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SHORT COMMUNICATION

A modified pressure wheel for the instrumentation of rotary tabletting machines

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IN any research into tabletting processes, it is necessary to know the force applied at the punch so that the tabletting pressure may be calculated. Much work has been done using single punch machines having strain gauges bonded to the shank of the punch (Higuchi, Nelson & Busse, 1954; Shotton & Ganderton, 1960). High-speed rotary machines require additional sophistication to enable useful results to be obtained, and there are two methods known. The first is that used by Shotton, Deer & Ganderton (1963). The resistance of strain gauges near the punch tips was used to control the frequency of an oscillator, and the signal was transmitted from the rotary part of the machine to a stationary aerial by radio emission. Thus the difficulty of providing a slip ring connection to the strain gauges was circumvented. However, because the radio transmitter took up space normally occupied by punches, it was difficult to obtain readings from more than one pair of punches, and impossible to obtain readings from all. In the second method (Knoechel, Sperry & others, 1967), strain gauges were placed on the compression screws interposed between the arm holding the movable axis of the pressure wheel and the spring used to adjust the compression force applied. Deflection, measured by the strain gauges, was proportional to the force applied to the punch. Since the gauges were stationary, their output could easily be displayed on a cathode ray oscilloscope, and the pressure to each punch recorded as its head passed under the pressure wheel.

The radio-link method allows the strain gauge to be on the punch itself, so that the recorded stress is in the actual machine component by which the compression force is applied: this makes for accuracy. The compression screw method gives a pressure record for every station, but the strain gauge is attached at a point remote from the place at which the force is actually being exerted. Between the punch head and the gauge are the pressure wheel axle, two linkages and a bar in torsion, all of which cause a reduction of, and introduce a possible non-linearity into, the strain to be measured. There is also a direct reduction due to the difference in length between the effective lever length of the arm carrying the pressure wheel axle and that communicating with the compression screw.

Accordingly, a modified pressure wheel* has been designed, which enables the applied force at all stations of a rotary machine to be measured; it also enables the measuring position to be kept in line with, and only 3 inches from, the head of the punch. The principle is to make the normally solid pressure wheel into one with two spokes, so that the periphery

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of the wheel can move relative to the hub, when the compression force is applied to the punch. The amount of movement produced by a given force is governed by the length and thickness of the spokes. A few thousandths of an inch per ton of applied force is a typical figure. The movement obtained may be measured in a number of ways, but two are described. The wheel (Fig. 1). consists of a central hub with a hole in

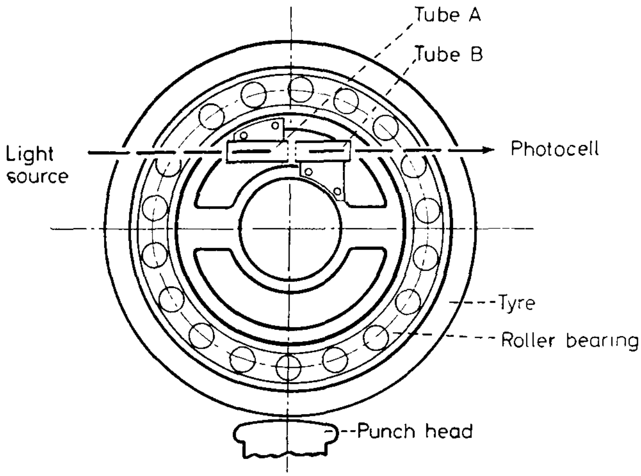

FIG. 1. A diagrammatic view of the pressure wheel, showing the tubes A and B which carry the moiré fringe plates.

its centre to fit the axle which normally runs in the machine bearings. The axle and the hub do not rotate: both are fixed relatively to the tabletting machine by means of grub screws. The hub carries two spokes, which carry a rim. Hub, spokes and rim are machined from a single piece of steel. The rim is a push fit into a $7\frac{1}{2}$ inch outside diameter Skefco roller bearing of conventional design. A hardened and ground outer steel tyre is shrunk onto the outside of the roller bearing. The tyre is impacted by the punch heads as they come round, and acts to spread the force of the impact onto several of the rollers and prevent the overloading which could result from a localized blow.

The horizontal tubes A and B (Fig. 1) are fitted at their ends with small matching moiré fringe plates made of glass. The black lines ruled thereon are equal in width to the spaces between them, and 100 lines to the inch proved a useful ruling interval. The moiré plates are adjusted so that the lines of the plate in tube A are opposite the spaces in the plate of tube B, both sets of lines running horizontally. The field of view through the tubes is then dark. Since A is fixed to the wheel rim and B to the hub, any applied force moves the moiré plates relative to one another, and light from a small projector bulb can pass down the tubes and fall onto the sensitive area of the phototransistor mounted in the end of tube B. The output of the transistor, a Mullard OCP 71, is displayed on an oscilloscope.

Two of these pressure wheels have been made, and one of them operated as the upper wheel of a Manesty D3 rotary tabletting machine. A commercial aspirin granulation ("Asagran", made by Monsanto Ltd.) was tabletted at the normal operating speed of about 500 tablets/min. An output of about 200 mV was available using the 100-line moiré fringe plates, the pressure wheel having a load sensitivity of 0·0025 inch per ton of applied load, as determined by a static test in a hydraulic press. There were no problems of inertia: the instrumentation system was capable of following the progress of a single compression by increasing the scanning rate of the oscilloscope. Alternatively, all 16 compressions occurring in one revolution of the rotary table could be inspected for peak height by displaying them on the screen simultaneously.

The second method of measuring the displacement of the wheel rim relative to the hub is to use strain gauges on the wheel spokes. By using four gauges, two on each spoke, it is possible to make the change of resistance a function only of vertical loading. The strain gauge is followed in the normal way by a bridge/amplifier.

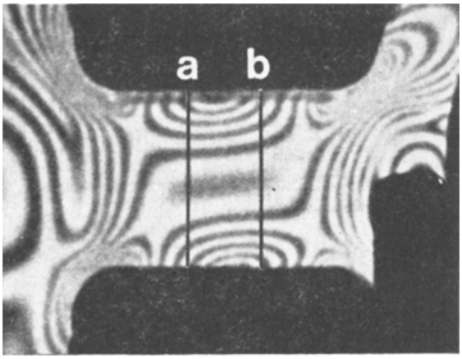

FIG. 2. The photoelastic fringe pattern produced by stressing a Perspex model of the hub, spokes and rim of the wheel. The fringe pattern characteristic of pure bending, parallel bands, appears between lines a and b, showing that a strain gauge in this position should give a response which is linear with applied force.

Strain gauges have not as yet been fitted to the wheel, but a Perspex model has been made. The model was stressed and viewed by polarized light; a typical fringe pattern is shown in Fig. 2. Between the lines marked on this photograph, the fringes are horizontal and parallel, indicating that in this small region the spokes are free from end effects and are subject to a pure bending moment. The stress in the spokes in this region is thus a linear function of the applied load, and if a strain gauge is fixed to a spoke in this region, it too will have a linear response.

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