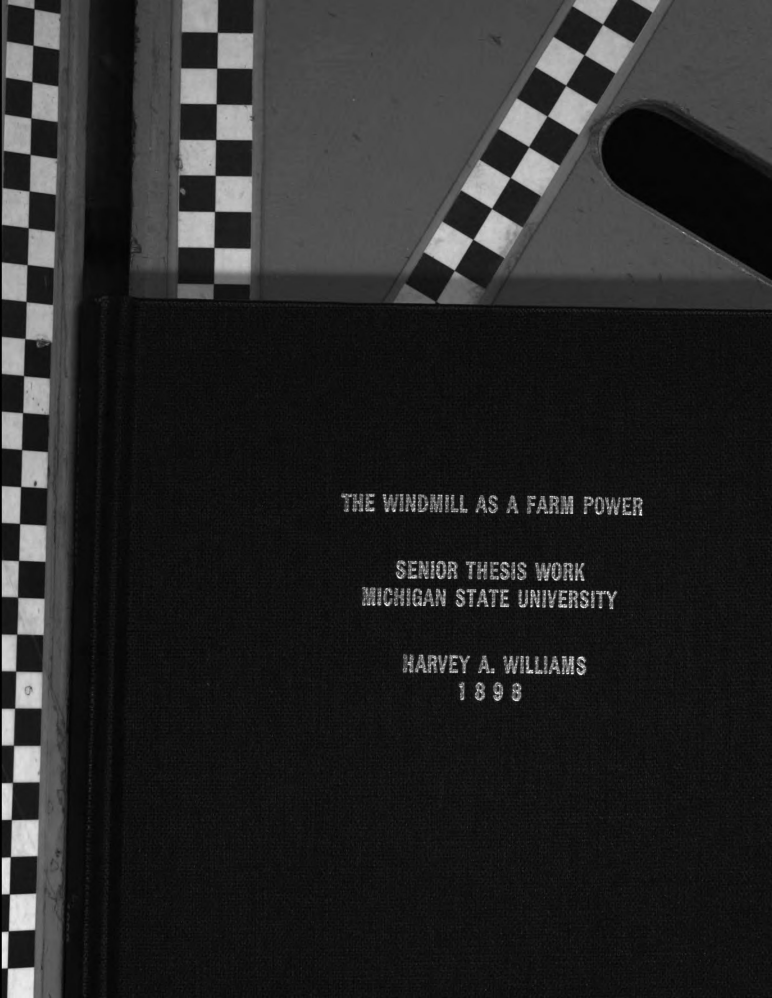


The background of the image is a black and white checkered pattern, resembling a racing flag, which is slightly out of focus. In the foreground, there is a dark, textured rectangular area, possibly a book cover or a sign, which contains the text.

THE WINDMILL AS A FARM POWER

SENIOR THESIS WORK
MICHIGAN STATE UNIVERSITY

HARVEY A. WILLIAMS
1898



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THESIS
THE WINDMILL
AS A
FARM POWER.
H. A. WILLIAMS,
1898.

Senior Thesis Work

on

The Windmill as a Farm Power

by

H. A. Williams.

Michigan Agricultural College,

Agricultural College, Mich.

THESIS

The Windmill as a Farm Power.

As the farmers, dairymen, and stockmen come more in the possession of small machinery, such as grinders, feed cutters, corn shellers, wood saws, etc., it becomes necessary for them to have some power or motor for running their machinery. It is the object of this "Thesis Work" to investigate the power windmill as to the adaption, durability, convenience, and economy for running light machinery.

The motors used for running small machinery are steam engines, gas and gasoline engines, electrical motors, water sweep powers motors, tread or railway powers, and power windmills. It is a well known fact that windmills have been used for motive power for years [#], and have done their work well, but until comparatively recent time they were so rudely constructed that so much time was lost in the attempt to adjust them to the varying winds that they did not come into extensive use.

If the power of a wind that passed over a farm could be harnessed and utilized it is very reasonable to assume that it would do all of the work on the farm and leave a nice margin for extras. If this power could be controlled and made to do service to man in driving machinery it would make a cheap motor, for the wind is free to all.

The power windmill as a motor differs from other motors in its working conditions. Its source of power is not stored or controlled like that of other motors, but is subject to "the freaks of the wind." By having some knowledge of the action of the wind, the windmill as a motor could be better understood, for it is the pressure of the wind against the sails that rotates the driving wheel.

[#] The Windmill as a Prime Mover, by Alfred R. Wolff, contains an account of the early history of windmills.

