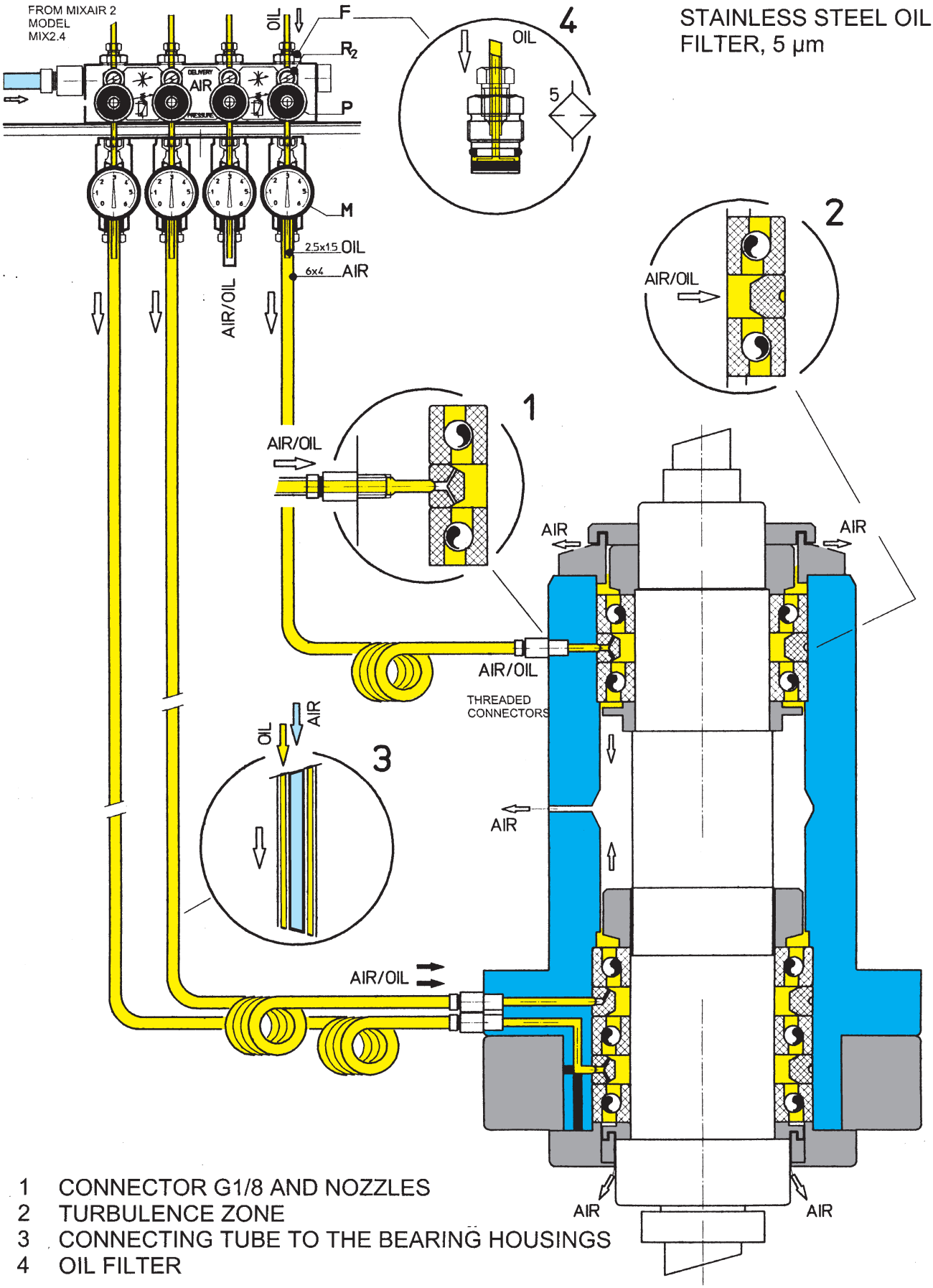
MINIMAL AIR-OIL LUBRICATION DIAGRAM FOR SPINDLE

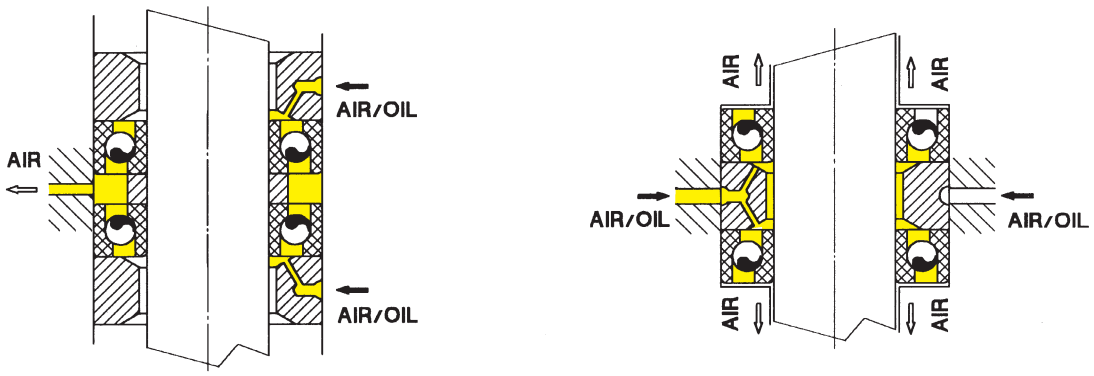


1 CONNECTOR G1/8 AND NOZZLES
2 TURBULENCE ZONE
3 CONNECTING TUBE TO THE BEARING HOUSINGS
4 OIL FILTER

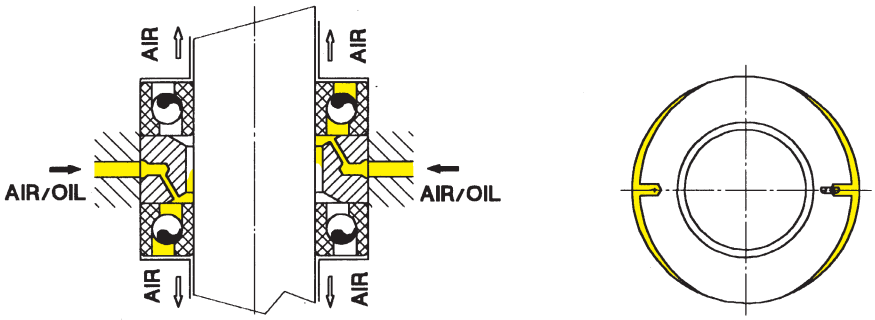
SYSTEM 055

THE SYSTEM

The minimal air-oil lubricating system, designed to solve the problem of lubricating parts rotating at high speed efficiently, is a reliable way of providing a correct and economic solution to this problem. Very small quantities of lubricating oil projected by a low pressure airflow in the sliding area of the bearings provide optimum friction conditions compared with any other lubrication method.



This system guarantees fluid friction even at high speeds of rotation, as in the case of spindles and electric spindles, but not just these, as figs. 1, 2 and 3 show.



Since there is never any formation of an oil mist, the air is able to flow through the drainage ducts, thereby avoiding overpressure in the bearing housings. As far as the range of applications is concerned, a simple formula based on the dimensions and speed of rotation of the bearings clearly illustrates where the air-oil lubricating system is the best method for efficient performance.

