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# Technical note: Food texture—modification of the shear press using a strain gauge system

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## Introduction

The shear press is an instrument for measuring food texture (Kramer, Burkhardt & Rogers, 1951). The original model was introduced in 1950 and it was later modified for electrical indicating and recording (Decker *et al.*, 1957). A new more versatile and precise model was introduced in 1956 (Kramer & Twigg, 1958). In this instrument force is measured by a maximum-reading dial gauge fitted across the vertical diameter of a proving ring. If time-force texture graphs are required, a transducer can be fitted across the ring in place of the dial gauge to give a print-out on a strip chart as the sample is tested.

This note reports an alternative and relatively cheap system for converting a dial reading shear press to a recording model. Strain gauges are attached to the proving ring and the electrical output is amplified and is recorded on a strip chart in the form of a texturegram. The dial gauge remains in place to indicate maximum deflection. The system is simple and easy to construct.

## Apparatus

Strain gauges, R1–R4, (Constantan foil type on a flexible polyimide backing) were attached to the proving ring (Fig. 1) by a high performance epoxy adhesive and protected by a thin coat of polyurethane and polysulfide epoxy. The four gauges were connected in a full Wheatstone Bridge configuration (Perry & Lissner, 1962). The output from the bridge $E_i$ was applied to the differential input of an operational amplifier through $R_i$ and $R_i$ (100 kΩ). The amplifier serves as a buffer stage between the strain gauges and the recorder to prevent over-loading of the signal source. It also provides the small voltage gain necessary to drive a recorder (in this experiment a Philips PM 8100 flatbed recorder was used).

The amplifier voltage gain is defined by the ratio $R_0/R_i$ (1 MΩ/100 kΩ) (Greame, 1973). The amplifier used (Burr Brown 3522J) has a moderately low offset and in this particular application a means of externally nulling this offset is provided with an external potentiometer (10 kΩ).

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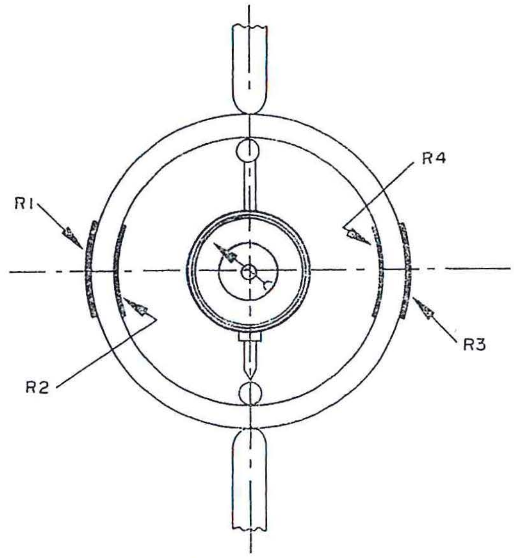


FIG. 1. Arrangement of strain gauges on the proving ring.

Strain gauges were attached to two proving rings, i.e. 2280 kg and 68 kg and a balancing network was provided to facilitate correction of small mismatches between rings. This balancing network can be adjusted to apply a small balancing voltage to point A on the bridge. The value of resistors in this network will depend on the required offset. A range control was also included which provided a means of varying the output voltage $E_0$ between 80 and 100% of maximum. It consists of a 1 kΩ potentiometer and a 3·9 kΩ resistor. The 2280 kg ring is used for measuring firm foods such as raw diced carrots and the 68 kg ring for soft foods such as strawberries.

The complete system is mains operated and a stabilized power supply was built which provides +5 V ($E_s$) to the bridge and ± 15 V to power the amplifier. A schematic diagram of strain gauges, amplifier and balancing network is shown in Fig. 2.

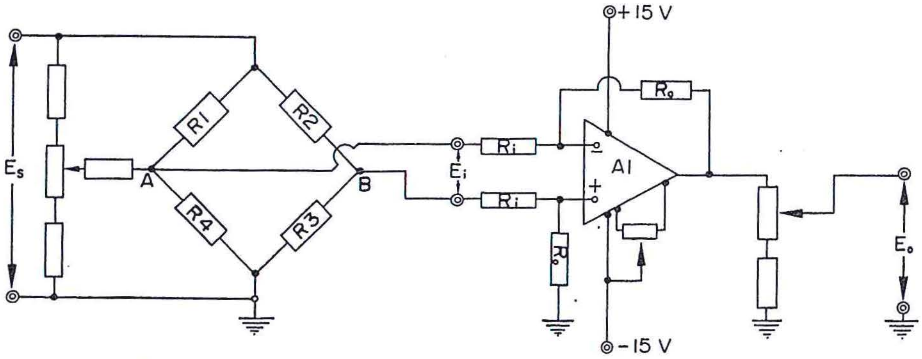


FIG. 2. Schematic diagram of strain gauges, amplifier and balancing network.