The pressure of the wind against a plane surface varies with the temperature, the barometric pressure, and the square of the mean velocity. The following table is known as Smeaton's Results, and is nearly accurate for a temperature of about 45°F at the sea level:-

Description	Miles per Hour	Feet per Minute	Feet per Second	Force in Pounds per Square Foot
Scarce Perceptible-	1	88	1.47	.005
Just Perceptible -	2 to (2	176	2.93	.020
	(3	264	4.04	.044
Gentle Breeze- - -	4 to (4	352	5.87	.079
	(5	440	7.33	.123
Pleasant Breeze- -	10 to (10	880	14.67	.491
	(15	1320	22.	1.107
Brisk Gale - - - -	20 to (20	1760	29.03	1.968
	(25	2200	36.06	3.075
High Wind- - - - -	30 to (30	2640	44.	4.428
	(35	3080	51.03	6.027
Very High Wind				
Storm- 40 to (40	3520	58.06	7.872	
	(45	3960	66.	9.968
Great Storm- - - -	50 to (50	4400	78.03	12.300
	(60	5280	88.	17.712
	(70	6160	102.07	24.108
Hurricane- - - - -	70 to (80	7040	117.03	31.488
	(100	8800	146.06	49.200

From the above table, it is to be seen that the pressure of the wind is four times as great when the velocity of the wind is only doubled. Theoretically, the windmill will develop four times as much power with a 20 mile wind as with a 10 mile wind. From the above table, it is also to be seen that the power or energy of a brisk gale or high wind is very great. But the windmill has not yet reached such a stage of perfection that it can utilize much of the power or energy of the wind which comes in contact with the surface of its sails. The reason why the windmill utilizes so small an amount of the energy of the wind may be seen from the following: Let A. B., in the diagram, be a strip taken from the outer end of one sail of a windmill. It may be curved, but for this purpose it may be considered a plain strip which makes an angle θ with the horizontal.

direction of the wind.

C represents the amount and direction of the wind; V

represents the amount and direction

of the velocity of the surface A B. Then the relative

velocity of the wind- that is, its velocity with respect

to the moving surface A B- is V' ; the diagonal of the parallelogram constructed on V and C as sides V' makes an angle

β with the sloping surface A B. If $V = 0$ - that is, if the wheel is held so that it cannot revolve- the angle $\beta = \alpha$. As

V increases β grows less and less, and finally becomes

zero, in which case V' is parallel to surface A.B. In this

case the surface receives no pressure from the wind- this portion of the sail is not utilizing any of the energy of

the wind. If V be still further increased, β becomes negative and the wind pressure is on the opposite side of A B.

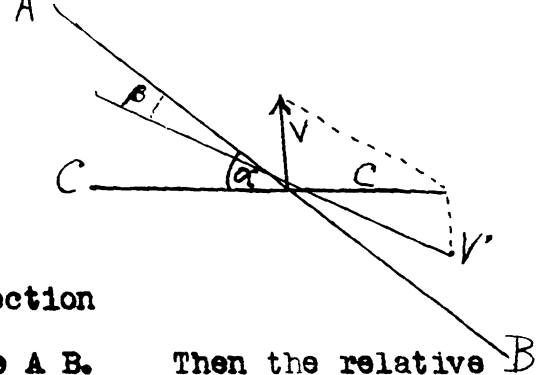
This portion of the sail is then doing work on the wind instead of the wind doing work on the sail. The effective

wind area of a sail being the projection of the sail on

a plane at right angles to the relative velocity of wind over it- that is, to V' - it is seen that as V increases the

effective wind area decreases. The energy which the sail takes from the wind is proportional to the effective wind

area.



The tables on this page and the preceding one are the records of the velocity of the wind during 1897 at O. M. A. B., in which it is nearly complete as could be obtained from the record sheet. The number of hours the wind moved at a certain velocity are tabulated for the days from 6 o'clock a. m. to 6 o'clock p. m. and for the night time from 6 o'clock p. m. to 6 o'clock a. m. for each month of the year.