The index **nDm**, or the product of **rotation speed** (rpm), and the **mean diameter** of the bearing (in millimetres) is the parameter which defines the specific operating conditions of the bearing concerned. The method concerned offers the best results if the index value is between **600,000** nDm and **2,500,000** nDm.

$$nDm \quad \begin{matrix} \geq 600{,}000 \\ \\ \geq 2{,}500{,}000 \end{matrix}$$

n = number of revolutions/min (rpm)
Dm = mean diameter in mm $\frac{(De+Di)}{2}$

Nevertheless, MIXAIR 2 can be used equally successfully where speeds are not quite as high.

THE SYSTEM

MIXAIR 2 is the most advanced solution for minimal air-oil lubrication.
This type of lubrication uses **micro-pumps** with adjustable delivery between $3mm^3$ and $24mm^3$ – more or less equivalent to a fraction of a drop. These minimum lubricant doses are injected into a tube connected to the bearing housings via the suitable air-oil mixing manifold, which also receives an air flow from the pressure control valve.
MIXAIR 2 can lubricate between one and eight bearing housings maximum and can also switch off some of these in operation. It is equipped with a 3 litre tank for the lubricant and also a sealed container, **IP65**, accommodating the pumps, the air control and adjustment system, the pilot and control valve.

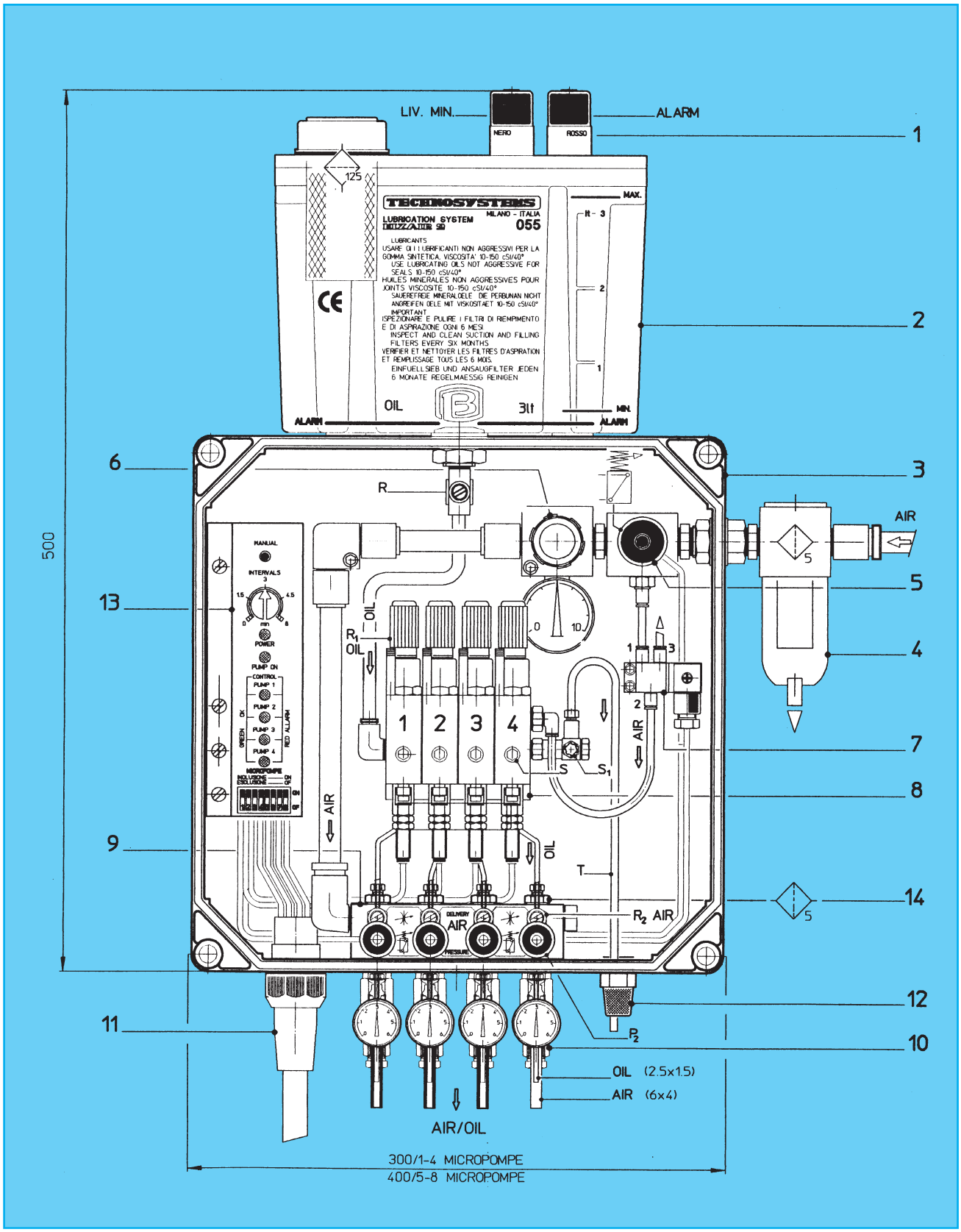
The basic features of the system are:

- **Adjustable dosing of the lubricant quantity** for each operation and therefore the possibility of supplying each bearing housing with the hourly quantity required according to the specification.

- **Positive control of the operation of each pump and delivery** per cycle.

MIXAIR 2 – The components

fig. 4



- **Constant control of the air pressure of each pipe as far as the bearing housing.**

- **Possibility of controlling the duty cycles of the pumps and frequency.**

- **Simplicity and flexibility of use,** the control of the two parameters – pump delivery and duty cycle – allows lubrication under any working conditions.

Figure 4 faithfully reproduces the components of **MIXAIR 2**. We shall take this as the basis to summarise and illustrate the functions which the system performs.

1) Level solenoids

Level solenoids, contacts closed in the presence of lubricant, 175 V – 50 Hz – 3A:
Top-up signal: add lubricant to the tank, black connector.
Alarm signal: switch off the machine. Danger of disengagement of the pumps through the possible formation of air bubbles in the micro-pump aspiration pipe, red connector.

2) Tank

3 litre transparent oil tank with cap and filter (125 µm) for filling and topping up.

3) Container

Transparent container, protection **IP65**.

4) Air filter

Compressed air filter with automatic condensation drain, 5µm filtration, maximum delivery **770 Nl/min** up to 4 pipes and **1600 Nl/min** between 5 and 8 pipes.

5) Air pressure switch

Pressure switch controlling the incoming compressed air, **set at 5 bar**, contacts closed when air is present with the above characteristics.

6) Pressure control valve

Mains pressure control valve equipped with pressure gauge, **scale 0 – 10 bar**, maximum delivery **770 Nl/min** for groups of up to 4 pipes and **1600 Nl/min** for groups of between 5 and 8 pipes.

