

microjet[®]

**Minimum-quantity lubricating systems
a solution to every application!**



Nozzle technology

Modular system

Sawing technique

HSC machining

Sheet metal working

Internal MOL

System expansions

Customer-specific models



LINK GmbH
Minimum-quantity lubricating systems

microjet® – Accurate application of fluids at the right place, in the required quantities

microjet® is used wherever minute quantities of a fluid have to be applied via an accurate, reproducible and reliable process. Its main field of use is metal machining. Manufacturers of that field benefit from the advantages of *microjet®* in turning, milling, drilling, thread moulding and cutting, sawing, engraving, high-speed machining as well as in the non-cutting shaping of various materials such as for example steel, stainless steel and aluminium.

The *microjet®* modular system allows accurate adaptation to the specific machining task.

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The microjet® technology

The liquid contained in a pressurized container is put under pressure through an adjustable flow of compressed air and forced into a capillary tube reaching up to within the two-phase nozzle. The capillary tube assumes the function of a metering element. The pressure container can be installed without regard to its level. The required minimum liquid quantity is adjusted by means of the pressure prevailing within the container and read at a pressure gauge.

Varying the pressure modifies the flow rate within the capillary. This allows to adjust the liquid quantity reliably and continuously down to a consumption approaching zero.

The air quantity can be adjusted through a throttle valve, fully independently of the liquid flow rate. Using intermediate manifolds, it is possible to connect to a single *microjet®* pressure container any number of nozzle hose bundles, each featuring up to 5 nozzles.

„Lubrication instead of cooling“

Concentrated lubrication reduces the friction at the lips of tools to such extent that cooling as used in flood lubrication is no longer necessary. Thermal relief of tool lips results in longer tool service life, while allowing higher tool feeds and reduced cutting speeds. Atomizing the lubricant into microscopic particles to spray workpiece surfaces produces noticeably better wetting of those surfaces and better dispersion of the lubricant, thus highly increasing the lubricating capacity – which can be roughly compared to mist droplets uniformly clinging to a window pane, in contrast to rain drops that immediately pearl down just after striking it.

The microscopic particles generated keep adhering to the workpiece even if pressure is high, the force applied expanding in fact their surface area, thus increasing the lubricating action.

What are the economic benefits of the *microjet*[®] minimum-quantity lubricating system?

Tools

Longer tool service life, reduced tool friction for higher cutting rate, prevention of built-up edges.

Workplace and working environment

Cleaner workplace, dry workpieces, dry chips, no lubricant disposal issue, no oily workshop floors, no contamination of the ground.

Machines

Shorter downtimes thanks to less maintenance times.

Production

Production rise through increased cutting parameters and tool service life. Less defective parts through unhindered view of tool lip. Neither splash guard nor protective clothes are necessary, no soiling of the operator's clothing.

Cleaning

Costs for cleaning workpieces, machines and their immediate environment can be considerably reduced.

Waste disposal

Treatment and disposal of cooling lubricant are no longer necessary, the high costs involved are dropped. No working time required for maintenance when using *microjet*[®].

Safety

Reduced risk of accident through clean and oil-free floors, no skin diseases caused by bacteria or fungus infections, none of the resulting staff failures.

Economy of operation

The pay-off time of a *microjet*[®] installation is often less than one year.

What speaks for the acquisition of the *microjet*[®] minimum-quantity lubricating system?

- Minute consumption of lubricant
- Optimum lubricating properties
- Improvement of tool service life
- Improvement of workpiece surface quality
- Relief of operators
- Low secondary costs
- Minute environmental load
- No waste disposal issue
- High economy of operation
- Clean working environment

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Types of unit

Depending on the expected field of application, spray intervals and quantity to be sprayed, different MKS units (pressure containers) featuring the suitable container volume and design are available to meet specific requirements. There is a choice of MKS units featuring a standard volume of 1, 2, 4 and 9 litres. On request, we also supply special sizes from 10 litres onwards.

MKS units are subdivided into two different groups:

MKS-G 100

Type MKS-G 100 is provided with a nozzle hose bundle and 1 or 2 nozzles in its standard version. The MKS-G 100 is suitable for drilling, turning and high-speed machining work. In its version with external air supply, it is possible to blow „only with air“. The system is thus able to remove chips, for example. All MKS-G 100 units can be controlled by solenoid or pneumatically.



Type MKS-G 100

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Technical Data:					
Systemtype MKS-G	100	260	500	1000	Unit
Max. pressure:	7	7	7	7	bar
Max. capacity of container:	1,6	2,6	5,0	10,0	litres
Max. contents in container:	1,0	2,0	4,0	9,0	litres
Max. pressure of feeding compressor:	10	10	10	10	bar
Opening pressure of the safety valve:	7	7	7	7	bar
Working pressure:	0,5 to 6 bar				
Air consumption up to approx. ¹	50 to 70 l / min. / nozzle				
Lubricant consumption up to approx. ¹	5 to 200 ml / h / nozzle				
1) depends on setting					
Control system manual:	hand-operated sliding valve (not on MKS-G 100)				
Control system electrical:	solenoid valve 24V, 110V, 230V				
Control system pneumatic:	4/2-port air/oil directional valve				

MKS-G 260, 500 und 1000

Units MKS-G 260 to 1000 are the basis of the modular building-block system and only differ in the container contents. Owing to the flexibility of the building-block system, these types of unit are able to equip single machines as well as complex installations using a central pressure container and several nozzle hose bundles. All system versions based on the MKS-G 260 to MKS-G 1000 units are expandable at will, even subsequently. Depending on the application, they can be actuated by solenoid, pneumatically or even manually. Here, too, the version equipped with external air supply allowing to remove the chips by blowing is possible.



Type MKS-G 260



Type MKS-G 500

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Type MKS-G 1000

Accessories

A liquid level monitoring device is available as accessory. Such liquid level monitoring device consists of a float actuating an NC or NO contact when reaching the level „Reserve“. An acoustic or optical signal transmitter can be connected to the liquid level switch. Liquid level switches featuring two switching points and thus allowing automatic refilling are also available.

On request, air and liquid flow rates can be regulated via the machine control system using proportional valves.

Nozzle technology

Funktional principle of the *microjet*[®] two-phase nozzle

The two-phase nozzle features an internal mixing chamber in which the lubricant is mixed using compressed air. Simultaneously, compressed air flows within an annular channel parallel to the mixing chamber and forms an air jacket when emerging from the nozzle end.

