

## Applications of NiTi-based shape memory alloys

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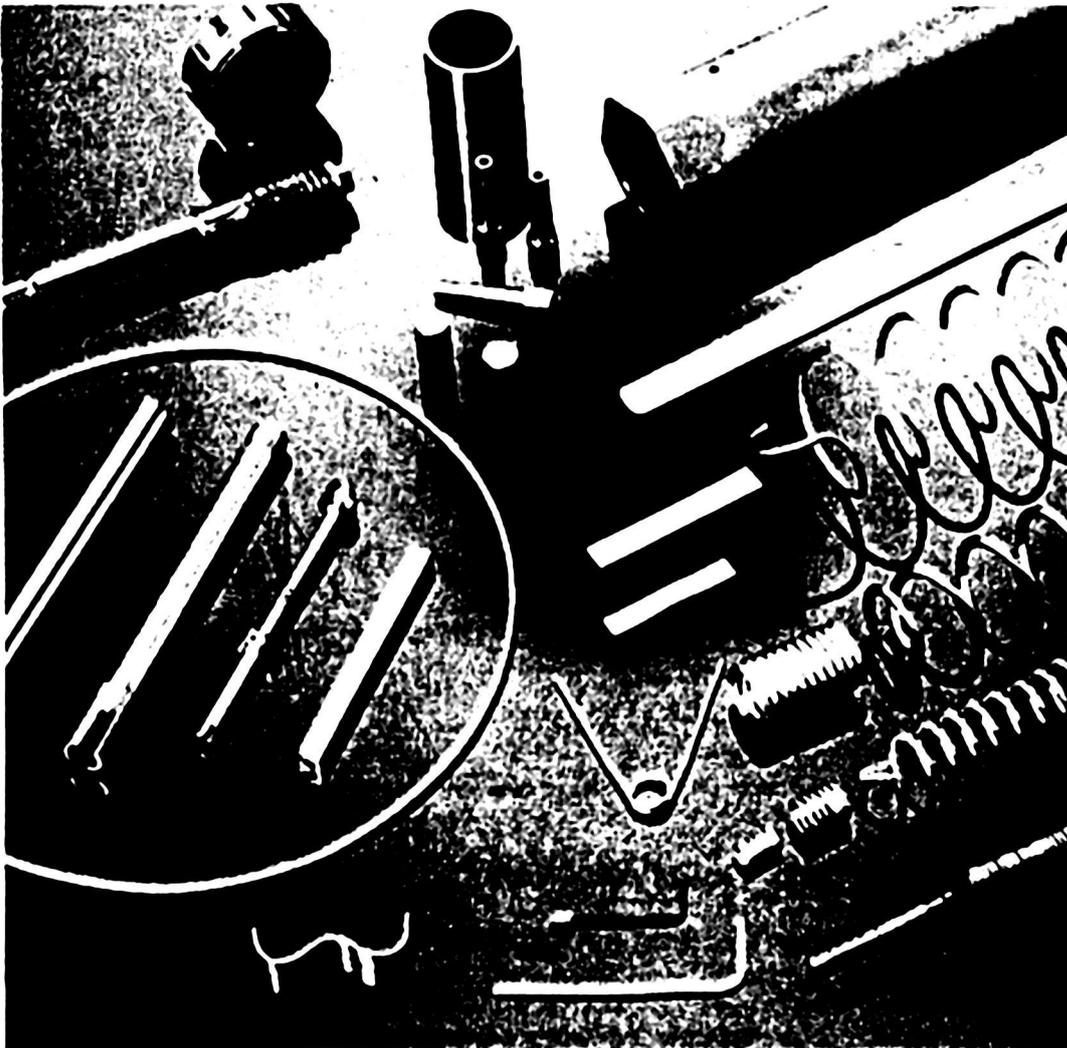
### The effect

The term memory alloy has been used for around 25 years to denote certain metallic materials which possess a pronounced shape memory. The most interesting memory alloy from an engineering point of view is that based on nickel-titanium.

The memory effect can be described as follows:

If a component made from this material is permanently deformed in the martensitic condition (low temperature phase) and then heated to a specific transformation temperature, it returns almost completely to the shape it possessed prior to deformation. In changing shape the component can perform mechanical work.

A distinction is made between the single and the repeatable memory effect. The single memory effect requires renewed permanent deformation before each transformation. The repeatable memory effect is developed by specific thermomechanical treatment. A component which has been pretreated in this way can remember two different shapes whenever required (hot/cold).



**Fig. 1:** Examples of components made from NiTi

## Fields of application

The material has potential applications in many spheres, e.g. automotive and electronic, mechanical and medical engineering, safety devices, plant and equipment construction, instrumentation and controls, sensors, model construction and the aerospace industry. The effect can be used for driving, switching, controlling, locking and unlocking, clamping and connecting.