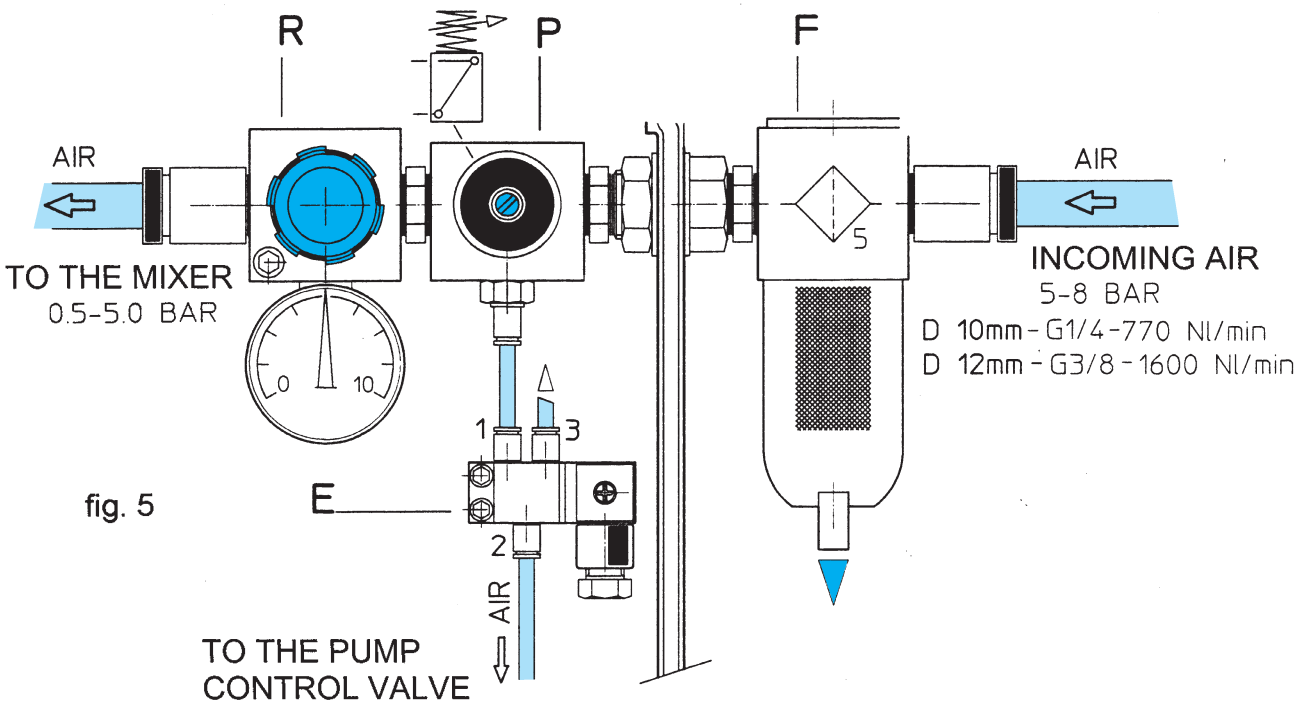


fig. 5

7) Solenoid valve

15 mm pneumatic micro solenoid for controlling the system, item **E**, 3/2 way, NC. fig. 5.

8) Micro-pump

Micro-pump **PLU320RCY**, adjustable delivery, oil and control air connection block.

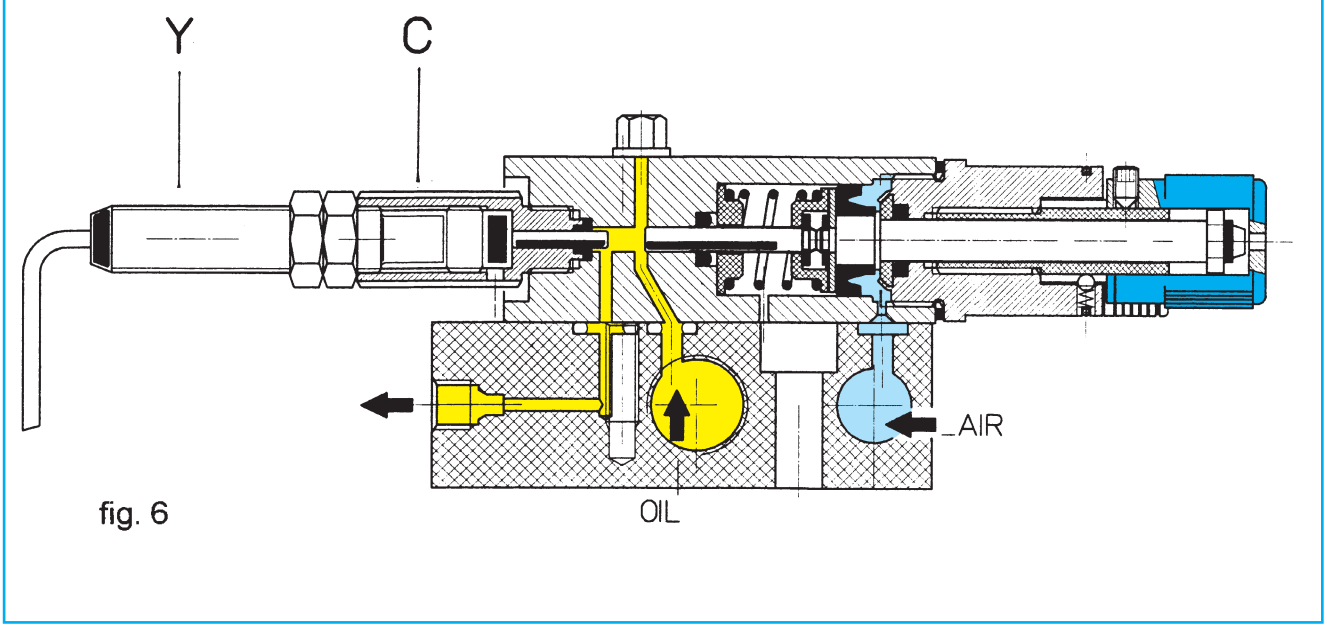


fig. 6

The pump has a nickel-plated brass body accommodating the pneumatic servo-control piston and the pumping piston. A mono-directional value is installed at the end of the piston stroke.

