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DESCRIPTION OF APPARATUS FOR DIAPHRAGM PRESSURE MEASUREMENTS

Project 1108-26S

Preliminary Report Five

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

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INTRODUCTION

Previous reports to the Technical Committee have discussed the effect of diaphragm pressure on bursting strength results (1), (2), (3), (4). In reference 3 the results indicated that present diaphragm specifications of 23 to 30 p.s.i. g. at 3/8-inch distention permit about a 2-p.s.i. g. difference in bursting strength of kraft linerboard.

Past experience leads many to question how well new diaphragms meet the above specifications. Therefore, arrangements have been made with B. F. Perkins and Son, Inc. to co-operatively determine the variance in diaphragm characteristics of present commercially manufactured diaphragms. Because various methods of measuring diaphragm pressure may yield differing results, the Institute has constructed a simple apparatus to facilitate accurate and reproducible measurements of diaphragm pressure by the Institute, manufacturer, and other users of diaphragms.

This present report discusses the diaphragm pressure measurement apparatus together with initial results obtained in checking its performance. It is now planned to co-operate with B. F. Perkins in evaluating a substantial number of diaphragms from their next large order to the manufacturer.

DESCRIPTION OF APPARATUS

The apparatus is designed so to be readily installed on a Jumbo Mullen tester having physical characteristics similar to those at the Institute. The components of the apparatus as shown in Fig. 1 are: (1) an intermittent duty 110v. ac solenoid (Guardian--14AC) mounted on the gear box and mechanically linked from the core to the pumping lever. It is positioned to allow complete freedom of the pumping lever from the solenoid when the latter is not in use; (2) a type Z microswitch attached to the rear of the solenoid and used to break the solenoid circuit when the core has completed its travel. The core was modified by drilling a hole in the back end and a corresponding hole in the rear of the solenoid housing. A nylon pin was inserted in the inner end of the core and adjusted for length so as to just depress the microswitch which was mounted against the other side housing in line with the hole; (3) a sensing head for determining the diaphragm height at which the pumping action is stopped. This head consists of an annular aluminum housing which supports modified microswitch. (Modification consisted of dissembling a BZ--2RD switch and weakening the copper spring used to open and close the contacts. A hole was drilled and tapped in the plunger pin to accomodate a small flat-headed 6-32 machine screw and lock nut.) These modifications provided low switch pressure and a means of diaphragm height adjustment; (4) a relay system to help avoid the possibility of an electrical shock when handling the sensing head. The operation of the apparatus is described as follows: Plug in the relay to a source of 110 v. ac. Connect the solenoid mounted on the gear box to the load output of the relay and connect the sensing head to the low voltage connection. Depress the switch

