Chapter 2: ELEMENTS OF CIRCULAR KNITTING MACHINES

I. YARN FEEDING

I.1. The creel

The creel supports bobbins (fig 1, 2). It could be on the machine top or lateral.

Fig 1. Top creel

Fig 2. Side creel

I.2. Yarn feeders/Foutnisseurs

The yarn feeder is a rotating device providing, without friction, yarn to needles. There are two types of yarn feeder.

I.2.1. Positive yarn feeder

It is a rotating device mechanically connected to the machine speed. It supplies, without friction yarn to needles. Figure 3 shows the aspect of a positive yarn feeder (MPF Memminger-IRO, Freudenstadt. Germany). The yarn 1 passes through two eyelets 2 and 3 then through a yarn brake 4 and a yarn feeler 5 that detects yarn breakage. When the yarn breaks, the support 13 makes electrical contact which stops the machine. The yarn is then wound onto the winding roll 7 to be delivered at a constant speed. It passes through a guide 9 and a second yarn feeler 11. The clutch 15 is a ring which can be set in the upper or lower position. This allows to drive the yarn feeder with the speed of the upper belt through the pulley 16 or the lower belt through the pulley 14.
Fig 3. Positive yarn feeder (MPF from Memminger-IRO, Freudenstadt, Germany)

Figure 4 shows another positive yarn feeder (CONI II Mayer & Cie, Albstadt, Germany).

All positive yarn feeders are driven by a belt which is driven by a drive wheel. The inner diameter of the drive wheel is variable in order to vary yarn consumption and control fabric weight (Fig. 5). When we need to increase fabric weight, for example, it is necessary to decrease yarn consumption by reducing the inner diameter of the drive wheel in order to
obtain shorter stitches and denser fabric. We have also to reduce couliering depth from cambox outside in order to reduce yarn tension caused by yarn delivery decrease.

![Fig 5. Positive yarn feeder driving](image)

3. belt  4. positive feeder  9. drive wheel 10. deviation roll 11. tension roll

Fig 5. Positive yarn feeder driving

### I.2.2. Storage yarn feeder

This device allows to obtain yarn coils winded on a roll driven by an individual motor. When the roll is almost empty, it winds yarn till a sensor stops yarn winding (Fig. 6). Needles consume a quantity of yarn which is not determined by the yarn feeder but by the couliering depth. This kind of yarn feeders is suitable for jacquard machines where yarn consumption is variable in the same feeder and between feeders.

![Fig 6. Storage yarn feeder](image)

N.B. Some yarn feeders may either work in positive or storage mode.
I.3. Yarn carrier

Yarn carrier adjustment is essential for a correct machine running. A yarn carrier has the following functions:

- Presentation of yarn to needles
- Keep open or closed needle latch

Figure 7 shows an example of yarn carrier adjustment performed according to 3 directions: horizontal, vertical and lateral:

- Lateral adjustment is given by the distance 7 which must be 2 or 3 needles.
- A space 9 of about 0.3 mm must be maintained between the yarn carrier 3 and the needle. This distance is checked with gauge leafs.
- A distance 10 of approximately 0.6 mm must be maintained between the yarn carrier 3 and the sinker 5.
- The yarn carrier has two chamfered surfaces 11 and 12 at its left side to protect semi-open or semi-closed latches from contact with yarn carrier. These surfaces control the state of opening and closing of the latch since they complete closing and or opening of semi-open or semi-closed latches and thus prevent impact with yarn carrier. The outer surface 11 keeps latches open under rebound effect during needle ascension.

Yarn carrier could have more than one hole. Feeding with more than one yarn is called plating. When the needle picks two yarns at two different levels, the yarn presented below appear in the face of the jersey fabric. Yarns could have different natures or different colours.
Elastane yarn has a high friction coefficient and is consequently fed through a special roller guide mounted on the main yarn carrier (Fig. 8, Fig. 9).

I.4. Stripers

Stripers supply separately 2, 3 or 4 different yarns at the same feeder. They allow the production of horizontal stripes having an important pattern height which are not possible to obtain with bobbins arrangement.