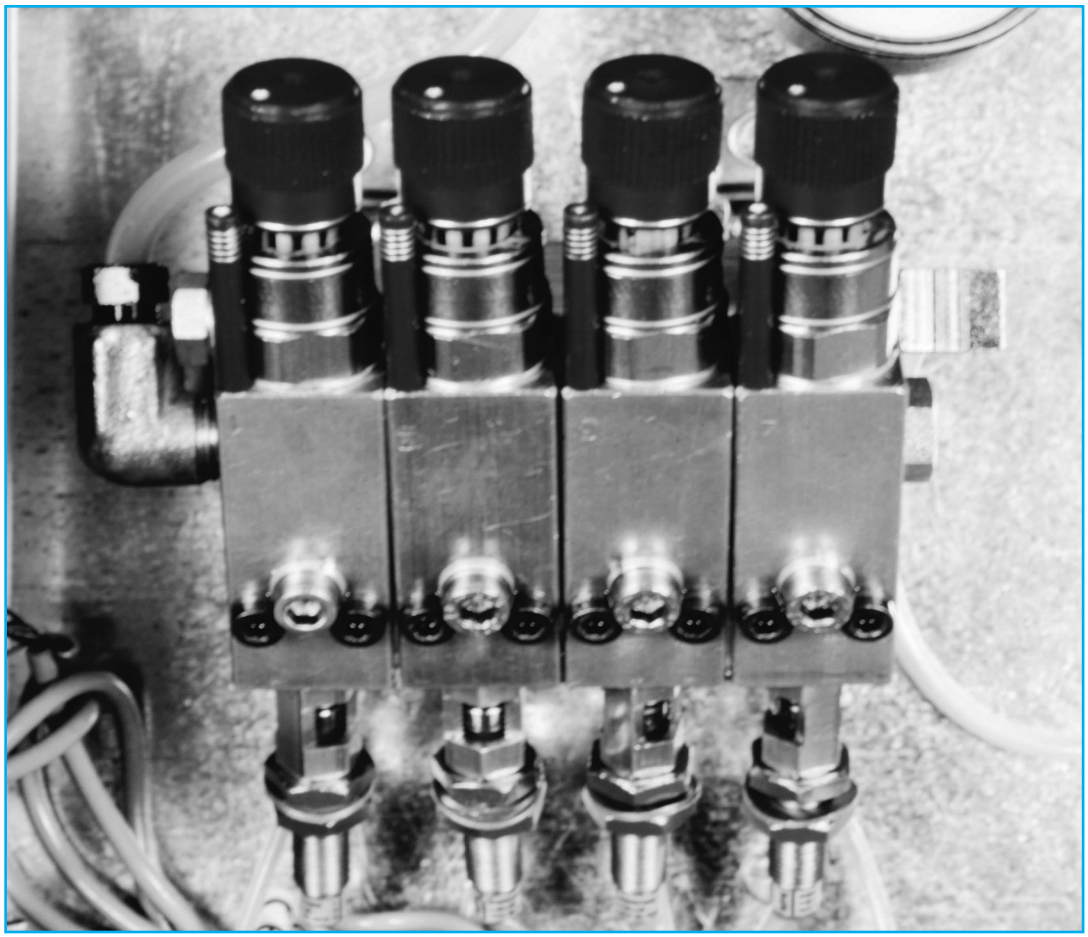


fig. 7

On the servo-control side, a control device is used to determine the delivery between 3 mm^3 and 24 mm^3 in increments of 0.7 mm^3. This adjustment is obtained by rotating the knurled knob **R1**, which increases the delivery by 7mm^3 with each clockwise turn and reduces it by the same amount when turned in the anti-clockwise direction. The adjustment precision is obtained by dividing one turn into 10 steps.

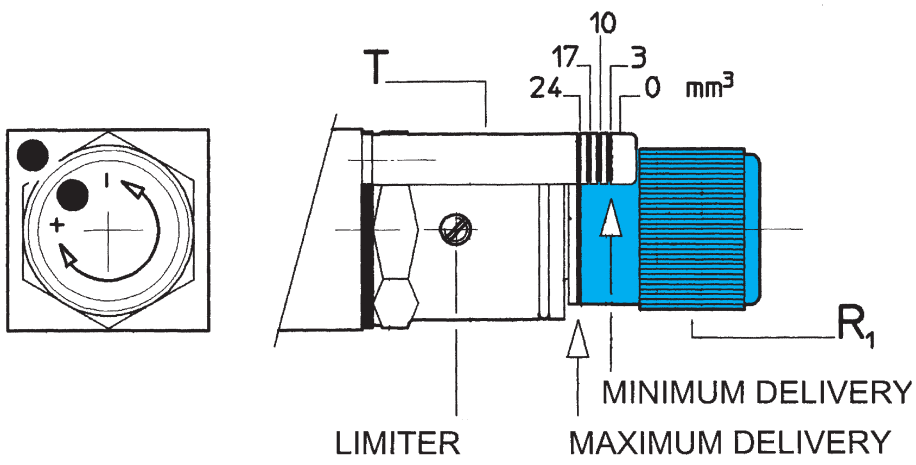


fig. 8

This knob also has a sight hole for monitoring the rotation and a graduated **T** bar indicates the axial movement, see fig. 8. Control sensor **C** is installed down-line of the delivery shaft, see fig. 6, which checks the delivery of the lubricant via a proximity switch **Y**, which transmits a signal to the programmer. As far as the plant engineering is concerned, the pump is always installed on a block. There are 8 variants of these, allowing **between 1 and 8 pumps** to be installed with just one lubricant supply tank. As already mentioned, the maximum number of pumps available is 8.
Fig. 4 shows the drainage screw **S** on the set of four micro-pumps, used to get rid of the last air bubbles remaining in the aspiration pipe.

9) Air-oil mixing manifold

In the **manifold**, the set quantity and pressure of compressed air is charged with micro-doses of oil which are transported to a nozzle along the internal walls of a tube.
The **manifold** is connected to the **micro-pumps**, from which it receives the lubricant, and to the air **pressure control valve,** which controls the pressure of the incoming air.
It has an aluminium block with the following components, as can be seen in figures 9 and 11:

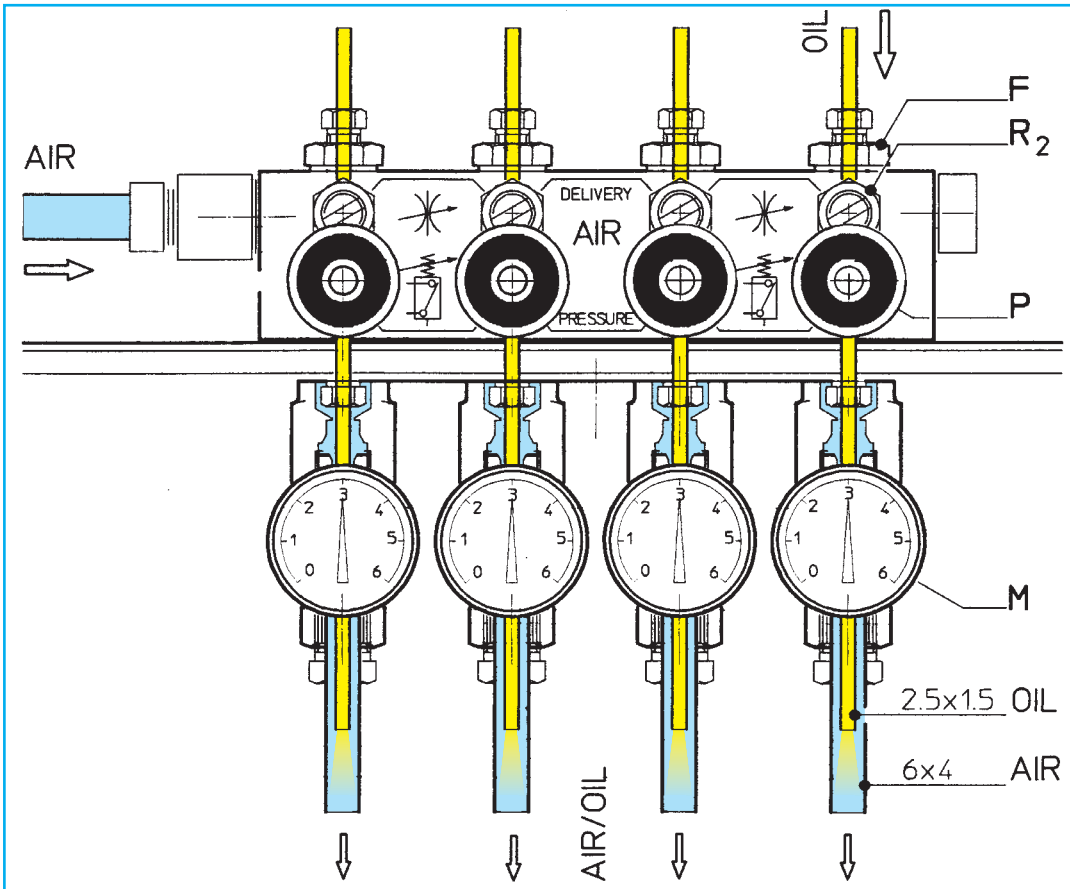


fig. 9

An **individual connection set** for each bearing housing for connecting the tubes leading to the point to be lubricated and which includes a pressure gauge M, scale 0-6 bar, for visually checking the pressure of the air flow transported to the bearing housings.

- A **plunger valve, R2**, for each individual pipe, which is used to adjust the air flow to the bearing housings.

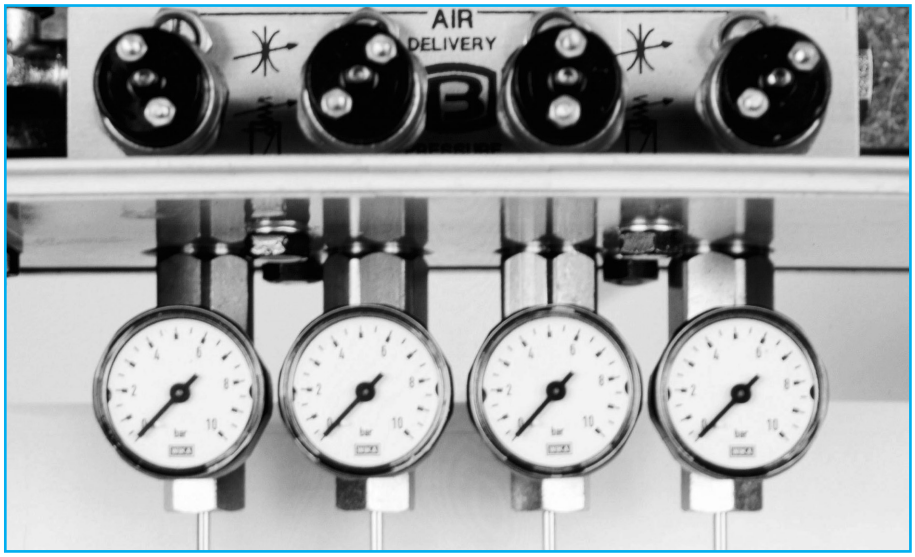


fig. 10

- A **minimum pressure switch P**, adjustable between 0.3 and 5 bar, NC in the presence of air whose pressure exceeds the set threshold. This means that the presence of air can be checked and consequently that the tubes leading to the bearing housings are intact.

- An **oil filter**, item 14, fig. 4, filtration 5 µm for each individual pipe.

