REPORT ON SEPARATORS.

HENRY C. WALLACE.

This Station is in receipt of numerous inquiries asking concerning the relative merits of the different separators in use in the Dairy building. For the purpose of answering such inquiries the data which appears in this report is submitted. It is our practice to require each dairy student to each day make a report on his work, these reports being tabulated and filed for reference. The report on the separators covers all of the conditions affecting separation, the temperature of the milk, speed of the machine, amount of fat left in the skim milk, fat in the cream, etc. The table which follows is compiled from the reports made by students during the six months ending June 10, 1894. In compiling the table all reports in which the conditions affecting separation were unusual were thrown out; as, for example, when the temperature of the milk was too low or when the speed of the separator was below that recommended by the manufacturers. An exception to this was made in the case of the Danish-Weston machine. It will be observed that the average speed of this machine is less than is recommended, but we have had more or less difficulty in keeping it up to its full speed and consequently included some trials when the speed was lower. There was nothing prejudicial to the Danish-Weston in this, however, as our records show that there was no more fat lost in the skim milk when running at 5,000 revolutions per minute than when running at 5,500.

The four machines mentioned in the table have been in regular use in the Dairy building. The "Alpha" is manufactured by the DeLaval Separator Company, New York City; the "Danish-Weston" is manufactured by A. H. Reid, Philadel-

phia, Pa.; the "Russian" by P. M. Sharples, West Chester, Pa. and Elgin, Illinois; the "Jumbo" by Davis & Rankin, Chicago, Ill.

The following table shows the number of trials made with each machine, the temperature of the milk when separated, the average speed of the separator, the average per cent of fat in the cream, and the average per cent of fat in the skim milk:

NAME.	No. trials.	Temperature of milk.	Speed.	Per cent fat in cream.	Per cent fat in skim milk.
"Alpha"	61	82.6	5,683	31	.06
"Danish-Weston"	52	82	5,340	25.58	.07
"Jumbo"	22	84	7,458	22	.22
"Russian"	54	83.4	7,461	27.5	.08

The table is self-explanatory. The skim milk and cream were tested by the Babcock method. It will be seen that there is very little difference in the amount of fat lost in the skim milk by the "Alpha," "Danish-Weston," and "Russian" machines; none of them averaging as much as one-tenth of one per cent. It should be remembered that the tests were made by dairy students during the course of their instruction, and consequently do not represent the best work that can be done with these machines, although perhaps fairly representing the work done in the average creamery. In the hands of a skilled operator either of the three machines above mentioned can be made to skim so close that no appreciable amount of fat can be detected in the skim milk by the Babcock method. We have not been able to do as good work with the "Jumbo" as with the three other machines mentioned. Attention is called to the fact that these tests extend through the season when milk separates with the greatest difficulty.

With a view to ascertaining the power required to run these different separators we requested Professor G. W. Bissell, the head of the Department of Mechanical Engineering, to make

the necessary tests. The following is his report. Not being familiar with the different machines Professor Bissell used letters to designate them. The letter A represents the "Alpha"; B, the "Danish-Weston"; C, the "Jumbo", and D, the "Russian."

AMES, IOWA, June 16, 1894.

DEAR SIR—I submit herewith a report of tests to determine the power consumed in the separation of cream:

Four separators were tested, the same being located in the creamery of the Iowa Agricultural College. They are arranged in a row north and south, and are designated in this report as "A," "B," "C," and "D" respectively, beginning at the south end of the row. All are centrifugal separators, and are in daily service educationally and commercially. Separators A, B, and C are belt driven, and separator D is driven by steam directly, the separator bowl being the rotating element of a steam turbine.

The power used in driving A, B and C was determined by the use of the steam engine indicator as follows: All the belts except the main driving belts were thrown off and hung or held up so as to clear the shafting. Ten sets of indicator cards, together with the speed of the engine and the pressure of the boiler were then taken. From these was determined the power necessary to run the engine and the line shafting. Separator A was then belted up, all other belts being hung or held up, and after waiting fifteen minutes for the separator to assume its normal speed and load, ten sets of indicator cards were taken. From these was determined the power required to run the engine and the line shafting in addition to separator A and its intermediate, and the power required for the separator and its intermediate was obtained by substraction.

In the tests of separators A, B and C, the intermediate was considered a part of the machine.

In like manner separators B and C were belted up and cards taken for each separately. Then all belts were thrown off as when the first set of cards were taken, and five sets were taken with the engine and line shaft only in motion.

All bearings and boxes had been thoroughly oiled the day

before, and the separators were worked under loads, which as far as possible, previous tests had shown to give the highest efficiency of separation.

For separators A, B and C, the output of the machine for exactly one minute was caught and weighed, and the hourly output calculated therefrom.

The data and results are as follows:

DATE, March 16, 1894.

Type of engine, slide valve throttling, built by Erie Engine Works. Diameter of cylinder, $9\frac{1}{32}$ inches; length of stroke 12 inches; diameter of piston rod, $1\frac{7}{16}$ inches; horse power for engine and shafting 1.821

Separator A, 5,500 revolutions per minute, 1,900 pounds of milk per hour (measured).

Horse-power required for Separator A, plus engine and shafting (10 observations)	2.010
Horse-power for the engine and shafting only	1.321
Horse-power for Separator A and intermediate	0.689
Horse-power for Separator A, per 1,000 pounds milk per hour	0.362

Separator B, 4,875 revolutions per minute, 3,210 pounds of milk per hour (measured).