From black 9 A.M. to 6 o'clock P.M.												
The number of hours for the year.	months											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
269	4	12	16	25	28	24	40	38	63	30	6	0
282	9	25	18	5	42	23	13	0	38	14	14	11
336	14	26	12	11	30	26	17	3	31	35	3	30
470	19	37	11	15	38	31	17	3	41	43	40	40
485	24	40	15	18	43	36	21	3	45	45	37	40
420	29	43	18	21	47	39	24	3	45	45	37	40
347	34	48	21	23	51	41	29	3	45	45	37	40
364	39	52	23	24	55	43	31	3	45	45	37	40
310	44	57	24	27	58	45	33	3	45	45	37	40
224	49	62	25	29	61	47	35	3	45	45	37	40
179	54	67	26	31	64	49	37	3	45	45	37	40
172	59	72	27	33	67	51	39	3	45	45	37	40
133	64	77	28	34	70	53	41	3	45	45	37	40
114	69	82	29	37	73	55	43	3	45	45	37	40
96	74	87	30	39	76	57	45	3	45	45	37	40
50	79	92	31	41	79	59	47	3	45	45	37	40
39	84	97	32	43	82	61	49	3	45	45	37	40
20	89	102	33	45	85	63	51	3	45	45	37	40
21	94	107	34	47	88	65	53	3	45	45	37	40
15	99	112	35	49	91	67	55	3	45	45	37	40
11	104	117	36	51	94	69	57	3	45	45	37	40
9	109	122	37	53	97	71	59	3	45	45	37	40
1	114	127	38	55	100	73	61	3	45	45	37	40
1	119	132	39	57	103	75	63	3	45	45	37	40
3	124	137	40	59	106	77	65	3	45	45	37	40
2	129	142	41	61	109	79	67	3	45	45	37	40
1	134	147	42	63	112	81	69	3	45	45	37	40
1	139	152	43	65	115	83	71	3	45	45	37	40
1	144	157	44	67	118	85	73	3	45	45	37	40
1	149	162	45	69	121	87	75	3	45	45	37	40
1	154	167	46	71	124	89	77	3	45	45	37	40
1	159	172	47	73	127	91	79	3	45	45	37	40
1	164	177	48	75	130	93	81	3	45	45	37	40
1	169	182	49	77	133	95	83	3	45	45	37	40
1	174	187	50	79	136	97	85	3	45	45	37	40
1	179	192	51	81	139	99	87	3	45	45	37	40
1	184	197	52	83	142	101	89	3	45	45	37	40
1	189	202	53	85	145	103	91	3	45	45	37	40
1	194	207	54	87	148	105	93	3	45	45	37	40
1	199	212	55	89	151	107	95	3	45	45	37	40
1	204	217	56	91	154	109	97	3	45	45	37	40
1	209	222	57	93	157	111	99	3	45	45	37	40
1	214	227	58	95	160	113	101	3	45	45	37	40
1	219	232	59	97	163	115	103	3	45	45	37	40
1	224	237	60	99	166	117	105	3	45	45	37	40
1	229	242	61	101	169	119	107	3	45	45	37	40
1	234	247	62	103	172	121	109	3	45	45	37	40
1	239	252	63	105	175	123	111	3	45	45	37	40
1	244	257	64	107	178	125	113	3	45	45	37	40
1	249	262	65	109	181	127	115	3	45	45	37	40
1	254	267	66	111	184	129	117	3	45	45	37	40
1	259	272	67	113	187	131	119	3	45	45	37	40
1	264	277	68	115	190	133	121	3	45	45	37	40
1	269	282	69	117	193	135	123	3	45	45	37	40
1	274	287	70	119	196	137	125	3	45	45	37	40
1	279	292	71	121	199	139	127	3	45	45	37	40
1	284	297	72	123	202	141	129	3	45	45	37	40
1	289	302	73	125	205	143	131	3	45	45	37	40
1	294	307	74	127	208	145	133	3	45	45	37	40
1	299	312	75	129	211	147	135	3	45	45	37	40
1	304	317	76	131	214	149	137	3	45	45	37	40
1	309	322	77	133	217	151	139	3	45	45	37	40
1	314	327	78	135	220	153	141	3	45	45	37	40
1	319	332	79	137	223	155	143	3	45	45	37	40
1	324	337	80	139	226	157	145	3	45	45	37	40
1	329	342	81	141	229	159	147	3	45	45	37	40
1	334	347	82	143	232	161	149	3	45	45	37	40
1	339	352	83	145	235	163	151	3	45	45	37	40
1	344	357	84	147	238	165	153	3	45	45	37	40
1	349	362	85	149	241	167	155	3	45	45	37	40
1	354	367	86	151	244	169	157	3	45	45	37	40
1	359	372	87	153	247	171	159	3	45	45	37	40
1	364	377	88	155	250	173	161	3	45	45	37	40
1	369	382	89	157	253	175	163	3	45	45	37	40
1	374	387	90	159	256	177	165	3	45	45	37	40
1	379	392	91	161	259	179	167	3	45	45	37	40
1	384	397	92	163	262	181	169	3	45	45	37	40
1	389	402	93	165	265	183	171	3	45	45	37	40
1	394	407	94	167	268	185	173	3	45	45	37	40
1	399	412	95	169	271	187	175	3	45	45	37	40
1	404	417	96	171	274	189	177	3	45	45	37	40
1	409	422	97	173	277	191	179	3	45	45	37	40
1	414	427	98	175	280	193	181	3	45	45	37	40
1	419	432	99	177	283	195	183	3	45	45	37	40
1	424	437	100	179	286	197	185	3	45	45	37	40
1	429	442	101	181	289	199	187	3	45	45	37	40
1	434	447	102	183	292	201	189	3	45	45	37	40
1	439	452	103	185	295	203	191	3	45	45	37	40
1	444	457	104	187	298	205	193	3	45	45	37	40
1	449	462	105	189	301	207	195	3	45	45	37	40
1	454	467	106	191	304	209	197	3	45	45	37	40
1	459	472	107	193	307	211	199	3	45	45	37	40
1	464	477	108	195	310	213	201	3	45	45	37	40
1	469	482	109	197	313	215	203	3	45	45	37	40
1	474	487	110	199	316	217	205	3	45	45	37	40
1	479	492	111	201	319	219	207	3	45	45	37	40
1	484	497	112	203	322	221	209	3	45	45	37	40
1	489	502	113	205	325	223	211	3	45	45	37	40
1	494	507	114	207	328	225	213	3	45	45	37	40
1	499	512	115	209	331	227	215	3	45	45	37	40
1	504	517	116	211	334	229	217	3	45	45	37	40
1	509	522	117	213	337	231	219	3	45	45	37	40
1	514	527	118	215	340	233	221	3	45	45	37	40
1	519	532	119	217	343	235	223	3	45	45	37	40
1	524	537	120	219	346	237	225	3	45	45	37	40
1	529	542	121	221	349	239	227	3	45	45	37	40
1	534	547	122	223	352	241	229	3	45	45	37	40
1	539	552	123	225	355	243	231	3	45	45	37	40
1	544	557	124	227	358	245	233	3	45	45	37	40
1	549	562	125	229	361	247	235	3	45	45	37	40
1	554	567	126	231	364	249	237	3	45	45	37	40
1	559	572	127	233	367	251	239	3	45	45	37	40
1	564	577	128	235	370	253	241	3	45	45	37	40
1	569	582	129	237	373	255	243	3	45	45	37	40
1	574	587	130	239	376	257	245	3	45	45	37	40
1	579	592	131	241	379	259	247	3	45	45	37	40
1	584	597	132	243	382	261	249	3	45	45	37	40
1	589	602	133	245	385	263	251	3	45	45	37	40
1	594	607	134	247	388	265	253	3	45	45	37	40
1	599	612	135	249	391	267	255	3	45	45	37	40
1	604	617	136	251	394	269	257	3	45	45	37	40
1	609	622	137	253	397	271	259	3	45	45	37	40
1	614	627	138	255	400	273	261	3	45	45	37	40
1	619	632	139	257	403	275	263	3	45	45	37	40
1	624	637	140	259	406	277	265	3	45	45		

