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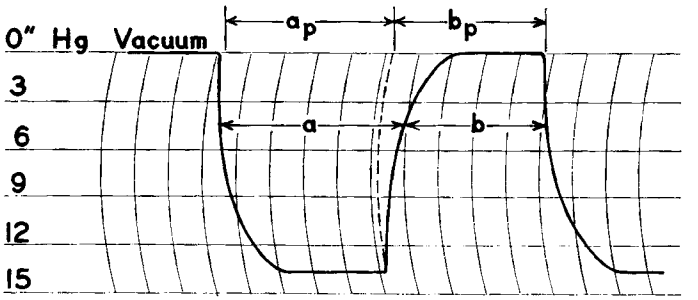

Typical recording chart showing pulsated vacuum reference points.

Testing accuracy of VACUUM RECORDING INSTRUMENTS FOR MILKING SYSTEMS

VACUUM RECORDINGS made at cow-side during milking are highly effective in detecting milking system inadequacies and malfunctions. This widely used technique is an outgrowth of research at University of California School of Veterinary Medicine, Davis, as early as 1957. Researchers Schalm and Noorlander conducted their investigations by recording vacuum levels with a strain gage amplifier. This electronic instrument is extremely sensitive and its measurements are accepted as the standard for accuracy. However, for use in the milking barn this equipment has several disadvantages—it is costly, complex, and fragile—and consequently, is seldom available.

By 1960 several relatively inexpensive, purely mechanical devices were produced commercially for the purpose of measuring and recording vacuum in milking systems. These were quite useful in picking out gross deficiencies, but were somewhat lacking in reliability for making certain critical evaluations. Successive improvements were made, and the capability of one instrument was greatly increased with the introduction of a dual recording feature. This development made it possible to record the pulsated vacuum and the milking vacuum simultaneously, and thereby observe the timing and magnitude of these two interacting forces which control the milking process.

To determine the degree of accuracy of this dual recorder, a series of simple, comparative tests were performed with a Detco dual vacuum recorder and a Sanborn strain gage amplifier. All tests were made by operating both instruments simultaneously while they were attached to a common source of vacuum, and with their sensing elements equidistant from the vacuum source.

First, it was determined that both instruments produced perfectly linear movement of the stylus as the vacuum level was progressively increased from 0 to 12 inches of mercury in 3-inch increments. Each vacuum level was accurately set with an adjusting valve, and by reference to a mercury column.

The table shows the measurements made from pulsated vacuum recordings produced by three distinctly different types of pulsator action. The chart illustrates the reference points used in making measurements on the graphs. Ratios are expressed as *vacuum creation phase* to *air admission phase*, and are extended to percentage figures. In all cases the two instruments were in perfect agreement in measuring the pulsator ratio a_p:b_p. At the higher vacuum levels the Detco recorder had greater fidelity in graphing a "snappy" pulsated vacuum than in graphing other types (presumably because of a slight drag in the stylus system).

Pulsator #2 produced the snappiest action (see table). When deviations occurred they were consistently in the same direction. The significance of the deviations should be viewed with respect to the units of measurements used. For example, in one of the comparisons, a full pulsation cycle was graphed on 29 mm of the strain gage amplifier's roll chart. A 50:50 ratio would have to be read as 14.5:14.5 mm, but it is difficult to read fractions of millimeters. If the operator read whole numbers he would read either 14:15, or 15:14. Extended to percentages these ratios would become either 48:52, or 52:48. In this sense, the differences between instruments which are reported in the table are within the scope of a normal measuring error. The opportunity for this type of error is minimized with the Detco recorder because its roll chart speed is nearly twice that of the strain gage amplifier.

In another test the two instruments were compared in their responsiveness to rapid changes of vacuum, such as may occur in the milking vacuum during milking. A common vacuum source was made to oscillate through a range of 5 inches of mercury at a frequency of up to 5 cycles per second. The responses were judged to be identical in character. However, when vacuum flutters were on the order of ½ inch to 1 inch of mercury, the strain gage amplifier tracings were noticeably sharper. This difference is not significant with reference to milking system evaluation.

In summary, these tests indicate that mechanical vacuum recorders of the type tested are sufficiently reliable for measuring and recording vacuum in milking systems.

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MILKING MACHINE VACUUM MEASUREMENTS OF PULSATOR RATIOS

	Strain gage amplifier	Detco dual vacuum recorded
Pulsator #1		
a_p:b_p	51:49	51:49
a_3:b_3	58:42	59:41
a_6:b_6	52:48	53:47
a_9:b_9	45:55	47:53
a_{12}:b_{12}	36:64	38:62
Pulsator #2		
a_p:b_p	48:52	48:52
a_3:b_3	54:46	54:46
a_6:b_6	48:52	48:52
a_9:b_9	45:55	46:54
a_{12}:b_{12}	39:61	40:60
Pulsator #3		
a_p:b_p	55:45	55:45
a_3:b_3	66:34	66:34
a_6:b_6	59:41	60:40
a_9:b_9	53:47	55:45
a_{12}:b_{12}	47:53	49:51