Figure 10 gives the aspect of a 4 fingers striper. We can see that the first finger (left) is being selected and the finger 4 (right) is being deselected. A rotating magnet placed on the machine top selects finger and a rotating cam pushes the finger to working position and a yarn hanger presents yarn to needles. A cutting blade cuts the deselected yarn. Yarn change occurs in small zone (about 7 cm width) having some missing needles because in this zone 2 yarns work simultaneously during yarn change.
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Fig 10. Striper device (Mayer & Cie)
The circular machines equipped with stripers have semi-positive yarn feeders. These yarn feeders present buffering rode absorbing yarn excess when yarn is deselected and authorizing yarn tension variation during yarn change (Fig. 11).

Fig 11. Four colour striper and semi-positive yarn feeding (CONI RS – Mayer & Cie)

II. MACHINE DRIVE

II.1. The motor

Motor power depends on machine diameter, the number of feeders and gauge (Exp: 1 to 25 kW for 10-24 "and 2-8 kW for 26 to 30"). All modern machines are equipped with invertors in order to gradually change the machine speed.

II.2. The brake

When an incident occurs (yarn breakage, needle breakage), the machine must be stopped immediately in order to limit the fault zone.
Figure 12 shows an electromagnetic disc brake located in the engine compartment. The armature 1 is attached to the motor pulley 3. After an incident, the brake is ON and the armature is in contact with the electromagnet 2 and motor stops. The braking force is regulated by using a rheostat having a lever 4 that can be positioned on different coils 6 by unscrewing the screw 5.

III. THE CAMS

There is 2 types of cams:

III.1. Interchangeable cams

There are 3 types of interchangeable ascension cams: knit, tuck and miss (Fig. 13). They have to mounted on the cambox by screws according to the needed binding (Fig. 14). Stitching cam is moveable and adjusted from outside when adjusting stitch length or yarn tension.
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Fig 13. Different types of interchangeable cams (Relanit 3.2 - Mayer & Cie)

Fig 14. Interchangeable cams (MV4 3.2 – Mayer & Cie)
III.2. Adjustable cams

The raising cam is composed of two parts adjustable from the cambox outside. The displacement of each cam element allows to have positions: knit tuck and miss (Fig. 15, Fig. 16).

III.3. Number of needle tracks

A circular machine is characterized by its diameter, gauge, number of feeders, number of needle tracks in cylinder and dial. The number of needle tracks is equal to the number of needle type. A machine can have:

- One needle track: one type of needle
- Two needle tracks: two types of needles (long/short)
- Four needle tracks: four types of needles (type 1, 2, 3 and 4)

IV. The spreader

Tubular fabrics is wound flat in double thickness on the roller. This tends to generate variable tensions around the knitting that can cause problems during stitch formation. The spreader (Fig. 17) suspended within the tubular fabric unforms these tensions. It can have an oval or a trapezoidal shape and is composed of two moveable symmetrical elements adjusted according to the elasticity of the fabric.
V. Take-down devices

They can be mechanically driven by the main motor or by an additional proper motor. Figure 18 shows a pawl mechanical take down. The lever 3 rotates the take-down roller 18 connected to rollers 17 and 19. It has at its end a roll 2 placed in contact with the sinusoidal profile of a circular cam. The sliding of the roller during the rotation of the take-down device oscillates the lever 3 and the roller 18 rotates causing take-down force. When the lever 3 is restored by the spring 4, the rollers are blocked by the pawls 5 and 9. The intensity of the take-down is adjusted through the tension of the spring 11.

1: circular cam, 2: roller, 3: lever, 5, 9: pawl 11: spring

Fig 18. Pawl mechanical take-down
Figure 19 shows an electrical take-down driven by an individual motor 17. The motor speed is synchronized with machine speed to provide a take-down force proportional to necessary fabric speed.

![Figure 19. Electrical take-down](image)

**VI. Needle control, fabric control and lubrication**

Figure 20 shows some machine accessories:

- Contact needle detector: it controls closed latches, broken needles or jammed fabric
- Needle brushes: it opens needle latch after stitches transfer
- Optical needle detector
- Fabric defect controller: composed of light transmitter and receiver that detect holes and other defects
- Oiler: it is a lubrication system, composed of valves and pipes. It delivers precise quantity of oil to needles, sinkers and cams.
Fig. 20. Machines accessories