Horse-power required for Separator B, plus engine and shafting (10 observations)	3.227
Horse-power for engine and shafting only	1.321
Horse-power for Separator B and intermediate	1.906
Horse-power for Separator B per 1,000 pounds of milk per hour	0.583

Separator C, 7,675 revolutions per minute, 1,500 pounds of milk per hour (weighed).

Horse-power for Separator C, plus engine and shafting (10 observations	2.898
Horse-power for engine and shafting only	1.321
Horse-power for Separator C and intermediate	1.577
Horse-power for Separator C per 1000 pounds milk per hour	1.051

The power used by Separator D was found by measuring the amount of steam consumed in running it. An attempt was first made to measure the steam consumption of the separator by condensing the exhaust steam from it. Owing to leakages of steam about the machine itself, produced by the

lack of free exhaust occasioned by the improvised condensing apparatus, much of the steam did not pass through the exhaust pipe, and the method was a failure.

It was then determined to calibrate the flow of steam through the reducing valve which controls the admission of steam to the machine. For this purpose the valve was taken to the laboratory of the Department of Mechanical Engineering, where, after being fitted with a graduated arc, over which the free end of the lever of the valve could sweep, and upon which the position of the lever could be noted, it was attached to a steam pipe of suitable size, in which was placed a standard steam gauge. The back pressure upon the valve, which, when it is in operation on the machine, is produced by the revolving bowl, was here produced by a common globe valve, to which was attached a hose through which the steam was led to a tank of cold water of known weight, placed on platform scales, where it was condensed and weighed. The initial pressure was maintained at 80 pounds, as per the standard gauge. The opening of the back pressure valve was varied and four runs made with the same fixed, to give four different positions of the lever on the arc. In each of these runs the time required to condense the weighed amount of condensed steam was noted. The weight on the lever of the reducing valve had been set by the creamery people for a back pressure of 40 pounds. Its position was not changed for the calibration.

The results of the calibration are as follows:

No. of Run	Arc Reading	Flow of Steam—Lbs. per Hr.
1	$2\frac{8}{8}$ inches	45.26
2	$2\frac{1}{3}$ inches	117.46
3	$1\frac{15}{16}$ inches	150.56
4	$1\frac{3}{4}$ inches	201.14

These results were plotted on cross section paper to show that the flow of steam through the reducing valve inversely proportional to the arc reading, initial pressure being 80 pounds and back pressure 40 pounds.

After the calibration was made the valve was replaced on the machine with the standard steam gauge to indicate the initial

pressure. The separator was then run as usual with the desired load, and observations of the position of the lever were taken at intervals of one minute for fifteen minutes. The initial pressure was maintained at 80 pounds. The average of the arc readings was then referred to the calibration curve and the flow of steam calculated therefrom.

DATE, March 30, 1894.

Separator D. 7,600 revolutions per minute, 2,055 pounds milk per hour (measured).

Average arc reading—inches	2.056
Corresponding value of pounds of steam used per hour	129.5
Pounds of steam per 1,000 pounds of milk used per hour	63.0

An attempt was made to determine the amount of steam or feed-water used by the engine per horse-power hour, with a view to securing a basis of comparison between the belted and the steam separators, Owing to the fact that the engine in use is much too large for its present duty, and to the fact that the water rate of engines increases rapidly as they are underloaded, the results obtained were (supposing then correct) so high as to justify the writer in not using them in the comparison. Moreover, the correctness of the results is open to question on account of unmeasured and unknown leakages about the boiler.

TESTS OF CHURNS AND BUTTER-WORKERS.

The churns will be designated as A and B, and the workers as A and B.

Churn A was a box churn of 300 callons capacity. Churn B was a combined churn and butter-worker of same capacity; either function being discharged at the will of the operator (This was the Disbrow combined churn and worker, manufactured by E. T. Winship, Owatoma, Minn.).

Worker A was an improved Fargo worker. Worker B was the combined churn and worker referred to above.

All of the above machines were driven by belts from the line shaft.

The method of conducting the test was the same as employed in testing the belted separator, except that the loose pulleys were running when the cards were taken for the line shafting.

DATA AND RESULTS.

Horse-power to drive shafting	1.585
Churn A, 55 gallons cream—to butter in twelve minutes:	
Horse-power, churn A, plus shafting	2.908
Subtracting 1.585, we have	1.323
as the horse-power required to churn 55 gallons, or horse-power to churn 100 gallons	2.405
Churn B, 55 gallons cream to butter in twelve minutes:	
Horse-power for churn and shafting was	2.89
Subtracting	1.585
Horse-power to churn 55 gallons in churn B	1.305
Or horse-power to churn 100 gallons in churn B	2.372
Worker A, 143 pounds butter worked in five minutes:	
Horse-power required	0.396
Or per 100 pounds butter in worker A	0.276
Worker B, 128 pounds of butter worked in four minutes:	
Horse-power required	0.330
Or per 100 pounds butter in worker B	0.260
Horse-power to churn 100 pounds cream in 300 gallon box churn, and work the resulting butter on Fargo drum worker	2.681
Horse-power required to churn 100 pounds cream in Disbrow and work resulting butter in same	2.632

Respectfully submitted,

G. W. BISSELL.