardening of the tooth tips is a special heat treatment. (Hardening and tempering). It is possible to harden all types of saw teeth but the method is not very widespread. One disadvantage with the hardening method is that the teeth get more brittle and break more easily. Annealing has to be carried out before reswaging of the teeth.

b) Stellite Welding of the Tooth Tips

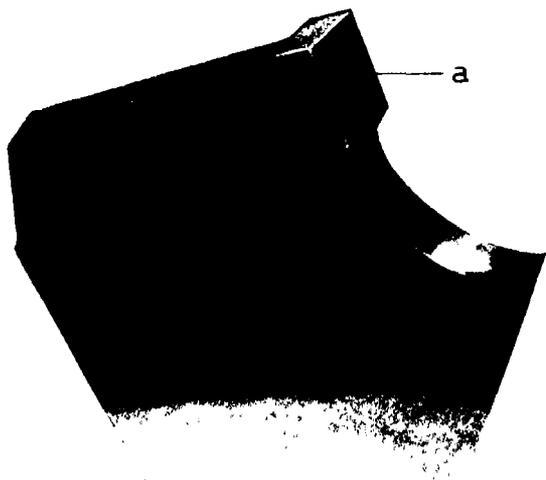
Stellite is a hard and very long-wearing alloy consisting of 2 - 4 percent carbon (C), 25 - 33 percent chromium (Cr), 5 - 20 percent tungsten (W), 20 - 55 percent cobalt (Co) and 0 - 10 percent iron (Fe). Stellite has a wearability which is five to ten times that of common steel. Stellite is marketed as:

- i) Plates which can be soldered to the tips
- ii) Welding rods for welding on the tips.

Sharpening of stellite saw teeth can be carried out with a normal grinding wheel which is a great advantage. Stellite saw teeth can be used for hardwoods, as well as softwoods in green or dry conditions.

c) Applying Hard Metal Tooth Tips

Hard metal is a sintered product mainly containing tungsten carbide and normally cobalt as a bonding agent. Figure 3 shows a tooth with a hard metal tip. The carbides are very hard and have a high melting point. Sawblades are available with different hard metal qualities. Hard metal tips have a wearability thirty to forty times that of normal steel. Hard metal is manufactured as small plates or tips which can be soldered to the saw teeth. The plates are designed mainly to avoid setting as well as swaging of the teeth. In principle, the hard metal tips function in the same way as swaged teeth. For sharpening of hard metal tips diamond grinding wheels and special sharpening equipment is required.



a Hard metal tooth tip

Fig.3 Saw tooth with hard metal tip

6. Surface Treatment of Sawblades

When the blade is working its way through the wood a certain amount of friction heat develops, especially in the tooth area. Evaporated resin from the wooden material is condensed on the centre part of the sawblade which is cooler than the tooth area. Thus, the condensation forms a coating in this part of the sawblade. The resin coating attracts fine sawdust and the coating has a tendency to grow quickly in thickness. This is particularly a problem when cutting plywood and other materials with a large content of glue or resin. If the resin coating is allowed to develop it will create friction between resin surface and saw cut. The increased friction creates abnormal heating of the blade. Such a blade does not function satisfactorily and has to be reconditioned. To prevent this type of over-heating the blade must be cleaned when necessary. Cleaning should be carried out with a suitable solution, e.g. turpentine. Never scrape when cleaning a sawblade.

In order to reduce friction and to simplify cleaning of the blades, surface treatment of the blades is carried out during manufacturing. The different types of surface treatment are:

- a) Polishing the sides of the blades which is the most common method.
- b) Chrome treatment.

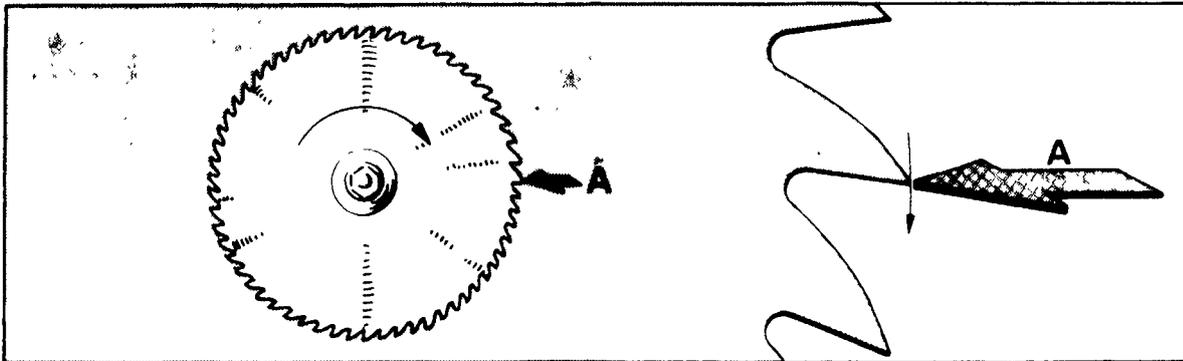
Experience has shown that chrome treatment of sawblades increases the blade's endurance. Chrome blades are easier to clean and have a better wearability. Chrome treatment also prevents rust formation on the blades.

- c) Teflon treatment

A teflon treated sawblade has a very smooth surface. The teflon is sprayed and burnt into the sawblade in a very thin layer. With teflon treated blades the resin coating is reduced and the friction is normal for a longer period. A disadvantage with the teflon treated blades is its sensitivity to damage. If the teflon coating is damaged its protective effect ceases. Accordingly, the method is not very widespread and will probably not be so until a more durable surface can be obtained.

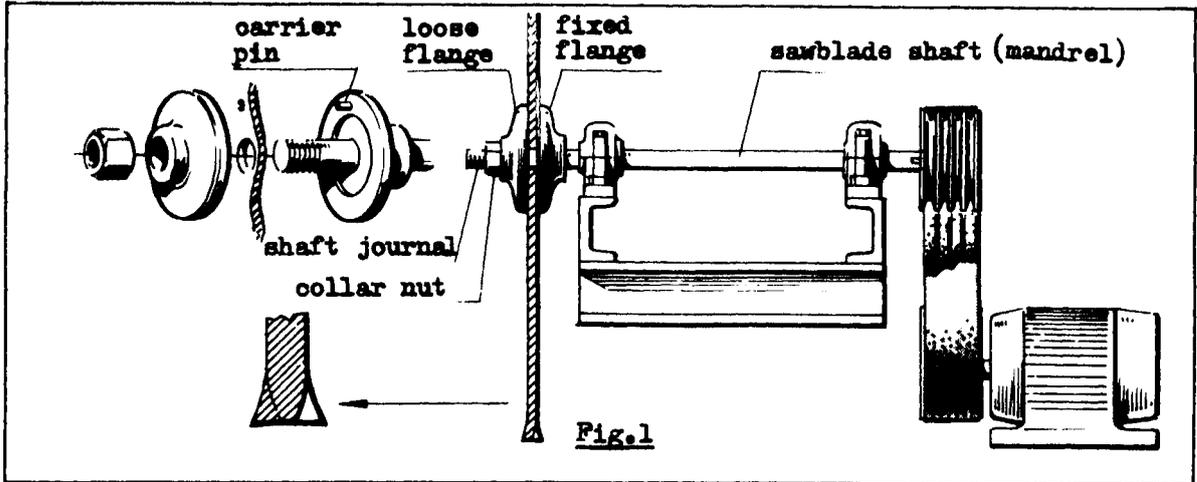
III CIRCULAR SAWBLADE, OPERATING FAULTS AND RESULTING EFFECTS

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1. The Rotation of the Sawblade, General

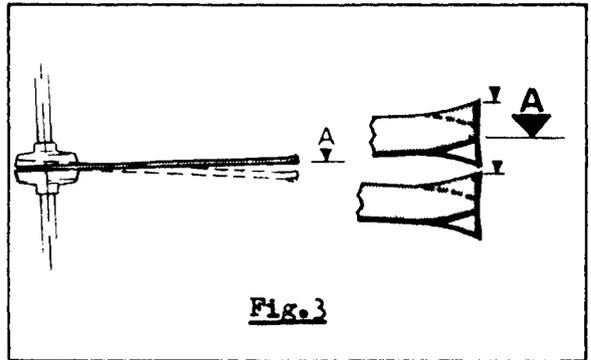
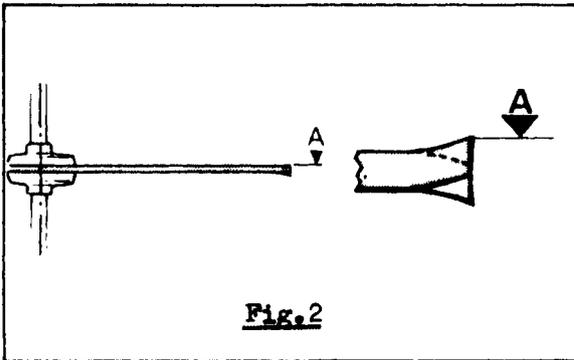
The design of the sawblade shaft and how the blade is attached can be seen in figure 1.



When the sawblade shaft and the sawblade are rotated, the blade must rotate evenly, i.e. it must not wobble or flutter. The difference between even and warped rotation is shown in figures 2 and 3.

When the sawblade rotates evenly, all tooth points will pass the line at arrow A.

When the sawblade is warped, all tooth points will not pass at the same distance from the fixed arrow A.

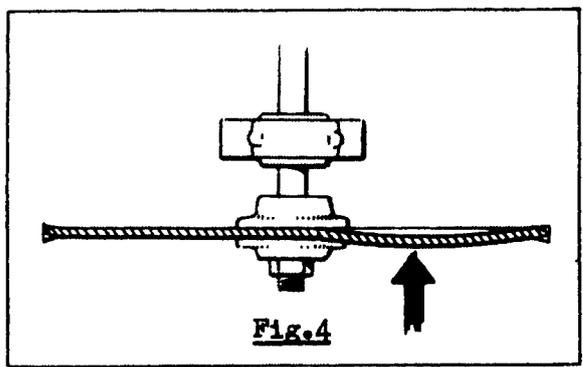


2. Reasons for Uneven Rotation of the Circular Sawblade

The reasons why the circular sawblade and its tooth line do not follow the same course during rotation, but wobble, can be:

a. The sawblade is not plane

There is a defect in the sawblade itself, see figure 4. This can be straightened in the sawdoctor's shop.

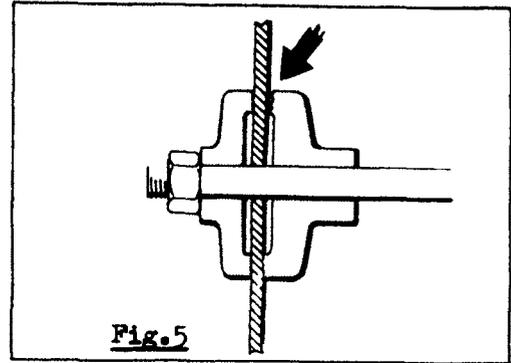


b. The sawblade is plane but faults occur in flanges or sawblade shaft (mandrel)

One of the flanges does not have an even contact surface (figure 5). This fault can cause the same effects as in figure 4 but, in addition, the sawblade is not tightly housed in the flanges.

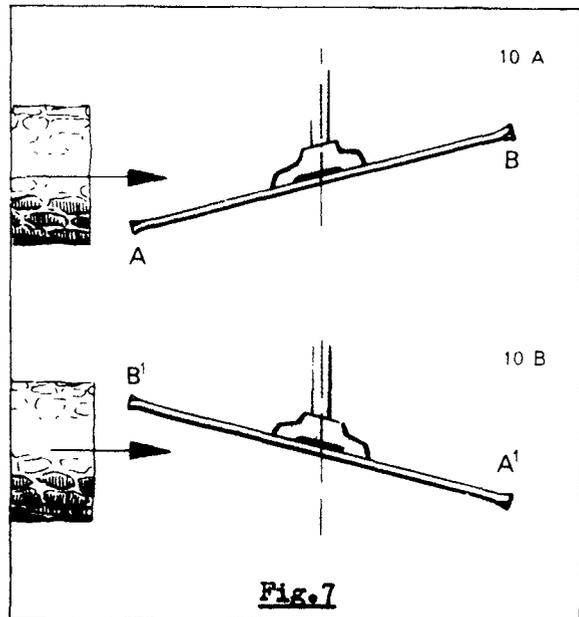
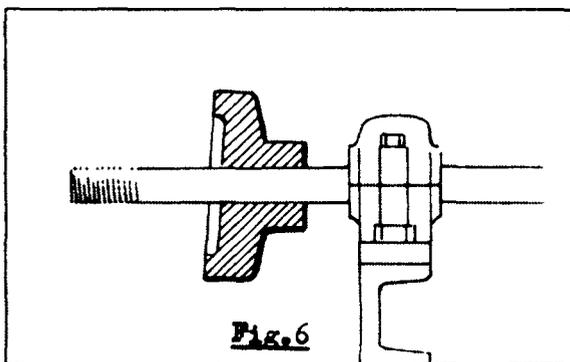
If one does not have a carrier pin (see figure 1), the sawblade may slip between the flanges as the load increases. This damages the centre of the sawblade as well as the flanges.

As the blade moves on the shaft its centring can also become incorrect.



The fixed flange may not be mounted at right angles on the shaft, (see figure 6). This leads to saw wobble. The result can be seen in figure 7.

The tooth line will be aimed alternately at either side of the direction of feed and the trailing edge of the saw will also follow the same pattern.

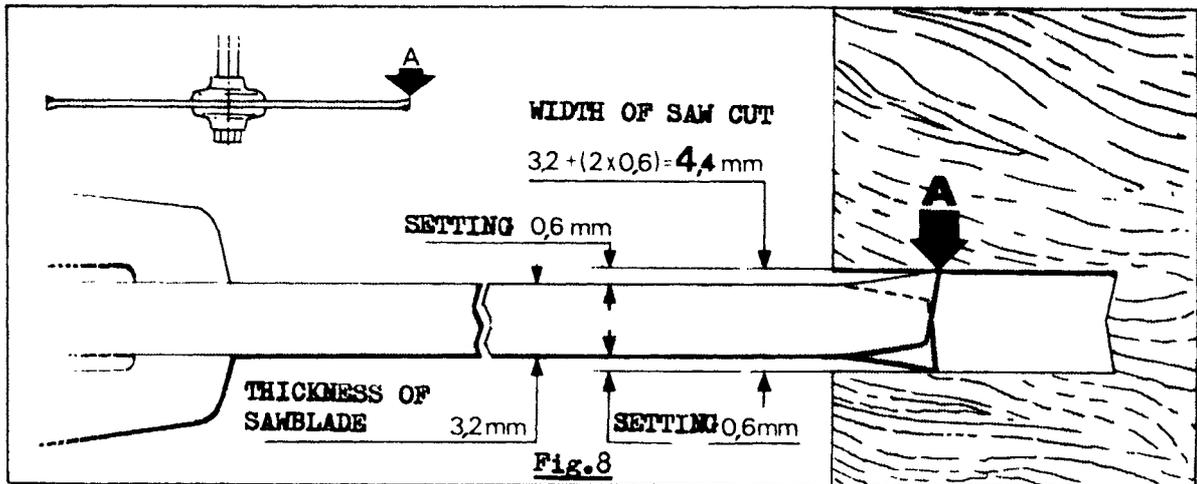


3. Consequences if the Circular Sawblade Wobbles

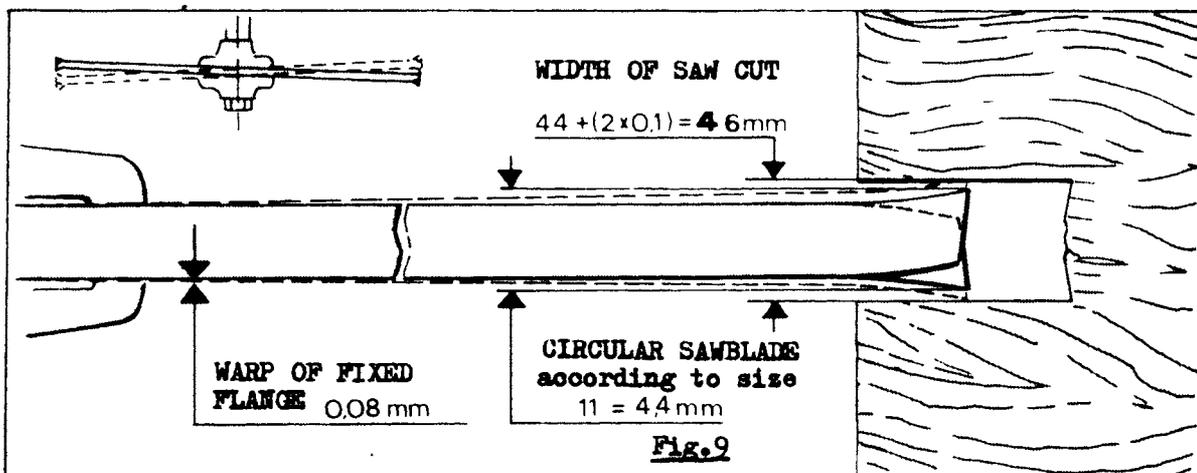
If a circular sawblade wobbles this will affect:

- a) the width of the saw out;
- b) the evenness of the sawn surface;
- c) the cutting ability of the blade.

An evenly rotating circular sawblade enables all its tooth points to pass the tip of the arrow A. (See figure 8).

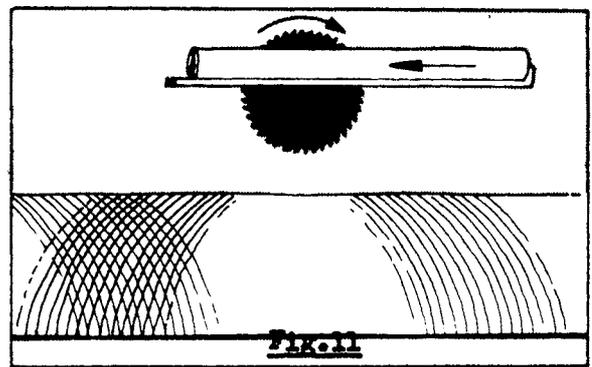
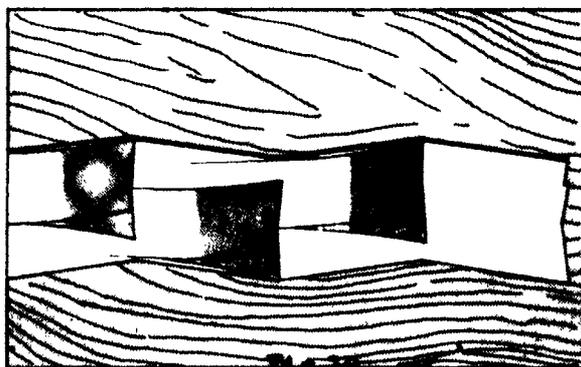


- a) The width of the saw cut will increase. (See figure 9). The warp shown in the movement of the circular sawblade has led to an increase in the width of the saw cut by about 5 percent, which has had the same effect as an increased setting by 0.1 mm on either side of the circular sawblade.



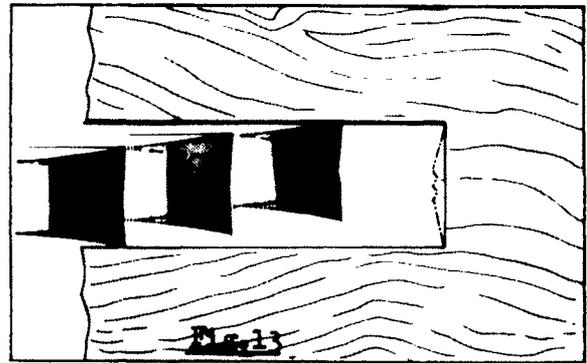
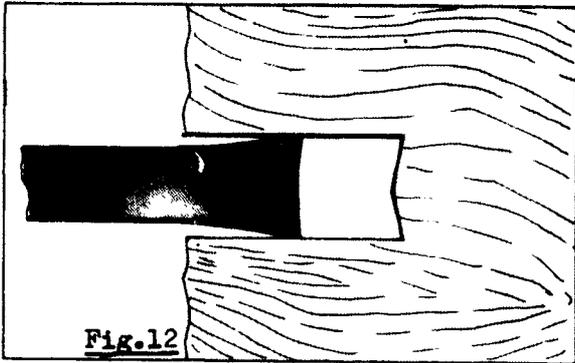
- b) The sawn surface of the wood becomes uneven. A warped sawblade will cut alternately with the left and the right-hand side of the tooth line. This creates an uneven saw cut. (See figure 10.)

At the leading edge of the sawblade, where the cutting takes place, the warp is somewhat suppressed. At the trailing edge of the sawblade, which has the same degree of warp as the front, the movement is not suppressed. Scratches will appear on the sawn surfaces in the opposite direction to those originating at the leading edge. (Figure 11.)



- o) The effectiveness of the sawblade decreases. A sharp circular sawblade shapes the bottom of the saw cut like a plough (figure 12) and even pressure on both sides of each tooth helps the blade steer in the right direction.

As the width of the cut widens with a warped blade more sawdust than necessary will be out. In addition, as the teeth do not cut in the same line, certain teeth will cut on one side only, other teeth on the opposite side. (Figure 13). As a result, the blade receives no steering and feed speed must be reduced to enable the blade to go straight.



4. Preventive Measures

A warped circular sawblade leads to poor sawing. To avoid this it is necessary that:

- the flanges are properly maintained. They must not be tampered with or damage may occur. They must be kept absolutely clean.
- the sawblade be properly attached so that it does not slip during sawing.
- the sawblade must be plane. In the centre where it is kept in place by the flanges it must be absolutely plane (without any sawdoctoring marks) and absolutely clean.

5. Centring of the Sawblade, General

To work properly during rotation the sawblade must be correctly centred on the saw shaft. The difference between correct and incorrect centring is shown in figures 14 and 15. With the sawblade correctly centred, all tooth points will follow the same circular orbit during rotation. All tooth points will just miss the fixed arrow A, figure 14.

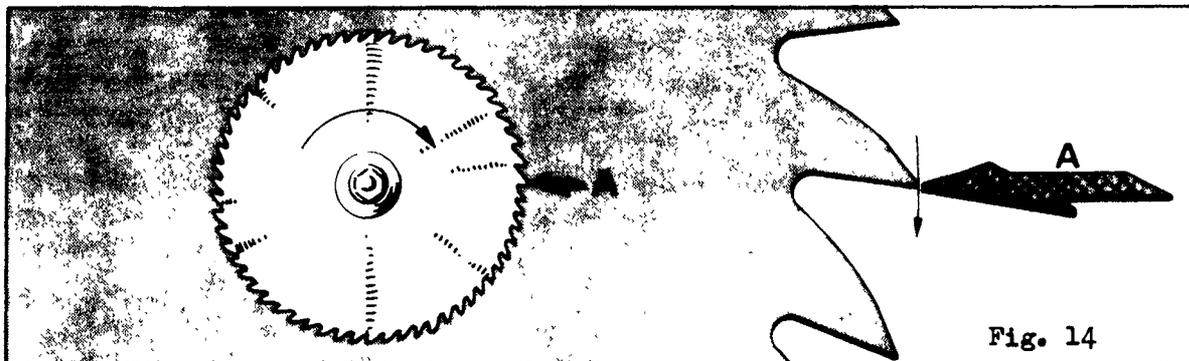


Fig. 14

With the sawblade incorrectly centred the tooth points will follow different circular orbits during rotation (figure 15). The tooth points will pass the fixed arrow A at different distances:

- sometimes away from the arrow
- sometimes touching the arrow.