From 6 o'clock P. M. to 6 o'clock A. M.

The number of house for the year.	Months											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
243	0	3	1	2	3	4	5	6	7	8	9	0
829	1	2	3	4	5	6	7	8	9	0	1	2
822	3	4	5	6	7	8	9	0	1	2	3	4
483	5	6	7	8	9	0	1	2	3	4	5	6
380	7	8	9	0	1	2	3	4	5	6	7	8
276	9	0	1	2	3	4	5	6	7	8	9	0
300	1	2	3	4	5	6	7	8	9	0	1	2
229	3	4	5	6	7	8	9	0	1	2	3	4
195	5	6	7	8	9	0	1	2	3	4	5	6
140	7	8	9	0	1	2	3	4	5	6	7	8
139	9	0	1	2	3	4	5	6	7	8	9	0
81	1	2	3	4	5	6	7	8	9	0	1	2
61	3	4	5	6	7	8	9	0	1	2	3	4
58	5	6	7	8	9	0	1	2	3	4	5	6
34	7	8	9	0	1	2	3	4	5	6	7	8
33	9	0	1	2	3	4	5	6	7	8	9	0
27	1	2	3	4	5	6	7	8	9	0	1	2
23	3	4	5	6	7	8	9	0	1	2	3	4
13	5	6	7	8	9	0	1	2	3	4	5	6
6	7	8	9	0	1	2	3	4	5	6	7	8
2	9	0	1	2	3	4	5	6	7	8	9	0
0	1	2	3	4	5	6	7	8	9	0	1	2
1	3	4	5	6	7	8	9	0	1	2	3	4
1	5	6	7	8	9	0	1	2	3	4	5	6
1	7	8	9	0	1	2	3	4	5	6	7	8
2	9	0	1	2	3	4	5	6	7	8	9	0