Particularly suitable are applications in which mechanical work is required to be done at a certain ambient temperature (e.g. of oil, water, air), e.g. actuation of a valve in a cooling circuit when operating temperature is reached, release of a coupling when a certain temperature is reached in case of overheating, adjustment/locking of a flap/door in case of fire etc. In such cases the element acts as both sensor and actuator.

If heat is applied from an external source (e.g. by means of a heating element, direct heating via ohmic resistance or by immersion in a heating bath) the single memory effect can be exploited in connecting elements such as shrink couplings or chip mountings etc. and repeatable effect in actuating elements or switches, particularly when a change from one position to another is required. To achieve intermediate positions, additional control is required.

If the superelasticity of the material is to be exploited, the transformation temperature selected must be so low that the material is austenitic under operating conditions. Applications such as this exist, for example, in textiles or spectacles.

## Sample applications

### Opening and closing flaps or louvres

The flaps covering a ventilating fan are opened and closed by means of a bending strip of NiTi. When the fan is activated the strip is heated to approx. 100 °C by a PTC thermistor. This causes the strip to bend and open the flaps. When the fan is switched off the strip cools down to ambient temperature and closes the flaps. The strip produces a force of around 2.5 N. Fitted in around 200,000 fans, it has been in successful operation for 3 years. Flaps for larger fans are operated by wires under tension (dia. approx. 0.8 mm, length approx. 95 mm, travel approx. 3.5 mm, force approx. 25 N).

### Miniature drives in technical models

Torsion elements or wires under tension can be used to operate barriers, signals, points, windows, doors, etc. The advantages are low space requirements for the drive and the scale accuracy of the movements.

Technical data of a typical memory alloy

Composition:	approx. 55 wt % nickel, approx. 45 wt % titanium
Density:	6.45 g/cm <sup>3</sup>
Electrical resistivity:	80 x 10 <sup>-6</sup> Ω cm
Transformation temperature:	-50 °C to +90 °C (adjustable to within ± 2 K)
Admissible load stress:	70 to 120 N/mm <sup>2</sup> (depending on alloy)
Tensile strength:	850 N/mm <sup>2</sup>
Memory effect:	6 - 8 % (single) 3 - 4 % (repeatable)

Today memory alloys are on the threshold of industrial application. GST devises shape memory solutions, constructs samples or prototypes and supplies sheet, wires or complete components.