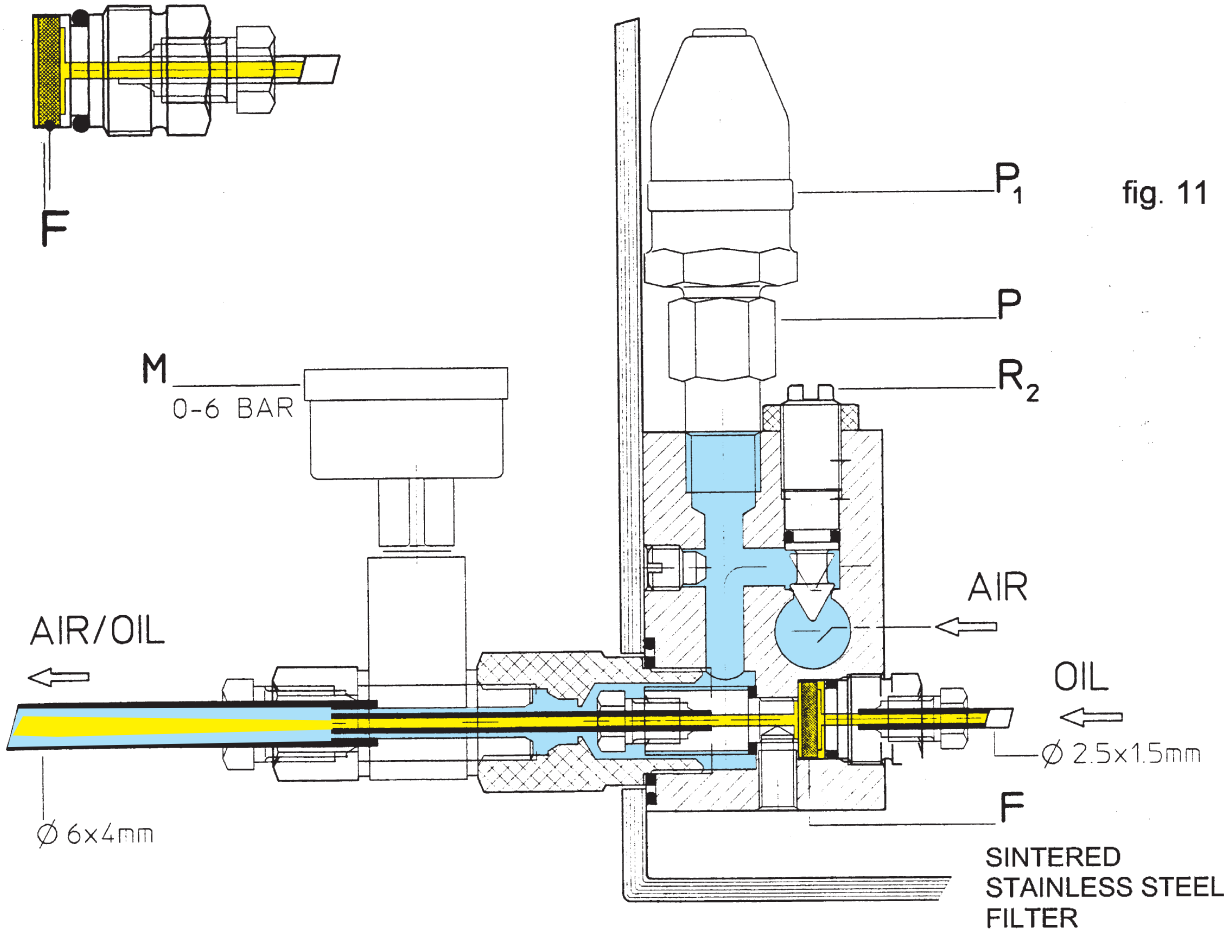


fig. 11

10) Supply tubes

We normally use **transparent polyamide tubes**, diameter 6x4 mm, which means that the presence of oil in the tube can be monitored visually without any problem. The minimum length of these tubes must not be less than 1 m and must not exceed 12 m. It is good practice to include in the tube one or more coils with a horizontal axis – see fig. 12 – to create a lubricant reservoir when the system is not operating.

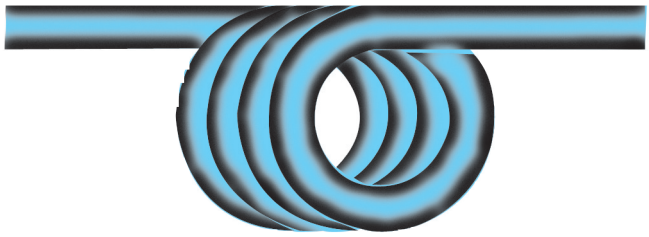


fig. 12

Changes in diameter of the tube for each pipe must be avoided and if intermediate connections are required, recesses, projections and scale must also be avoided, as these could produce lubricant deposits and interrupt the continuity of the oil film.

11) Connector for electrical connections

14 pin connectors for electrical connections. Signal supply and remote control. See the section on installation and commissioning for the connection diagram.

12) Air vent

Solenoid air vent.

13) Programmer for monitoring and controlling the system

The programmer for monitoring and controlling the system is equipped with:
- a knob **P** for adjusting the interval;
- a push button **M** for additional cycles;
- two LEDs for monitoring the functioning of the equipment;
- one LED for displaying the status of each pump.

The **MIXAIR 2** control unit includes programming the lubrication cycles and controlling the delivery of the pumps.
The **interval can be adjusted** over a scale of 0 – 6 minutes or 0 – 20 minutes, using knob **P**.

The programmer is supplied and signals are transmitted outside via a 14 pin connector. **The function starts when the equipment is switched on.**
When the equipment is switched on, the electronic programmer runs a **test**. All the LEDs light up for approximately 2 seconds and if everything is operating correctly, the first lubrication cycle – **prelubrication** – takes place, otherwise there is an alarm signal. At the end of the prelubrication stage, the set interval time counter starts followed by the actual lubrication cycle.
At the end of the programmer interval time, the system starts to operate as follows:
First of all, the solenoid is energised for 1.5 second, during which the pumps inject oil into the pipe. If these operations are successful, the oil is then transported to the bearing housings. A monitor then allows the next interval to start.
If just one of the pumps does not transmit a positive signal, then the corresponding LED changes from green to continuous red and after a 3 second interval, the solenoid is re-energised. In this case, too, if all the checks are positive, all the LEDs are green and it proceeds to the next interval stage, otherwise, even if just one pump is not functioning, the corresponding LED changes to continuous red and the above procedure is repeated for the third and last time.
At this point, if not all the control signals are positive and the system proceeds to the next interval, the programmer transmits an alarm signal. The LEDs change from continuous red to flashing red, the equipment stops and switches the alarm signal to the connector contacts.
To reactivate the programmer after remedying the problems causing the switch-off, simply press the button for the manual mode or switch off the equipment and switch it on again. The interval time may be positive or as a function of the effective working hours of the components to be lubricated. To operate in this mode, you have to use the machine contact, **CM**, pins 6 and 7 of the connector, whose logic allows the interval time to be counted when the contact between these is open.