That patented technology prevents the particles of liquid from undesirably dispersing in the surrounding air, and simultaneously gives the mixture jet a stable direction. Without fogging.

At the atomizing nozzle the mixture jet is also given a rotation through a swirl generator, which causes the air/oil mixture to penetrate deep into the bores without separating. This also allows to spray oils that are difficult to atomize.

Technological lead through innovative nozzle engineering

- Precise and directionally stable mixture jet
- Mixture jet directed to the machining point within a non-polluting air jacket
- No nebulizing of lubricants
- Low noise level ≤ 65 dB(A)
- Savings in compressed air consumption of up to 30% in comparison with other nozzles

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Two-phase nozzles



The *microjet*[®] 7 mm miniature two-phase nozzle makes its way into the smallest space.



The *microjet*[®] 8 mm two-phase nozzle is particularly suitable for nozzle bars.



The *microjet*[®] 8 mm two-phase nozzle with air jacket generator produces a directed small-area spraying pattern, even over large distances, without any nebulization.

The *microjet*[®] 10 mm two-phase nozzle is the standard nozzle and features a hardened end. It is particularly suitable for large distances.



The *microjet*[®] atomizing nozzle with air jacket generator is suitable for oils that are difficult to atomize, when oiling metal sheets for example.

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The *microjet*[®] two-phase articulated nozzle can rotate by 360° and tilt by 60°. It is perfectly suited to HSC machining and is available in a short and a long model.



microjet[®] atomizing head for internal lubrication. A swirl generator breaks the oil into minute particles.

Nozzle hose bundles

Examples of design

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Fig. 1

Miniature nozzle bar with 4 miniature two-phase nozzles (e.g. to oil sheet metal, see page 15)

The comprehensive range of nozzle hose bundles available allows to solve any particular application in an individual way. Such flexibility is made possible by the great variety of nozzle shapes and holders.

From special designs suitable for the sawing technique to nozzles built into the spindle carrier, any conceivable solution is possible.

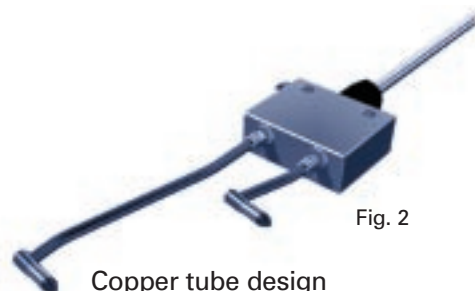


Fig. 2

Copper tube design for circular saws (see page 12)



Fig. 4

Flexible metal hose with 2 two-phase nozzles (Ø 10 mm) and magnet holder



Fig. 3

Flexible metal hose with 1 two-phase nozzle (Ø 10 mm), magnet holder and two-phase coupling



Fig. 5

Aluminium fastening block with copper tubes and 3 two-phase nozzles (Ø 10 mm)



Fig. 6

Nozzle ring with 4 miniature two-phase nozzles

Two-phase coupling



The two-phase coupling is characterized by the simple way it permits to cut off the two-phase flow of air/liquid in the nozzle hose bundle.

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Fields of use

- Subsequent extensions of hoses.
Fig. 1



Fig. 1

- Variable number of nozzles, e.g. whenever one, two or different variants of nozzle are needed.
Fig. 2, 3

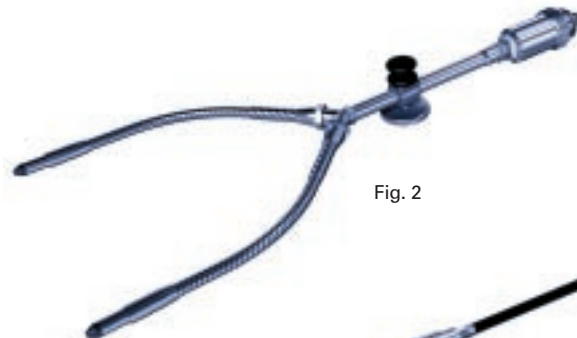


Fig. 2



Fig. 3

- Leading a nozzle hose bundle through the machine booth.
Fig. 4

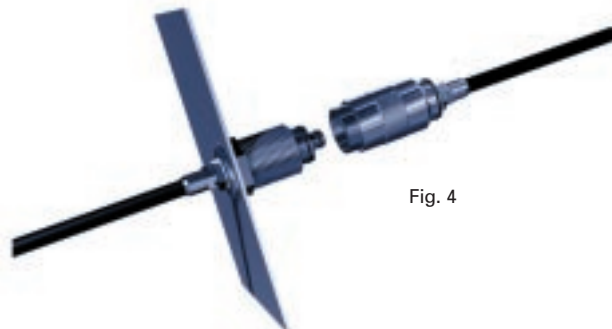


Fig. 4

microjet® Building-block system

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microjet® articulated two-phase nozzle, short