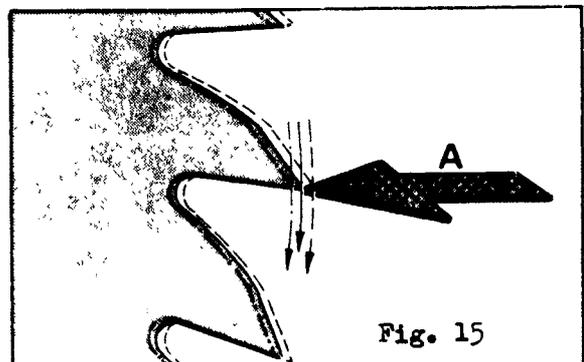


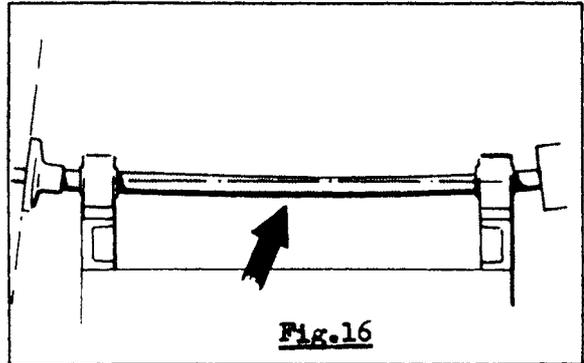
Fig. 15

6. Reasons for Incorrect Centring of the Circular Sawblade

There are two main reasons why the sawblade is incorrectly centred:

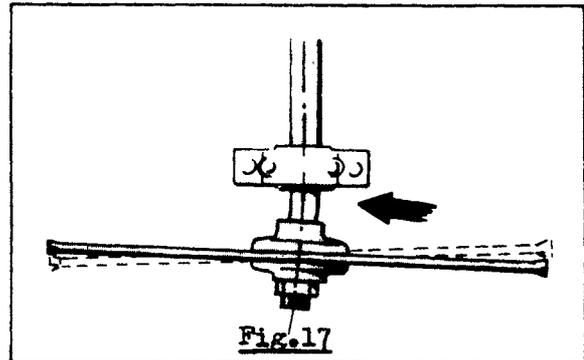
a) A bent shaft (mandrel)

Incorrect centring occurs if the shaft has become bent either between the bearings or in the shaft journal where the flanges are positioned, figure 16.

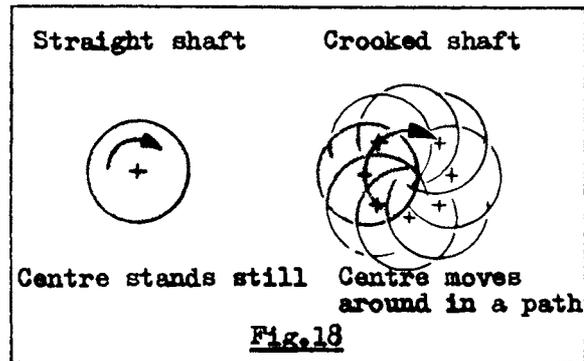


As shafts are usually generously sized this fault is rather uncommon but if it should occur, it results in:

- i) the plane of the fixed flange being no longer perpendicular to the centre line through the bearings, causing the sawblade to wobble. (Figure 17).
- ii) the shaft journal on which the blade is mounted receiving a revolving movement. In figure 18 this is compared with a straight shaft rotating.



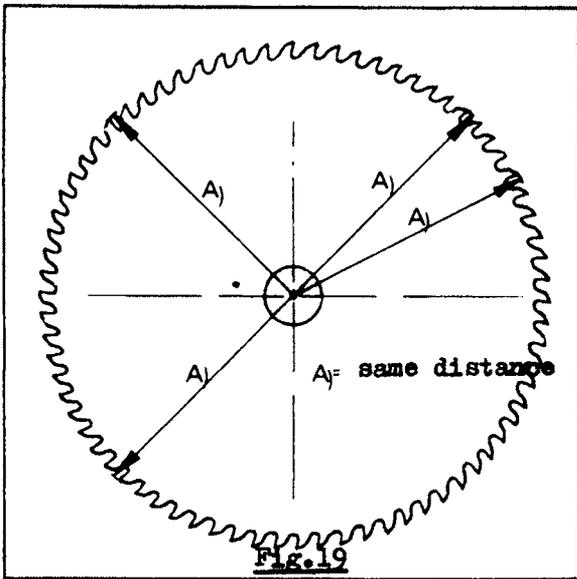
If the shaft is straight, the shaft journal and its centre will stand still during rotation. If the shaft is crooked, the centre of the shaft journal will move around in a circular path causing the same movement in the journal and sawblade tooth line.



b) The centre of the circular sawblade does not coincide with the centre of shaft.

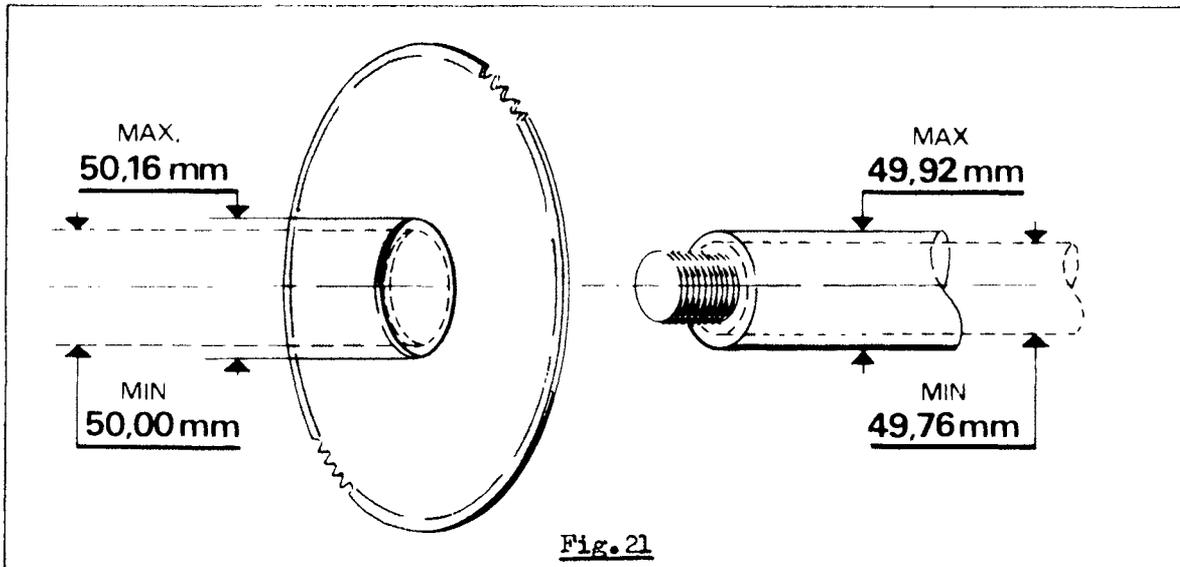
A circular sawblade is manufactured perfectly round. Each individual tooth point around the blade is situated at exactly the same distance from the centre. (See figure 19.)

To mount the sawblade onto the shaft journal, the hole in the blade must be slightly bigger than the diameter of the journal. In Spare Part catalogues, under the column that gives the size of the hole in the sawblade (designated by the letter d), there is also the designation H 11, which is a tolerance designation. It indicates how much the size of the hole may differ from the measure given for each size D of circular sawblades: for example, a hole which according to the table is 50 mm, may (with the allowed tolerance H 11) vary in size from 50.00 mm to 50.16 mm from one circular sawblade to another. The hole must not be smaller but may have a plus tolerance. (Figure 20.)



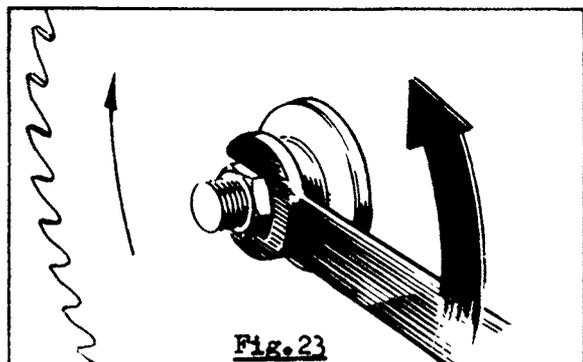
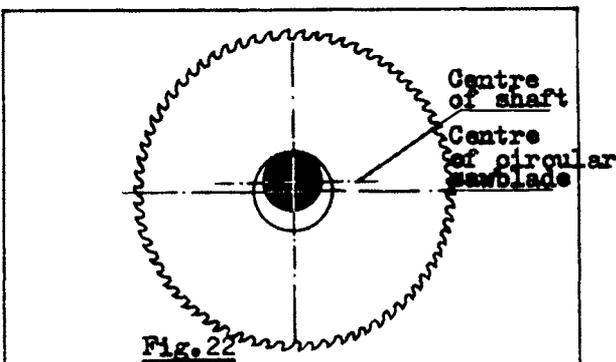
D	d	H 11	t
800	(40)	50	3.0
900		50	3.0
1000		50	3.2

If the shaft journal where the sawblade is to be mounted were exactly 50.00 mm in diameter and the hole in the circular sawblade 50.00 mm in diameter also, the blade would have to be forced onto the journal. This could lead to stress in the steel which, in turn, could distort the sawblade. A 50 mm journal is therefore manufactured just under 50 mm in diameter. A 50 mm shaft, tolerance designated D 11, must have a true measure between 49.76 and 49.92 mm.



From figure 21 we can see that, if sawblades with 50 mm holes, as well as 50 mm shaft journals, are manufactured as indicated, all circular sawblades with 50 mm shaft holes will fit all 50 mm shaft journals but, at the same time, a tolerance will occur between the shaft journal and the hole. This can vary from 0.08 mm to 0.40 mm.

A new circular sawblade mounted on a journal will hang eccentrically (exaggerated in figure 22) as the hole in the circular sawblade is always bigger than the diameter of the journal. The centre of the shaft will, in this case, not coincide with the centre of the circular sawblade. If the flange nut is tightened in this position the sawblade will maintain its incorrect position in relation to the journal during rotation. (Figure 23.)



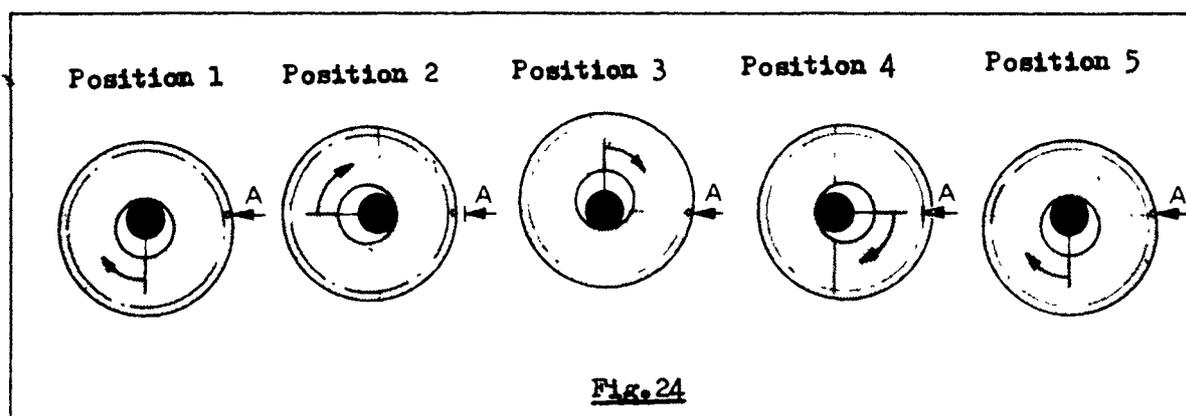


Figure 24 shows how the tooth line of the sawblade will move in relation to a fixed point (arrow A) during one revolution of the blade.

- Position 1. The sawblade is in the position where it was mounted between the flanges. The tooth points are exactly adjoining A.
- Position 2. The blade has moved a quarter of a turn and the tooth points have moved away from A.
- Position 3. Half a turn. The tooth points are again adjoining A.
- Position 4. The circular sawblade has completed three quarters of a turn. The tooth points have now moved in over A.
- Position 5. The blade has now completed a full turn and is back in position 1.

During one revolution of the sawblade the tooth points will therefore not regularly pass the fixed arrow A but sometimes are a little away from A and sometimes almost on top of A.

IF ALL THE TOOTH POINTS DO NOT FOLLOW THE SAME CIRCULAR ORBIT THIS MEANS THE CIRCULAR SAWBLADE IS INCORRECTLY CENTRED.

7. Consequences of Incorrect Centring

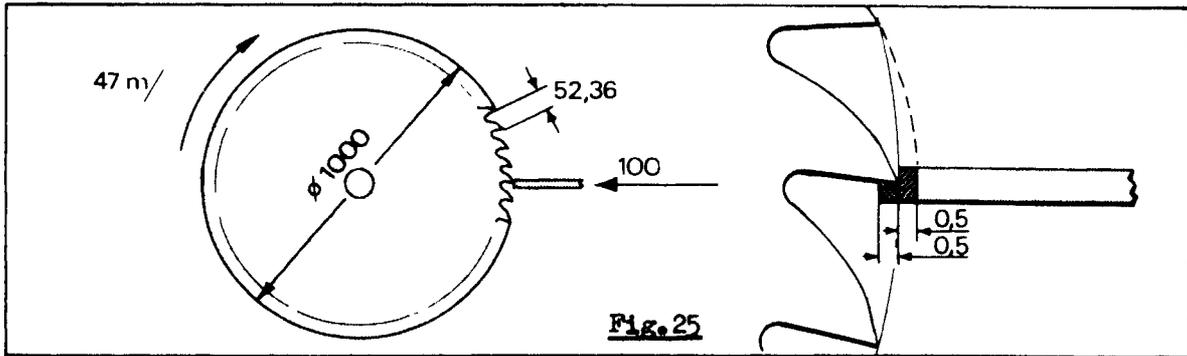
Incorrect centring of the circular sawblade will affect:

- a) the thickness of the sawdust;
- b) the sawn surface;
- c) the wear and tear of the teeth;
- d) the wear and tear of the bearings.

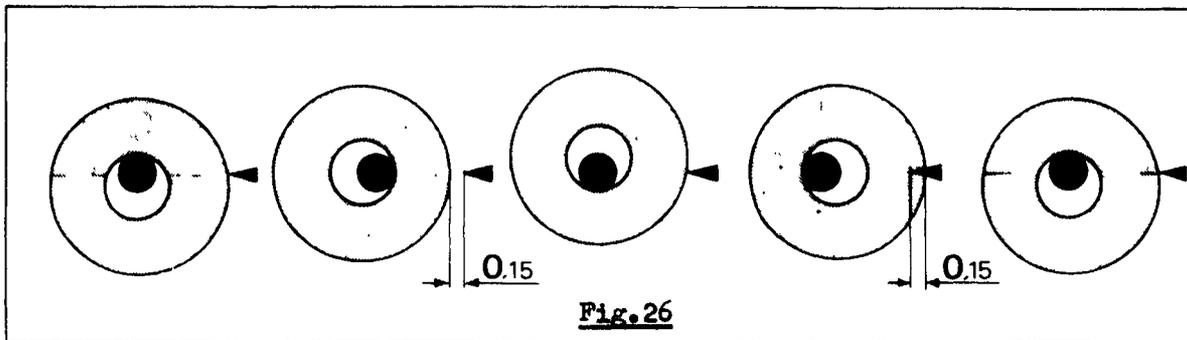
a) The thickness of the sawdust

Incorrect centring means that different parts of the tooth line must perform a different amount of cutting work or, in other words, different teeth must cut sawdust of different thickness.

Figure 25 gives the data for a circular sawblade correctly centred. The board being out has been drawn thin to enable a direct comparison with the arrow, point A in figure 24. If the blade is correctly centred, each tooth around it will cut a 0.5 mm thick piece of sawdust and, during one turn of the blade, a sawn distance of $60 \times 0.5 = 30$ mm will be covered. (60 = number of teeth)



As an example of a circular sawblade incorrectly centred we chose a case where a new sawblade is fitted on a shaft, the hole in the blade being 0.30 mm bigger than the thickness of journal. Apart from this, the same data as in figure 25 is applicable. In figure 24 we saw that the tooth points changed their positions in relation to the fixed arrow A during one turn of the blade. Figure 26 shows how big this change in position becomes with the above play of 0.30 mm between the hole in the sawblade and the journal.



The correctly centred sawblade (figure 25) covered a sawn distance = 30 mm/revolution or = 15 mm/half a revolution.

The incorrectly centred blade in this example makes the different halves of the blade perform a different amount of cutting work:

Part a) cuts $15.00 + 0.15 = 15.15$ mm/revs.

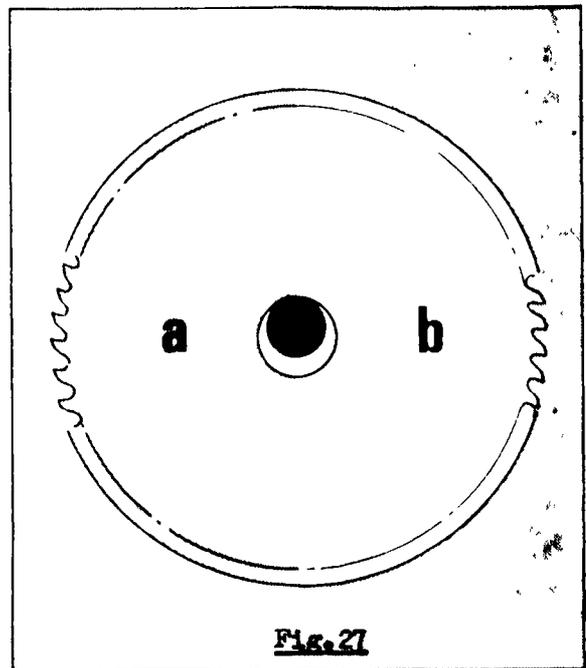
Part b) cuts $15.00 - 0.15 = 14.85$ mm/revs.

The total sawn distance is still 30 mm/revs.

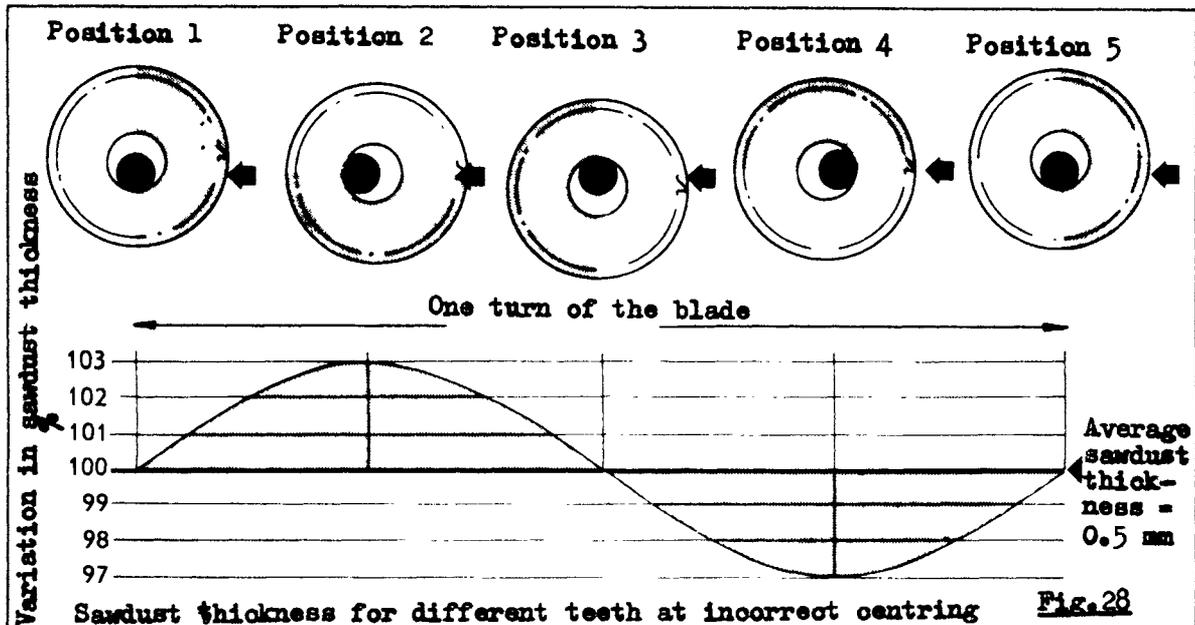
Part a) must, in other words cut + 1 percent above the average (15.00 mm) and part b) must cut - 1 percent below the average (15.00mm)

The unevenness on the two halves seems to be small at ± 1 percent.

Note, however, that the additional work that part a) must perform is not distributed evenly on its teeth; neither is the reduced workload on part b) evenly distributed on its teeth.



The cutting of individual teeth results in sawdust averaging 0.5 mm in thickness, but the thickness can vary upward and downward 3 percent (i.e. from 0.485 to 0.515 mm thick).



b) The sawn surface

The smoothness of the sawn surface depends on the thickness of the sawdust from each tooth, the thicker the sawdust the rougher the surface. When the circular sawblade is incorrectly centred some teeth will cut thicker and some teeth will cut thinner sawdust (figure 28). As a result the sawn surface will become uneven and rough, even when the tips of the teeth are sharp.

c) Wear and tear of the teeth

The teeth that must cut thicker sawdust are worn down and become blunt more quickly than the other teeth. This reduces the effectiveness of the sawblade; prevents the blade from cutting straight, resulting in sawn timber of uneven thickness, and spoils the sawn surface of the timber.

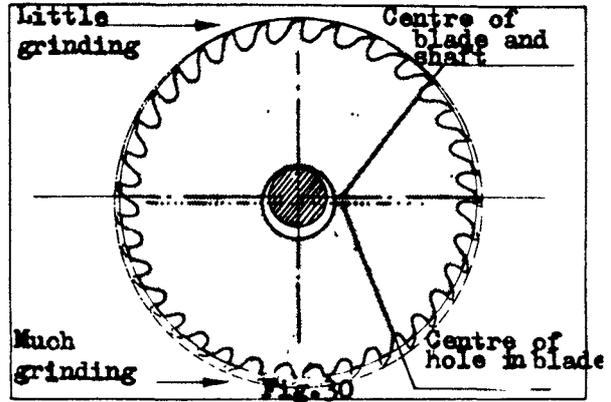
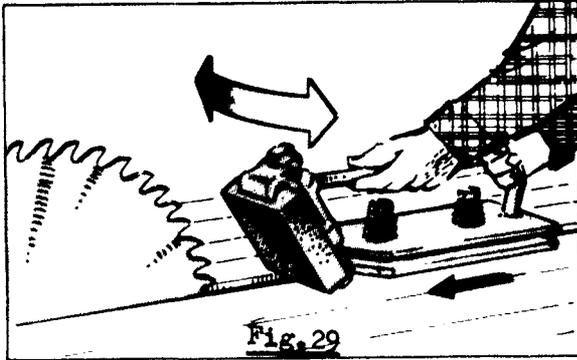
d) Wear and tear on the bearings

As the tooth line of the sawblade moves to and fro and cuts differently during each revolution, the load on the sawblade shaft and, in turn, the shaft bearings will vary, causing increased wear.

8. Preventive Measures

Some shaft journals are fitted with a self-centring device, a conical bush or self-centring bush, which ensures centring. If not, the following measures are taken: the sawblade must be ground so that it is perfectly circular in the journal. This is done by a grinding device that can be moved forward (figure 29). The sawblade is mounted in the journal and rotated at normal speed during grinding. Grinding continues until all tooth points have been smoothed down. The grinding is then stopped and the blade is sharpened. The grinding of a blade that is incorrectly centred means that different tooth points grind differing amounts depending on where they are situated on the blade. The grinding must continue until all tooth points have been touched.

In principle, this round grinding means that the arrow in figure 14 has been substituted by a grinder that is pushed forward until all tooth points touch. Through grinding, the centre of the sawblade is no longer in the middle of the centre hole. (Figure 30.)

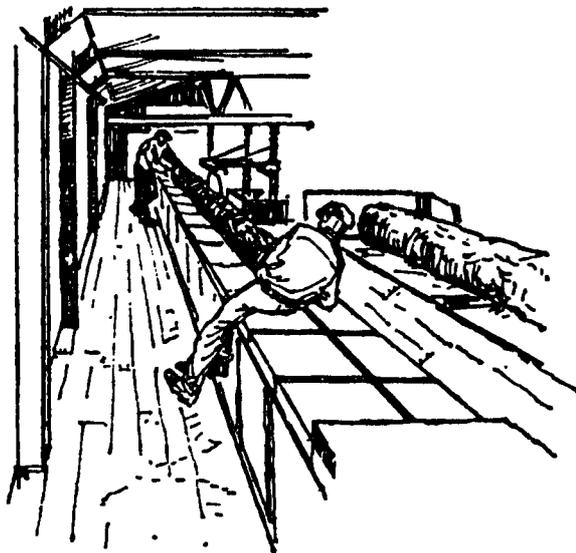


WHEN THE CIRCULAR SAWBLADE HAS BEEN ROUND GROUND ON THE SHAFT JOURNAL IT MUST BE RESHARPENED. This must be done with the circular sawblade still mounted on the shaft and positioned between the flanges in the same position as when the grinding took place.

