PIN-HOLES DETECTOR

1. APPLICATION OF THE DETECTOR

1.1. Steel industry Environment

Sheet metals used for the manufacture of food packaging (in particular) are produced by companies from the steel and aluminum industry.

Sheet metals are manufactured using rolling mills to stretch the raw material and form a steel sheet metal of some tenth millimeters of thickness.
The stretching process of the sheet metal can induce a lack of homogeneity of the metal structure and form pin-holes.

Machine equipped with a pin holes detector

In order to meet the quality requirements of their customers, control and improve their manufacturing processes, both the steel and aluminum companies need to constantly control any material defect of their production.

The most critical defects are very small holes created on the metal sheet during the forming process (lamination in warmly or in cold for example). These holes can not be detected visually.

In order to detect those defects, we propose an automatic detector using the “dark room” principle :
the strip of metal to be controlled is placed in a dark room with a specific lightening going through the holes in the metal in order to activate ultra sensitive photoelectrical sensors.
The amplified and shaped signal is then compared with a threshold of tension to deliver a discreet information " Everything or Nothing " and temporarily calibrated.
This alarm is activated by the coil rolling system and permits to detects which part of the metal sheet is defected.

Systems conceived by ARCK ELECTRONIQUE allow to detect at a linear speed of 10m/s holes in diameter 15 µm on metal sheets of thickness 0,25mm and of variable width.

The performances of the standard product are the following ones :

- Detection of perpendicular holes of 15 µm minimum
- Strip thickness from 0,120 mm to 0,250 mm
- Chrome-plated or tin-plated sheet
- Width of sheet between 700 and 1250 mm
- Range of temperature of functioning from + 15°C to + 50°C.

1.2. Presentation of the opto-electronical technology used

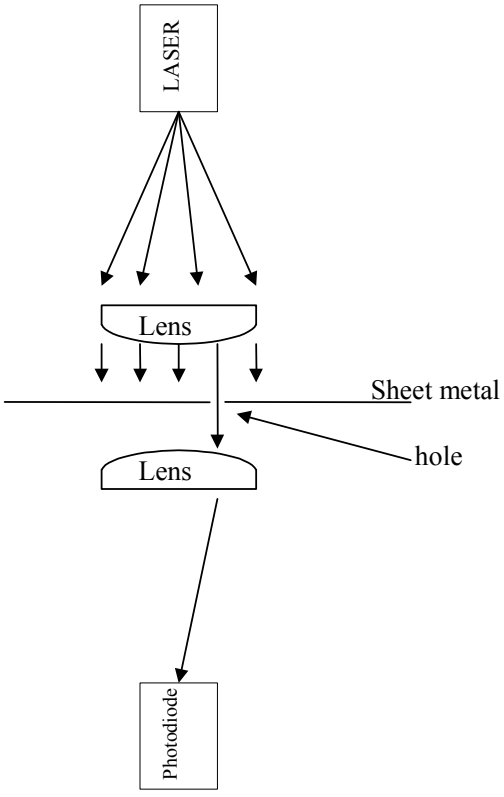
The principle is based on the use of a laser beam as a light source and of photo sensors suited for the reception of the light through possible holes in the sheet metal.

1.2.1. Light source

Considering the size of holes and in order to avoid the use of hypersensitive sensors, the emitted light energy must be high. The use of a laser source meets this requirement.
A laser diode of some mW produces an high energy source because the power is condensed into a very thin light spot. The original beam is made divergent to sweep the detection zone using a line generation lens.
We use a special particular generator which offers a constant relative intensity on the line.

1.2.2. Principle of detection

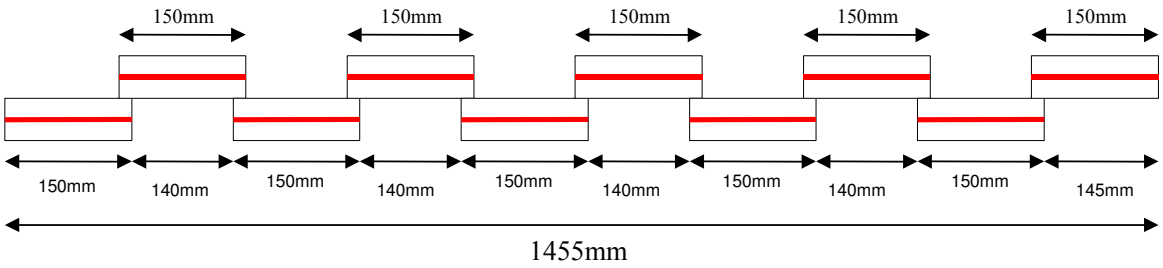
The synoptic of light flow appears below.



The strip to be controlled in real time is of a maximal width of 1250 mm and can be moved of 75 mm on both sides of the median axis, what gives a width to be watched of 1250 + 75 + 75 = 1400 mm.
It is necessary to rotate in a vertical direction the light beam produced with the laser line and to re-focus towards the photodiode. For technical reasons, an optical module does not cover more than 15 centimeters.
This implies the use of several optics with a covering of 5 mm on each side.

The useful width of an optics becomes 140 mm.
Ten optics are therefore needed to cover the required width.

The drawing below represents the arrangement of the 10 lenses seen from the top, as well as the existing overlap between every device. We see that the total width of detection is 1455 mm.



1.3. Sides mask

The mask of sides is an opaque piece embarked on a mobile device driven at the edge of strip and which protects the photo-receivers from the laser beam in case of lack of strip.

It ensures three functions :

- The automatic adaptation of the system to any width of strip included between 700 mm and 1250 mm.
- The compensation of the axial movement of the strip of + /-75mm.
- The masking of the defects of the strip on 1mm (a hole at 1mm of the edge must be discovered).

Considering he axial movement of the strip, it is necessary to drive independently the right and left masks of edge, what requires to double both the sensors and the actuators.

During the power-on, the possible dazzle of photo-detectors activates the removal of the masks of side of the window of passage of the strip.
Also, during the power-off, the masks of sides are removed before the switch-off (only the urgent stop will allow an immediate cut of tension).

1.3.1. Detection of the position of the strip

The detection of the strip is realized with a photoelectric barrier with integrated CCD.
The output is analogical, this is possible to drive with accuracy the sides masks.

1.4. Electronics of treatment

1.4.1. Management of information from photodiodes

Signal emitted by photodiode is processed with a synchronous detection and is amplified before fast trigger inputs.

1.4.2. Alimentation

From the network 220V / 50Hz, tensions used by the system are generated with an adapted electronic module.

2. CHARACTERISTICS

2.1. Dimensions

Dimensions : Width 1994 mm
Height 915 mm
Depth 300 mm

2.2. Power supply

230VAC 50 Hz / maximal consumption 100W / 16A.

2.3. Digital output

Three signals are present : 1 micro-hole detection signal, 1 maxi-holes detection signal and 1 signal of the active zone status (in service or not?).

For each digital output: output isolated with an optocoupler 200mA , 24 V.

For the output "Pin-holes": pulsed output T = 10 ms.
For the output " Maxi-holes ": pulsed output T = 100 ms.
For output " active Zone ": 24V indicates an active zone.

3. POSSIBLE EVOLUTIONS OF THE PRODUCT

Evolutions below are practicable :

- Modification of the working width
- Modification of the thickness of the sheet steel
- Modification of the size of holes
- Modification of the speed of projection

Other materials can be treated after an eventual prototype qualification.