microjet® articulated two-phase nozzle, long

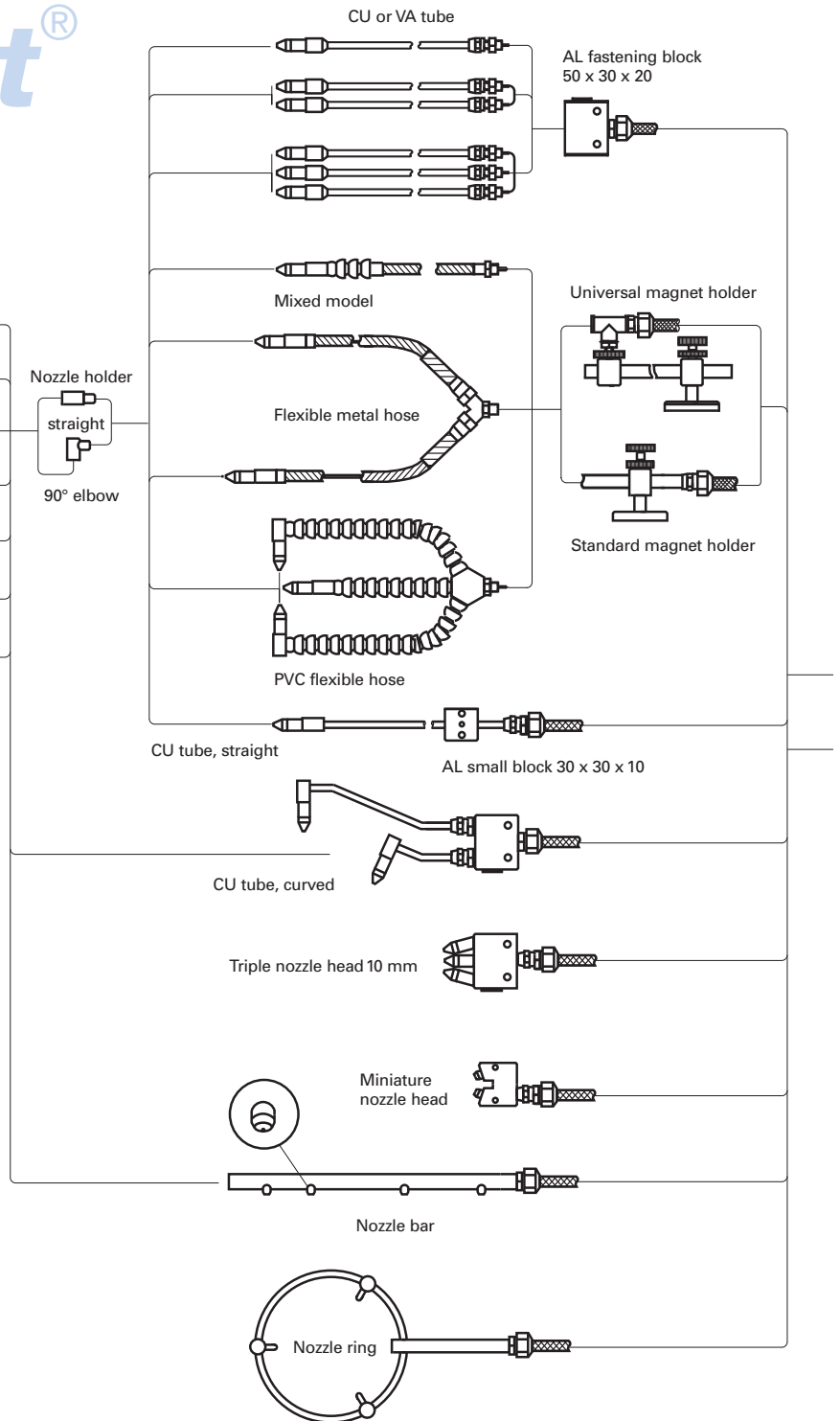
microjet® miniature two-phase nozzle 7 mm

microjet® two-phase nozzle 8 mm

microjet® two-phase nozzle 10 mm

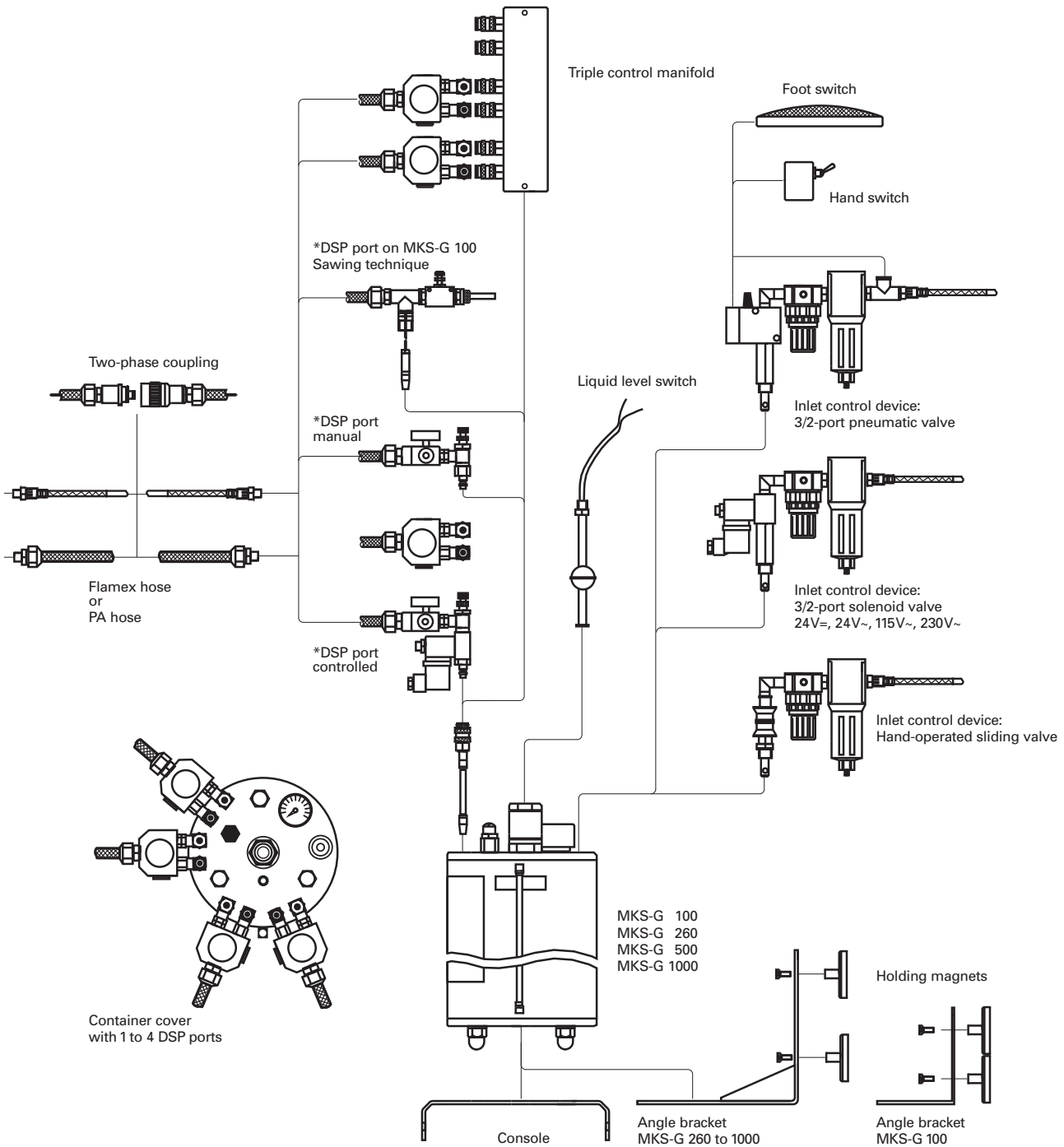
microjet® two-phase nozzle 8 mm with air jacket generator

microjet® atomizing nozzle with air jacket generator



*DSP = Nozzle hose bundle

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Sawing technique



Type MKS-G 100
for spraying heads and nozzle heads up to 2 nozzles



Type MKS-G 500
for nozzle heads with 3 nozzles

Examples of design



microjet® two-phase nozzle with
adapter for protective hood, for
circular saws up to Ø 300 mm