Calibration of the system can be checked with any sample tested as the maximum dial gauge reading can be related directly to the peak height on the recorder.

## Operation and performance

When carrying out a shearing test a weighed sample of food is placed in the standard shear-test cell and the dial gauge is set at zero. The shearing blade assembly and the strip chart are started simultaneously by the operator. When the shearing system reaches the end of its travel the chart drive is stopped. The maximum dial reading (kg) is then related to the peak height (mm) on the chart. Different chart speeds can be used depending on the detail required from the texturegram. The chart speed can be related to the speed of descent of the shearing blades and the area under the curve is adjusted accordingly to give the work (force-time) required to shear the sample. Adjustments may also have to be made to the area depending on which recorder 'span' setting is selected. The area is measured conveniently by weighing the etched-out curve (Barker & Webbing, 1974). Alternatively, a simple electronic integrator with digital print-out could be attached to the system.

A range of fruit and vegetables was sheared to test the system and texturegrams for an under-ripe tomato, a ripe tomato and a sample of diced carrots are shown in Fig. 3

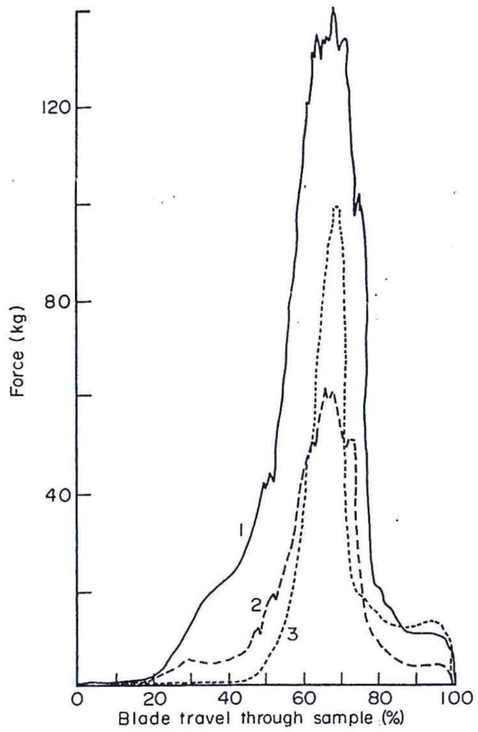


FIG. 3. Texturegrams for three samples: 1, green whole tomato (65 kg); 2, mature whole tomato (60 g); 3, diced carrots (40 g, force reading kg/4).

TABLE 1. Linearity check for dial reading versus recorder peak height (2280 kg ring)

| Sample* | Dial reading (kg) | Peak height (mm) | Recorder span (mV) | Ratio kg/mm/10 mV span |
|---|---|---|---|---|
| 1 | 720 | 103 | 200 | 0·35 |
| 2 | 680 | 97 | 200 | 0·35 |
| 3 | 580 | 167 | 100 | 0·35 |
| 4 | 480 | 135 | 100 | 0·36 |
| 5 | 400 | 112 | 100 | 0·36 |
| 6 | 250 | 149 | 50 | 0·34 |
| 7 | 124 | 179 | 20 | 0·35 |

* Sample weights from 10–100 g of raw diced carrots were tested.

TABLE 2. Linearity check for dial reading versus recorder peak height (68 kg ring)

| Sample* | Dial reading (kg) | Peak height (mm) | Recorder span (mV) | Ratio kg/mm/100 mV span |
|---|---|---|---|---|
| 1 | 65 | 167 | 100 | 0·39 |
| 2 | 58 | 151 | 100 | 0·39 |
| 3 | 51 | 132 | 100 | 0·39 |
| 4 | 43 | 110 | 100 | 0·39 |
| 5 | 32 | 82 | 100 | 0·39 |
| 6 | 27 | 68 | 100 | 0·40 |
| 7 | 21 | 52 | 100 | 0·40 |
| 8 | 16 | 81 | 50 | 0·40 |
| 9 | 11 | 55 | 50 | 0·40 |

* Sample weights of 3–15 g cooked cauliflower were tested.

(1, 2 and 3 respectively). The linearity of the ratio between dial reading and peak height was checked over a number of sample weights for both proving rings. The ratios of kg/mm (adjusted for recorder span setting) thus obtained were almost constant (Tables 1 and 2) indicating a degree of linearity well within acceptable limits for practical texture testing.

## Conclusions

The strain gauge system reported is simple to construct and is of low cost. The main expense is that of purchasing a flat bed recorder. However, most laboratories already have recorders for other purposes and this system can be connected to one of these when necessary.

## Acknowledgment

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