GRINDING AS DESCRIBED ABOVE IS A DANGEROUS OPERATION AND SHOULD BE CARRIED OUT WITH GREAT CARE. DO NOT USE LOOSE FILES BUT ONLY A PROPER GRINDING DEVICE.

IV ALIGNMENT OF A CIRCULAR SAWBENCH

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Introduction

To enable the circular sawbench to operate properly it must be correctly installed and its different components must be correctly aligned with each other.

The erection of a new machine must therefore be done with great care. During the sawing process the sawbench is under different stresses which may result in movement of some parts out of correct alignment. This can be caused by settling of the machine foundations or in the various components of the sawbench.

CHECKING OF ALIGNMENT OF THE CIRCULAR SAWBENCH MUST THEREFORE BE DONE AT REGULAR INTERVALS AND BE REGARDED AS PREVENTIVE MAINTENANCE. IT SHOULD NOT BE DONE ONLY WHEN DEFECTS HAVE BECOME OBVIOUS. In this manual practical methods to ensure correct alignment are described.

Figure 1 shows the components of the sawbench.

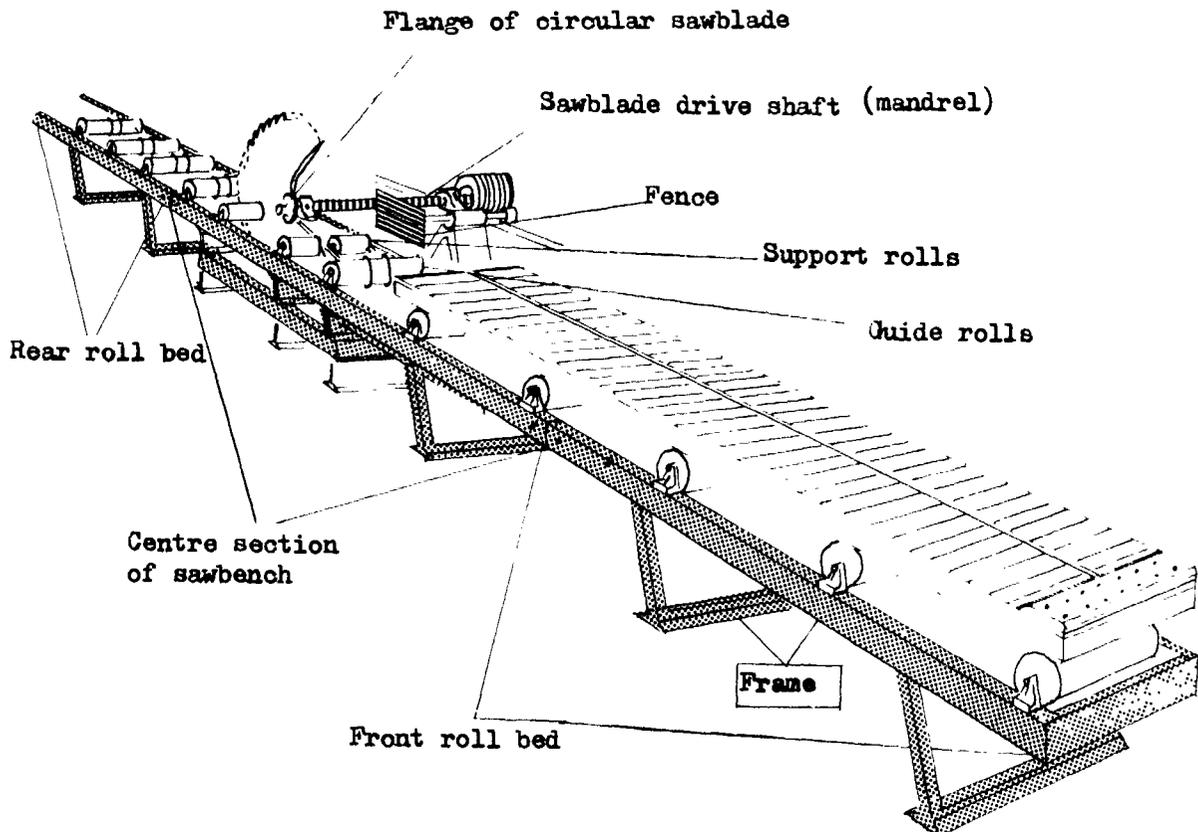


Fig. 1

To ensure correct operation the following checks must be made, in sequence:

1. Check plane of flanges.
2. Check that plane of the fixed flange is constant during rotation.
3. Check that sawblade shaft is horizontal.
4. Check that centre section of sawbench is horizontal.
5. Check alignment of sawbench in longitudinal direction.
6. Check position of front and rear roll beds horizontally and vertically.
7. Check alignment of fence.

Before alignment checking can start the sawtable is removed from the roll bed.

1. Checking the Plane of the Flanges

The fixed flange: Put a straight edge against the flange. Turn the flange and check the evenness of the flange against the straight edge through a full rotation. (Figure 2).

The loose flange: Put a straight edge against the flange. Turn the flange and check its evenness. (Figure 3).

The plane of each flange is usually manufactured with a clearance towards the centre, as shown in figure 4, here exaggerated for clarity.

When the flange nut is tightened the centre sections of the flanges are pressed against the circular sawblade which gives close contact. Because of the clearance of the flanges, their outer sections will have the tightest contact with the blade. This is most important as it applies the driving torque to the sawblade as far from the drive as possible.

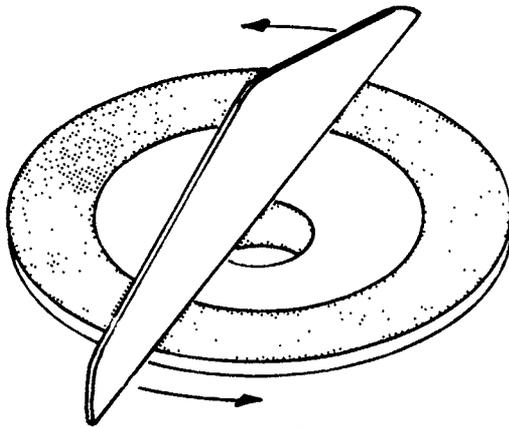


Fig.3



Fig.2

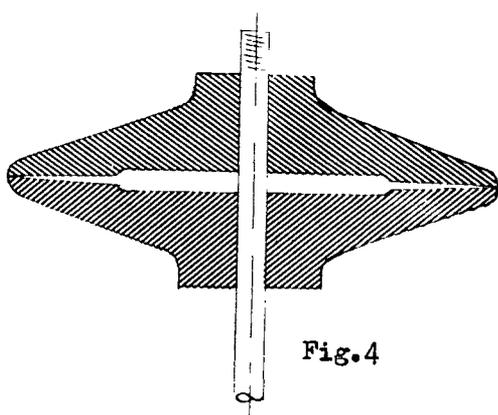


Fig.4

Damaged flanges might have an incorrect clearance or uneven planes, fig.5 a and b.

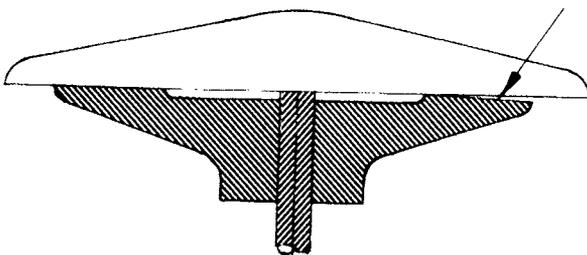


Fig. 5a

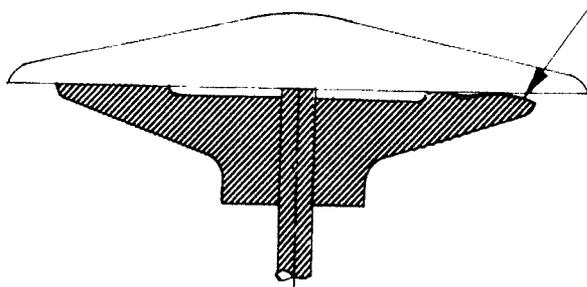


Fig. 5b

2. Checking that the Plane of the Fixed Flange is Constant during Rotation

As any warp in the plane of the fixed flange is magnified four to five times by the time it reaches the tooth line of the sawblade, warp must be minimised. Should warp occur, it must not exceed one or two hundredths of a mm.

To check this, a measuring gauge that can measure small tolerances, for instance, a surface gauge or a dial test indicator, is needed. (Figure 6).

SURFACE GAUGE

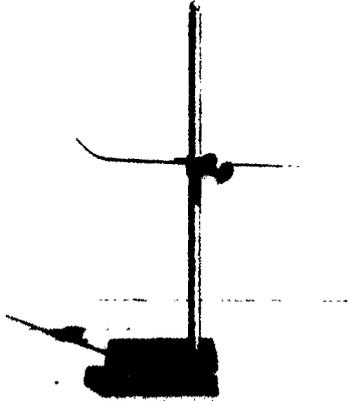


Fig. 6a



Fig. 6b

In principle, the check is done using a measuring point which is put against the plane of the fixed flange. While the sawblade shaft is turned a full revolution, the measuring point must stay at the same distance from the fixed flange.

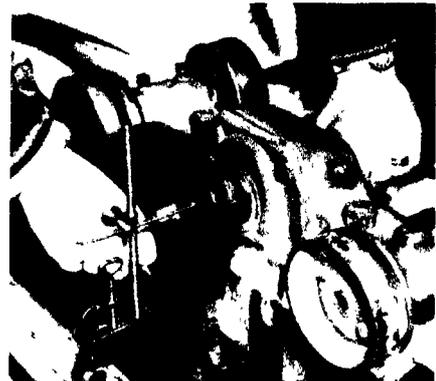
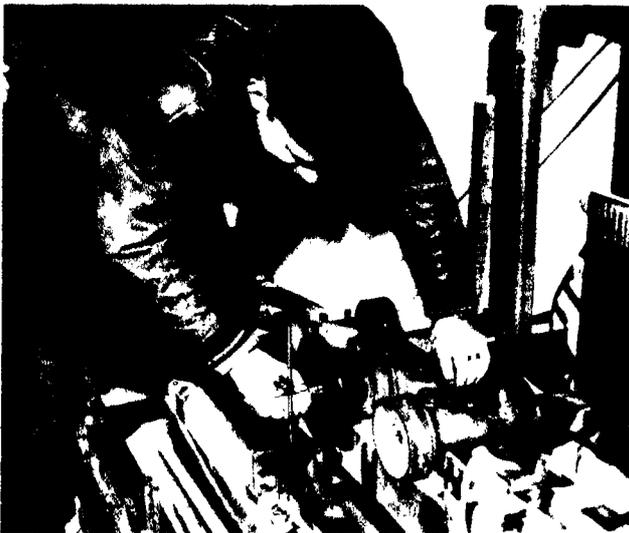


Fig. 7. Checking the plane using a surface gauge

Figure 7 shows the use of a surface gauge attached to the machine frame by a screw clamp. To make the check easier it should be done by two men. One man turns the saw shaft, while the other checks the distance between the measuring point and the plane of the fixed flange. As the tolerance measurements are very small a magnifying glass should be used.

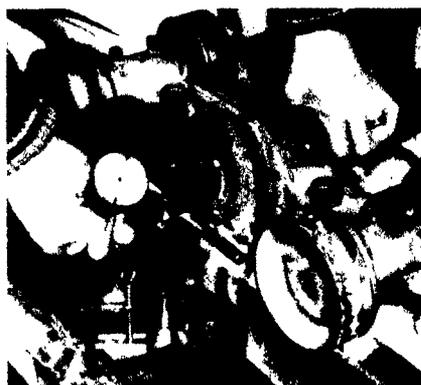


Fig. 8. Checking the plane using a dial test indicator

Figure 8 shows the check being done using a dial test indicator. This instrument has been positioned so that its measuring point is pushed back about 2 mm when the check starts. When the flange is then turned, the indicator hand can detect any variations. This procedure is the most accurate relying on measurement, not estimation, of warp

TO CORRECT ANY DEFECTS IN THE EVENNESS OF THE FLANGES OR ANY WARP IN THE FIXED FLANGE IT IS NECESSARY TO REGRIND THE PLANE OF THE FLANGES.

3. Checking that the Circular Sawblade Shaft is Horizontal

To do this accurately with simple tools, the check is done as follows:

- 3.1 A plumb-line is attached to a point above the flanges, for instance, the opened saw guard, so that it hangs inside but close to the fixed flange. (See figure 9a). The plumb-line is made as long as possible without the plumb-bob touching anything because it must hang free.
- 3.2 A board with an indicator nail as a measuring point is clamped between the flanges and positioned vertically upwards. (Figure 9a).
- 3.3 Then either the position of the plumb-line at its attachment point or the position of the nail is adjusted so that the tip of the nail just misses touching the plumb-line. (Figure 9b). The position of the indicator now is seen in figure 10a, with the tip of the nail just missing the plumb line. (Figure 9b).

Indicator board

Plumb line



Fig. 9 a

Nail close to plumb line



Fig. 9 b

3.4 By turning the sawblade shaft the indicator is lowered from its original position. (Figure 10a) until it is vertically downwards. (Figure 10b). While the indicator is being lowered, it must remain firmly clamped between the flanges and not touch any part of the machine stand.

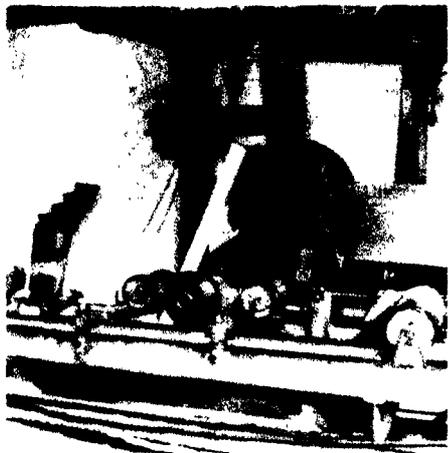


Fig. 10 a



Fig 10 b

3.5 WHEN THE INDICATOR HAS REACHED THE POSITION SHOWN IN FIGURE 10b, THE POSITION OF THE TIP OF THE NAIL IS AGAIN CHECKED IN RELATION TO THE PLUMB LINE.

If the tip of the nail in the down position just misses the plumb line (i.e. the same position as when the nail was in the up) the circular saw blade shaft is horizontal.

If the tip of the nail in the down position does not just miss the plumb line but there is a difference, this indicates that the circular saw blade shaft is not horizontal.

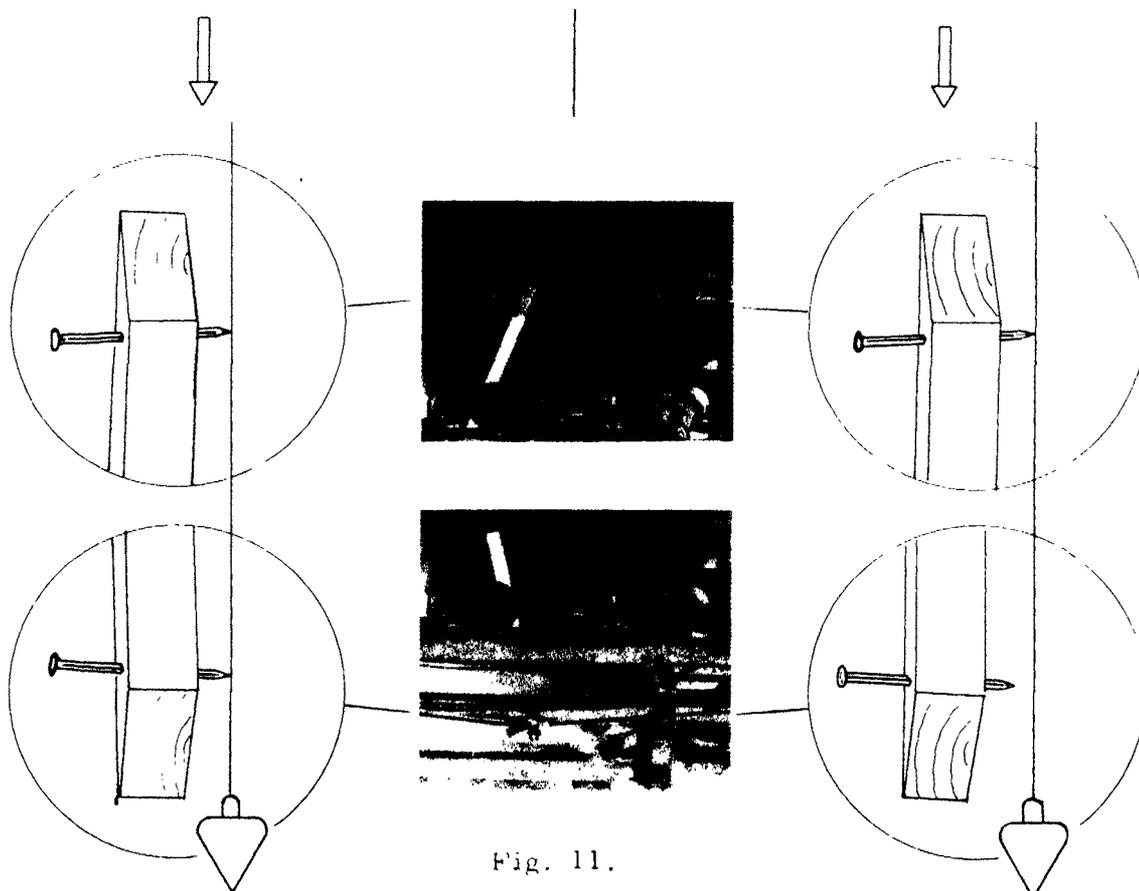


Fig. 11.

4. Checking that the Centre Section of the Sawbench is Horizontal

To check this a water-level is used. First, the water-level must be checked against the horizontal sawblade shaft.

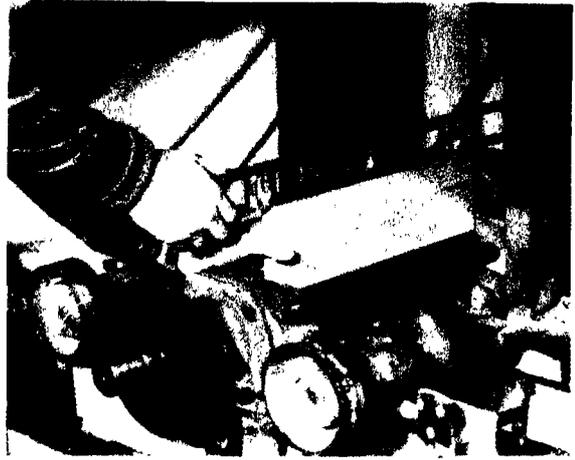


Fig. 12 Control of water-level

Using the water-level, the guide and support rolls of the centre sections are checked to see if they are horizontal and at right angles to the moving direction of the sawbench. (Figures 13 and 14).



Fig.13 Checking the guide roll



Fig.14 Checking the support roll

At the same time, check that the guide and support rolls are at the level and that the whole centre section is also horizontal in the direction of sawing. (Figure 15).

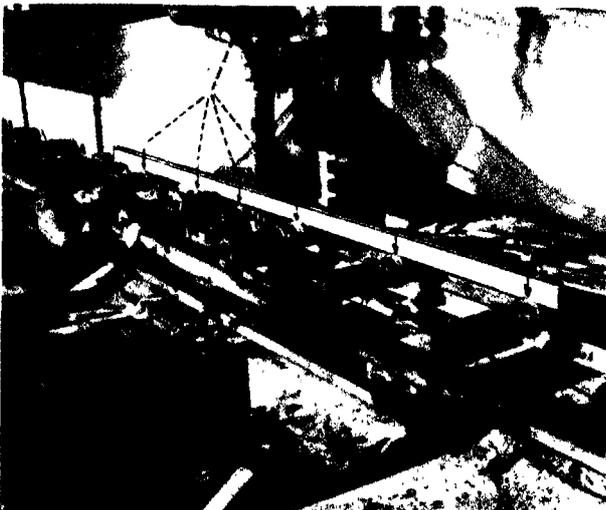


Fig.15 Control of the centre section along the direction of sawing.

If the centre section is not horizontal in the direction of the sawing, its position must be adjusted in accordance with figure 16. Do the blocking up with care so that the sawblade shaft is not moved out of the horizontal.

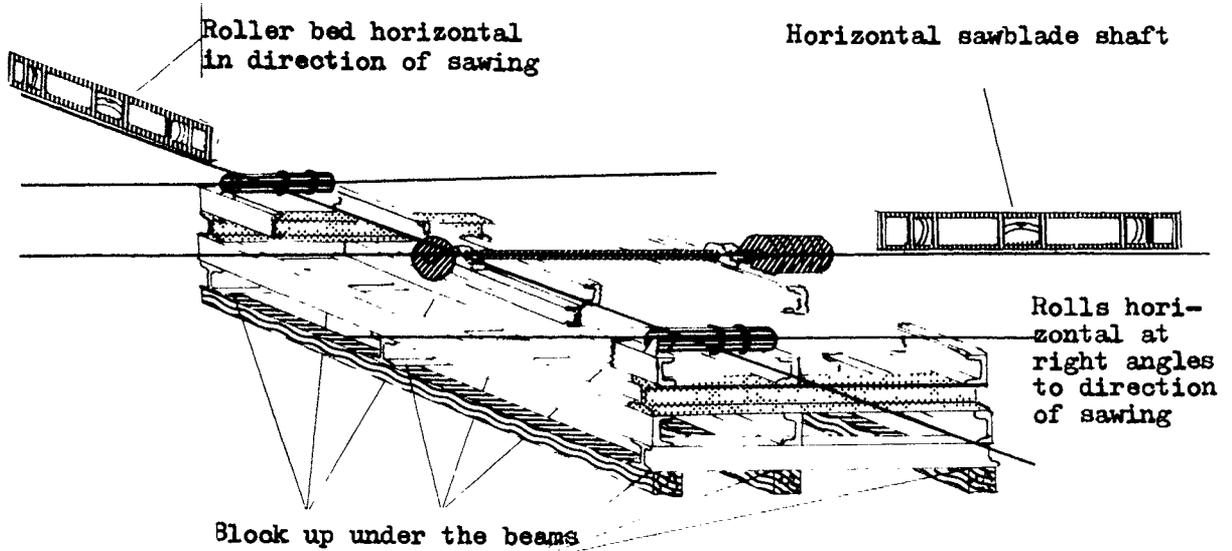


Fig. 16. Adjustment of centre section

ALIGNMENT OF CENTRE SECTION WHEN THE CIRCULAR SAWBLADE SHAFT IS NOT HORIZONTAL

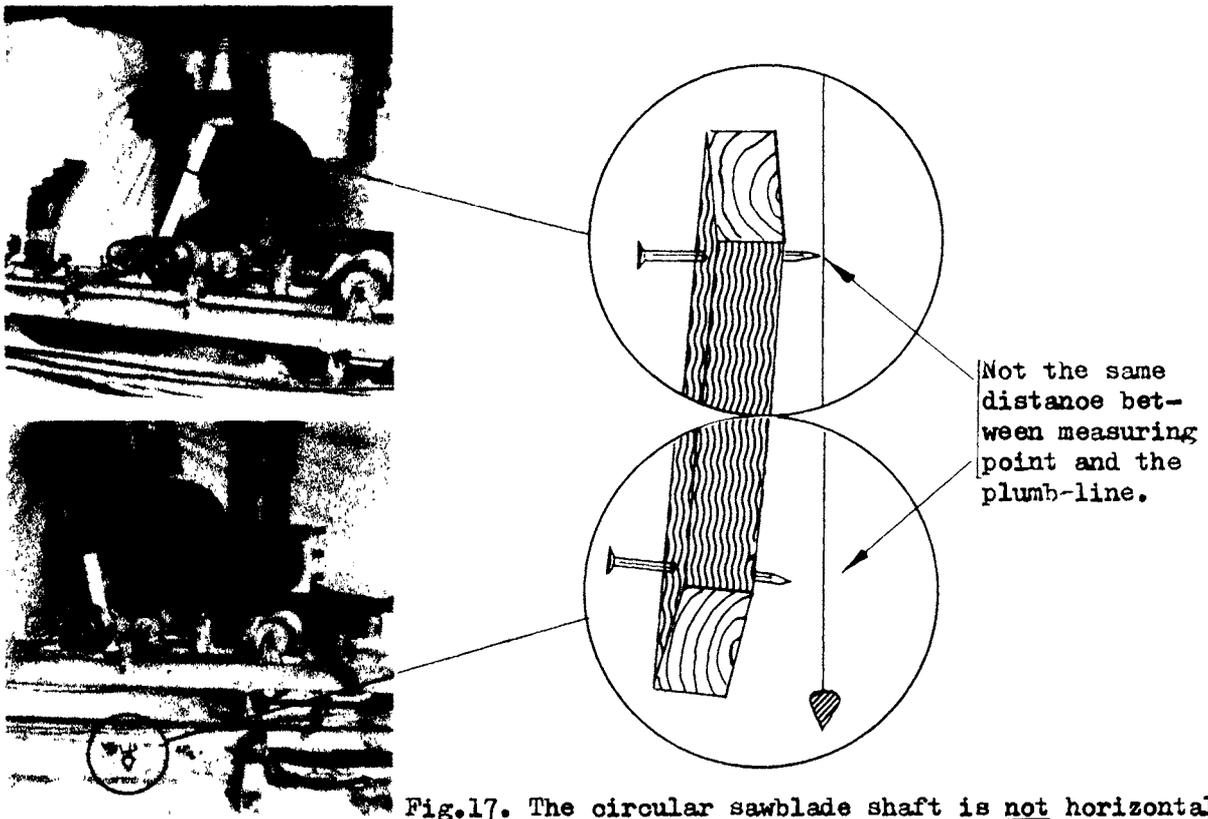


Fig.17. The circular sawblade shaft is not horizontal

If the sawblade shaft is not horizontal, block up the centre section until the distance between the measuring nail and the plumb line becomes exactly the same at the two different positions as in figure 11.