Copper pipe design for circular
saws from Ø 300 mm onwards



Triple nozzle head
for large ribbon saws with
sawing ribbons up to 80 mm



Triple spraying head
for ribbon saws with sawing
ribbons up to 35 mm



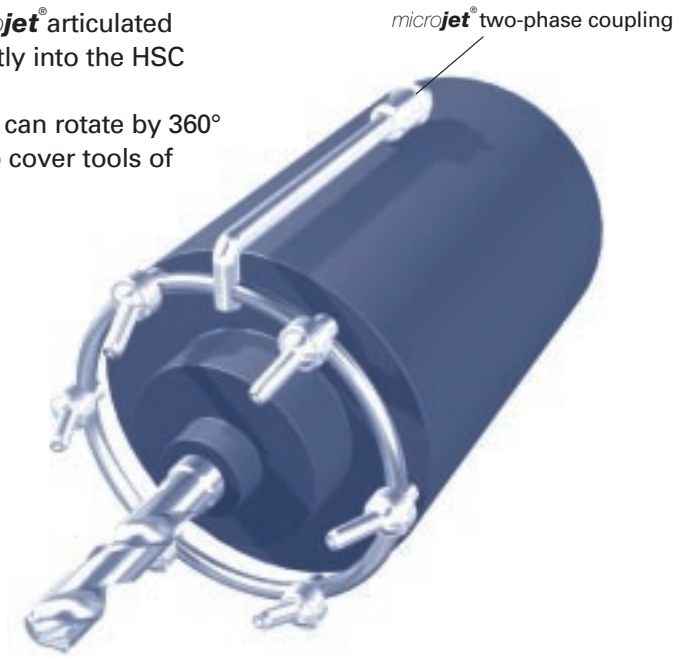
Double miniature nozzle head
for ribbon saws with sawing
ribbons from 34 mm onwards



Triple miniature nozzle head
for ribbon saws with sawing
ribbons from 40 mm onwards

HSC machining

Owing to their small size *microjet*[®] articulated nozzles can be mounted directly into the HSC spindle carrier for example. Articulated two-phase nozzles can rotate by 360° and tilt by 60°, which allows to cover tools of various length.



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**High-frequency spindle SKM – 02.3/40
manufactured by IMT of Heuchelheim.**

Technical Data:

Spindel housing:	Ø 126/105 mm
Speed:	up to 40.000 min ⁻¹
Continuous output:	5,0 kW
Peak output:	9,0 kW

That spindle is fitted with a built-in minimum-quantity lubricating device.

Two *microjet*[®] articulated two-phase nozzles at the housing flange. The connection to the system makes use of a two-phase coupling allowing to exchange the spindle easily and rapidly.



Nozzle modules



Functional principle

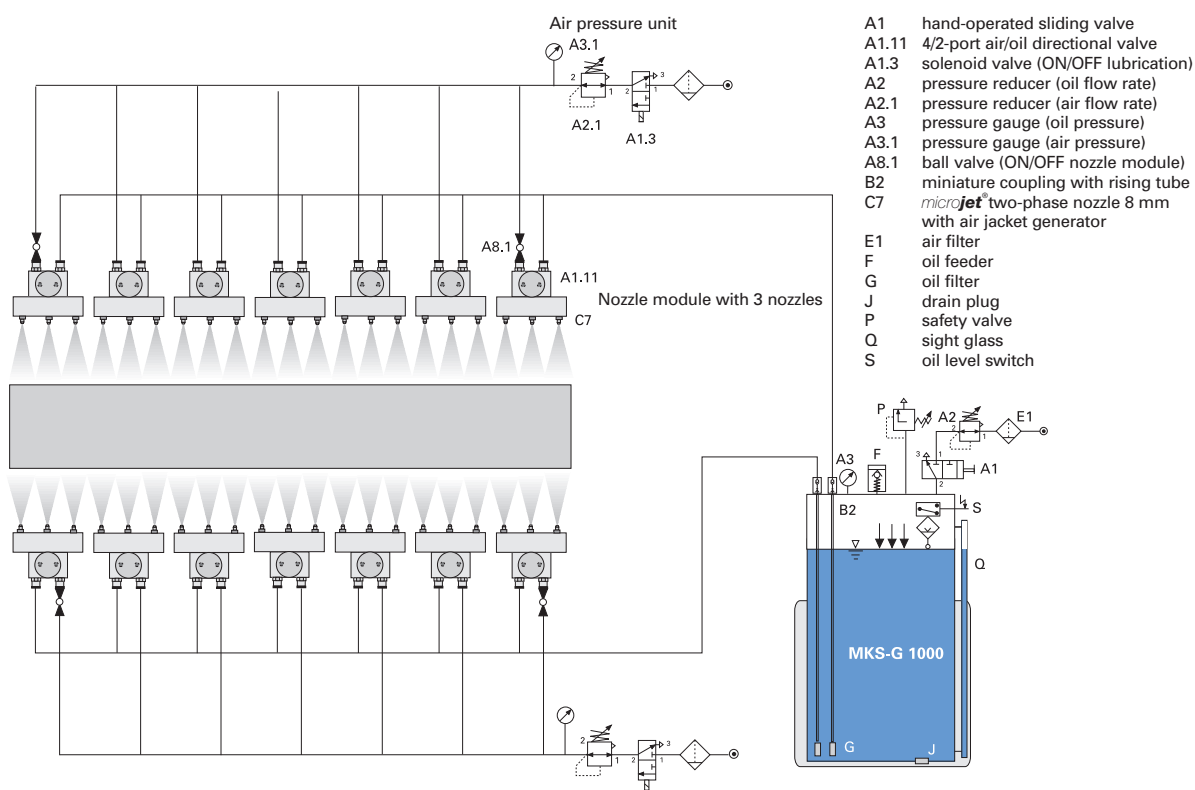
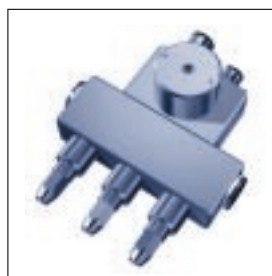
The nozzle module requires only a liquid port and an air port. As soon as air flows, the built-in valve opens and liquid flows, too.