The average velocity of the wind for the day time during 1897 at M. A. C., was 5.8 miles per hour; for the night time 3.59 miles per hour. The number of hours the velocity of the wind was above 9 miles per hour was 522 hours for the day time, and 348 hours for the night time. In the U. S. Weather Bureau Report for 1896-'97, we find the average velocity of the wind ending Dec. 31, 1896, as follows:

	Detroit	Alpena	Grand Haven	Marquette	Port Huron	Sault Ste. Marie
Jan.	10.4	9.5	11.1	10.8	10.8	8.4
Feb.	13.2	11.1	12.5	10.6	13.8	9.0
Mar.	11.9	11.3	11.2	12.8	13.5	9.4
Apr.	11.2	10.5	13.0	10.7	12.0	9.4
May.	11.1	10.5	10.5	9.8	11.7	10.4
June.	7.8	7.7	7.6	7.7	8.3	7.4
July.	8.3	7.5	7.7	8.3	9.6	6.7
Aug.	7.9	8.0	8.3	9.3	9.5	7.3
Sept.	8.9	9.5	9.1	11.8	10.7	8.7
Oct.	9.9	9.0	9.6	9.9	10.6	8.2
Nov.	12.8	11.6	13.8	11.4	13.7	11.2
Dec.	9.9	8.8	9.8	9.9	10.6	8.0
Year	10.2	9.6	10.4	10.2	11.2	8.6

The windmill as a power is adapted to run all sorts of small machinery where constant and steady power is not required, the work being in proportion to the size of the mill. It is made to run a pump, and the pump may be at any reasonable distance; it is most largely used for grinding, cutting feed, and shelling corn, but may also be attached to wood saws, lathes, churns, elevators, or other light machinery. The cream separator cannot be run by this kind of power, because the wind is not steady; nor can it be used for filling silos with ensilage, because the wind cannot be depended upon.

The durability of the power windmill depends largely upon the material and the workmanship in its construction, but the care of the mill is also an important factor. Being

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exposed to the weather three hundred sixty-five days of the year, the gearing of the windmill needs to be kept well oiled, and its wood work needs to be kept well painted. Like other machinery, the power windmill will last longer if it is simply constructed. If a steel power windmill is properly erected on a good foundation there is no reason to doubt but that it will last as long as any other power.

The convenience of the power windmill depends upon the use to which it is put. It is as convenient as any stationary motor, except it can be used only when the wind blows. With bins and elevators the power windmill for grinding has the same advantage over other motors as the windmill for pumping has over other motors. The power windmill needs but very little attention, and it generally runs on stormy days when work cannot be done out of doors.

The motor that furnishes the desired amount of power for the least current expense is the most economical. The current expense depends upon the first cost, interest on the capital invested, deterioration, repairs, attendance, oil, and fuel (when used). The last is zero in the case of the windmill, for the wind is a free gift of nature. The attendance for the leading American type of windmill requires only the filling of oil cups once a week, (which can be done in a few minutes), twenty-five cents a month would be extravagant wages for such service. The expense for repairs and depreciation items could be covered by five per cent per annum on the investment, and the expense for lubricants for one year would not exceed one dollar.

A certain 14-ft power windmill and grinder, costing

\$150.00 during the year 1897, finely ground 80 tons of hay, besides cutting all the stalks from 8 acres of good corn, and doing other work. At eight cents per cwt., it would cost \$25.60 for grinding 16 tons. The expense for grinding this amount with the windmill was as follows:

Interest at 7% on \$150.00-	-	\$10.50
Repairs, etc at 5% on \$150.00-		7.50
Attendance at 25¢ per month-		3.00
Oil - - - - -		1.00
Total-- --		<u>\$22.00</u>

The difference in the cost of grinding the grain would be \$3.60, while the power for the rest of the work would be clear gain. In this case the handling of the grain was not considered, for it would have been necessary to handle the grain if it had been ground by any other power. I should also say that this mill did not do one fourth of what it could have done.

The mechanical horse power developed by the power windmill varies with the size of the wheel and the velocity of the wind. With varying velocity of wind, several tests of different mills were made by means of the Prony brake. The brake consisted of a piece of six inch belt laid over the top of the driving wheel. A spring balance reading to quarters of a pound was made fast at one end, the other end being fastened to the tight end of the belt. By weighing the loose end of the belt, the spring balance could be made to read any desired number of pounds, and thus the load on the mill could be regulated. By holding the speed counter on the end of the shaft, the number of revolutions of the driving-wheel per minute was found. If V equals the number of revolutions of the driving-wheel per minute, L the load as shown by the spring balance minus the weights

1. The first part of the document is a list of the names of the persons who were present at the meeting. The names are listed in alphabetical order.

2. The second part of the document is a list of the topics that were discussed at the meeting. The topics are listed in alphabetical order.