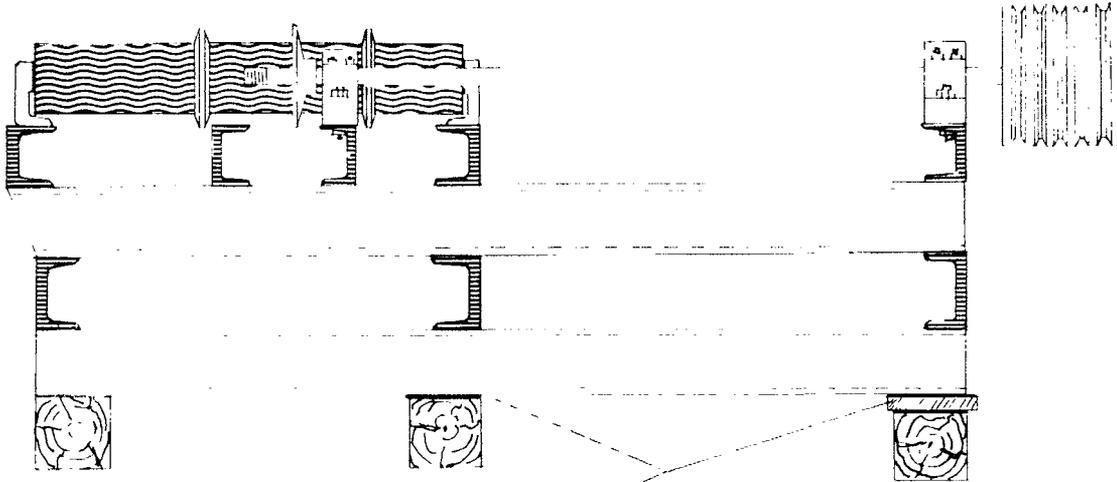


Fig.18 Blocking up of the centre section at right angles to direction of sawing.

When the sawblade shaft is horizontal, check the water-level as shown in figure 12. Then check the rollers at right angles to the direction of sawing, as shown in figures 13 and 14 and adjust their positions, if necessary by means of pads.

At the same time make sure that the guide and support rolls are at the same level and that the whole centre section is also horizontal in the direction of sawing.

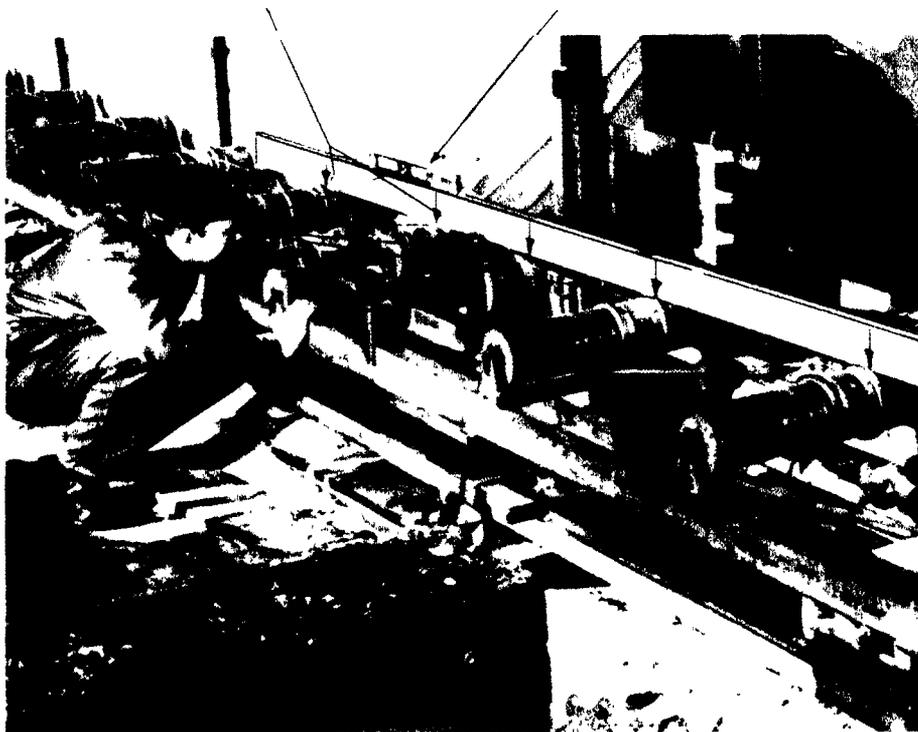


Fig.19 Checking the centre section in the direction of sawing

5. Checking the Alignment of the Sawbench Longitudinally

The roller beds must be at right angles to the sawblade shaft in the longitudinal direction of the sawbench and the flanges of the guide rolls in a straight line.

To be able to check this it is necessary to fix and align a cord above the sawbench and at right angles to the sawblade axle. The easiest way is to use the same principle as applied when deciding if the sawblade shaft was horizontal, this time applied as follows:

- 5.1 Behind the ends of the sawtable, transverse boards are put up so that a cord can be attached between them. This cord must pass in front of the flanges and as close to the roll bed as possible but without touching any of the rolls. The attachment of the cord at the ends is done so that it is easy to adjust its position sideways. (Fig.20).
- 5.2 An indicator board with a nail as its measuring point is clamped between the flanges and with the nail facing the cord. (Figure 21). (Compare with page 8).



Fig. 20

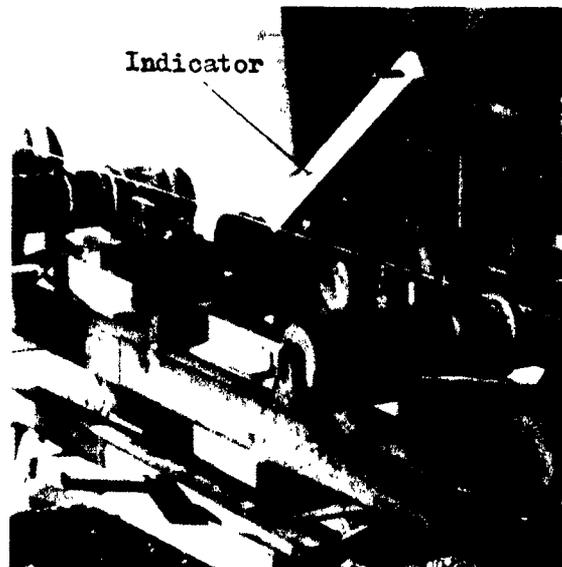
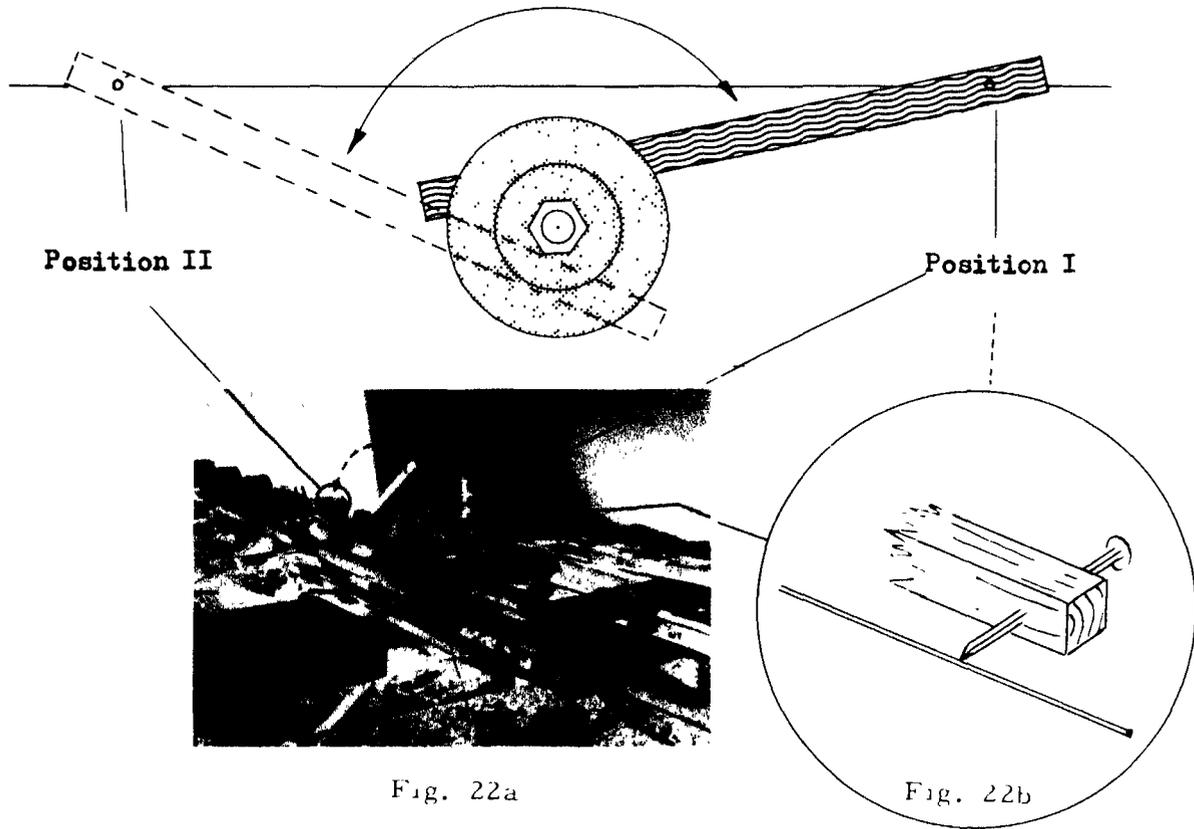


Fig. 21

- 5.3 By turning the sawblade shaft the indicator is brought to position I, (see figure 22a), so that the nail is level with the cord. Then the cord is adjusted at one of its attachment points so that it just misses touching the tip of the nail. (See figure 22b).



5.4 Following this, the indicator is brought to position II, figure 22a, by turning the sawblade shaft. If the cord is at right angles to the sawblade shaft, the tip of the nail will once again just miss the cord. But this is seldom the case the first time the indicator is brought from position I to position II. One can see, however, in which direction the cord needs to be moved. It is then necessary to move both ends of the cord many times until the indicator nail in both positions shows that the cord is at right angles to the sawblade shaft.

THE CORD IS AT RIGHT ANGLES TO THE CIRCULAR SAWBLADE SHAFT WHEN THE TIP OF THE NAIL JUST MISSES THE CORD BOTH IN POSITIONS I AND II (FIG.23), WITHOUT ANY FURTHER ADJUSTMENTS BEING NECESSARY.

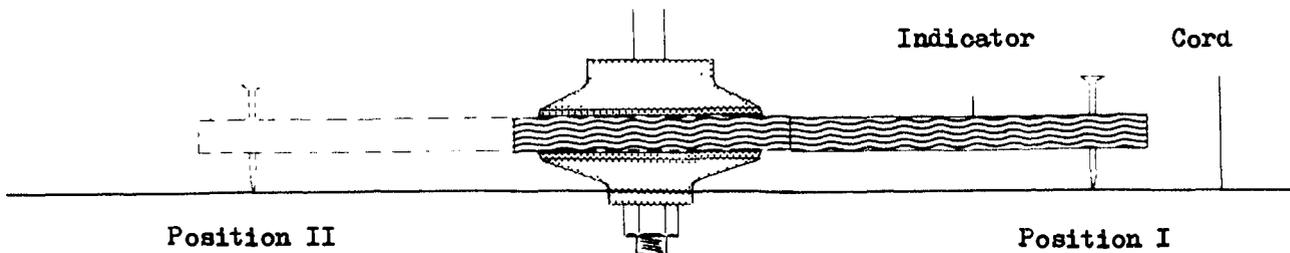


Fig. 23

When the cord is correctly aligned check the position of a guide roll in relation to it. As the cord passes above the roller beds it is difficult to check accurately enough by eye that the roller beds run exactly in line with the cord. It is therefore necessary to measure the position of each roll in relation to the cord, which is done quite simply as follows:

- 5.5 Put a short, even board (planed) on the guide roll with one end of the board pressed against one of the flanges of the guide roll. (Figs. 24a, b).
- 5.6 Place a set square on top of the board and in line with the axle of the roll so that it just touches the cord. Mark the position of the set square on the board with a pencil. (Figures 24a, b).

THE DISTANCE BETWEEN THE END OF THE BOARD AND THE PENCIL MARK IS THE SAME AS THE DISTANCE BETWEEN THE GUIDE FLANGE AND THE CORD.

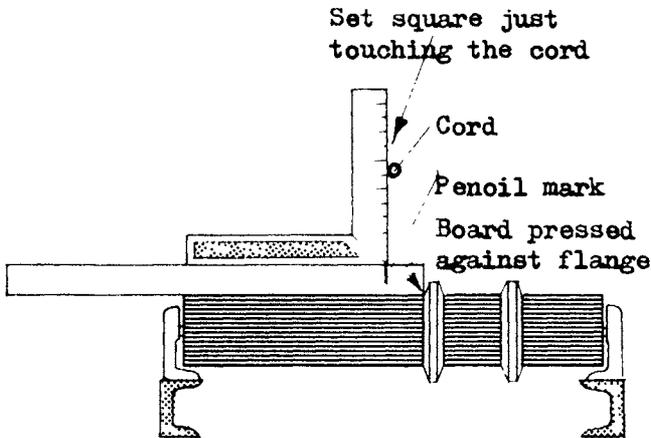


Fig. 24a

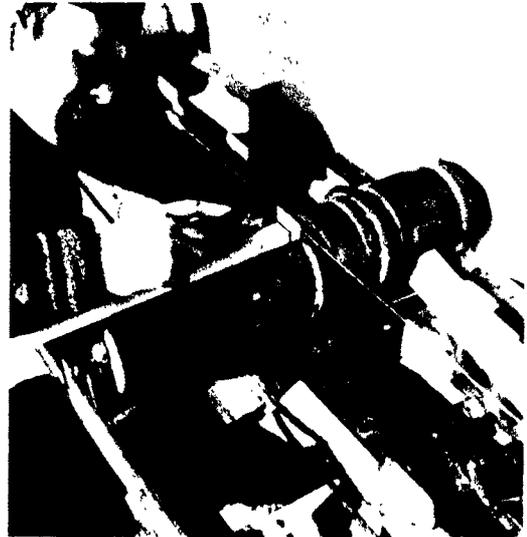


Fig. 24b

This measurement is done for all the rollers in the centre section of the sawbench. (Figure 25).

IF ALL THE MEASUREMENTS ARE THE SAME THE ROLL BED OF THE CENTRE SECTION IS CORRECT, I.E. AT RIGHT ANGLES TO THE SAWBLADE SHAFT.



Fig. 25

A small defect in the position of an individual roll can usually be adjusted by moving its bearing bracket sideways. If the measurement indicates a large error in the position of the rolls because the direction of the roll bed is not in line with the direction of the cord, as indicated in figure 25, the sawblade shaft has probably moved from its correct position.

Cord aimed perpendicularly to blade axle by means of indicator

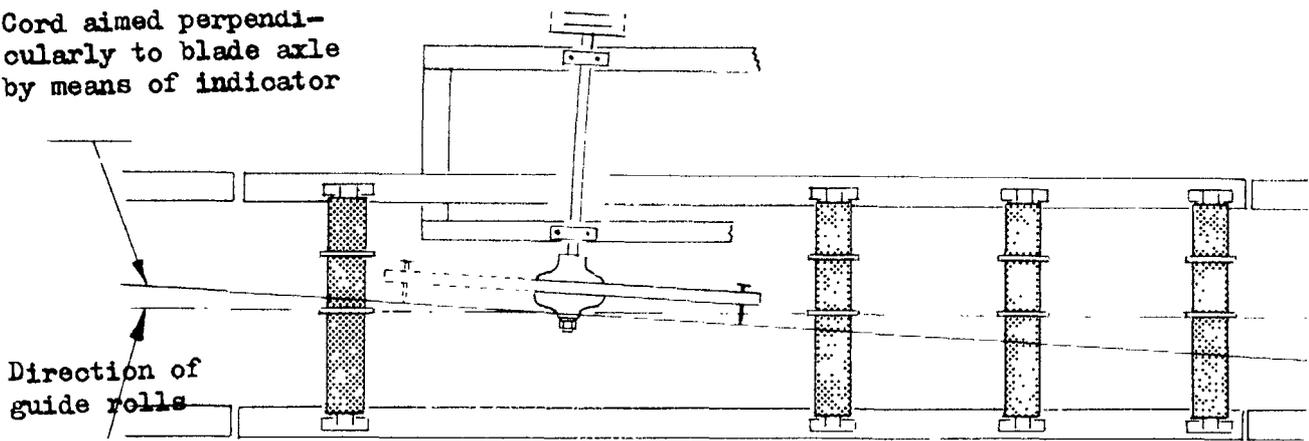


Fig. 26

THE POSITION OF THE SHAFT MUST THEN BE ADJUSTED TO BE AT RIGHT ANGLES TO THE GUIDE ROLL BEDS OF THE CENTRE SECTION. This is done as follows:

- 5.7 Make sure that the flanges on the guide rolls of the centre section are in line with each other. This can be done by looking along the line of flanges.
- 5.8 Then the cord above the sawbence is realigned. This is done following the outer guide rolls of the centre section (roll 1 and 4, figure 25), so that the distance between guide flange and cord (using the method shown in figure 24) becomes the same for the two rolls.
- 5.9 All V-belts and drive belts are disconnected from the sawblade shaft. The bearing bolts at both ends of the shaft are loosened.
- 5.10 The position of the sawblade shaft in the machine stand is then adjusted so that the shaft is at right angles to the cord, which is aligned with the guide rolls of the centre section. (Point 2). The alignment is done using the indicator fixed between the flanges. (Figure 21). The shaft end closest to the V-belt pulley is moved until the indicator nail shows the same distance to the cord at positions I and II. (Figure 27).

WHEN ADJUSTING THE POSITION OF THE SAWBLADE SHAFT IT IS VERY IMPORTANT THAT THIS IS DONE SO THAT NO STRESS IS PLACED ON THE BEARINGS. THE BEARINGS MUST BE AT RIGHT ANGLES TO THE SHAFT. When any adjustment is made both bearings must be loosened from the machine stand.

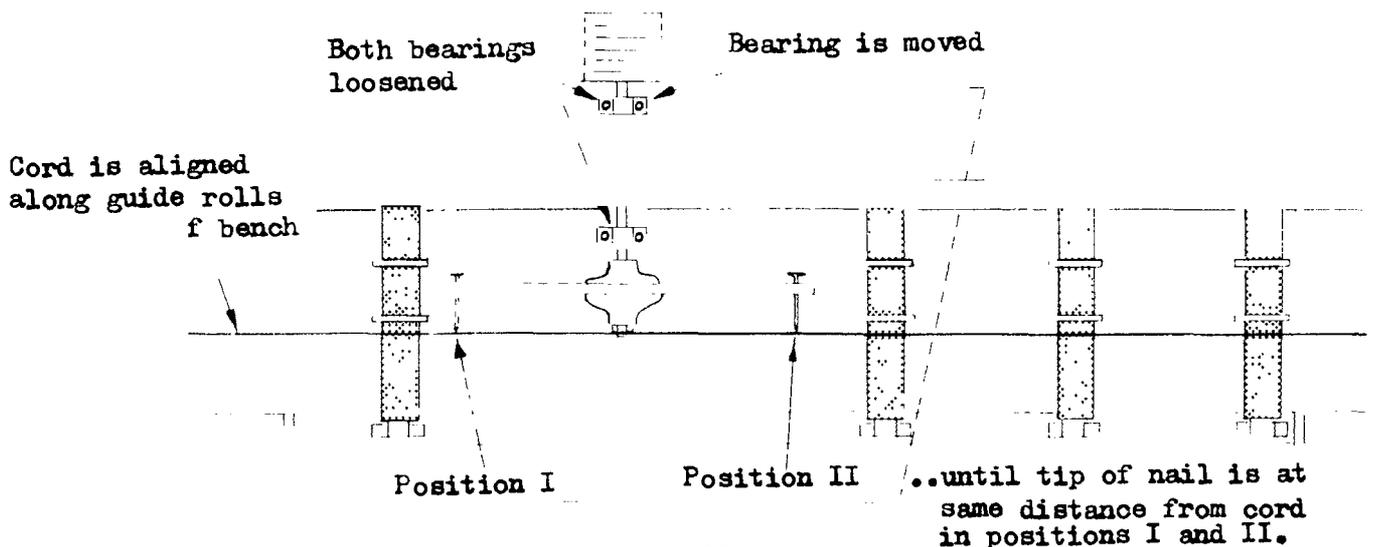


Fig. 27

To check that the front and rear roll beds of the sawbench are in line with the fixed cord above the sawbench (that is in line with the centre section of the roll bed), use the set square, figure 28a. The distance from the guide flange to the cord must be exactly the same for the front and rear guide rolls as for the guide rolls in the centre section.

When this distance has been measured on one of the guide rolls in the centre section, the check of the roll beds of the outer guide rolls should be done in order to get the overall picture of the position of the beds.

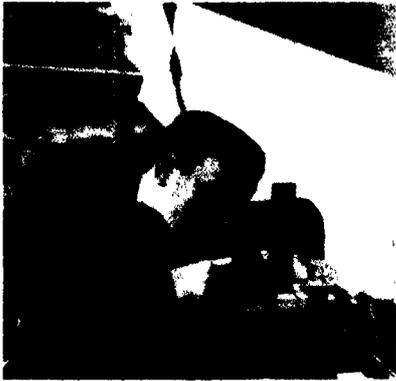


Fig. 28 a



Outer guide
rolls of the
roll bed

Fig. 28 b

Any fault in alignment of the front and rear roll beds as shown in figure 29 for instance, is adjusted by moving the stands of the roll beds sideways.