The compressed air needed is switched on through a solenoid valve. Nozzle modules are available with 1, 2, 3 or 4 nozzles selected from our extensive nozzle range.

The modules are easy to combine to form nozzle bars of any length, for example for the spraying of sheet metal or pipes.

Advantages of nozzle modules

- Easy connection of the nozzle module to any air and liquid pipe
- Suited to quick change of liquid
- Air and liquid pipes can be of any length
- Easy mounting
- No additional control air required



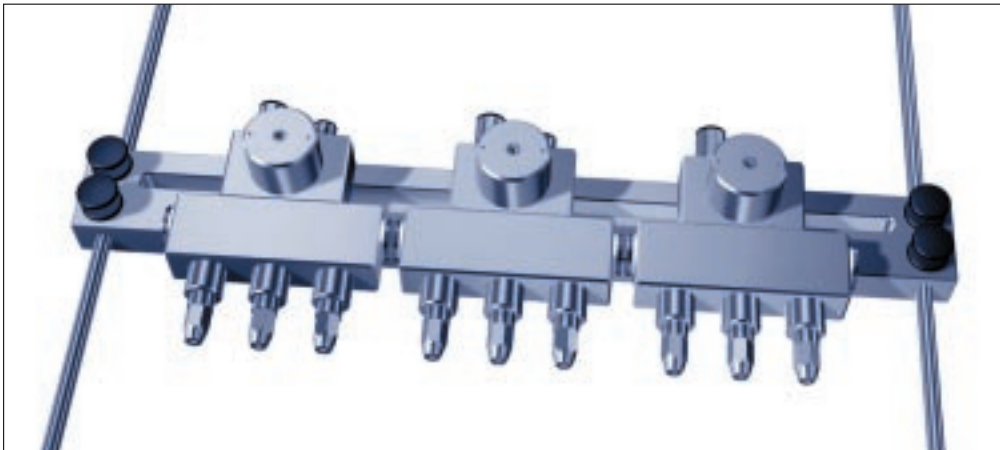
Sheet metal working

The *microjet*[®] nozzle bar

For use in non-cutting metal shaping (e.g. punching, drawing, bending, pressing, forming, perforating, etc.), the modules are easy to combine to form complete nozzle bars.

The patented *microjet*[®] nozzle technology allows controlled metered application of the lubricant onto machining surfaces. The friction taking place in the deformation area is dramatically reduced during the machining process. This results in less heat being generated on the tool, which in turn increases its service life by up to three times.

While lubricant consumption is extremely low, machining will yield a superior quality finish even in the upper speed range.



Decisive advantages in comparison with other oiling equipment:

- Minute consumption of lubricant
- Leaves no residues
- Clean working environment
- Operators friendly
- Reduction of cleaning costs
- Active environmental protection
- Easy, safe and clean handling
- Optimized application of the lubricant onto ribbons and materials of various width as each nozzle module can be separately switched on and off
- High quality finish
- Oiling of machining parts without any contact

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Minimum-quantity lubrication through the spindle with the *microjet*[®] atomizing head (formation of mixture outside the spindle)

Functional principle

The aerosol is formed within the atomizing head that is screwed directly in the rotary transmission. Then the aerosol is conveyed to the tool through the spindle using the rotary transmission.

Air and lubricant transport is coaxial up to the atomizing head.

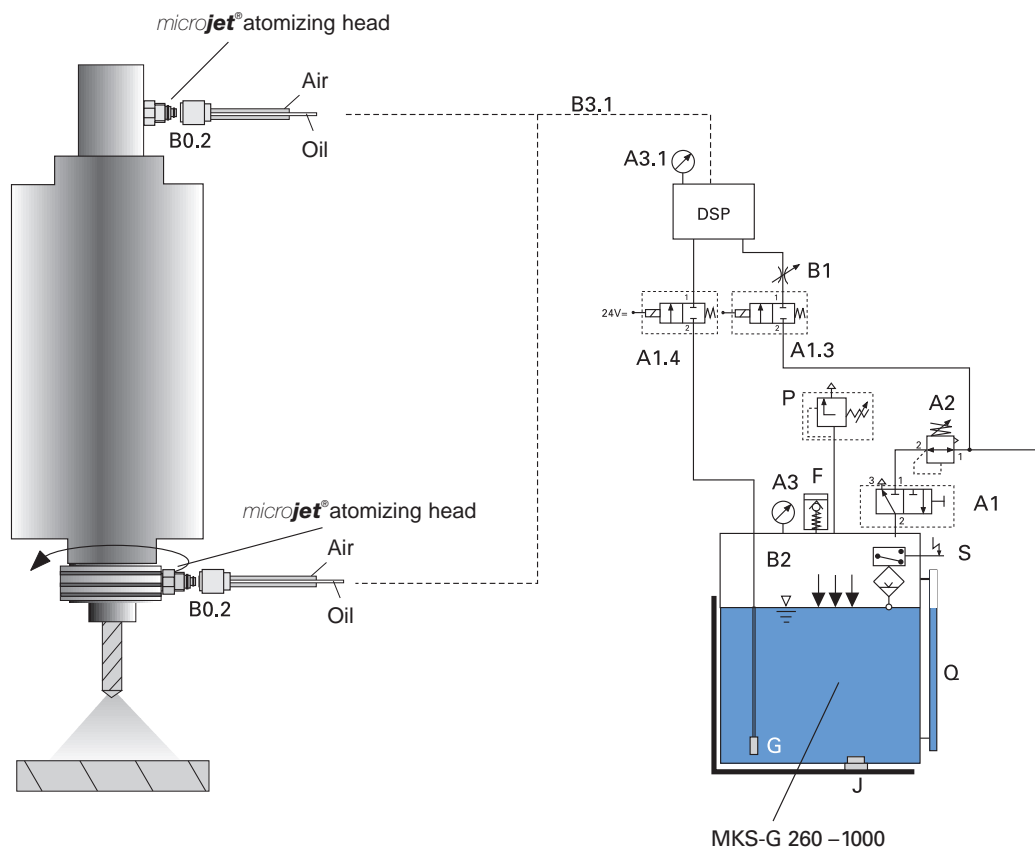
The atomizing head breaks the liquid into the finest microscopic particles and generates, during the subsequent alignment, an aerosol that condenses only when it emerges out of the feed channels, ensuring there the required lubricating action.

