



**Production Line for  
Stainless Steel Micro Tubes  
with Optical Fibres**

**UNIWEMA® 5L**

# General

Stainless steel micro tubes with optical fibres (**Fibre in the Steel Tube: FIST**) are integrated into a number of different end products such as **OPtical Ground Wires (OPGW)**, **OPtical Phase Conductors (OPPC)** and Fibre Optic Submarine Cables. In these products the optical fibres must be protected from harsh environmental conditions. Laser welded, hermetically sealed stainless steel micro tubes are ideal to meet these requirements as they provide mechanical and thermal protection for optical fibres and good resistance to moisture and hydrogen ingress. The optical

fibres are isolated from stress and strain. In addition to the requirements of the end product the stainless steel micro tubes with optical fibres also have to endure the mechanical strain during integration into the end product.

Such stainless steel micro tubes with optical fibres are specified in many different diameters, different wall thicknesses and with many different numbers of fibres. Also, the fibre excess length in the micro tube shall be adjustable.

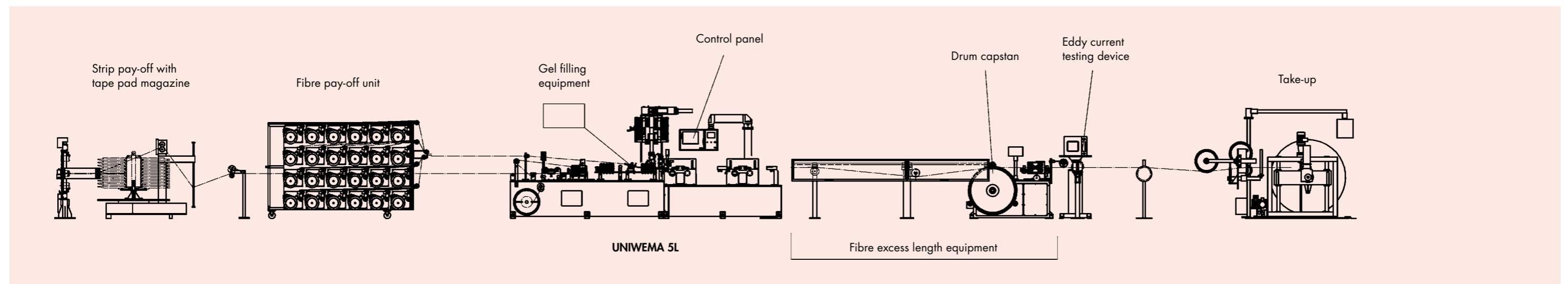
In our production line such stainless steel micro tubes with optical fibres, which do meet all these requirements, are produced in long lengths in a single continuous process. The core equipment of this production line is the UNIWEMA® 5L which perfectly coordinates forming and welding with the other requirements of the production process. The UNIWEMA® 5L is the smallest type of our forming and welding machines UNIWEMA® which are successful around the world for more than 40 years.

# Description of the Production Line

## Overview

The production line consists of the following major sub-units:

- strip pay-off with tape pad magazine
- fibre pay-off unit
- micro tube forming and welding machine UNIWEMA® 5L
- gel filling equipment
- fibre excess length equipment
- take-up
- control of the production line
- strip splicing equipment



### Strip pay-off with tape pad magazine

A continuous strip supply for a fixed production length must be ensured to allow continuous production. As the strip coils delivered by the strip manufacturers have limited lengths only, the strip ends of several coils have to be spliced by cross welding to achieve the required length.

This cross welding is done by a strip spli-



cing equipment separated from the main production line. By such separation any interference of the splicing process with the main continuous production process is avoided. In the strip splicing equipment a unique tape pad magazine is filled with a number of strip coils, which are spliced by butt cross welding.

The strip pay-off consists of a driven turntable on which an exchangeable tape pad magazine, filled with a number of strip coils, is assembled. Via a sophisticated guiding and speed control device, the strip runs from the coil into the production line. The change-over from one coil to the next does not affect the production speed.



### Fibre pay-off unit

The single fibre pay-off can take up standard fibre bobbins as supplied by the fibre manufacturers. The drive of each pay-off is dancer controlled. The fibre tension can be adjusted between 20 and 140 cN.

A fibre pay-off unit comprises 24 single fibre pay-offs. The number of these fibre pay-off units installed in the production line depend on the production requirements, i.e. the OPGW specification. A standard line layout includes 2 fibre pay-off units.

### Micro tube forming and welding machine UNIWEMA® 5L

The micro tube forming and welding machine UNIWEMA® 5L is the core equipment of the production line.

By the UNIWEMA® process the metal strip coming from the strip pay-off is introduced into the machine and, in a single operation, the strip edges are trimmed and formed into a tube. Then, the opposing strip edges are longitudinally butt welded. A split-clamp caterpillar capstan located downstream from the welding station pulls the tube through the machine. The perfect coordination of the forming and welding operation with the split-clamp caterpillar capstan is a precondition for obtaining a uniform weld seam. This is the basic con-

cept of about 200 UNIWEMA® machines supplied to companies around the world for more than 40 years for the manufacture of various products.