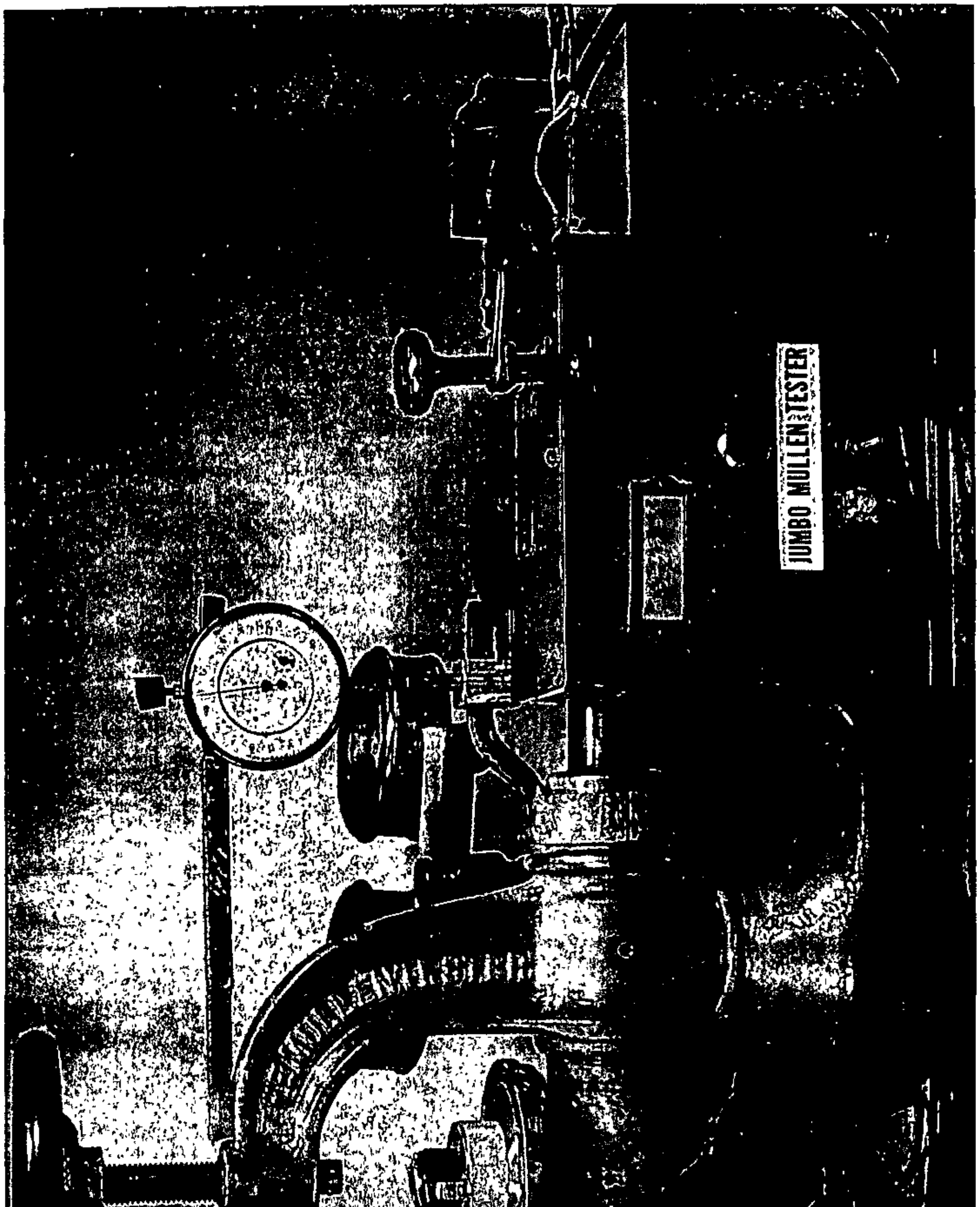

Figure 1. Diaphragm Distention Pressure Apparatus

in the sensing head to check out the circuit. If the solenoid retracts, the circuit is in operating condition. Place the sensing head over the diaphragm and push the pumping lever to the forward position. The diaphragm, when extended, will contact the switch and will result in the pumping lever being retracted to neutral. Immediately check the diaphragm height with some suitable means and, if necessary, adjust the switch adjusting screw in the sensing head to give the proper distention.

A 60-lb. maximum indicating gage was used to indicate diaphragm pressure.

TRIAL OF APPARATUS

In general, in designing the apparatus it was felt that two requirements should be met. They were

1. The distention at which the diaphragm pressure is read should be controlled within close limits.

2. A 60-p.s.i. g. pressure gage with 0.5 p.s.i. g. graduations should be used to permit more accurate pressure readings.

With regard to the first requirement, it was felt that means for stopping the pumping action at the desired distention would provide the necessary reproducibility. To check this feature of the apparatus, a number of diaphragms were inserted in the bursting strength tester. They were distended ten times to 1.8 cm. to "stabilize" the pressure and, then, five consecutive diaphragm pressure measurements at 3/8-inch were made. A cathetometer was used to measure diaphragm height on each distention to 3/8 inch. Three diaphragms of each of the following types were evaluated. They were

a. current commercial (type 305B)

b. Sirvene 409241 (type 305B)

The results obtained are summarized in Table I. Referring to the table it may be noted that:

1. Within each set of five measurements for a given diaphragm, the distentions as measured by the cathetometer were reasonably uniform. The average range values of 0.009 inch and 0.012 inch indicate a standard deviation of approximately 0.004 to 0.005 inch.

TABLE I

VARIABILITY IN DIAPHRAGM PRESSURE AND DISTENTION USING DIAPHRAGM PRESSURE APPARATUS

Diaphragm No.	Diaphragm Pressure, p.s.i. g. Average (n=5)	Range	Distention, inches Average	Range
	Current Commercial Diaphragms			
1	31.5	0.4	0.374	0.007
2	20.9	0.3	0.383	0.007
3	25.4	1.2	0.381	0.012
Average	25.9	0.6	0.379	0.009
	Sirvene 409241 Diaphragms			
4	48.2	2.0	0.392	0.005
5	46.6	4.6	0.392	0.023
6	50.0	2.5	0.392	0.008
Average	48.3	3.0	0.392	0.012

Note: When distention was stopped, the diaphragm pressure for the current commercial diaphragm held relatively constant--rarely dropping more than 1 p.s.i. g. In contrast, the diaphragm pressure for the Sirvene 409241 diaphragms decreased substantially--up to 15 p.s.i. g.--implying that creep occurred after halting the distention. The decrease occurred rapidly and distention measurements could not be taken before the pressure drop occurred. Thus, the measured distentions include any creep occurring and, in the case of the Sirvene 409241, diaphragms are slightly greater than the actual distention when pumping was halted.