Benefits

- Can be retro-fitted for machines with internal feed of coolant
- Easy mounting (connection thread G1/4 or others)
- Separate adjustment of air and oil flow rates
- Formation of aerosol directly upstream of the rotary transmission, therefore only a short way for the aerosol
- Quick response and fluid availability at the machining point, even after lengthy rest periods

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- | | | | |
|------|----------------------------------|------|-------------------------------------|
| A1 | hand-operated sliding valve | B2 | miniature coupling with rising tube |
| A1.3 | solenoid valve (ON/OFF air) | B3.1 | PA hose with capillary tube inside |
| A1.4 | solenoid valve (ON/OFF oil) | F | oil feeder |
| A2 | pressure reducer (oil flow rate) | G | oil filter |
| A3 | pressure gauge (oil pressure) | J | drain plug |
| A3.1 | pressure gauge (air pressure) | P | safety valve |
| B0.2 | miniature two-phase coupling | Q | sight glass |
| B1 | throttle valve (air flow rate) | S | oil level switch |

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Please note

- It is essential to prevent any enlargements of bores, protruding edges and hollow spaces in the direction of flow.
- The higher the speed, the narrower should be the central bore through the spindle. This is the only way to keep the centrifugal force acting on the oil particles as small as possible.
- The rotary transmission must be suitable for dry operation.

System expansions

Modular expansion control manifolds allow to enlarge the *microjet*[®] system easily to form complex lubricating facilities. Such control manifolds can be actuated by solenoid or pneumatically. To adapt them to the customers' requirements and local constraints, a great number of nozzle variants and different models of nozzle hose bundles are available. The control manifolds and nozzle hose bundles are easy to connect with each other using two-phase couplings.

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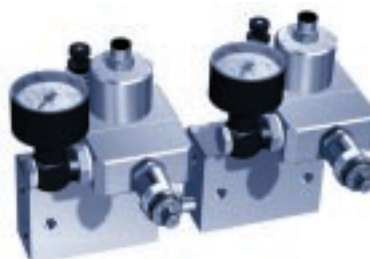
Single control manifold, electrically controlled



Single control manifold, pneumatically controlled



Double control manifold, electrically controlled



Double control manifold, pneumatically controlled



Triple control manifold, electrically controlled



Triple control manifold, pneumatically controlled

Example of planning

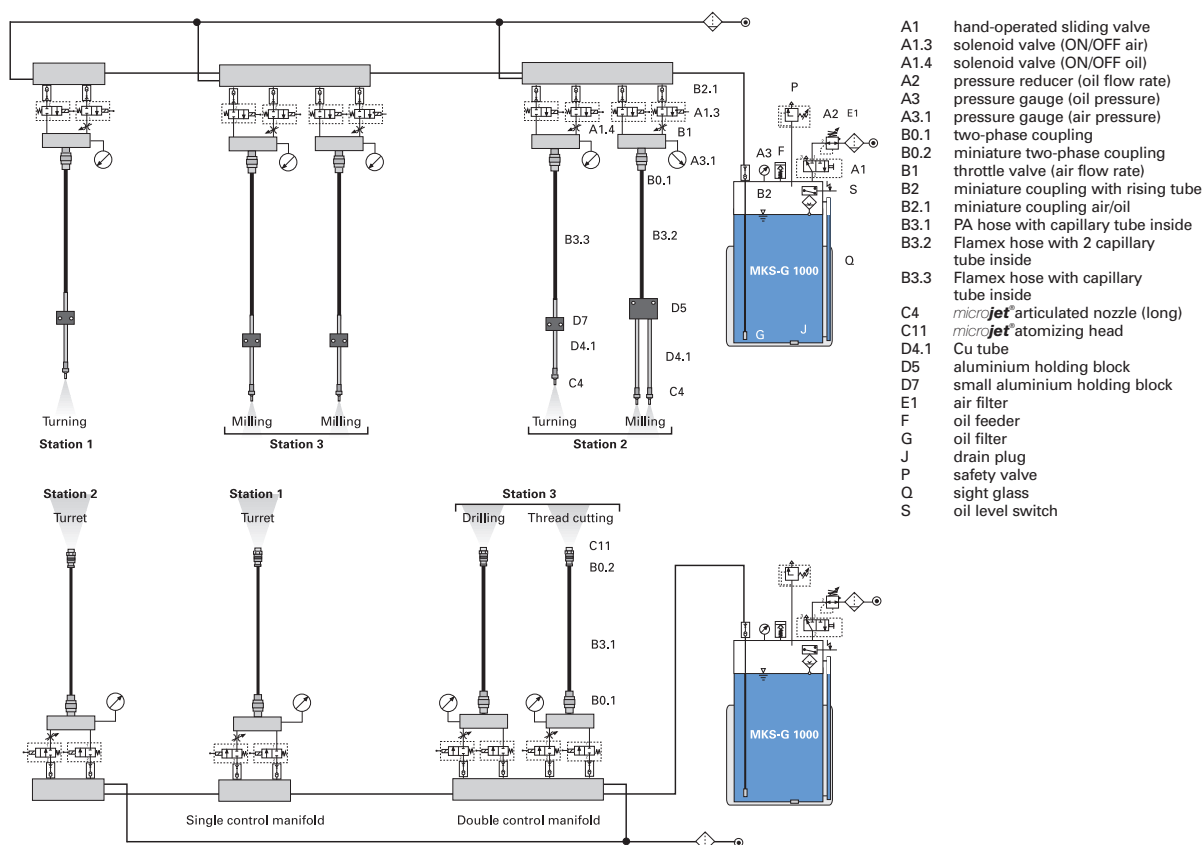
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Sliding table machine with various machining stations

