COMMUNICATION TO THE EDITOR
Power-Input Meter for Laboratory Dough Mixers

DEAR SIR:

Rapid advances in baking technology in recent years, in which mechanical development processes have replaced the bulk-fermentation stage, have made necessary the measurement of power consumption during mixing of bread doughs. While metering devices are available for the measurement of power consumption in commercial bakery installations, nothing appropriate has been available for use in the laboratory to measure power consumption during mixing of doughs for pup or pound-loaf baking procedures. A power-input meter, to measure the relatively small amounts of work imparted to dough during mixing in laboratory mixers, has been designed and built in this laboratory. This unit, which has proved satisfactory in almost daily use in the laboratory's research bake shop for about 3 years, is described briefly below. The major components of the power-input meter (Fig. 1) are: 1) a domestic or household-type watt-hour meter; 2) an add-subtract electrical impulse counter; 3) an idling load adjustment to compensate for the different power requirements of laboratory mixers when running under a no-load condition; and 4) an interval timer.

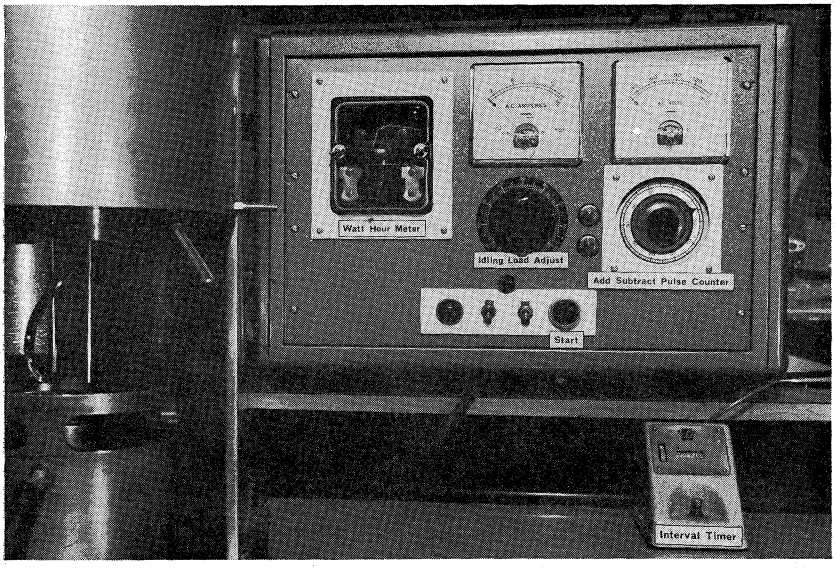

Fig. 1. The power-input meter with a GRL mixer on the left.

The meter was assembled in the laboratory from parts readily available from electronics supply houses. The unit measures 23 by 12 by 15 in., and is compact enough to stand on the divider shelf between back-to-back laboratory benches.

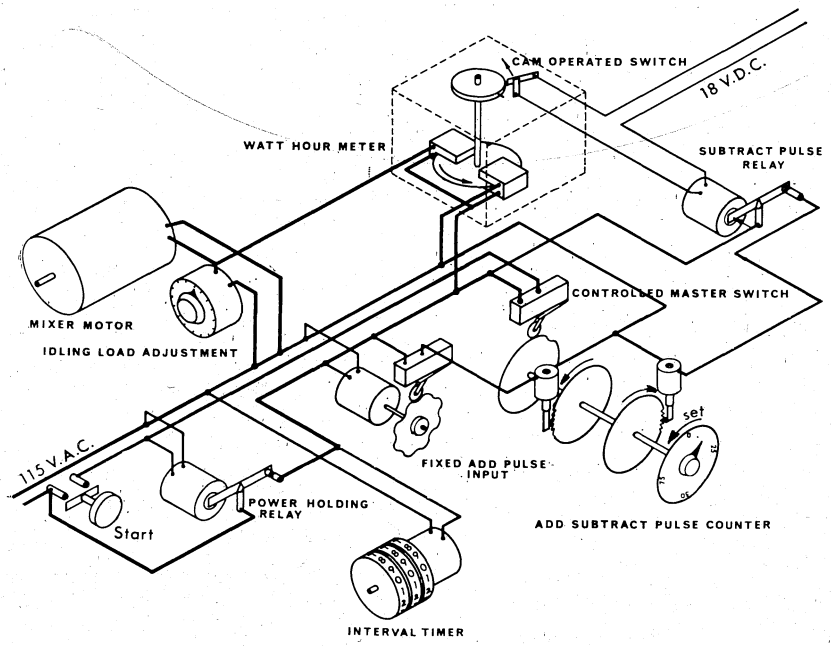

Fig. 2. Schematic diagram showing components of the power-input meter.