14) Oil filter

Stainless steel, 5 µm filtration, located on the pipes of each micro-pump.

COMPRESSED AIR

It is advisable to use dry air, filtered to 5 µm, with a pressure between 5 and 8 bar. The **MIXAIR 2** system is already equipped with a pressure regulator **R** and a filter **F** with water and condensation drain. See fig. 5.

CONNECTIONS TO THE BEARING HOUSINGS

The supply of lubricant to the bearing must take into account the type of bearing and its position. The hole downstream of the tube connected to the bearing housing must have a diameter according to its length. As a guide, the recommended diameter is 0.5 mm for lengths of approximately 5 mm, which increases linearly with the increase in length by one tenth of a millimetre for each additional millimetre of length. This hole must allow the lubricant jet to be projected towards the internal bearing ring and reversed towards the outside by the centrifugal force.

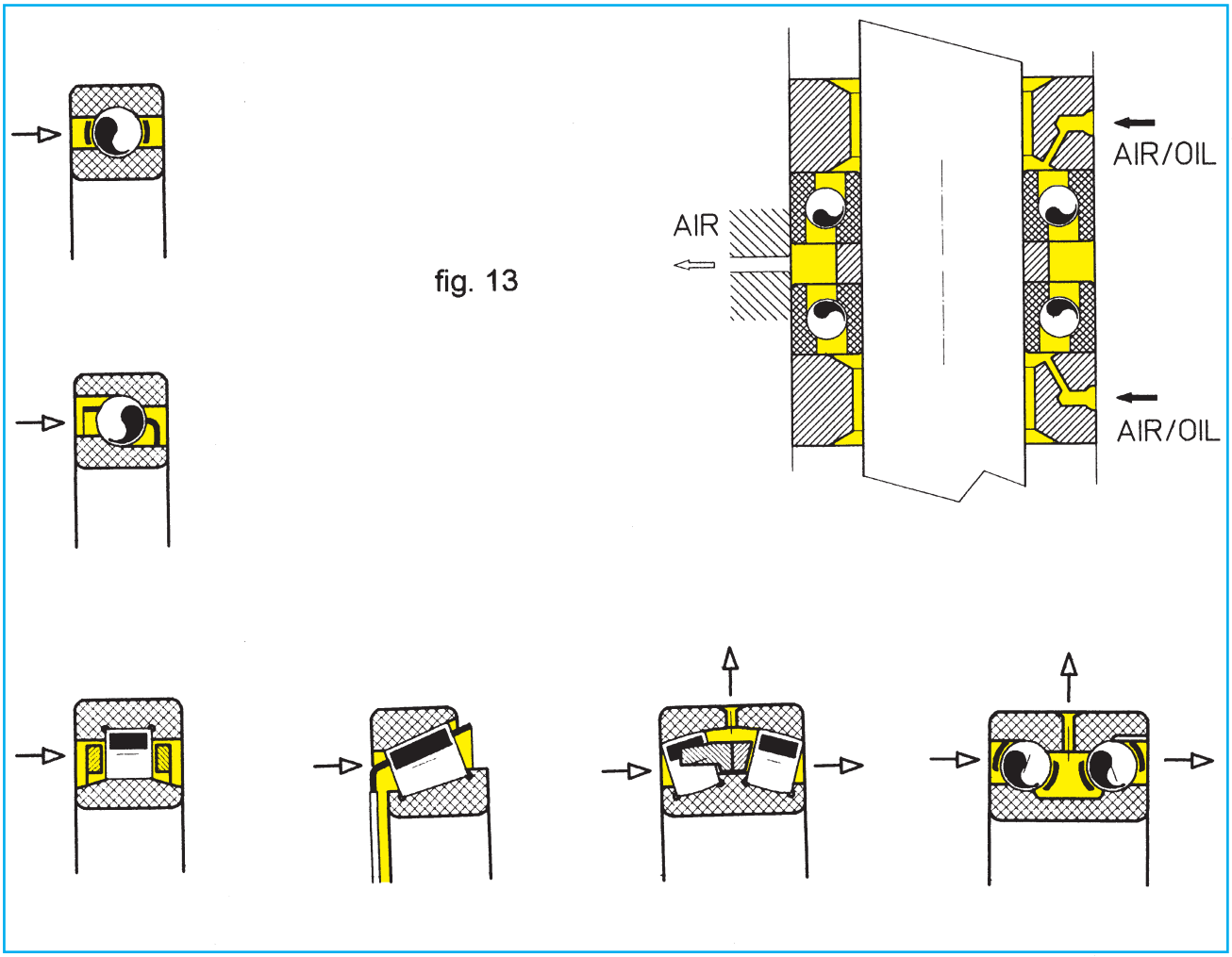


fig. 13

The jet must never be directed at the ball or roller cage. In the case of bearings at an angle, the supply must correspond to the direction of the load. Each bearing requires its own injection point; only in some cases – with low loads and speeds – is it possible to have a single injection for a pair of bearings.