Station 1: Facing head

Station 2: Milling and turning

Station 3: Drilling and thread cutting



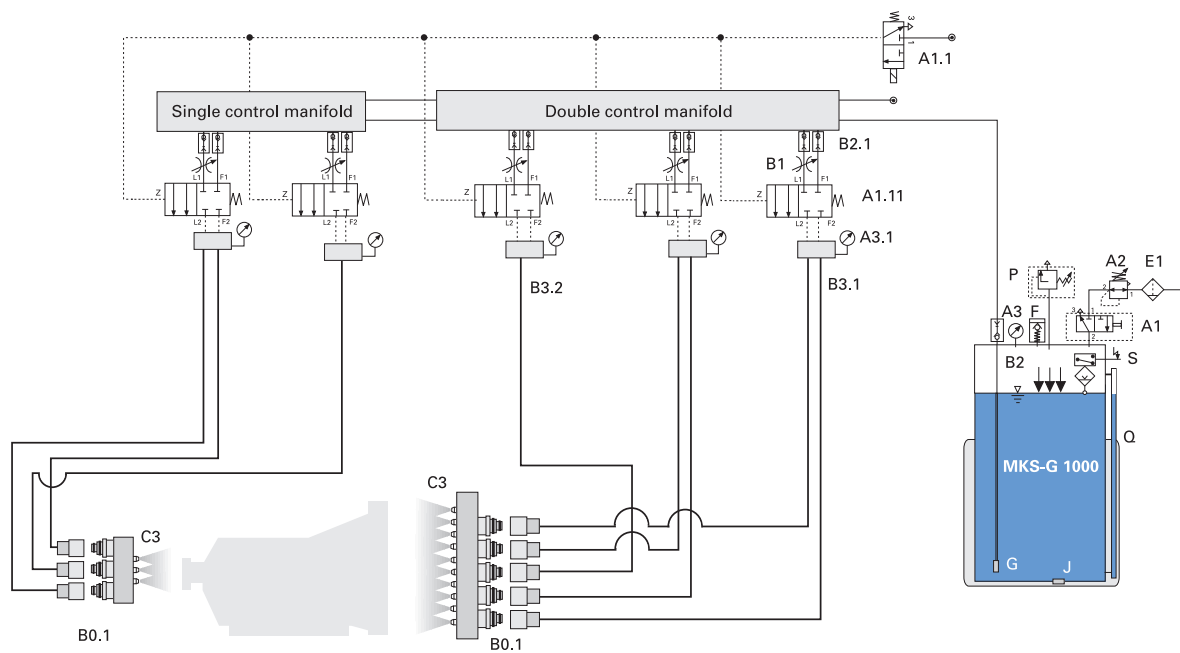
In that example a total of 6 machining points distributed among 3 stations have to be sprayed.

For turning it is planned to use combined external and internal minimum-quantity lubrication through the turret. The minimum-quantity lubrication required for thread cutting and drilling will be carried out through the spindle only, while lubricant supply required for milling will be ensured only by the external way. A total of 3 nozzle hose bundles with 1 two-phase articulated nozzle (long model) and 1 nozzle hose bundle with 2 two-phase articulated nozzles (long model) are used for the external minimum-quantity lubrication together with 4 nozzle hose bundles for the minimum-quantity lubrication through the spindle turret.

Each nozzle hose bundle can be triggered by a solenoid valve independently of the others. Thus, 3 double control manifolds as well as 3 single control manifolds are required. The control manifolds are provided with two-phase couplings that allow to install the nozzle hose bundles quickly and easily. Since the requirements on the lubricants are extremely different for external and internal minimum-quantity lubrication, the liquids are supplied through two separate MKS units of type MKS-G 1000 (container contents 10 litres).

Customer-specific systems

Protective coating of gearbox flanges



Nozzle flanges with 7 miniature two-phase nozzles

Nozzle flanges with 19 miniature two-phase nozzles

- | | | | |
|-------|-------------------------------------|------|--|
| A1 | hand-operated sliding valve | B3.1 | Flamex hose with 2 capillary tubes inside |
| A1.1 | solenoid valve (ON/OFF air) | B3.2 | Flamex hose with capillary tube inside |
| A1.11 | 4/2-port air/oil directional valve | C3 | <i>microjet</i> ® miniature two-phase nozzle |
| A2 | pressure reducer (oil flow rate) | E1 | air filter |
| A3 | pressure gauge (oil pressure) | F | oil feeder |
| A3.1 | pressure gauge (air pressure) | G | oil filter |
| B0.1 | two-phase coupling | J | drain plug |
| B1 | throttle valve (air flow rate) | P | safety valve |
| B2 | miniature coupling with rising tube | Q | sight glass |
| B2.1 | miniature coupling air/oil | S | oil level switch |

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In that application gearbox flanges are sprayed with a preservative agent. Preservation is carried out prior to shipping to prevent the gearboxes from rusting during transport. Two nozzle flanges were devised to be equipped with 19 and 7 *microjet*® miniature nozzles respectively, which are triggered pneumatically through a triple and a double control manifold. In each case the nozzles are arranged in groups. Each group can be actuated separately. This allows to use the installation for flanges of various sizes. The use of two-phase couplings makes it possible to disconnect the nozzle flanges from the system quickly and easily.

Oiling of streamlined-section pipes

(e.g. manufacture of exhaust pipes)

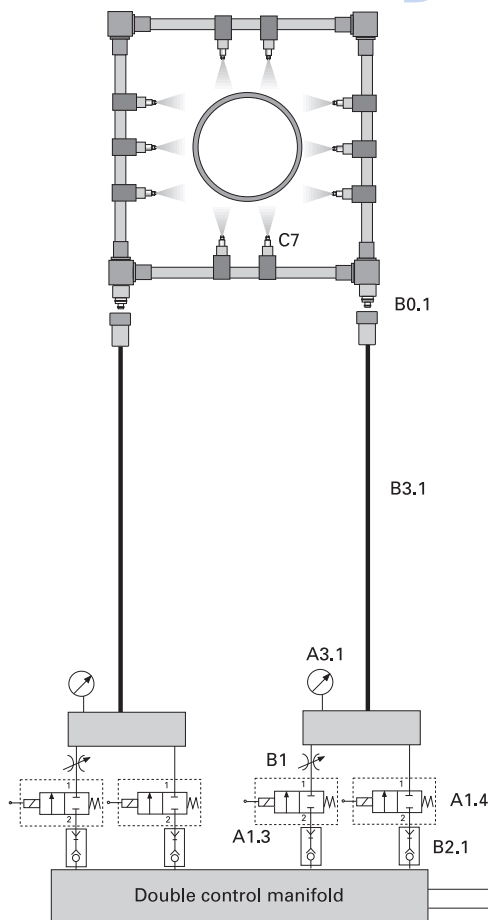
That minimum-quantity lubricating installation allows to spray oil onto the pipes prior to the shaping process to prevent striation. A nozzle frame was designed and fitted with a total of 10 two-phase nozzles (8 mm) with air jacket generator.