2. The average distention from diaphragm-to-diaphragm was reasonably uniform--constant for the Sirvene 409241 diaphragms and only varying from 0.374 to 0.383 for the current commercial diaphragms.

3. While some difference in average distention appeared to exist between diaphragm types, it was felt that creep taking place in the interval of time between stopping the diaphragm and taking the height reading was responsible. That creep took place was evident in the swift decrease in pressure after halting the pump for the Sirvene diaphragms.

4. Based on the average range of 0.6 p.s.i. g. for the current commercial diaphragms, two standard error limits for the average pressure would be near 0.25 p.s.i. g. The sirvene 409241 diaphragms exhibited greater variability and the corresponding two standard error limits are greater--near 1.2 p.s.i. g. for averages of five measurements. The pressure measurements, therefore, appear sufficiently reproducible.

5. As a matter of interest, only one of the current commercial diaphragms met present pressure specifications. The experimental diaphragms (Sirvene 409241) were all above specifications as would be expected from previous work.

To supplement the above three diaphragms of each type were evaluated for diaphragm pressure and distention after

a. 10 distentions to 1.8 cm.

b. 30 distentions to 1.8 cm.

c. 20 combined board tests.

Five pressure and distention measurements were obtained at each condition. The only change in procedure consisted of a slight adjustment in microswitch height for the Sirvene 409241 diaphragms in order that the measured distentions would more closely approach 0.375 inch.

The results obtained are summarized in Table II. In the table it may be noted that reproducibility in diaphragm distention was not affected by the working of the diaphragm. Diaphragm pressure variability was slightly higher after completion of the 20 combined board tests; however, additional data would be required to confirm the trend.

TABLE II

COMPARISON OF DIAPHRAGM PRESSURE AND DISTENTION AFTER VARIOUS TREATMENTS

Test Condition	Current Commercial Diaphragms 1	2	3	Av.	Sirvene 409241 Diaphragms 1	2	3	Av.
After 10 distentions to 1.8 cm.								
Pressure, p.s.i. g.								
Average	31.5	20.9	25.4	25.9	50.8	44.2	46.7	47.2
Range	0.4	0.3	1.2	0.6	4.9	2.4	1.0	2.8
Distention, inches								
Average	0.374	0.383	0.381	0.379	0.371	0.382	0.381	0.378
Range	0.007	0.007	0.012	0.009	0.003	0.000	0.007	0.003
After 30 distentions to 1.8 cm.								
Pressure, p.s.i. g.								
Average	31.6	20.2	25.4	25.7	50.7	42.6	46.3	46.5
Range	0.5	0.7	1.0	0.7	2.2	1.8	2.5	2.2
Distention, inches								
Average	0.377	0.383	0.378	0.379	0.373	0.380	0.382	0.378
Range	0.002	0.013	0.017	0.011	0.001	0.008	0.003	0.004
After 20 combined board tests								
Pressure, p.s.i. g.								
Average	33.3	20.2	26.0	26.5	50.3	44.4	47.4	47.4
Range	1.9	1.3	0.8	1.3	2.1	3.4	4.8	3.4
Distention, inches								
Average	0.379	0.384	0.382	0.382	0.373	0.381	0.384	0.379
Range	0.006	0.004	0.004	0.005	0.000	0.005	0.010	0.005

LITERATURE CITED

1. An investigation of diaphragm characteristics. Part I. Comparison of diaphragm types 305A and 305B in a simulated life test and an exploratory investigation of diaphragm contribution. Project 1108-26S Preliminary Report One to the Fourdrinier Kraft Board Institute, Inc., September 21, 1960.

2. An investigation of diaphragm characteristics. Part II. Comparison of diaphragm types 305A and 305B in a simulated life test using combined board and additional exploration of means of measuring diaphragm contribution. Project 1108-26S Preliminary Report Two to the Fourdrinier Kraft Board Institute, Inc., November 29, 1960.

3. Effect of diaphragm pressure on bursting strength. Preliminary Report Three to the Fourdrinier Kraft Board Institute, Inc., June 6, 1961.

4. Comparison of ribbed style and Sirvene 409241 diaphragms with current commercial diaphragms. Project 1108-26S Preliminary Report Four to the Fourdrinier Kraft Board Institute, Inc., October 10, 1961.