A TEST OF HAND SEPARATORS.

BY

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Within recent years there has been invented a machine which has revolutionized the dairy business. This machine is the hand centrifugal separator. The first machines were comparatively simple affairs, the essential feature of which was a cylindrical bowl, which by means of a suitable mechanism was given a rotary motion with great speed. The milk was fed into the top of the bowl and came out at openings made for the purpose. This simple machine had a great advantage over the old system of gravity setting. It was but a short time however after the original machine was invented, until others went to work to make improvements, which resulted in several new and better machines.

To-day we have six different machines which are sold quite largely in the west and there is intense rivalry among the manufacturers. The manufacturers of these machines advertise extensively and each manufacturer claims to have the machine which will skim the closest, run the easiest, and last the longest.

All of this is very confusing to the prospective purchasers many of whom have never run a separator and have no basis on which to form an opinion of the merits of a machine.

In order to in some measure overcome these difficulties an experiment was undertaken to test the respective merits of six of the machines in most common use, namely: DeLaval, Sharpless, Empire, Iowa Dairy, National, and United States. While this test is in many ways not all that could be wished for it is hoped that it may at least be a help to any one wishing to select a separator. It is incomplete in that it was made with but one machine of each kind and that it was not continued as long as could be desired. However we have made tests under some of the more common adverse conditions likely to be en-

countered on the farm or dairy. It is hoped also that the care and accuracy with which it has been conducted may in some small degree compensate for the incompleteness which characterizes some of its pa parts.

The first series of tests were made under normal conditions. The machines were run at the proper speed and the milk was at the proper temperature. Each machine was run five times and the length of run was ten minutes. The machine was started and the milk was turned on when the required speed was reached. When the flow of skim-milk and cream had reached the maximum, vessels were placed under the respective spouts to receive it and at the same instant the time was noted. The receiving can was kept full and an endeavor was made to keep the speed as near uniform as possible. The temperature of the milk was taken once each run and recorded. The temperature of the cream and skim-milk was also taken and recorded as they left their respective spouts. At the instant the ten minutes were up other vessels were placed under the spouts and the ones for the tests removed. The seed was kept up and when all of the milk was out of the receiving can skim-milk was puored in and allowed to run through for the purpose of flushing out what cream might adhere to the inside mechanism of the bowl. No account of the amount of skim-milk so used was taken because it was found that owing to the difference in viscosety of the cream that it might take much more at one time than another.

Skim-milk was poured in until no more cream came out or until apparently only skim-milk would come from the cream spout. The machine was then stopped and what remained in it was removed, this was afterwards added to the water used to rinse the bowl. This constituted the bowl washings. It was carefully weighed and recorded.

A sample was then taken to test for butter fat. The skim-milk and cream were similarly carefully weighed and sampled. The weights of the cream and skimmilk were combined and from this data the capacity of the machine per hour was calculated.

Here it may not be out of place to note the precautions which were taken in order to secure accurate tests of the milk, cream, skim-milk, and bowl wash. The whole milk bottles were calibrated by the water method using a burette. The cream bottles were also calibrated with water but in this case instead of using a burette the water was weighed out and a delicate analytical balance was made. No bottle was retained which showed an error of more than one-tenth of one per cent. The skim-milk bottles were not calibrated but were found to be of the same degree of accuracy by testing milk from the same sample with all the bottles. The results of the first series of tests are given in the following tables.

DELAVAL"ALPHA"BABY NO. I.

Trial No.	Temperature of Milk	Cream	Skim Milk	Weight Milk lbs.	Oz.	Cream lbs.	oz.	Skim-milk lbs.	oz.	Bowl Wash lbs.	oz.
1	90	84	88	79	4	8	12	70	8	15	4
2	93	88	92	77	15	7	5	70	10	16	8
3	90	87	89	79	14	8	6	71	7	15	6
4	90	84	88	76	6	8	6	68	0	14	7
5	88	85	87	77	6	8	6	69	0	9	6

(DeLaval Table Continued pp 3)

Capacity per hour lbs. oz.	Babcock Test per cent. Milk	Cream	Skim Milk	Bowl Wash.	Loss in pounds. Skim-milk	Bowl Wash	Total
476	3.8	34.2	.04	.05	.0283	.0077	.0360
468	4.	39.4	.033	.125	.0233	.0206	.0439
480	4.	38.7	.05	.01	.0357	.0015	.0372
457	4.2	41.6	.045	.02	.0306	.0029	.0335
464	4.4	39.2	.06	.015	.0414	.0143	.0557

The capacity of the DeLaval Baby No 1 as given in the catalogues is 450 pounds per hour, which the manufacturers further state, "Is equal to 600 pounds claimed capacity in any other make of separator." The table shows that it ran over its rated capacity in every trial. The tables which follow will show with what justice the second claim is made. Other points will be discussed in detail later.