The pipes are pulled through the frame and uniformly sprayed from all sides.

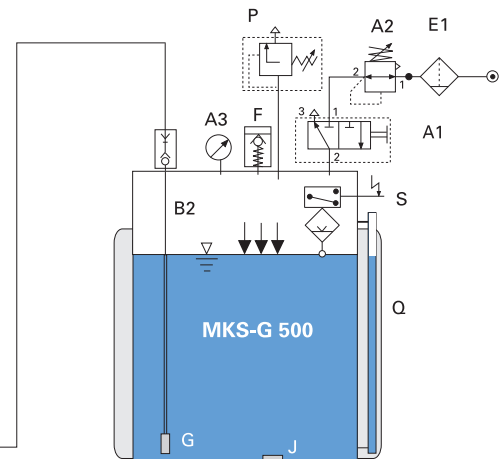
The use of two-phase couplings allows to disconnect the nozzle frame from the system quickly and easily. The spraying operation is actuated by solenoid via the machine control system.



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- A1 hand-operated sliding valve
- A1.3 solenoid valve (ON/OFF air)
- A1.4 solenoid valve (ON/OFF oil)
- A2 pressure reducer (oil flow rate)
- A3 pressure gauge (oil pressure)
- A3.1 pressure gauge (air pressure)
- B0.1 two-phase coupling
- B1 throttle valve (air flow rate)
- B2 miniature coupling with rising tube
- B2.1 miniature coupling air/oil
- B3.1 Flamex hose with capillary tube inside
- C7 *microjet*[®] two-phase nozzle 8 mm with air jacket generator
- E1 air filter
- F oil feeder
- G oil filter
- J drain plug
- P safety valve
- Q sight glass
- S oil level switch



Questions and answers about *microjet*[®] minimum-quantity lubricating system (FAQs)

How does *microjet*[®] minimum-quantity lubricating system differ from other spray systems?

The *microjet*[®] minimum-quantity lubricating system essentially differs from conventional spray systems in the following points:

- directional stable lubricant jet
- no generation of oil mist
- minimum and reproducible liquid consumption
- nearly maintenance-free
- modular system
- reliable process

What kind of liquid can be sprayed?

All Newtonian fluids can be sprayed.

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How is the fluid fed into the nozzle?

Due to the overpressure existing within the storage container, the fluid is forced into a capillary tube leading into the mixing chamber of the two-phase nozzle. Fluid and compressed air are not mixed until they reach the nozzle.

How is the minimum quantity of liquid adjusted?

The minimum quantity of liquid is regulated using the variable pressure existing in the container. The capillary tube assumes the function of the metering element. Throttle valves do not allow to regulate minimum quantities down to a few millilitres an hour.

Does the system ensure a constant quantity of liquid?

The quantity of liquid at the nozzle remains the same at any time. Unlike systems with reciprocating piston, the minimum quantity is not obtained by pulsing, which results in rich and rare mixtures continuously alternating with each other, but by a permanent steady flow rate within the capillary hose.

Does each two-phase nozzle receive the same quantity of liquid?

Each two-phase nozzle receives, through a separate capillary tube, exactly and invariably the quantity of liquid intended for it.

Does the quantity of liquid vary when the air flow rate changes?

Since the air flow rate can be separately controlled, independently of the pressure existing within the container, the quantity of liquid does not vary. It is thus possible, the quantity of liquid remaining constant, to make the jet of lubricant richer or weaker in oil by setting a low or a high air flow rate.

What is the function of the air jacket at the two-phase nozzle?

The air jacket focusses the jet of lubricant and prevents the liquid particles from escaping into the surrounding air. It is thus possible to work without any oil mist at all.

How many nozzles can be connected to a *microjet*[®] system?

Basically, any number of nozzles can be connected to such system.

Using intermediate manifolds, it is possible to connect to a single *microjet*[®] pressure container any number of nozzle hose bundles, each featuring up to 5 nozzles.

Can the aerosol jet be pulsed?

Each port intended for a nozzle hose bundle at the *microjet*[®] apparatus or a control manifold can be fitted with electrically or pneumatically controlled valves allowing to trigger the air and liquid flow separately. This makes very short pulse times possible.

Can the two-phase nozzle also be used to blow pure compressed air?

The separate control of the air and liquid flow allows to trigger the air valve separately. It is thus possible to blow pure compressed air, e.g. for cooling or removing chips from the machining area.

What are the consequential costs resulting from the use of a *microjet*[®] minimum-quantity lubricating system?

Except for the modest consumption of air and liquid, there are no further costs for using the *microjet*[®] minimum-quantity lubricating system.

How can *microjet*[®] be adapted to various types of machining centre?

The great variety of possible configurations allows to adapt *microjet*[®] to the conditions existing on the various machines within very wide bounds.

How are chips removed when using *microjet*[®] on metal-cutting machines?

As machining with *microjet*[®] only produces dry chips, these can easily be sucked off or blown away. Due to the characteristic focussing of the jet sprayed within the air jacket, a small quantity of air is quite sufficient to keep the immediate working area permanently free from chips.

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Why does *microjet*[®] ensure longer tool service life?

The air jacket allows the *microjet*[®] lubricant jet sprayed to penetrate the envelope of air generated by fast rotating tools, thus ensuring excellent lubrication exactly at the point of action between tool and workpiece, even at the highest cutting speeds. The minute mass of the fluid particules prevents them from being hurled away by the centrifugal force.

Have workpieces to be cleaned after machining with *microjet*[®]?

After machining with *microjet*[®] a cleaning process is not necessary as workpieces remain dry and clean.

Must particular protective measures be taken at the workplace when machining with *microjet*[®]?

When using the *microjet*[®] system no protective measures must be taken at the workplace. So, *microjet*[®] is also perfectly suitable for use on manually operated machines as no harmful effect has to be feared in the working environment.

Where is *microjet*[®] successfully used right now?

microjet[®] is used in various sectors for cutting and non-cutting metal-shaping processes of any kind. There are also a great variety of special uses such as, for example, the lubrication of bearings and chains as well as the application of preservatives, antiadhesive agents, liquid fats, liquid wax, or food oils.