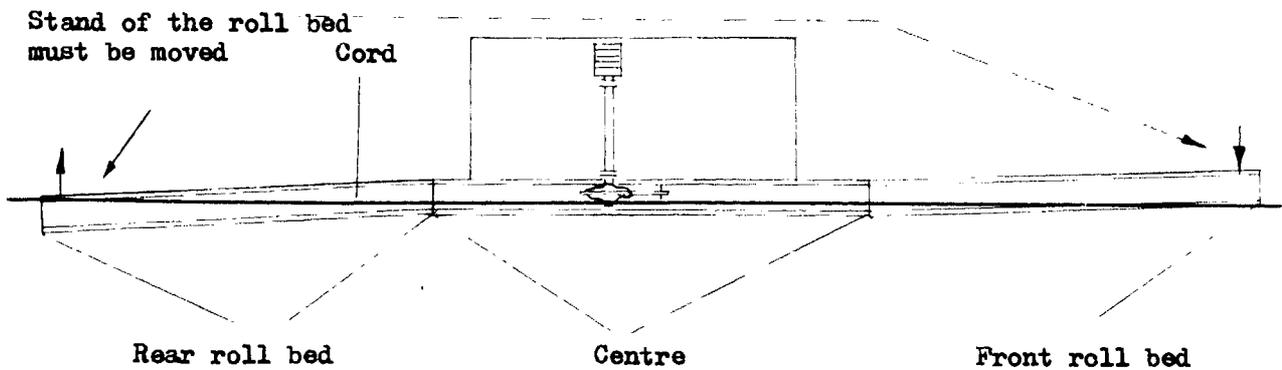


Fig 29

6. Checking the Position of the Front and Rear Roll Beds Horizontally and Vertically

The three roll beds of the sawbench, the front, rear and centre sections, are now longitudinally aligned at right angles to the sawblade shaft.

The centre section of the sawbench, as well as its guide and support rolls, is correctly aligned in the direction of sawing and also at right angles to that line. (Figure 16).



Fig. 30

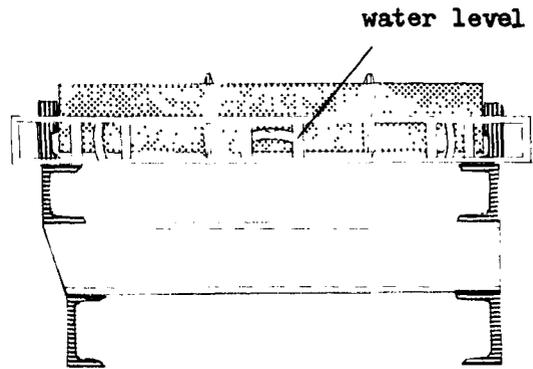


Fig. 31

Starting from the centre section check that the front and rear roll beds are horizontal and that all the rolls are at the same level. This is done (Figure 30) using a straight edge and a water-level. The check starts with one end of the straight edge across the rolls in the centre section and continues out towards the ends of the roll beds, the straight edge being moved forward over one or two rolls at a time.

In addition, check with the water-level (see figure 31) that the front and rear roll beds are horizontally at right angles to the direction of sawing. If these controls indicate that the roll beds are incorrectly placed, adjustments are made by inserting pads under the legs of the stand. If only one roll is wrongly positioned, this is adjusted with pads under its bearing brackets.

Figure 32 shows an example of the adjustment when the whole bed is sloping and there is a depression between the outer contact points of the straight edge.

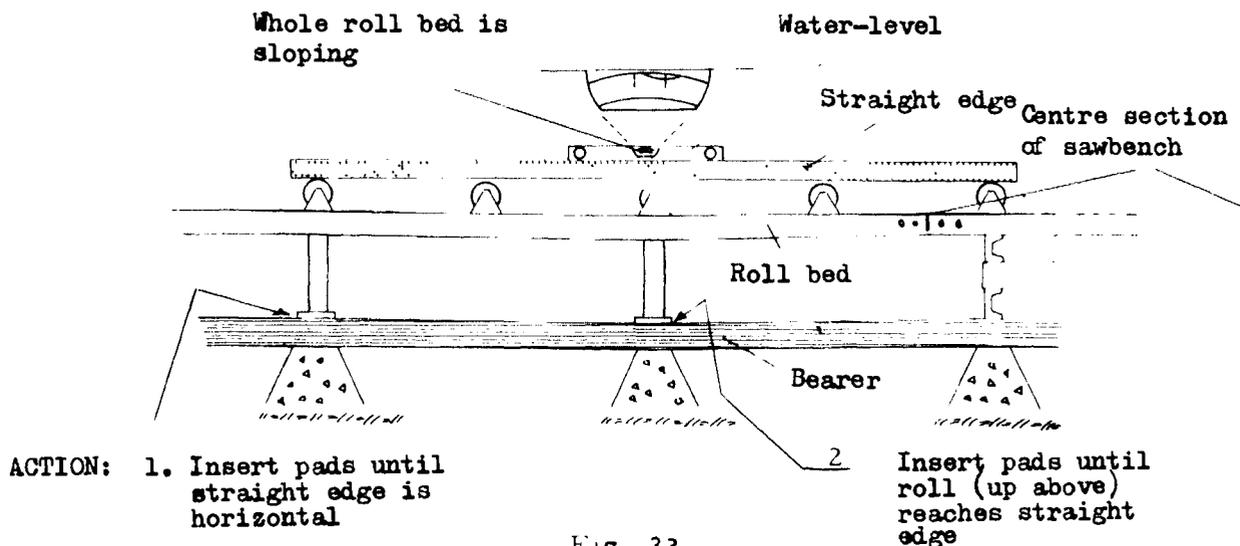


Fig. 32

Figure 33 shows an example where the straight edge is horizontal but one roll is placed too low in relation to the others. This fault is corrected by lifting only this particular roll.

One Roll is Incorrectly Positioned

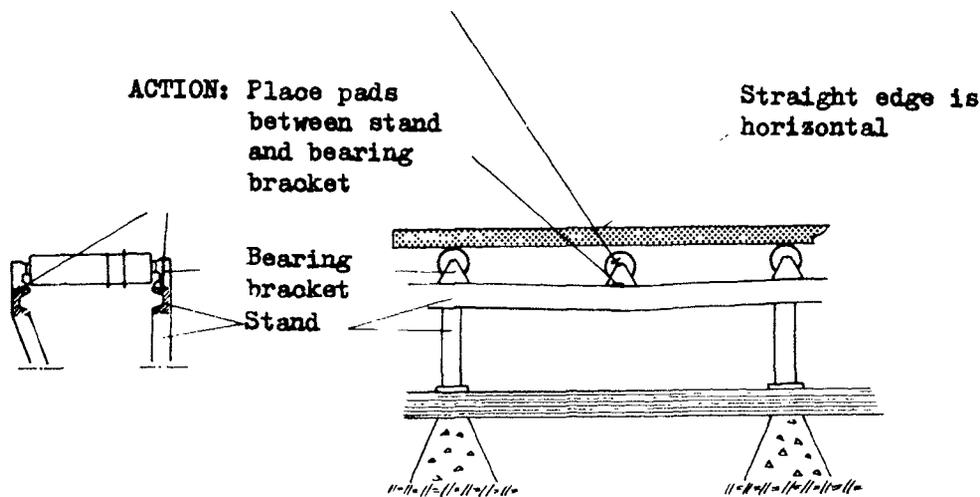


Fig. 33

Figure 34 shows an example where the roll bed is not horizontal at right angles to the direction of sawing. This is adjusted with pads under the legs of the stand or, for a single roll, between the stand and one of the bearing brackets.

Roll Bed is not Horizontal

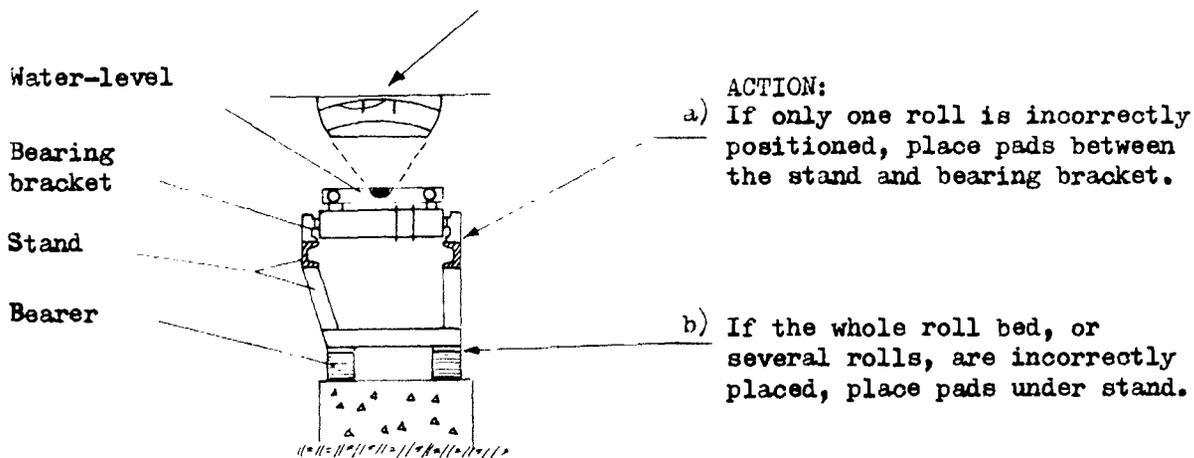


Fig. 34

7. Control of the Position of the Fence

The fence must be positioned vertically and with a small clearance in the direction of sawing. (Figure 35).

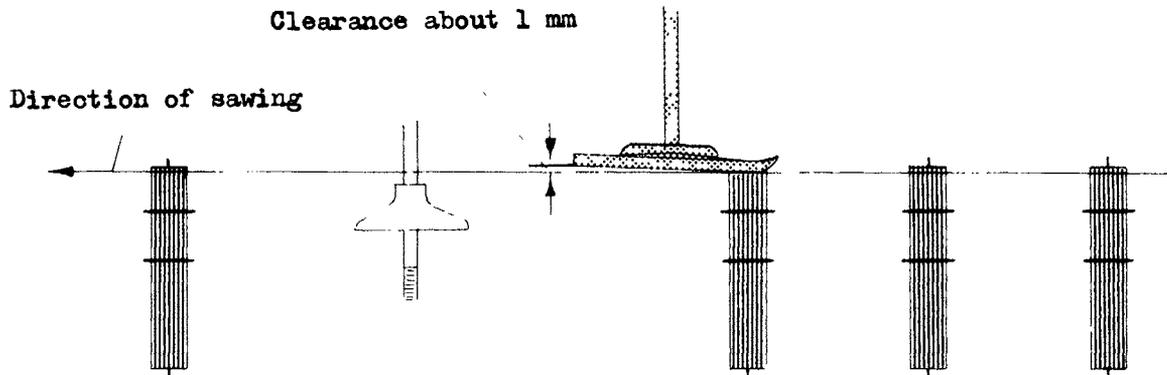


Fig.35

To check that the fence is vertical, place a plumb-line so that the fence can be moved against it. (Figure 36a). If the fence is quite vertical, the plumb-line and the plane of the fence plate coincide.

To increase accuracy, the check can be done with a straight edge, as shown in figure 36b.



Fig. 36a



Fig. 36b

To check that the fence is adjusted with the correct clearance in the direction of sawing (figure 35):

1. Place a straight edge on the roll bed with one edge close to the flanges of the guide rolls.
2. On the straight edge a surface gauge is placed. This is aligned so that the measuring point just touches the fence about 1 cm inside its leading edge. (Figure 37).
3. The straight edge is pushed in the direction of sawing with its edge pressed against the flanges of the rolls until the surface gauge is about 1 cm from the trailing edge of the fence. Check carefully that the surface gauge is not moved from its location on the straight edge during this movement.

IF THE FENCE IS ADJUSTED CORRECTLY THE DISTANCE BETWEEN THE MEASURING POINT AND THE PLANE OF THE FENCE SHOULD NOW BE ABOUT 1 MM.

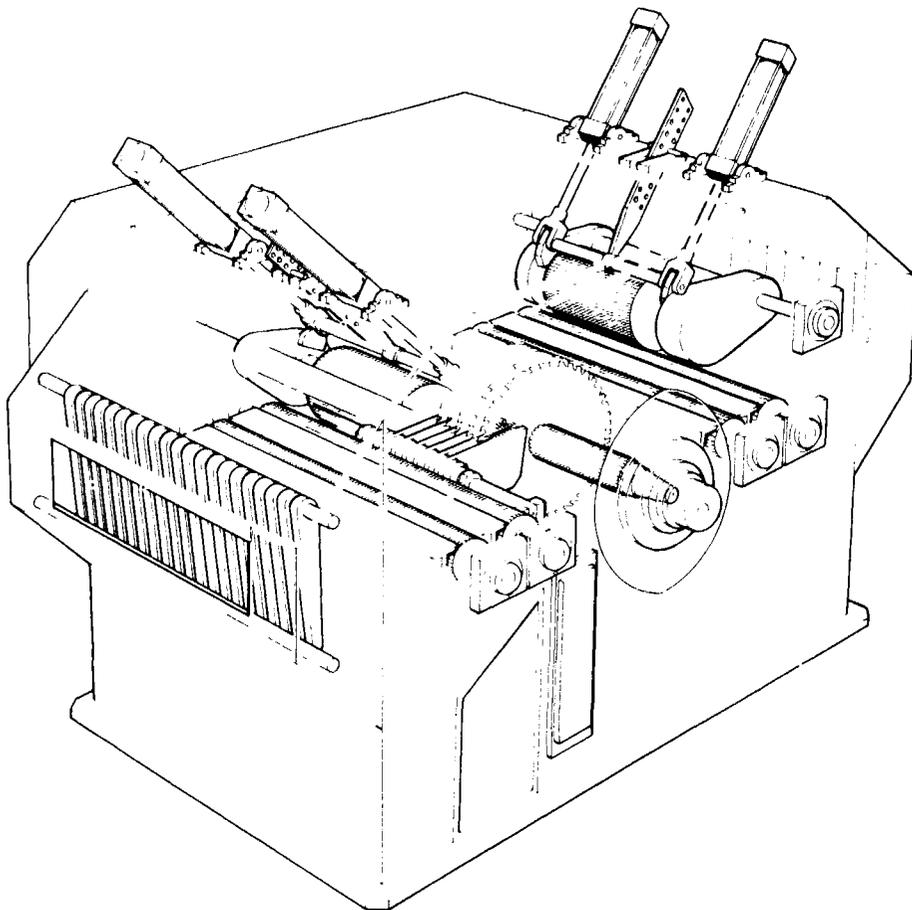


Fig. 37

Checks and adjustments must always be made with the greatest care. When blocking up under the machine stand, for example, make sure that it receives a solid contact surface against the bearers. In this type of work one adjustment must not interfere with adjustments made earlier.

V MODERN CIRCULAR SAWS, DESCRIPTION AND CONTROL

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In the following chapter machines for log sawing, cant sawing, split sawing and edging are briefly described. As examples, machinery of Scandinavian origin, manufactured by ARI of Sweden and Jajod of Norway has been chosen.

Log breakdown saws or log saws are normally equipped with two sawblades, enabling log breakdown in one operation.

Resawing of cants. Cant sawing is normally carried out in cant saws equipped with one to three or more blades.

The following are the main components of a circular saw:

1. Frame with sawdust evacuation and safety devices.
2. Saw mandrel with bearings, main transmission and motor mandrel/s (shaft).
3. Measure monitoring system.
4. Circular sawblade/s.
5. In and outfeed devices.

These main components have different designs depending on the type of sawing.

1. The Processing Cycle

The processing cycle in a circular sawing machine is:

- a) Setting of dimensions, i.e. the distance between two sawblades or between fence and sawblade.
- b) Feeding, i.e. transport of the log or the cant through the machine.
- c) Sawing, i.e. the movement of the sawblade through the wood.

1. Dimension setting
2. Feeding
3. Sawing

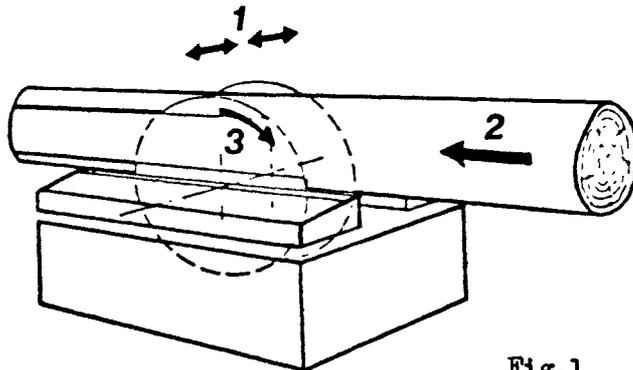


Fig.1

Dimension setting is usually done by means of one of the following systems:

- a) Electro-hydraulic system
- b) Electro-pneumatic system
- c) Mechanical system.

Of these systems the electro-hydraulic system is the most complicated but it is also the system achieving the best precision and setting speed. The mechanical system is the simplest type. It is still used on simple rip saws and edgers.

The feeding through a circular saw is done by means of:

- a) Roller feeding, or
- b) Chain feeding.

Log breakdown saws are normally equipped with chain feeding whilst cant saws and edgers are equipped with roller feeding.

1.1 Circular Sawing - Advantages

Some of the advantages when using circular saws are:

- a) They are comparatively cheap and easy to maintain.
- b) The circular saws are relatively small and no heavy foundations are required compared to frame saws. This also applies to bandsaws to a limited extent.
- c) High dimension accuracy and straight cuts can be achieved.
- d) Rotating cutting tools (blades) work comparatively free from vibrations.

1.2 Circular Sawing - Disadvantages

Some disadvantages when using circular saws:

- a) The saw kerf is wider compared to other sawing methods, especially where large sawblades are used.
- b) Circular sawblades are fairly sensitive to friction and heat and proper tensioning requires skilled personnel.

1.3 Saw Kerf

The width of the saw kerf depends on the thickness of the sawblade, the setting or swaging of the saw teeth and the guidance of the blade. Comparison between circular saws, frame saws and band saws is shown in Table 1.

Table 1

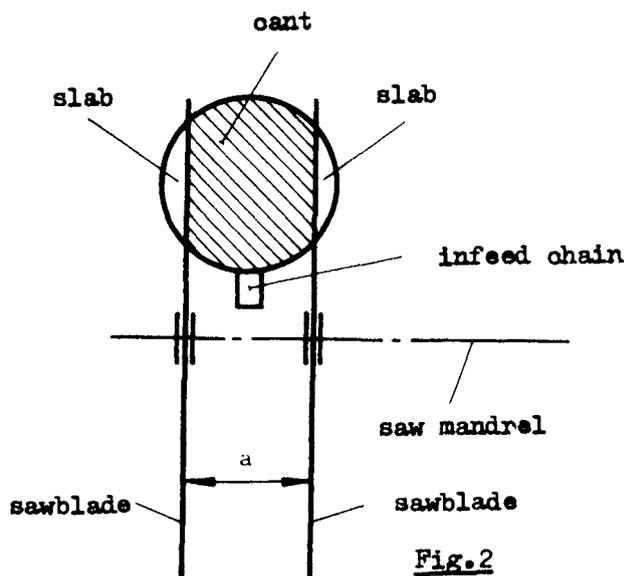
Type of Saw	Thickness of sawblade mm	Tooth Setting mm	Saw kerf <u>a</u> mm	Sawdust area mm ²
Circular saw	3.2	2 x 0.5	4.2	3 448
Frame saw	2.0	2 x 0.5	3.0	2 439
Band saw (high strain)	1.2	2 x 0.5	2.2	1 828

The width of the saw kerf a equals the thickness of the sawblade, plus swaging or setting of the teeth. In Table 1 the setting is 0.5 mm in each direction. Using a conical sawblade, the saw kerf is slightly narrower than shown in Table 1 and, by using modern guided thin sawblades, saw kerfs of around 2.5 mm can be achieved.

In the following section on circular sawing machines log saws, cant saws, split saws and rip saws will be briefly described. Comments are also made on common faults in the machines and proposed controls to avoid them.

2. Log Saws

Log saws to be used for sawing cants out of logs are normally of the two blade type, as shown in Figure 2. The setting of dimensions is done by means of an electro-hydraulic system which is regulated from the seat of the operator. Normally, the cant and the slabs are further processed in other sawing machines. However, by using a "merry-go-round" system it is possible to let the log pass the machine twice, thus producing a square block. Setting of dimension a depends on the log diameter.

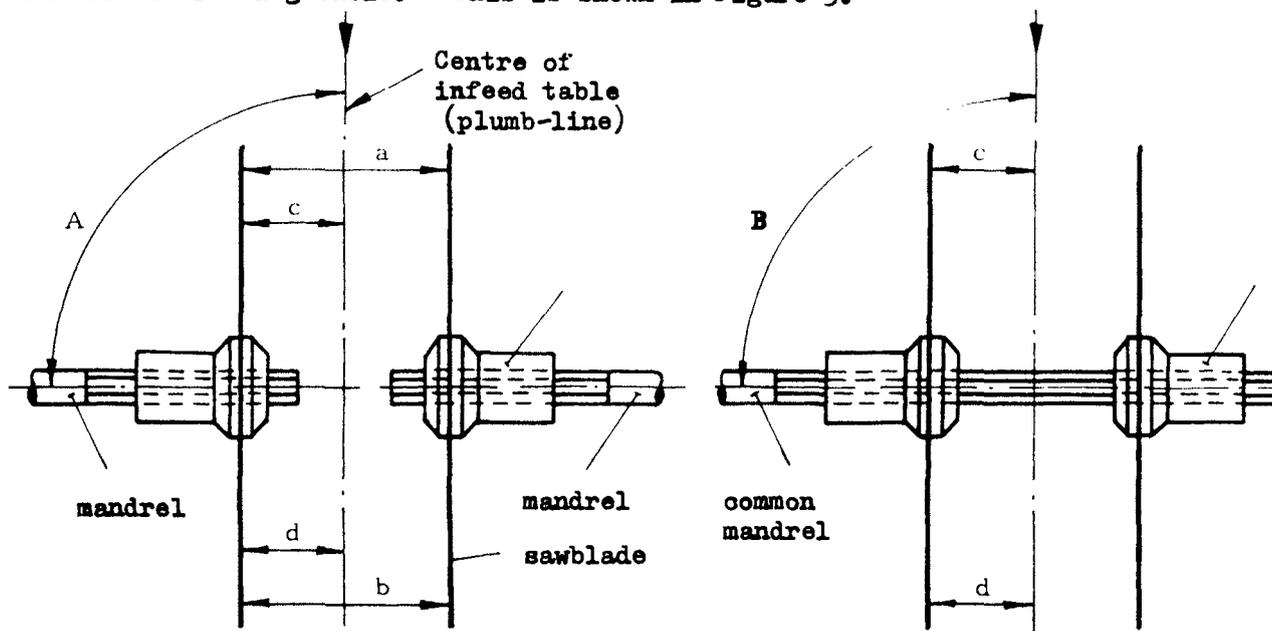


In order to produce timber of an acceptable accurate measurement the following are the most important prerequisites:

- a) The log must be fed parallel to the plane of the sawblade.
- b) The sawblade must rotate parallel or with a slight "toe in".
- c) The guide knife must be properly adjusted.
- d) The sawblade guide pins must be functioning properly.
- e) The sawblades must be properly levelled, tensioned and sharpened.