SHARPLESS TUBULAR NO. 4.

Trial No.	Temperature Milk	Cream	Skim Milk	Milk lbs.	oz.	Cream lbs.	oz.	Skim-milk lbs.	oz.	Bowl-Wash lbs.	oz.
1	90	88	89	86	6	15	6	71		18	12
2	92	88	90	85	13	9	6	76	7	17	7
3	90	86	88	94	6	9	6	85		13	15
4	90	86	88	86	12	11	4	75	8	15	15
5	91	88	90	86	14	9	6	77	8	15	15

(Sharples Tubular Table Continued pp 4)

Capacity per hour	Babcock test per cent. Milk	Cream	Skim Milk	Bowl Wash	Loss in pounds. Skim-milk	Bowl Wash	Total
508	3.8	20.6	.04	.1	.0284	.0188	.0472
515	4.	34.6 *	.05	.05	.0382	.0087	.0469
514	4.2	39.2	.04	.125	.034	.0175	.0515
520	4.35	32	.049	.07	.037	.0112	.0482
521	4.5	32.4	.037	.12	.0287	.0192	.0479

* Cream screw shanged to make richer cream.

Tha capacity of the Sharples Tubular No. 4 is also rated at 450 pounds per hour; but it exceeded its rated capacity even more than the DeLaval. Both the Sharples and the DeLaval run very easy and did not give any trouble and get out of order during the tests. In the second run with the Sharples the cream screw was changed to give a richer cream.

EMPIRE NO. 2.

Trial No.	Temperature Milk	Cream	Skim Milk	Milk lbs.	Oz.	Cream lbs	oz.	Skim-milk lbs.	oz.	Bowl Wash Lbs.	Oz.
1	88	86	87	74	12	9	4	65	8	15	8
2	89	86	88	75	12	8	12	67	0	15	6
3	90	86	90	72	7	8	2	64	5	15	11
4	91	88	90	67	7	8	4	59	5	17	7
5	90	86	90	70	5	9	5	61	0	20	7

(Table of Empire No. 2 Continued)

Capacity per hour	Babcock Test per cent Milk	Cream	Skim Milk	Bowl Wash	Loss in pounds. Skim-milk	Bowl Wash	Total
448	4.	30.6	.03	.4	.0197	.0620	.0817
454	4.35	35.2	.059	.37	.0395	.0574	.0969
434	4.	34.15	.03	.3	.0193	.0473	.0666
406	4.2	35.2	.035	.3	.0198	.054	.0739
422	3.2	32.8	.045	.4	.0275	.082	.1095

The Empire No. 2 is rated with a capacity of 450 pounds per hour and the table shows it fell below it in but one instance. It gave no trouble except in one instance when the oil tubes becamee clogged.

IOWA DAIRY.

Trial No.	Temperature Milk	Cream	Skim Milk	Weight Milk lbs.	Oz.	Cream lbs.	oz.	Skim-milk lbs.	oz.	Bowl Wash lbs.	oz.
1	89	84	88	75	4	7	4	68		12	8
2	90	84	89	77	7	7	7	70		15	15
3	90	89	90	80	5	10	5	70		14	9
4	90	85	89	73	5	7	5	66		16	1
5	90	84	88	76	13	10	5	66	8	9	4

(Table of Iowa Dairy Continued.)

Capacity Per Hour	Babcock Test Per cent. Milk	Cream	Skim milk	Bowl Wash	Loss in pounds. Skim-milk	Bowl Wash	Total
451	4.	38.4	.03	.36	.0204	.0450	.0654
463	4.1	38.8	.045	.37	.0315	.0592	.0907
482	4.2	33.8	.0675	.215	.0473	.0317	.0786
450	3.2	39.2	.05	.2	.0330	.0320	.0650
461	4.15	32.8	.08	.3	.0532	.0278	.0810

The Iowa Dairy separator is also rated with a capacity of 450 pounds per hour. It will be seen in the foregoing table that it never fell below its rated capacity and ran over it in all but one trial. This machine is so constructed that the elevation of the receiving can would change the capacity. This would probably often occur in the hands of a farmer. The machine was found to be hard to turn and also gave trouble in other ways.