Figure 2 is a schematic diagram showing the principal components and an outline of the wiring of the input meter. The add-subtract pulse counter is from the HZ200 series manufactured by the Eagle Signal Company. The add-and-subtract pulses may occur in any order and may be simultaneous without miscounting. The impulse counter dial is rotated *counterclockwise* at a fixed rate, e.g., 24 divisions per min. by electrical impulses from a switch actuated by a 24-lobe cam on a 1-r.p.m. synchronous clock motor.

The wattmeter is a Sangamo type S-3 (0.333 watt-hour) adjusted to make one revolution per 0.25 watt-hours. It was further modified by removing the dials and gear train and by installing a small cam on the rotor shaft. A single lobe on the cam actuates a gold leaf switch in a low voltage circuit. Each electrical interruption in the low-voltage circuit rotates the impulse counter dial one division *clockwise*, and rep-

resents one revolution of the watt-hour meter or 0.25 watt-hours. The rate at which the dial moves clockwise depends therefore on the power passing through the watt-hour meter.

The idling load adjustment is a Powerstat Variable Transformer, 21 series, single phase, 120-volt 60-cycle, with a maximum output of 3.5 amps. (The input to the Powerstat is in parallel with the mixer; the output is connected to a 100-ohm, 200-watt power resistor.) This provides a useful working range for the meter of 125 watts. Over and above the power to operate an empty dough mixer, additional power is drawn through the wattmeter and dissipated as heat by means of the idling load adjustment, which is set so that the total load moves the counter dial 24 divisions per min. clockwise. The add-subtract pulses are then of equal frequency and the dial remains stationary with the mixer running empty. Additional power required to mix a dough results in the impulse counter being rotated clockwise at a rate greater than 24 dial divisions per min. This additional power is totaled by the instrument.

For mixer motors which draw very low current while idling, it may be necessary to speed up the *clockwise* rotation of the impulse counter by connecting a light bulb of appropriate wattage in parallel with the motor: the lower the current drawn by the motor, the higher the wattage of the bulb. The light bulb is then in effect a coarse adjustment, and the Powerstat a fine adjustment, for achieving the necessary stationary position of the impulse counter dial with the mixer running empty.

The power supply for the meter is a Sola Constant Voltage Transformer, 2,000 volt amps, for 115-volt operation. This is used primarily to stabilize operating conditions so that a recorder *can* be used in conjunction with the meter to record the power input to doughs during the mixing. It should be emphasized that while it is a simple matter to use a recorder with the meter, this is by no means a necessity. The meter itself was assembled at a cost of about $450 to $500. Any suitable recorder costs severalfold this amount.

The unit is versatile; it is readily adaptable to various mixers with different power requirements. It has been used to measure the power input to doughs mixed in a Hobart C-10 mixer (1/8-h.p. motor) using both McDuffee and Swanson bowls, the GRL mixer (1/4-h.p. motor) (1), the Chopin Alveograph mixer (1/3-h.p. motor), and the farinograph (1/3-h.p. motor), using both a 50-g. and a 300-g. mixer. Mixers with even somewhat larger motors could be accommodated simply by substituting a cam with more than 24 lobes on the 1-r.p.m. clock motor.

The unit can be used to shut off a mixer automatically when a predetermined amount of energy has been imparted to a dough; or it can simply total up power consumption during mixing. The interval timer in the control circuit registers the time in seconds that the mixer operates, and this information may be used to compute the power input rate.

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May 7, 1965

Literature Cited

1. HLYNKA, I., and ANDERSON, J. A. Laboratory dough mixer with an air-tight bowl. Cereal Chem. **32**: 83–87 (1955).