2.1 Control of Infeed Device and Sawblades

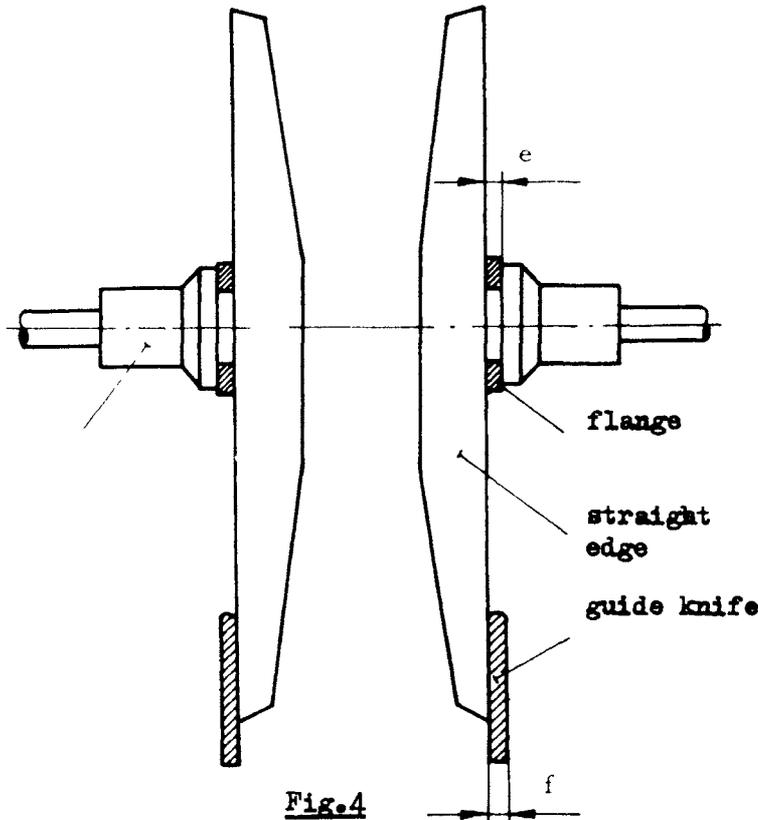
The alignment of the infeed table is checked by using a plumb-line between the two ends of the feeding table. This is shown in Figure 3.



A = B = angular to mandrel (shaft)

Fig.3

To check the alignment of the sawblade, a straight edge is used as shown in figures 3 and 4. Some sawing machines are equipped with special straight edges to be attached to the fixed flanges. The angle A between the saw mandrel and the infeed table should always be 90° . To set the saw blades parallel, the measurement a should be equal to b and the measurement c equal to d, as shown in figure 3. However, experience has shown that setting the sawblades with a slight "toe in" is preferred. This means that the measurement b in this case equals the measurement a, plus 0.2 mm, and the measurement d equals measurement c, plus 0.1 mm. Each manufacturer should state in the instruction manual how a proper "toe in" is set. This also depends on the density of the species.



2.2 Control of Guide Knives

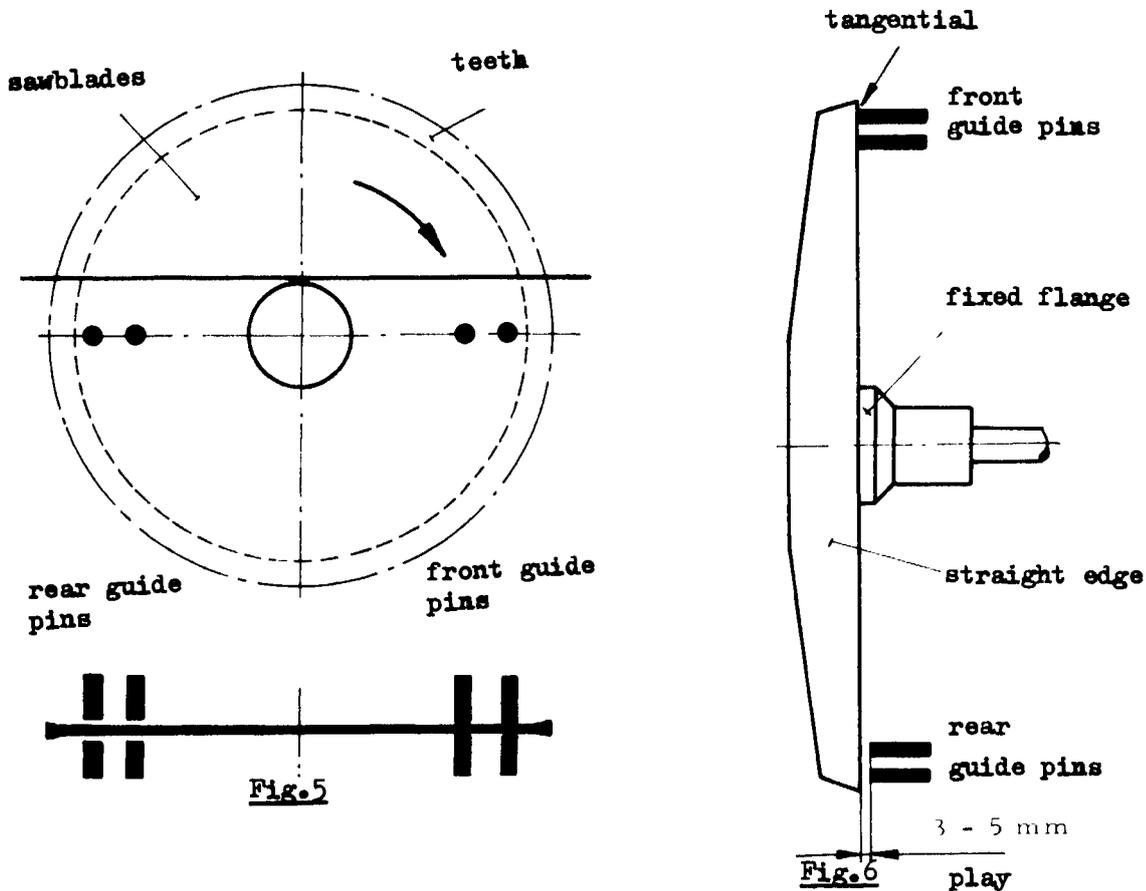
The function of the guide knives is as follows:

- (a) To guide the log or the cant and to prevent its turning.
- (b) To prevent the wood from coming into contact with the saw teeth on the outfeed side. This is to avoid the cant being thrown back towards the operator.
- (c) To expand the saw cut to prevent unnecessary friction between the sawblade and the wood material, resulting in premature blunting of the saw teeth.
- (d) To improve the quality of the cutting surface by preventing the saw teeth on the outfeed side from scratching the surface. The shape of the front edge of the guide knife should coincide with the sawblade and should be set about 1 cm distance from the circumference of the blade.

In figure 4 the proper alignment of the guide knife is shown, with reference to the fixed flanges. The measurement e as shown in the figure should be equal to the thickness of the sawblade at centre, plus a single setting measurement. The minimum thickness of the guide knife measurement f should be equal to the cutting width. Further reference is made to manufacturers' instructions.

2.3 Control of Guide Pins

For proper guidance of the sawblades, saw machines are equipped with guide pins. These are called the front guide pins on the infeed side and rear guide pins on the outfeed side, as shown in figures 5 and 6. Pins are mounted just under the saw table and as close to the teeth as possible. The front pins are made of a low friction material such as ebony or teflon, whilst the rear pins are usually made of steel. The play between the front pins and the blade is only some tenth of a millimeter. In practice, this means that the pins are mounted tangential to the blade. Figure 6 shows adjustment and control of the front pins on the driven side of the blade. This applies when using a plain sawblade. When using conical sawblades the play has to be adjusted according to the conicity of the blade.



The front guide pins of the opposite side of the blades should be adjusted while the blade is at full speed. For accuracy and safety reasons, modern saws are equipped with mechanical pin adjustment devices.

The rear guide pins play should be 3 to 5 mm. These are only a safety device to prevent the sawblade from cutting into the saw table. The position of the guide pins should be changed when another dimension of sawblade is used.

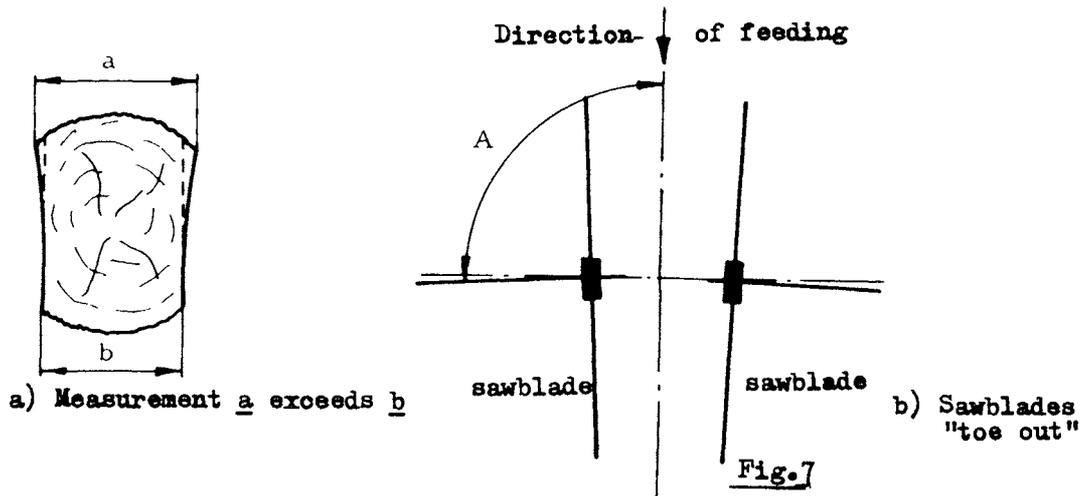
Due to tension in the blade it is not straight when idle, therefore:

- a) Final adjustment of the front guide pins should be carried out at full sawblade speed when the blade is straight.
- b) Check that the blade at full speed does not touch any of the guide pins. This creates abnormal heating and a change in tensioning of the blade.
- c) Never try to force the sawblade straight by using the guide pins. This also creates abnormal heating and a change in the tensioning of the blade.

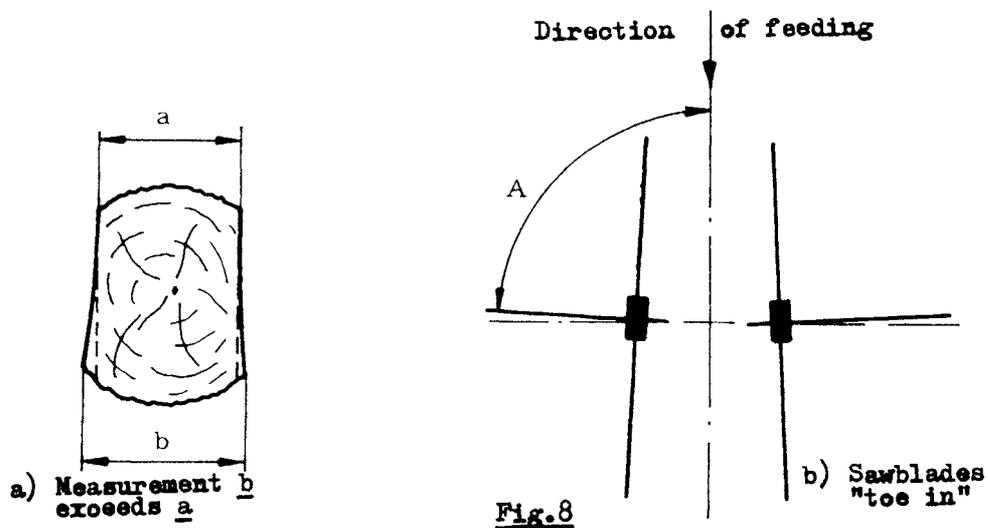
2.4 Common Cutting Faults in a Two Blade Log Saw

There are mainly three typical cutting faults that might occur in a two blade log saw. Faults occurring by using incorrectly treated blades are not considered.

- a) The thickness of the cant varies in the outfeed end, as shown in figure 7 a). The reason for this fault is:
 - i) The mandrels are not properly aligned and thus the sawblades are not parallel.
 - ii) Positioning of the guide pins is preventing a plane rotation of the sawblades.



- b) The opposite situation is shown in figure 8 where inaccurate sawing occurs at the other side of the cant.



- c) The cant is skew as shown in figure 9. The most common reasons for this are:
- i) The guide knives are mounted too far from the cant size allowing the cant to roll while being out.
 - ii) The vertical alignment of the guides is not correct, creating twist of the cant.

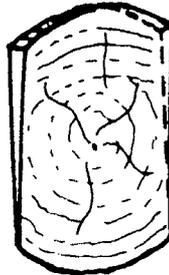


Fig.9

3. Cant Saws

In order to achieve an effective breakdown of the cants, saw machines of different kinds are used. Three blade saws, five blade saws and multi-blade saws are available on the market. Also single blade split saws are employed. Below, a three blade saw and a single blade split saw is described.

3.1 Three Blade Cant Saw

Figure 10 shows possible sawing patterns in a three blade cant saw.

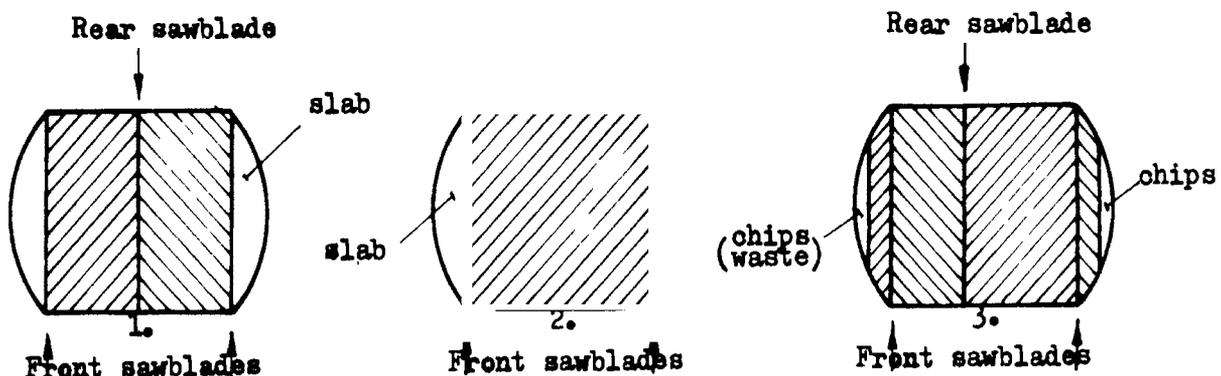


Fig.10

In a three blade cant saw there are three different alternatives for cant breakdown:

- a) Two pieces of main yield and two slabs. The picture shows a symmetrical cutting pattern.
- b) A square block for further processing. In this case the rear sawblade will be removed.
- c) Two pieces of main yield in an unsymmetrical sawing pattern. The picture also shows the final rip saw cuts required for production of boards.

Figure 11 shows the principal construction of a three blade cant saw. This machine is equipped with a front saw mandrel with two adjustable sawblades and a rear saw mandrel with a fixed blade. The feeding device consists of three pairs of horizontal feeding rollers. The three upper feed rollers can be lifted and lowered by means of a high pressure cylinder. The feeding speed varies between 10 and 60 m per minute.

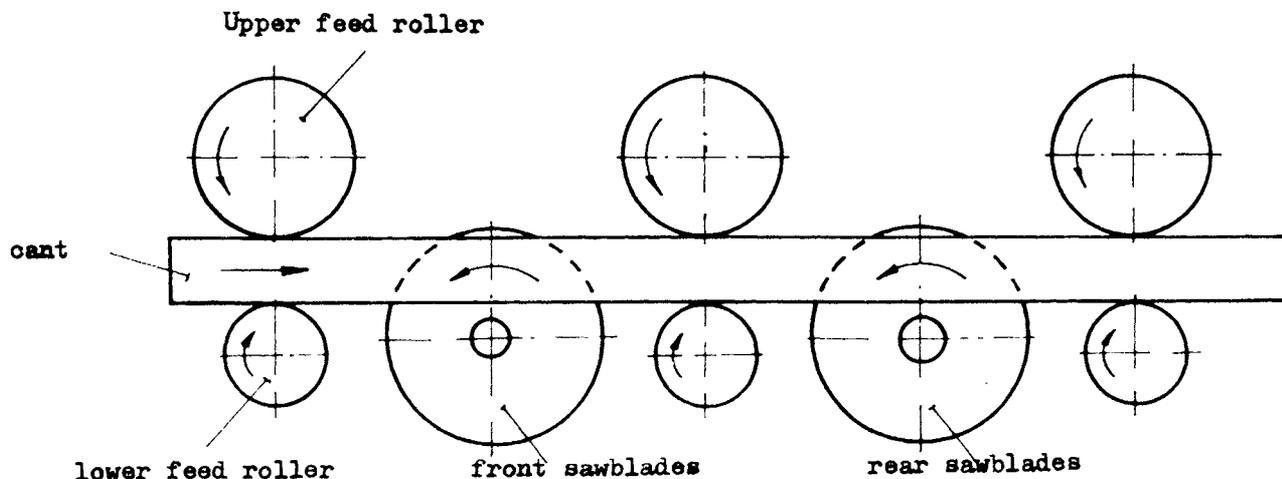


Fig.11

3.2 Control of Cant Saws

In order to achieve an acceptable sawing accuracy the following are the most important prerequisites:

- a) The cant must be fed parallel to the plane rotation of the sawblades.
- b) The three sawblades must rotate parallel (the two front sawblades, possibly with a slight "toe in").
- c) The guide knives should have the proper thickness and adjustment.
- d) The guide pins should be properly adjusted, not forcing the blade in any direction.
- e) The sawblades should be properly levelled, tensioned and sharpened.

The construction of this saw machine does not allow any changes in the infeed direction once the cant has entered the machine. If this occurs, side forces create overheating of the blade. One example, (see figure 12): infeed of a cant with non-parallel sides results in improper feeding as the feeding forces tend to push the cant sideways.

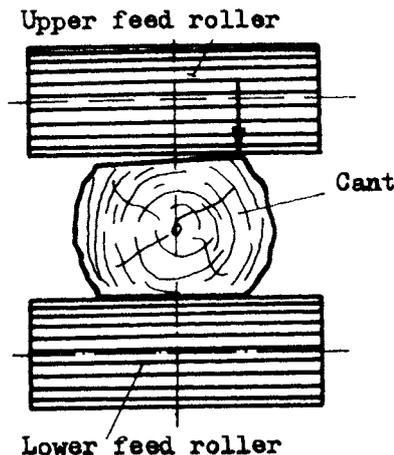


Fig.12

3.3 Control of Feed Rollers and Sawblades

As stated before, the first prerequisite for an accurate sawing is a straight feeding through the machine. Therefore (see figure 13):

- a) All feed rollers and saw mandrels must be exactly angular to the infeed direction.
- b) A slight "toe in", depending on wood hardness of the two front sawblades is recommended.
- c) The guide pins should be adjusted by means of a straight edge as previously described.
- d) The guide knives behind the two front sawblades should be adjusted as described for the log saw.
- e) The guide knife behind the rear sawblade should be adjusted with a straight edge and thus positioned in the middle of the saw out.

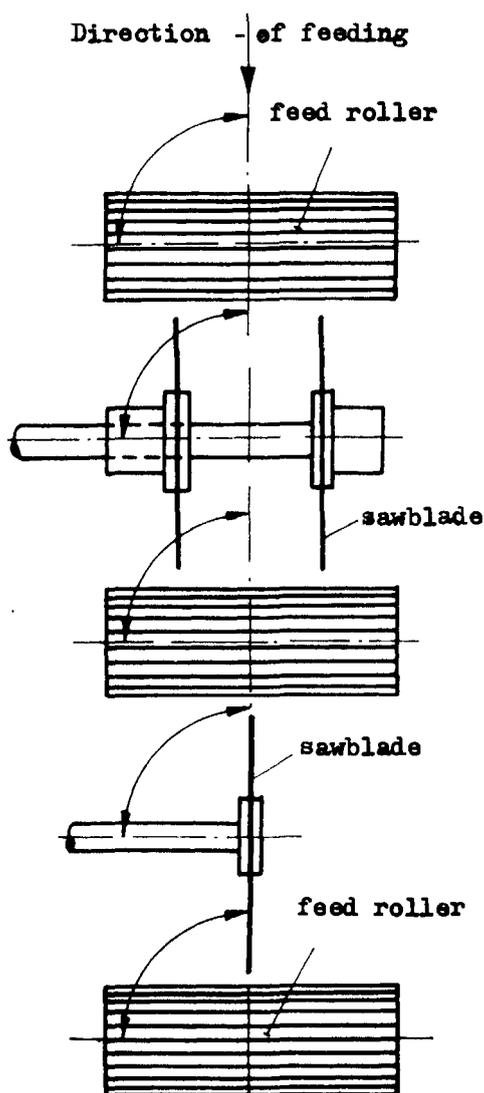


Fig.13

3.4 Control of Guide Knives when using Conical Sawblades

Conical sawblades can be used in two blade log saws and also in three blade cant saws, provided a symmetric sawing pattern is used, i.e. the two pieces of main yield should have same width as shown in figure 14.

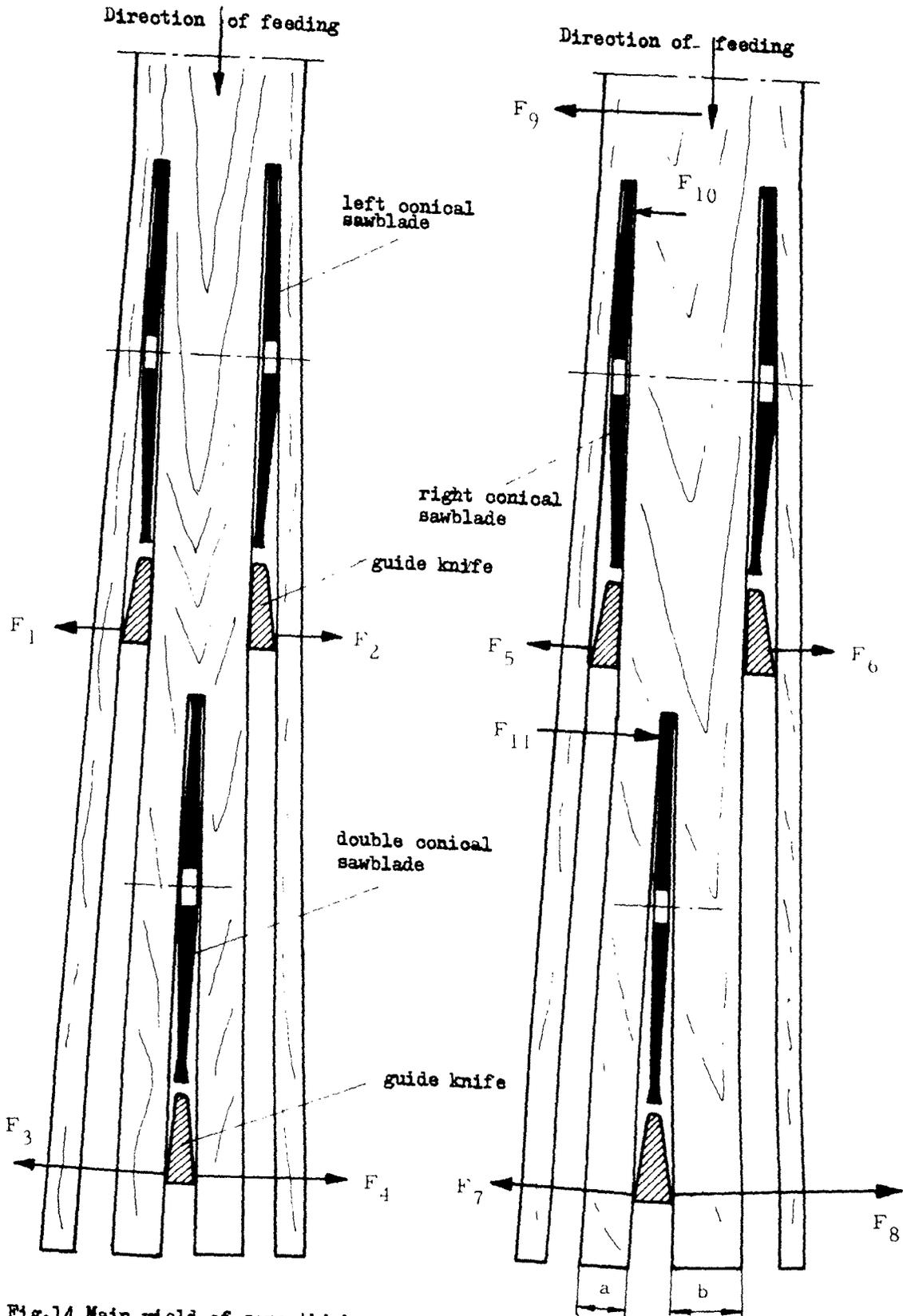


Fig.14 Main yield of same thickness

Fig.15 Main yield of different thickness

By using conical sawblades the saw kerf can be reduced and the timber recovery will be increased accordingly. However, when using conical sawblades a thicker guide knife has to be used in order to open the saw out to avoid friction against the thicker centre part of the sawblade. When using a guide knife thicker than the saw out the guide knife will have a guiding function.