NATIONAL NO. 6.

Trial No.	Temperature Milk	Cream	Skim Milk	Milk lbs.	oz.	Cream lbs.	oz	Skim-milk lbs.	oz.	Bowl Wash lbs.	oz.
1	94	90	93	85	6	7	6	78	0	17	7
2	94	90	93	83	6	6	4	77	0	17	8
3	89	88	88	76	11	7	11	69	0	17	7
4	90	84	89	74	8	5	6	69	0	13	15
5	90	89	90	87	4	8	4	79	0	12	15

(Table of National No. 6 Continued.)

Capacity Per hour	Babcock Test Per cent. Milk	Cream	Skim Milk	Bowl Wash	Loss in pounds. Skim-milk	Bowl Wash	Total
512	4.	41.8	.047	.125	.0367	.0219	.0586
500	4.	50.3	.04	.3	.0308	.0525	.0831
460	4.	26.1*	.125	.065	.0863	.0114	.0977
446	4.1	49.2**	.08	.3	.0552	.042	.0972
523	4.2	45.4	.03	.15	.0237	.0195	.0422

* Cream screw changed to produce thinner cream.

** " " " " " thicker "

The National Number 6 is rated with a capacity of 500 pounds per hour. It will be seen in the table that in two trials it did not come up to 500 pounds per hour. This machine was found to be delivering cream that was too rich and in the third run the cream screw was changed to make a thinner cream. It was then found to deliver the cream too thin and was changed again for the fourth run. This accounts for the great difference in the test of the cream.

UNITED STATES NO. 6.

Trial No.	Temperature Milk	Cream	Skim Milk	Weight Milk lbs.	oz.	Cream Lbs.	oz.	Skim-Milk lbs.	oz.	Bowl Wash lbs.	oz.
1	90	84	89	69	7	5	15	63	8	13	14
2	93	88	90	72	5	8	13	63	8	14	8
3	90	85	90	74	3	8	13	65	5	13	14
4	93	86	91	70	6	8	6	62		20	7
5	90	85	89	70	14	7	9	63	5	15	6

(Table of United States No. 6 Continued pp 8)

Capacity per hour	Babcock Test Per Cent. Milk	Cream	Skim Milk	Bowl Wash	Loss in pounds. Skim-milk	Bowl Wash	Total
416	4.2	44.3	.035	.2	.0222	..0278	.0600
433	4.15	34.4	.042	.125	.0267	.0181	.0448
445	3.6	30.9	.04	.15	.0261	.0210	.0471
426	4.2	35.	.0125	.02	.0078	.0041	.0119
425	4.	36.1	.04	.05	.0254	.0077	.0332

The United States No. 6 is rated with a capacity between 400 and 450 pounds per hour and its true capacity is found to be between those limits. It was found to be a hard-running machine and otherwise gave trouble in two or three instances.

The following is a recapitulation of the foregoing tables and shows in brief the comparative efficiency of the different machines.

RECAPITULATION.

Name of Machine	Capacity	Test of Skimmilk	Test of Cream	Loss Skim-milk	Bowl Wash	Total
DeLaval	469	.0456	38.25	.03186	.00940	.04126
Sharpless	515.6	.0432	31.76	.01508	.01508	.04874
Empire	432.8	.0398	33.59	.06054	.06054	.08570
Iowa Dairy	461.4	.0544	36.60	.03914	.03914	.07614
National	488.2	.0644	42.56	.02946	.02946	.07576
United States	429.	.0339	36.14	.01574	.01574	.03980

It will be seen in the table that the Sharples stands highest in capacity. Arranged in order of greatest capacity the six machines would stand thus: Sharples, National, DeLaval, Iowa Dairy, Empire, and United States. It should be remembered that the National is rated at a capacity of 500 pounds per hour and the United States at 400 to 450. The United States is the most efficient in skimming and the National is the poorest. Arranged in the order of skimming efficiency the machines would stand as follows: United States, Empire, Sharples, DeLaval, Iowa Dairy, and National.

A study of the foregoing tables will convince one that a machine may be a very efficient skimmer and leave so much butter fat in the bowl that the amount of butter fat lost will be greater than that lost by a machine which does not skim so close. If we arrange the six machines in order of the least total loss they would rank as follows: United States, DeLaval, Sharples, National, Iowa Dairy, and Empire. However the amount of butter fat left in the bowl would be very little if any more in a longer run. The Empire which ranks second in skimming efficiency and sixth in total loss would make a better showing in a longer run.