3. The third part of the document is a list of the actions that were taken at the meeting.

4. The fourth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

5. The fifth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

6. The sixth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

7. The seventh part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

8. The eighth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

9. The ninth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

10. The tenth part of the document is a list of the persons who were responsible for the actions that were taken at the meeting.

on the belt, and D the diameter of the driving-wheel in feet, we have the number of foot- pounds per minute:

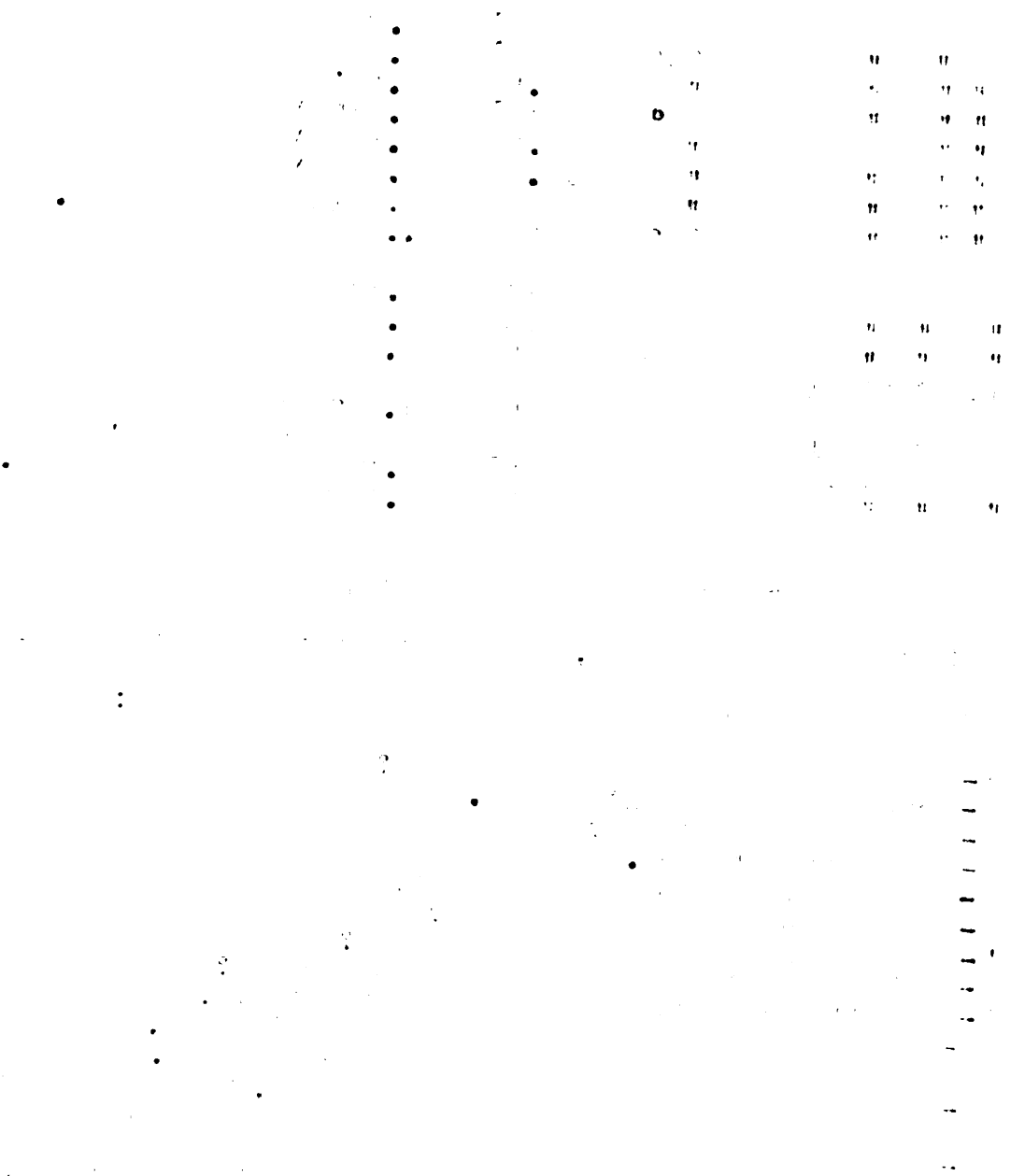
Foot-pounds equal $L V \pi D$. The horse-power equals $\frac{L V D \pi}{33000}$

During the time each mill was tested, the velocity of the wind was measured by an anemometer near the sails. The results are as follows:

Size of mill.	Temper- ature.	Velocity of wind	Horse power	Remarks.
12 ft steel windmill	20°F	23½	.827	
#13 " "	28°	13½	.808	
" " "	"	12.74	.803	
" " "	26°	13½	.8173	
" " "	"	12.73	.8	} mill stopped for a few seconds during the test.
" " "	"	14.	.848	
" " "	"	13½	.8212	
" " "	30°	30	1.81	
14 ft wood windmill	20	14	.2185	
" " "	24	18	.538	
" " "	20	27	1.219	
14 ft steel windmill	22	27	1.060	#the seven following are from the same mill.
13 ft steel mill	20	13½	.305	
" " "	20	17	.5805	

In order to obtain more practical information regarding motors for farm purpose, a few letters were sent to different parties containing the following questions:

- 1-How long have you had your power?
- 2-What condition is it in now?
- 3-What did it cost you?
- 4-Do you use it much?
- 5-What machinery do you run by it?
- 6-Does the power pay for itself?
- 7-Have you paid out much for repairs?
- 8-What is the expense of running it one day?
- 9-What can you accomplish in one day with it?
- 10-If you have objections to your present power,
please state them briefly.
- 11-If you did not have your present power, what kind of a
power would you purchase?
- 12-What kind of power would you recommend for a common
farmer to buy?



The following are answers corresponding to the questions:-

A 14 ft. steel mill.

- 1-Nearly three years.
- 2-Nearly as good as new.
- 3-\$214.00, with grinder.
- 4-Yes.
- 5-Wood saw, emery wheel, feed grinder and feed cutter.
- 6-It would pay for itself in six years.
- 7-No.
- 8-Nothing.
- 9-Grind from 5 to 10 bushels per hour.
- 10-It does not always run when I want to use it.
- 11-Steam engine.
- 12-Power windmill. (This person has a 14 ft steel mill).

A 14 ft wood wheel.

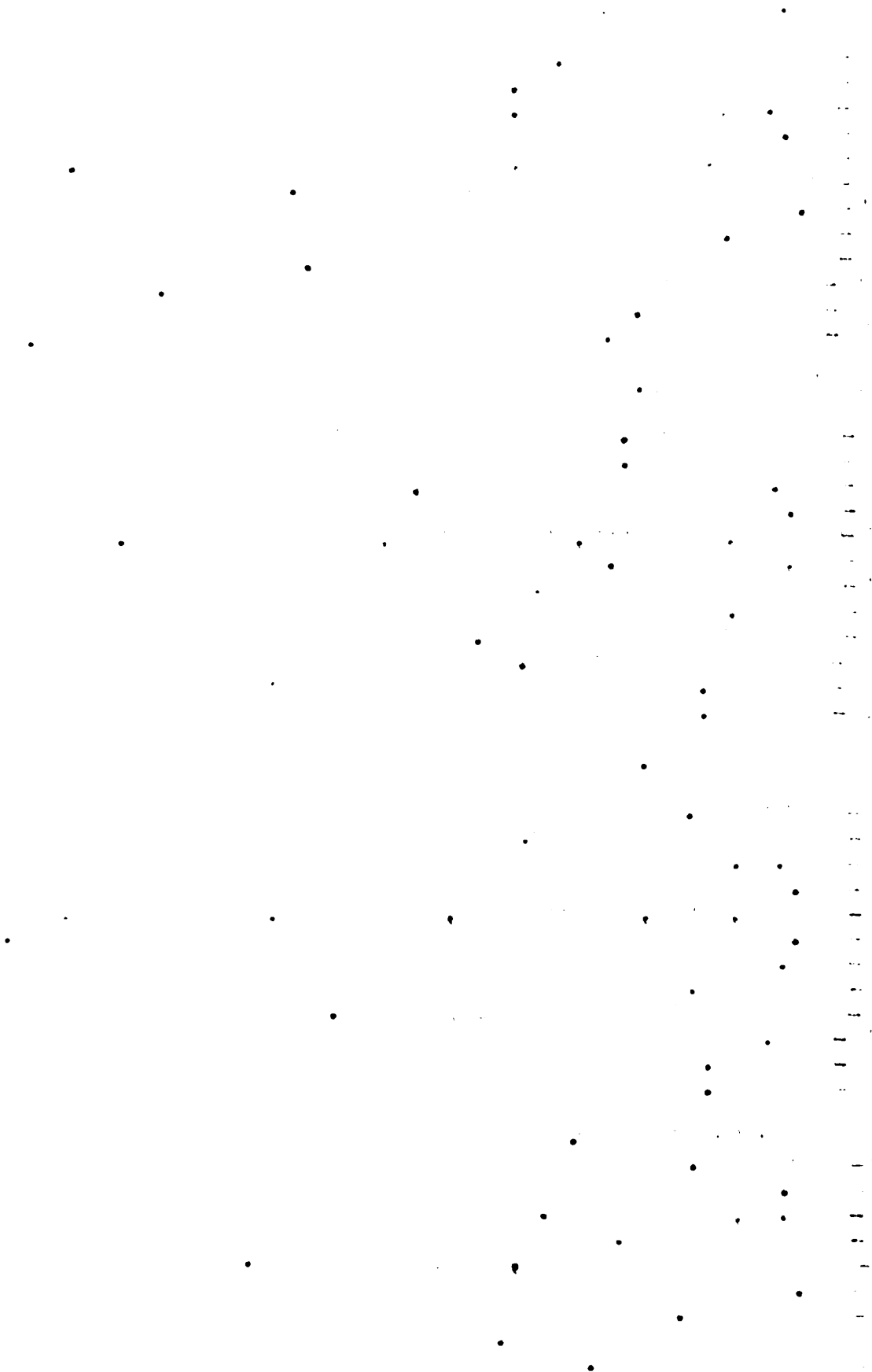
- 1-Eighteen years.
- 2-Fair condition.
- 3-\$225.00 for mill and grinder.
- 4-Yes.
- 5-Grinder, wood saw, feed cutter, and corn sheller.
- 6-Yes, many times.
- 7-Nothing only for oil.
- 8-Nothing.
- 9-Grind 15 bushel per hour.
- 10-I have no objections.
- 11-Windmill.
- 12-Windmill.