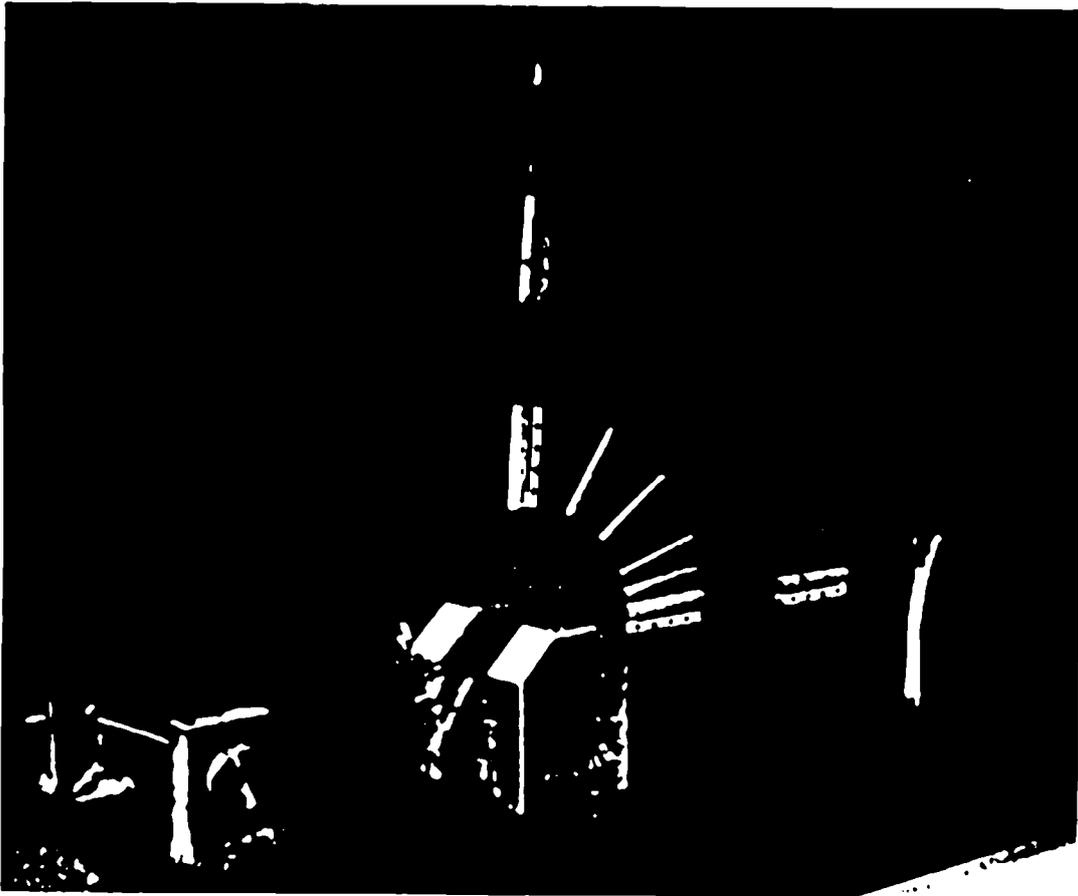


Fig. 2: A torsion element of NiTi operates a technical model of a barrier

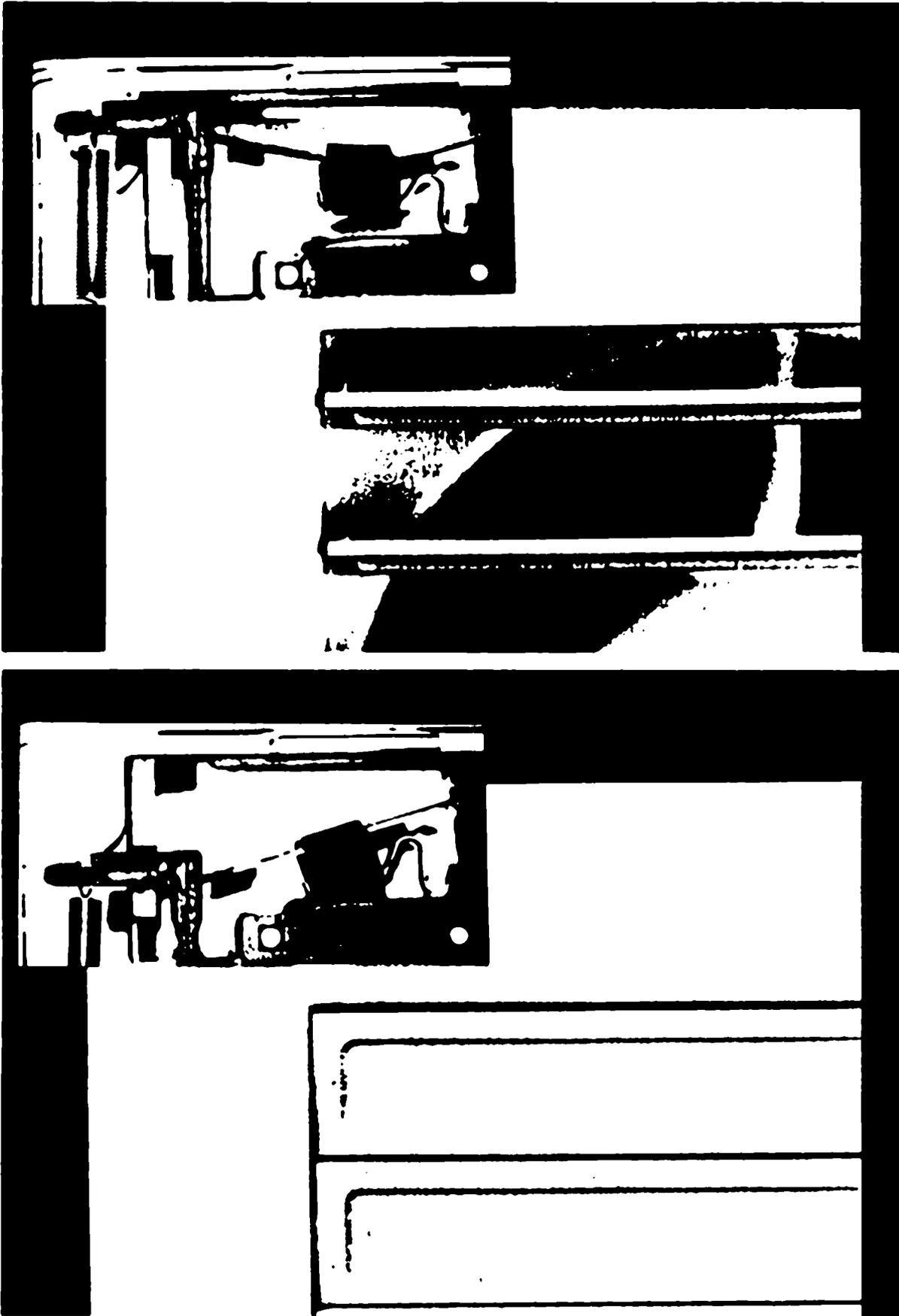


Fig. 3: A strip of NiTi opens and closes the flaps of a ventilating fan