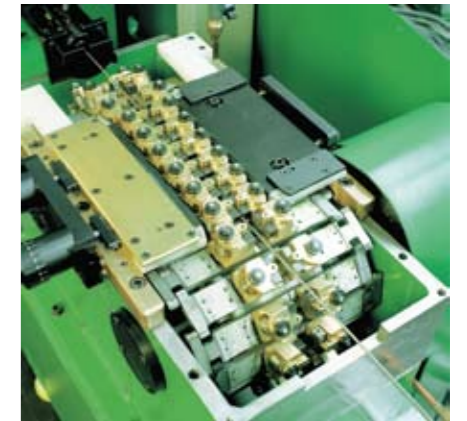
For the production of Fibre in the Steel Tube this basic UNIWEMA® concept has been modified and redesigned. On the UNIWEMA® 5L the steel strip is prepared and formed in two main sections. The first section prepares the tape edges, which are to be welded and starts forming the tape into an open u-form. Here the forming tool shows an interval which is used to introduce the fibres, the welding gas and the thixotropic gel through a lead-in nozzle. After this interval the tape is formed into a circular shape for welding.



By the patented design of the lead-in nozzle the gel does not interfere with the welding area and the welding heat does not effect the fibres. At the same time it allows the covering of the welding area by the welding gas. Welding of small diameter/thin wall thickness micro tubes as produced on this line is done by Laser. The Laser welding technique applied on this line is the conduction limited welding which has been optimized for this kind of small diameter/thin wall thickness micro tube production. The very narrow weld seam is achieved by this welding method, requiring a precise guiding of the strip edges under the laser spot. The combination of the high

precision forming tool and the split clamp caterpillar capstan which holds the seam within the tolerance needed, makes the use of a seam detection and guiding unit obsolete. The weld seam quality is tested in-line by an eddy current testing device.

The UNIWEMA® 5L for the production of Fibre in the Steel Tube comprises 2 split clamp caterpillar capstan units. Between the 2 units and behind the second unit the micro tube is reduced in diameter. Because of these 2 tube reductions the actual production speed is higher than the welding speed.



### Gel filling equipment

The micro tubes are filled with thixotropic gel. The filling equipment comprises the gel container with dosing pump, pressure and temperature control/measuring instruments, heated gel pipe and injection unit for the lead-in nozzle.

### Fibre excess length equipment

Because of different elongation characteristics of the steel tube and the glass fibres the design of the final cable requires an excess length of the fibres in the steel tube. Depending on the size of the micro tube and the number of fibres a set excess length in the range of 0.2 to 0.7 % is reliably obtained in our production process.

With the drum capstan a pulling force is applied to the micro tube which elongates it to some extent. The pulling force is controlled by means of a special force measuring device. The percentage of elongation depends on the pulling force. As this elongation is within the elastic range of the micro tube, it returns to its original length as

soon as the pulling force is released, i.e. behind the drum capstan the micro tube returns into its original length. The length of the fibres in the micro tube yet stays at the elongated length of the micro tube. That means that the percentage of excess length of the fibres is in accordance to the percentage of temporary elongation of the micro tube.

### Take-up

After the fibre excess length has been achieved the micro tube is spooled via dancer control onto a take-up. A standard traversing take-up has been modified to meet the special requirements of this production process. Standard wood and metal spools can be used.



## Technical Data

### Control of the production line

All individual parameters of the production line such as speeds of the different components, tensile strengths, welding power and also all measurable and adjustable parameters are PLC-controlled and adjusted/monitored by an industrial computer operating with Windows-compatible software. The machine operator controls the line from the main control panel at the UNIWEMA® 5L. This panel includes a color monitor to display the welding puddle and a 15" TFT touch screen, which shows a clear arrangement of all functions of the total line.

In addition, quality-relevant data can be monitored and stored. Recipes for different products manufactured can be stored and managed to be recalled at a later date. All parameters can be set by touching the corresponding square on the touch screen or by using the IPC-keyboard below the touch screen.

An optional remote error maintenance system can be integrated in the production line to enable our specialists to check the electronics of the customer's equipment from Hannover with the help of special software via Internet.



### Strip splicing equipment

The strip coils delivered by the strip manufacturers have limited lengths. For a required micro tube length several coils have to be spliced to allow smooth and reliable continuous production. These production requirements are met by a unique strip coil magazine which is filled with the joined coils, using the strip splicing equipment.

This strip splicing equipment comprises the coil roll-off stand, a turntable with the exchangeable strip coil magazine and the Laser cross welding equipment. In the strip coil magazine coils are placed above

each other, separated by spacers. After the end of the lower coil is butt welded by the Laser cross welder to the beginning of the next coil the spacers are introduced. The quality of the cross weld is as good as the longitudinal weld and does not affect the quality of the final micro tube.

The capacity of the strip splicing equipment allows preparation of exchangeable strip coil magazines for several production lines.

Diameter of the welded tube:	2.0 - 5.5 mm
Diameter of the final tube:	1.5 - 5.5 mm
Wall thickness of the tube:	0.15 - 0.3 mm
Max. continuous production length:	50,000 m
Production line speed:	3 - 25 m/min
Number of optical fibres:	1 - 48 (Standard)
Adjustable fibre tension:	20 - 140 cN
Adjustable excess length (depending on type of FIST):	0.2 - 0.7 %



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