When sawing thin slabs and also thick centre pieces, as shown in figure 14, the guiding function of the guide knife does not result in any forced feeding, as in this case the two slabs and the two centre pieces have the same bending resistance. The side forces as shown in figure 14 are: $F_1 = F_2$ and $F_3 = F_4$.

Figure 15 shows cutting of centre pieces of different thickness and using a double conical rear sawblade and thick guide knife. The difference in bending resistance of the centre pieces results in side forces and causes inaccurate feeding. The side forces are as shown in figure 15: $F_5 = F_6$ but F_8 is $>$ than F_7 . This creates side forces F_9 , F_{10} and F_{11} on the cant and on the blades.

When following an unsymmetrical sawing pattern in a cant saw the rear sawblade must be plane and the rear guide knife should not be thicker than the saw kerf.

3.5 Five Blade Cant Sawing Line

By combining the three blade cant saw with a two blade cant saw as shown in figure 16, the main yield can be out into four pieces. This machine combination allows great flexibility and symmetrical and unsymmetrical sawing patterns. This is shown in figure 16.

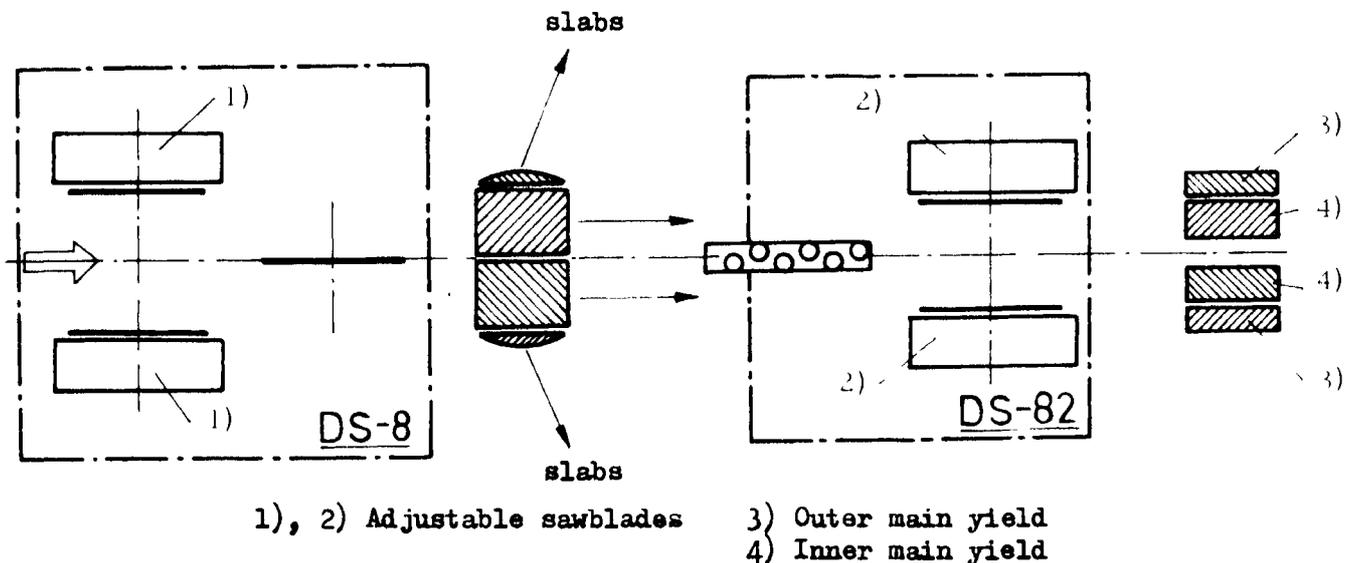


Fig.16

3.6 Multi-blade Saw

Technical development in circular sawing seems to tend towards:

- a) several blades on the same shaft
- b) more precise sawblade guidance
- c) thinner sawblades.

The technique using air or watercooled guideblocks (packing) to guide the sawblade enables a very accurate sawing and allows the use of considerably thinner blades.

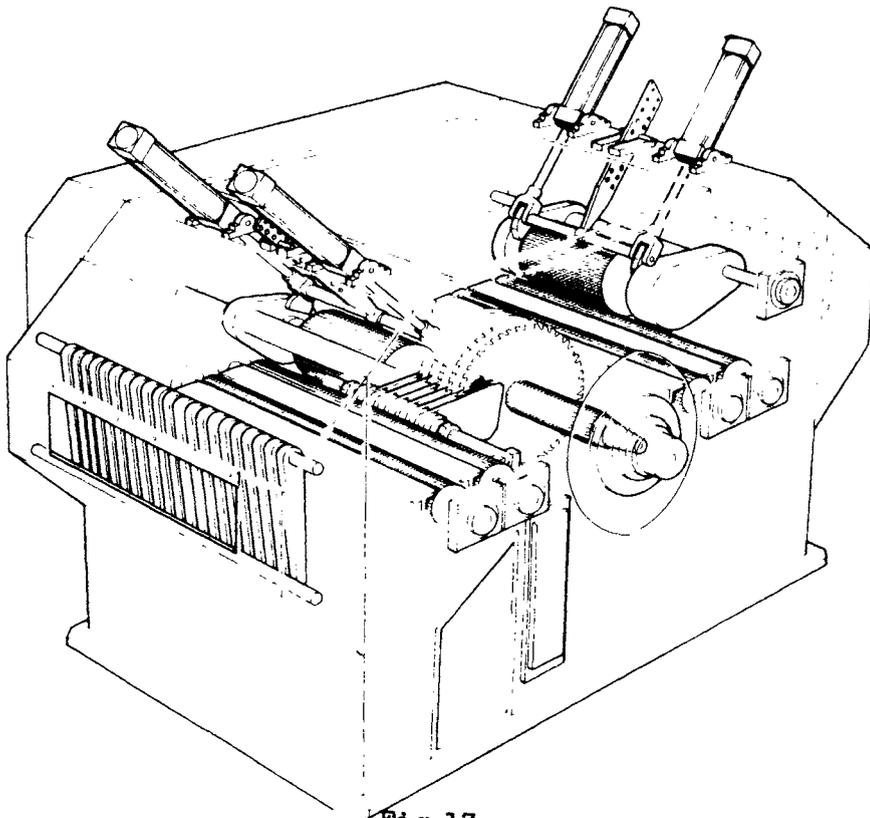


Fig.17

Figure 17 shows a multiblade cant saw with sideways floating sawblades, guided by air and water cooled guide blocks. Setting of the sawblades is done by means of separate networks for each blade.



3.7 Single Blade Cant Saw

This saw is specially designed for split sawing and rip sawing, either through the pith or parallel to it. Figure 18 shows split sawing of a cant. The two half cants will be further processed in a single blade rip saw. The single blade cant saw is ideal for curve sawing. (Figure 19). It enables sawing through or parallel to the pith even if the cant is curved.

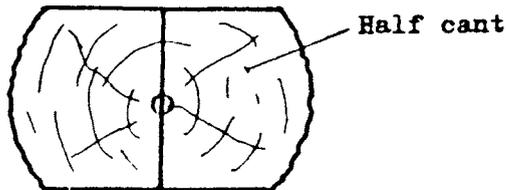


Fig.18

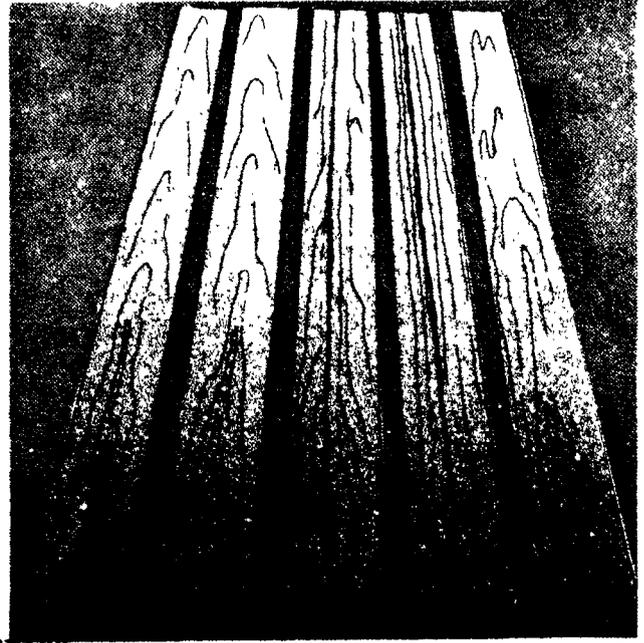
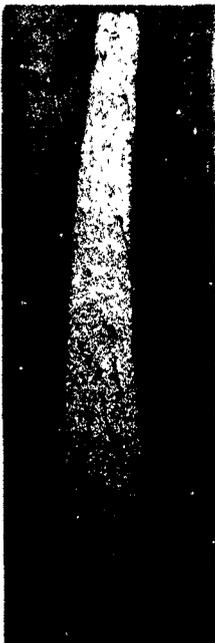
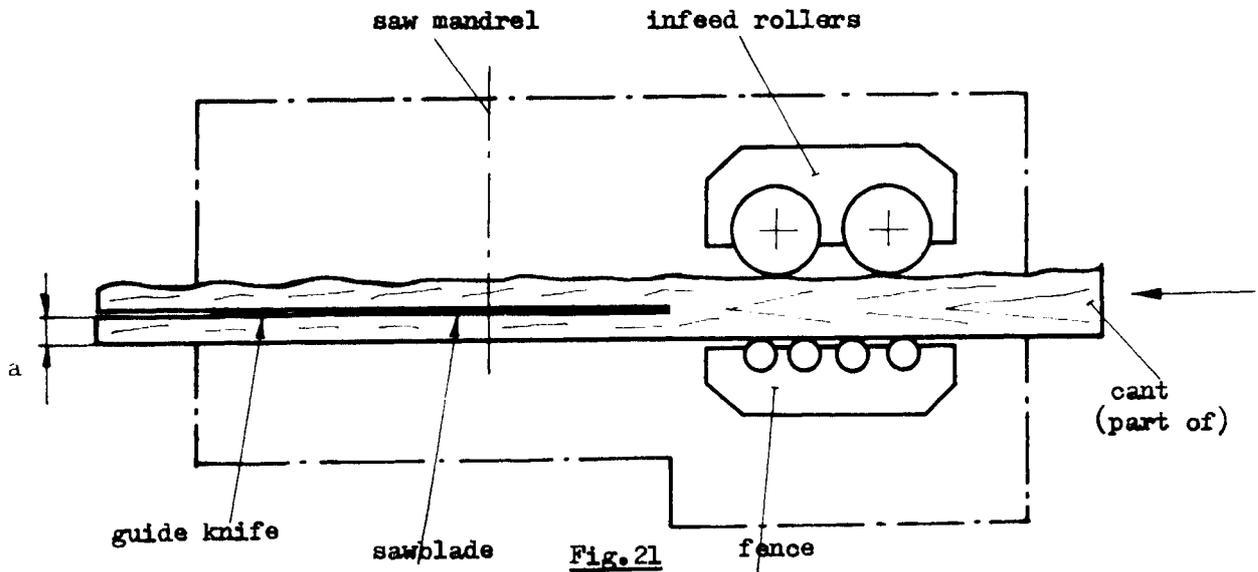
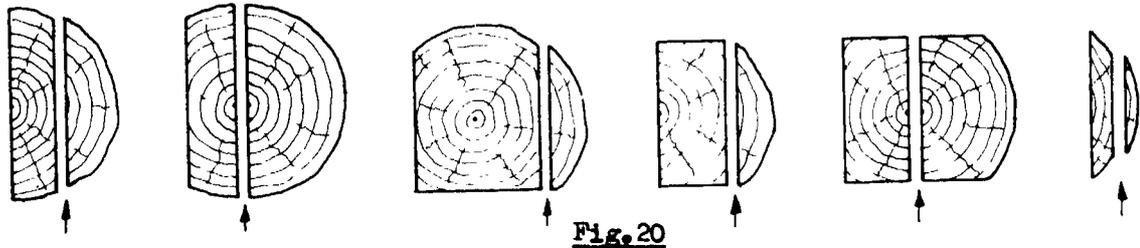


Fig.19
Curve Sawing

4. Single Blade Rip Saws (Split Saws)

Rip saws are used to split or rip cants square block's or slabs into timber. Figure 20 shows common saw cuts in a rip saw. Figure 21 shows the principle construction of a rip saw.



4.1 Rip Saw Cutting Faults

There are mainly four typical cutting faults occurring in rip saws. Faults caused by wrongly treated sawblades are not considered. The faults and their main causes are described below:

- a) The sawn timber is too thin in the end and too thick at the middle. The fence is not angular to the saw mandrel, causing a side force F as shown in figure 22a.
- b) The sawn timber is too thick in the infeed end and continuously thinner at the other end. The fence is at an angle of more than 90° to the saw mandrel, creating a side force F as shown in figure 22b.
- c) The sawn timber gets different thicknesses, i.e. it is conical as shown in figure 23. The fence is wrongly positioned vertically, as shown in figure 23. To avoid these faults the fence must be adjusted to a 90° angle to the saw mandrel, as shown in figure 24a. The measurement a and b must be equal. This is checked by using a straight edge against the flange, as shown in the figure. Control of the vertical alignment of the fence is carried out as shown in figure 24b.

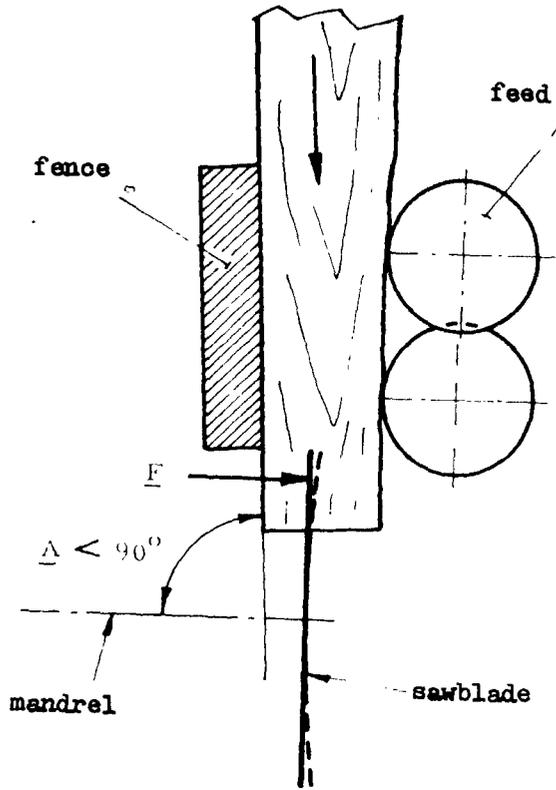


Fig. 22a

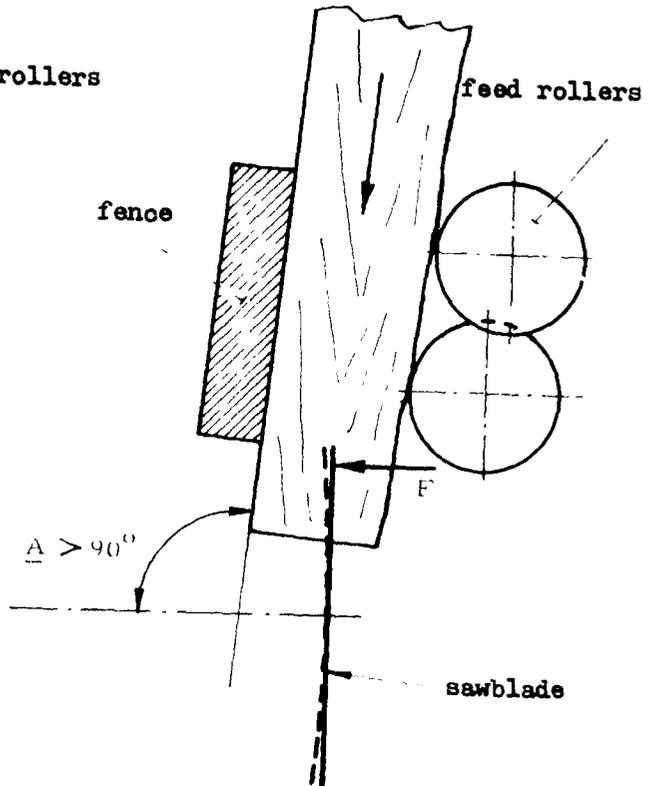


Fig. 22b

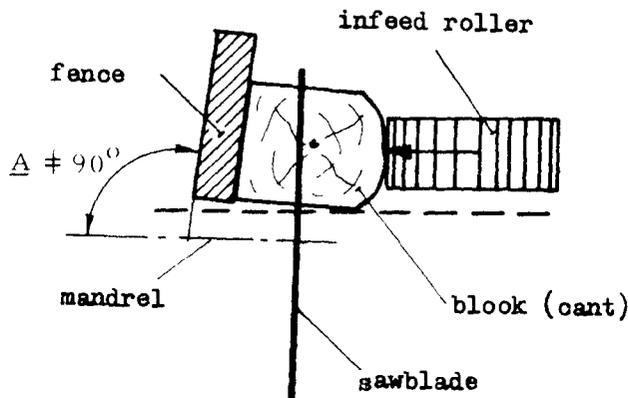


Fig. 23

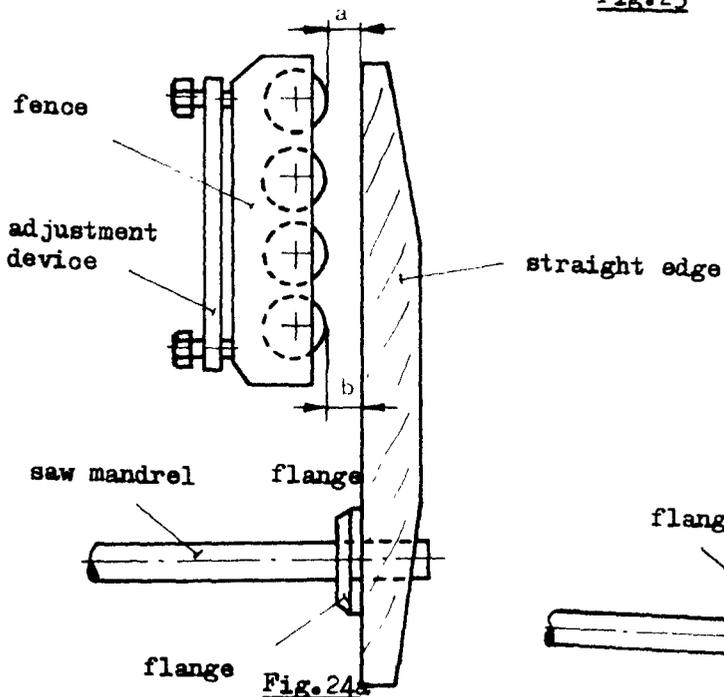


Fig. 24a

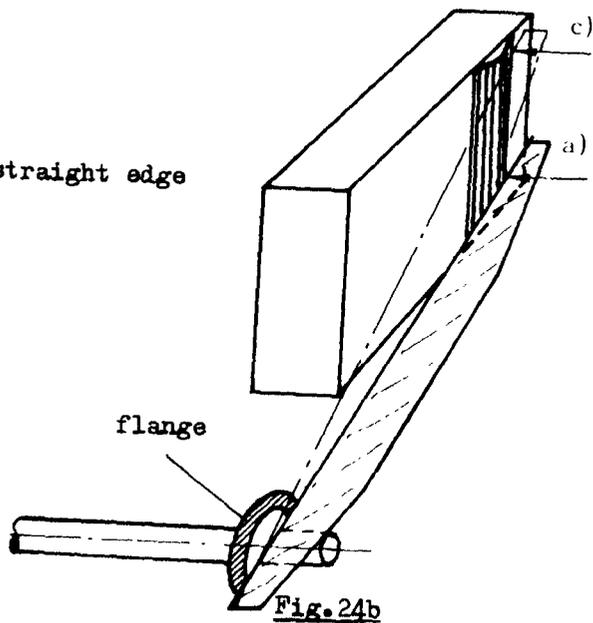


Fig. 24b

- d) Cutting faults due to wrong combination of sawblades and guides. This is illustrated in figure 25. When using conical sawblades and relatively thick guide knives to expand the saw out the knives get an incorrect guiding function. As the two parts of the cant are of different thickness and thus have different bending strength the forces F_1 and F_2 are not equal. This creates side forces causing improper feeding of the cant.

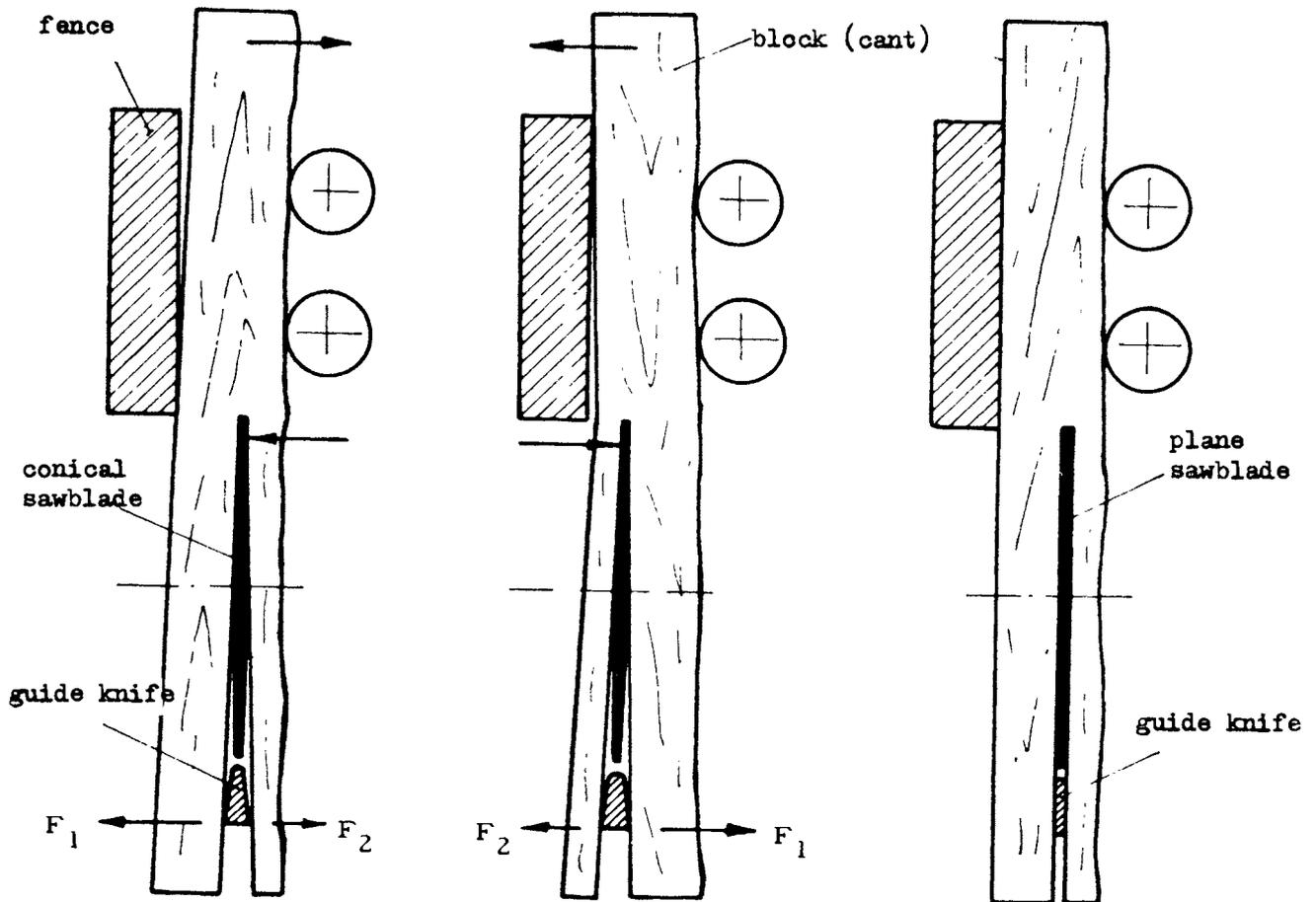


Fig.25

In order to achieve an accurate sawing and to avoid forced speeding the following is recommended:

- a) To use a plane sawblade.
- b) To use a hard metal blade with a guide knife which is not thicker than the saw out.
- c) If a conical sawblade is used the thickness of the guide knife has to be carefully calculated.
- d) Check that the guide knife is exactly aligned with the sawblade, thus avoiding side forces.