Realizing that under farm conditions a separator may not always be turned at the proper rate of speed, we decided to make a comparative test of these machines at three-fourths of the required rate. In all other respects the conditions were normal. The results are given in the following table.

TEST OF LOW SPEED.*

Name of Machine	Temperature			Weight								
	Milk	Cream	Skim Milk	Milk lbs.	Milk oz.	Cream lbs.	Cream oz.	Skim-milk lbs.	Skim-milk oz.	Bowl lbs.	Bowl oz.	Wash
DeLaval	99	92	92	78	8	11	8	67		15	1	
	89	86	88	77	4	11	4	66		13	15	
Sharples	88	86	87	82	13	15	5	69	8	12	7	
	89	87	88	78	4	11	2	66	8	18	6	
Empire	90	88	90	71	12	7	12	64		13	6	
	88	85	87	68	5	7	5	61		18	7	
Iowa Dairy	90	87	89	71	4	11	4	60		15	15	
	90	88	90	71	12	7	12	64		13	6	
National	97	90	91	81	8	13	8	68		14	7	
	91	90	91	78	6	11	6	67		14	14	
United States	92	88	90	69	3	8	3	61		18	15	
	92	88	90	70	6	8	14	61	8	17	1	

* Cream screws readjusted at beginning of test.

(Table of Low Speed Continued pp 11)

Name of Machine	Capacity Per hour	Babcock Test Percent Milk	Cream	Skim Milk	Bowl Wash	Loss. Lbs. Skim-milk	Bowl wash	Total
						lbs. oz.	lbs. oz.	
DeLaval	470	3.8	24.6	.165	.05	.1105	.0075	.1180
	463	4.2	28.5	.19	.03	.1254	.0042	.1296
Sharples	497	4.2	24.8	.25	1	.1738	.o125	.1863
	469	3.65	24.1	.15		.0997		
Empire	410	3.7	29.8	.22	.45	.1408	.0598	.2006
	409	3.2	27	.236	.45	.1415	.0833	.2248
Iowa Dairy	427	3.7	23	.20	.19	.1200	.0303	.1504
	410	3.7	29.8	.22	.45	.1408	.0598	.2006
National	489	3.6	21.	.29	.27	.1972	.0382	.2354
	470	4.	20.3	.21	.17	.1407	.0255	.1662
United States	415	4.2	32.8	.15	.05.	.0915	.0095	.1010
	423	3.6	27.6	.13	.13	.0800	.0222	.1021

Owing to some mistake with the second trial of the Sharples, the sample of bowl wash was lost. This makes the test of that machine incomplete. It has been deemed best however to retain the figures for what they are worth.

A study of the table reveals striking differences between the results of two trials where conditions are substantially the same. in every respect. In order to bring the results more clearly to mind the following summary is given.

RECAPITULATION.

Name of Machine	Capacity	Test of Skim-milk	Test of Cream	Loss Skim-milk	Loss Bowl Wash	Loss Total
DeLaval	466.5	.175	26.50	.11795	.00585	.12380
Sharples	483	.200	24.45	.13675	.01250	.14925
Empire	409.5	.226	28.40	.14115	.07155	.21270
Iowa Dairy	418.5	.210	26.40	.13040	.04505	.17550
National	479.5	.250	20.65	.16895	.03185	.90080
U. S.	419.	.140	30.20	.08575	.01587	.10155

In these trials as in the series under normal conditions the United States Separator leads with the least loss of butter fat. The DeLaval is second in this respect and first in regard to amount of butter fat lost in the bowl wash. The United States separator left the lowest percentage of butter fat in the skim-milk The Empire which was second in skimming efficiency in the series of trials under normal conditions fell to fifth place in these trials.

A series of trials was next made with cold milk. A temperature of about 90° is regarded as the most favorable for separating milk, but as milk is handled at most farms and dairies it will often get much colder in winter. As farmers and dairymen seldom have any convenient method of warming the milk, a machine that would affect a complete separation at a temperature as low as 75° would be of great value to them. We have in this case endeavored to have the milk about that temperature.

It is much to be regretted that in this case the Empire and the United States had to be left out because the agents who had charge of them took out the bowls and left new ones in their places.