5. Edgers

Figure 26 shows processing of slab from, for example, the log saw through rip saw and edger. After rip sawing the boards are waney and must be edged in order to get square sawn. See figure 26 b) and c). Setting of dimensions (width) is done by the operator after ocular judgement of the possible yield. An edger is normally equipped with an infeed device with a special equipment for centring of the board. In modern edgers scanning and yield calculations are carried out automatically using computers.

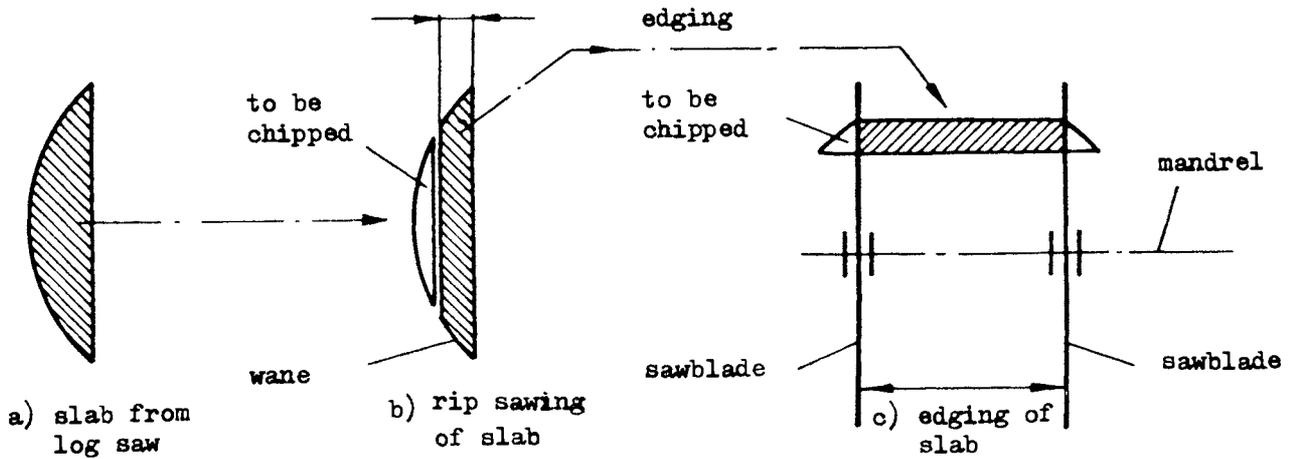
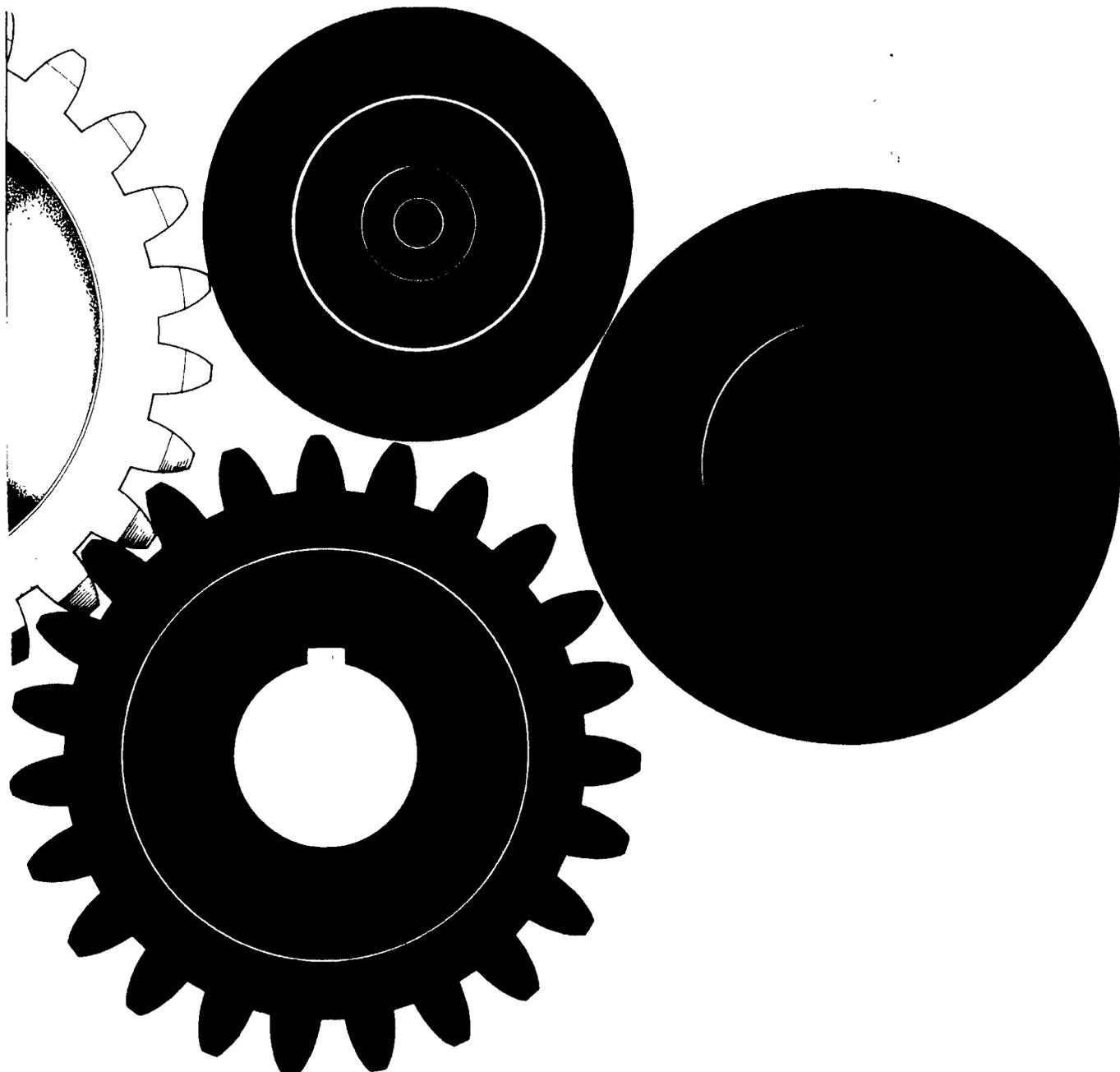


Fig. 26

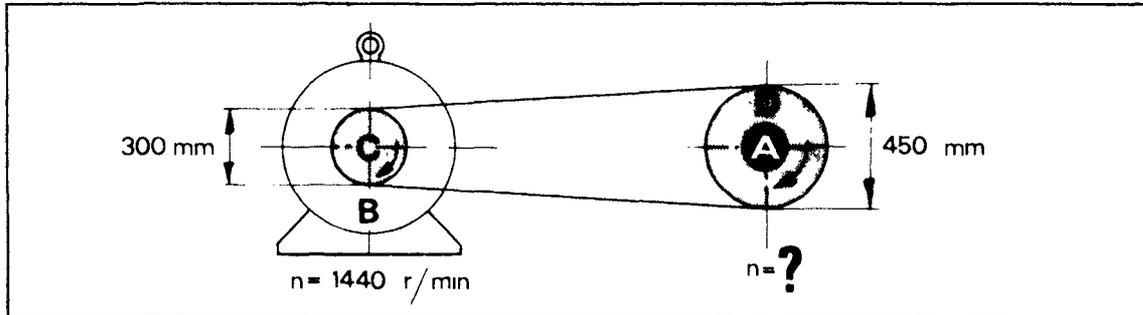
VI REVOLUTIONS, COG NUMBERS AND PERIPHERAL SPEEDS

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3. How to Calculate the Number of Revolutions of a Shaft

- i) TASK: To find the number of revolutions of the driven shaft A in the figure below.



- ii) INITIAL POINTS: We start from what we know:

- that the engine B runs at 1440 r/min.
- that the pulley C has a diameter of 300 mm.
- that the pulley D has a diameter of 450 mm.

- iii) CALCULATIONS: To find out the unknown number of revolutions the following calculations are made:

- The number of revolutions of the engine is multiplied by the diameter, in mm, of the pulley of the engine.
- In this case it is 1440×300 .
- This figure is divided by the diameter of the driven pulley, which gives the unknown number of revolutions, i.e.

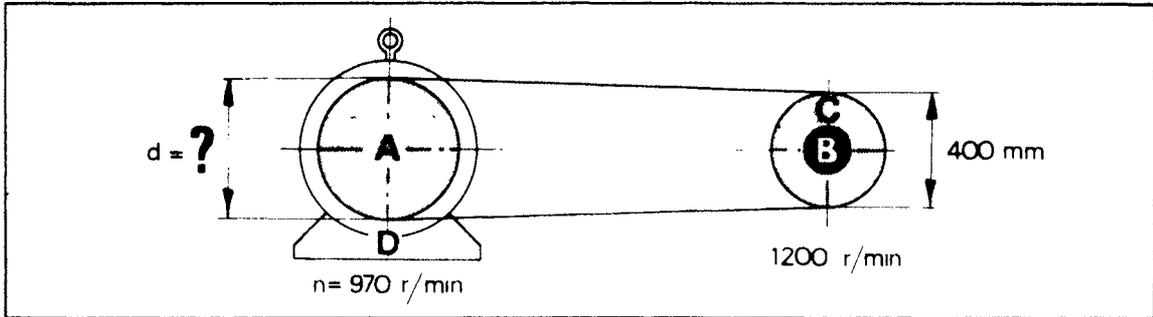
$$n = \frac{\text{engine speed} \times \text{diameter of driving pulley}}{\text{diameter of driven pulley}} = \text{unknown number of revs.}$$

In this case the answer is:

$$n = \frac{1440 \times 300}{450} = 960 \text{ r/min.}$$

4. How to Calculate the Diameter of a Pulley

i) TASK: To find the suitable diameter of pulley A in the figure below.



ii) INITIAL POINTS: We start from what we know:

- that the driven shaft B has a pulley C, the diameter of which is 400 mm.
- that this shaft needs to rotate at 1200 r/min.
- that the engine D runs at 970 r/min.

iii) CALCULATIONS: To find the unknown diameter the following calculations are made:

- To start with, we calculate the gear ratio between the pulley and the engine. This is done by dividing the number of revolutions of the pulley by the number of revolutions of the engine, i.e.

$$\frac{\text{number of revolutions of pulley/min}}{\text{number of revolutions of engine/min}} = \frac{1200}{970}$$

- Then, this ratio is multiplied by the diameter of the driven pulley C, i.e.

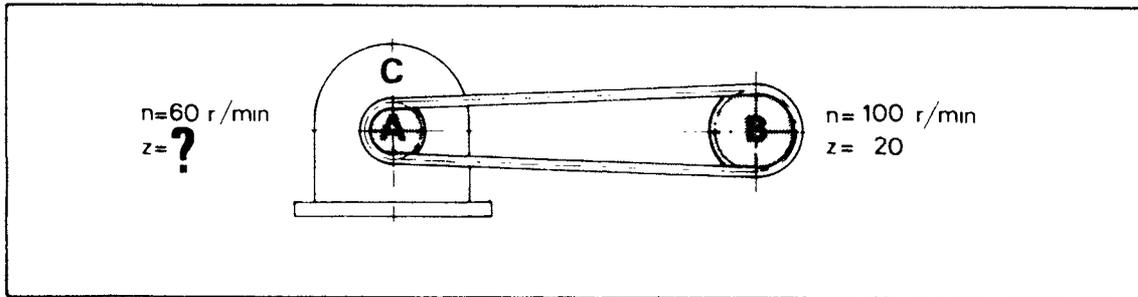
$$d = \frac{1200}{970} \times 400 = 495 \text{ mm.}$$

This result can be rounded off to the higher figure of 500 mm which is a standard diameter.

5. How to Calculate the Number of Teeth required on a Sprocket

To calculate the gear ratio for chain drives or cog transmission, i.e. the relationship between the number of teeth or cogs of the driving and the driven sprocket, the same procedure can be used as in the previous example. The only difference is that, instead of using the diameter of a wheel, the number of teeth or cogs is used.

- i) TASK: To find the necessary number of teeth of the driven sprocket A in the figure below.



- ii) INITIAL POINTS: We start from what we know:

- that the conveyer roller B will do 100 r/min.
- that its sprocket has 20 teeth.
- that the engine C does 60 r/min.

- iii) CALCULATIONS: The following calculations are made according to the general formula:

$$\frac{\text{speed of cog wheel A}}{\text{speed of cog wheel B}} \times \text{the number of teeth of cog wheel B} =$$

= the unknown number of teeth of cog wheel A.

Applied to our example:

- divide the speed of engine A by the speed of conveyor roller B, and
- multiply the result by the number of teeth of the chain wheel B, i.e.

$$\frac{\text{engine speed A/min}}{\text{conveyor speed B/min}} \times \text{number of teeth of wheel B} =$$

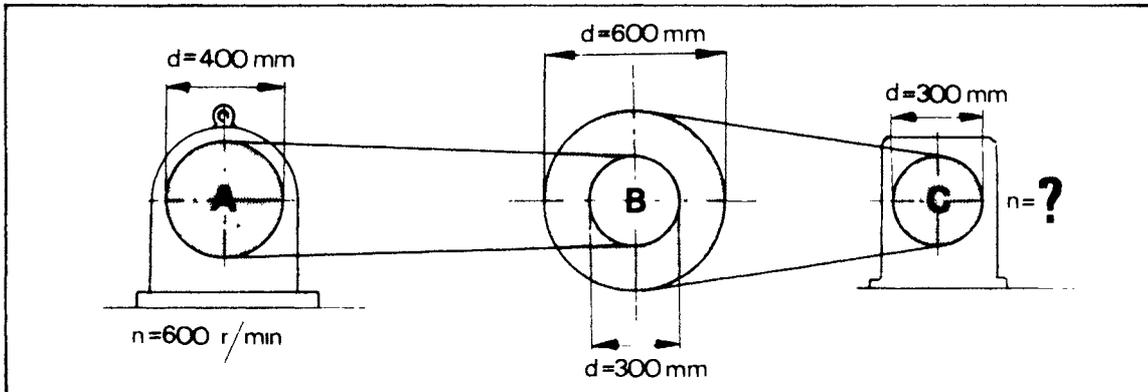
= unknown number of teeth of wheel A.

With figures inserted

$$Z = \frac{60}{100} \times 20 = 12 \text{ teeth}$$

6. How to Calculate the number of Revolutions of a Shaft when Power is transmitted over several intermediate Shafts

- i) TASK: To determine the rotation speed of machine C when power is transmitted through an intermediate shaft B from the driving wheel A, as illustrated in figure below.



ii) INITIAL POINTS: We start from what we know:

- that the speed of the driving wheel A is 600 r/min.
- that the diameter of the driving wheel A is 400 mm.
- that the driven wheel of the intermediate shaft B has a diameter of 300 mm.
- that the diameter of the disc of machine C is 300 mm.

iii) CALCULATIONS: To find the unknown number of revolutions, the following calculations are made:

- the number of revolutions of the intermediate shaft B is first calculated as follows:

$$\frac{\text{diameter of driving wheel}}{\text{diameter of driven wheel}} = \frac{\text{number of revs of driven wheel}}{\text{number of revs of driving wheel}}$$

Note: Make sure which wheel is driven and which is driving.

With figures inserted:

$$n = \frac{400}{300} = \frac{\text{number of revolutions of B}}{600}$$

$$\text{the number of revolutions of B} = \frac{600 \times 400}{300} = 800\text{ r/min.}$$

- the number of revolutions of C can be calculated using the same formula:

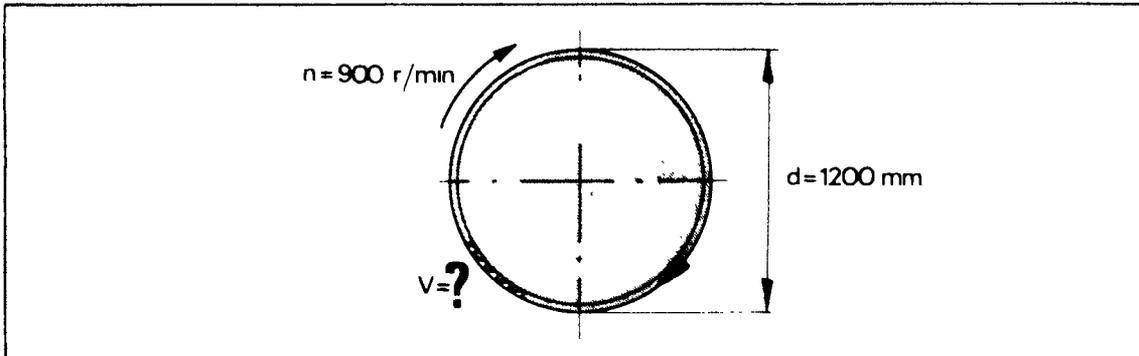
$$n = \frac{600}{300} = \frac{\text{number of revolutions of C}}{800}$$

$$\text{the number of revolutions of C} = \frac{600 \times 800}{300} = 1600\text{ r/min.}$$

7. How to Calculate Peripheral Speeds

Peripheral speed (henceforth marked with the letter V) is the speed of an imagined rotating point situated on the circumference of the rotating shaft. It is usually expressed as metres per second (m/sec).

- i) TASK: To find the peripheral speed (V) of the tooth points of a circular sawblade. (See figure below).



- ii) INITIAL POINTS: We start from what we know:

- that the diameter of the sawblade is 1200 mm.
- that the sawblade does 900 r/min.

- iii) CALCULATIONS: To find the unknown peripheral speed, the following general formula is used:

- The circumference of the sawblade (c) (in metres) is multiplied by the number of revolutions of the sawblade (in r/sec).
- Using the formula for the circumference of a circle ($c = \pi \times d$), we calculate the circumference of the sawblade:

$$c = \pi \times 1.2 = 3.14 \times 1.2\text{ m} = 3.77\text{ m.}$$

- The circumference, c, is then multiplied by the number of revolutions per second of the sawblade, i.e.

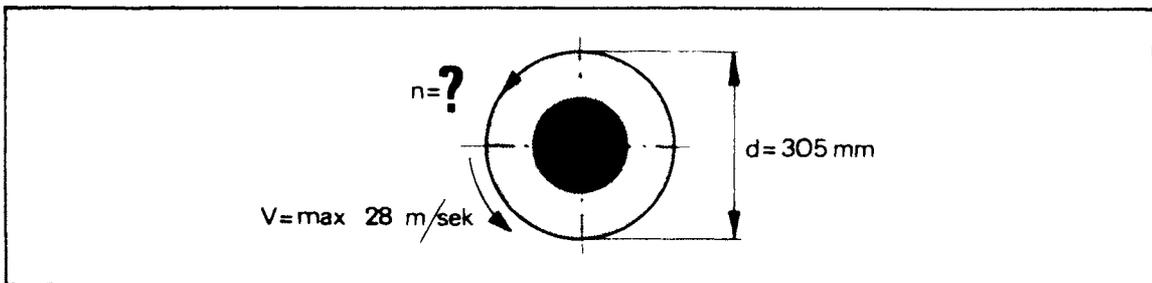
$$V = 3.77 \times 900\text{ r/min} = 3.77 \times \frac{900}{60}\text{ r/sec} = 57\text{ m/sec.}$$

(Note $\text{revs/second} = \frac{\text{revs/minute}}{60}$)

8. Some Practical Examples

A. How to calculate the maximum number of revolutions of a grinding disc.

- i) TASK: To install a new grinding disc in a grinder mounted on a circular saw we need to know the maximum number of revolutions of a disc of a given diameter. (See figure below.)



- ii) INITIAL POINTS: We start from what we know:

- that when grinding free-hand with a ceramic disc, as in this case, a maximum peripheral speed of 28 m/sec is allowed.
- that the diameter of the disc is 305 mm.

- iii) CALCULATIONS: The unknown number of revolutions (n) can be calculated from the formula:

$$\text{peripheral speed } V = \text{circumference } c \times \frac{\text{number of revolutions (r/min)}}{60}$$

In this example $V = 28 \text{ m/sec}$.

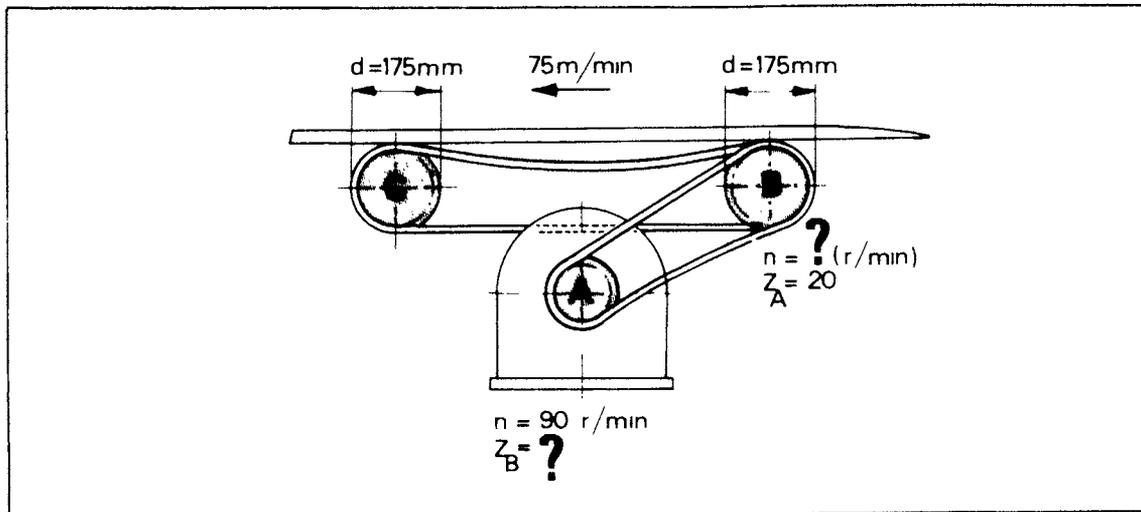
$$c = \pi \times \text{diameter of disc} = 3.14 \times 0.305 = 0.96 \text{ m}$$

Inserted into the above formula we find:

$$n = \frac{28 \times 60}{0.96} = 1750 \text{ r/min.}$$

B. How to calculate the necessary number of teeth of a sprocket.

- i) TASK: To calculate the required number of teeth on the sprocket of motor A (in figure below) to make the roll conveyer work at a desired speed.



- ii) INITIAL POINTS: We start from what we know:

- that the required speed of the roll conveyer is about 75 m/min.
- that the sprocket on motor A does 90 r/min.
- that the driven sprocket B has 20 teeth (Z_B) and diameter of 175 mm.

- iii) CALCULATIONS: This problem is solved by using the formula

$$\frac{\text{number of revolutions of sprocket A}}{\text{number of revolutions of sprocket B}} \times \text{number of teeth of sprocket B} =$$

= the unknown number of teeth of sprocket A.

To be able to use this formula we must first calculate the number of revolutions of sprocket B.

We know that the peripheral speed of B must correspond to the desired peripheral speed of the roll conveyer, i.e. 75 m/min. By using the formula below we can therefore calculate the number of revolutions of B:

$$\text{peripheral speed} = \pi \times \text{diameter} \times \text{number of revolutions.}$$

With figures inserted:

$$75 = \pi \times \frac{175}{1000} \times n$$

$$n = \frac{75 \times 1000}{\pi \times 175} = 136 \text{ r/min.}$$

(Note that 175 mm = $\frac{175}{1000}$ m)

We can now calculate the necessary number of teeth of the driving sprocket A by using the first formula.

The unknown number of teeth (Z_A) is:

$$Z_A = \frac{90}{136} \times 20 = 13.25 = 13 \text{ teeth (rounded off to nearest whole number)}$$

By checking this example for $Z_A = 13$ teeth, we find that the roll conveyer will work a little faster than 75 m/min.

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