The following table will show the result of the test:

TEST WITH COLD MILK.*

Name of Machine	Temperature Milk	Cream	Skim Milk	Weight Milk lbs.	oz.	Cream lbs.	oz.	Skim-milk lbs.	oz.	Bowl Wash lbs.	oz.
DeLaval	75	73	74	77	5	6	5	71	[illegible]	14	7
	75	73	74	79	11	9	11	70	13	15	15
Sharples	76	75	75	82	14	9	14	73		14	9
	73	72	73	79	4	7	4	72		12	1
Iowa Dairy	74	73	74	71	7	8	5	63		15	1
	75	73	75	69	5	6	7	63		14	7
National	76	75	76	81	3	6	3	75		18	6
	74	73	74	84		10		74		17	1

* Cream screws adjusted to produce thinner cream at beginning of test.

(Table of Test With Cold Milk Continued)

Name of Machine	Capacity Per hour	Babcock test Percent Milk	Cream	Skim Milk	Bowl Wash	Loss lbs. Skim-milk	Bowl Wash	Total
DeLaval	464	4.5	49.2	.075	.11	.0533	.0159	.0692
	478	4.5	35.7	.055	.10	.0385	.0545	.0545
Sharples	497	3.85	31.6	.085	.05	.0621	.0073	.0694
	483	4.1	44.6	.040	.06	.0288	.0073	.0361
Iowa Dairy	428	4.0	33.2	.175	.185	.1103	.0279	.1380
	416	3.85	43.2	.075	.450	.0472	.0651	.1125
National	487	4.2	44.8	.1	.08	.0750	.0147	.0918
	504	4.5	41.	.15	.16	.1110	.0272	.0382

It will be seen that the losses are not so great in the case of cold milk as with slow speed. None of the machines clogged with the cold milk as might have been expected. The results are summarized in the following table.

RECAPITULATION.

Name of Machine	Capacity Per hour	Test of Skimmilk	Test of Cream	Loss in Pounds. Skim-milk	Bowl Wash	Total
DeLaval	469	.0650	42.45	.04590	.01595	.06165
Sharples	490	.0625	38.10	.04545	.00730	.05275
Iowa Dairy	422	.1250	38.20	.07875	.04650	.12525
National	495.5	.1250	42.90	.09300	.02095	.11500

In this case the Sharples comes out ahead in that it shows the lowest total loss of butter fat in a ten minutes run, and the lowest percent of butter fat in the skim-milk. The DeLaval is a close second in both of these respects.

A test to determine the power required to run these separators has been made by the Department of Physics of the Kansas State Agricultural College. The results of this test are given in the following table.

Name of Machine	Number	Turns of handle per min.	Revolutions of bowl per minute	Weight of bowl lbs.	Weight of bowl oz.	Length of crank in inches.
DeLaval	1	45	7065	12	10 1/4	10 1/2
Sharples	4	45	16615	6	7 3/4	13
Empire	2	55	9969	8	12	9 1/2
Iowa Dairy	0	60	10680	7	14 1/2	9 1/4
National	6	60	10200	9	8 3/4	9 1/2
United States	6	60	10200	11	6 1/2	10 3/4

(Continuation of above Table)

Name of Machine	Horse Power no load	Pounds pull on crank no load	Horse Power full load	Pounds pull on crank full load.
DeLaval	.08	10.67	.10	13.33
Sharples	.06	6.46	.10	10.77
Empire	.09	10.85	.11	13.26
Iowa Dairy	.13	14.79	.15	17.03
National	.12	13.30	.13	14.41
United States	.18	17.56	.19	18.56

The table shows that the DeLaval and Sharples both require the same power when they have a full load, and this is less than that required by any other machine. The Sharples having a longer crank requires less force exerted on the handle than the DeLaval. Arranged in the order of the least force to be exerted on the handle, the machines stand as follows: Sharples, DeLaval, Empire, Iowa Dairy, National and United States.

It is not possible with the figures given here to determine absolutely which machine is best. In the two series of trials in which the United States separator has been usedt has proven to be the most efficient in separating but it requires the most power of any of the six machines. The Empire was found to be a very efficient skimmer, but the fact that it leaves so much butter fat in the bowl wash would prove a serious disadvantage where only a small amount of milk is to be separated. The Iowa Dairy was hard to turn but did fairly good work The National was easier to turn but left more butter fat in the skim-milk than any other machine. The DeLaval and Sharpless have the advantage of all the others in the ease with which they are operated. It will be seen that no machine excells in all the points.