A 14 ft wood wheel.

- 1-Four years.
- 2-Nearly as good as new.
- 3-\$100.00.
- 4-Yes.
- 5-Grinder, saws, emery wheel, grindstone, corn sheller,
and feed cutter.
- 6-Yes.
- 7-None.
- 8-No expense.
- 9-Grind from 5 to 10 bushel per hour.
- 10-None.
- 11-Windmill.
- 12-Windmill.

Three Horse tread power.

- 1-Five years.
- 2-Good.
- 3-\$120.00, and freight.
- 4-About one month.
- 5-Thresher and separator, 34 inch cylinder.
- 6-Yes.
- 7-Very little.
- 8-The use of three horses.
- 9-Thresh 75 bushels.
- 10-
- 11-



Tread Power.

- 1-Sixteen years.
- 2-Good.
- 3-\$180.00.
- 4-Yes.
- 5-Threshing machine, wood saw, and ensilage cutter.
- 6-Many times over.
- 7-Repairs too little to consider.
- 8-Very little.
- 9-
- 10-No objections.
- 11-A new one like it.
- 12-A two horse tread power.

Gasoline Engine.

- 1-Nearly three years.
- 2-Good as new.
- 3-\$800.00.
- 4-Fall and winter, mostly.
- 5-Corn husker, buzz saw, feed grinder, and corn sheller.
- 6-It will in time.
- 7-75¢ per dozen tubes, and one tube will last three days.
- 8-40¢ to 80¢ per day.
- 9-Husk 5 acres of corn, cut 15 to 20 cords of wood, and grind a bag of grain in 90 seconds.
- 10-Fire goes out on windy days.
- 11-Gasoline engine.
- 12-For the amount of money, a gasoline engine.

The amount of feed ground by a 14 ft wood wheel windmill for three years was fifty tons. (This was done beside doing other work). The same mill ground 466 pounds of corn and 200 pounds of oats in 11 hours with a ten mile wind. With a 24 $\frac{4}{7}$ mile wind it ground 330 pounds of corn and 270 pounds of oats in three hours. In both cases the grain was ground fine. At another time it ground six bushels of grain in one hour, and it furnished the power to cut 20 cords of wood in five hours, velocity of the wind not known.

It may be of interest to note that Mr. Mcquesten, of Marblehead Neck, Mass., has a 20 foot power windmill which furnishes power for a small electric light plant, consisting of a 3 Kw. dynamo and a set of 46 cells of storage

battery, having 140 lamp-hours capacity. This plant furnishes lights for his buildings, containing in all 137 lamps. From 40 to 80 lamp hours per day are used.

From a letter written to Mr. McQuesten inquiring about the electric light plant, the following letter was received from his brother:

"Dear Sir: Replying to your favor of January 7th, the electric light plant you refer to belongs to my brother, who is abroad and will not return for several months.

While I am not well enough acquainted with the plant to give you all the information you ask for, I know the plant is, and always has been, a success. It is practical, gives a steady light, and is economical to run."

For further information on this subject, the following articles found in the Library at M. A. C., may be of service:

The Windmill as a Prime Mover, by A. R. Wolff, (T.B.W.83)			
The Power of a 16 ft Windmill, Bulletin No.68 of the Wis. Ag.			
			Exp. Sta.
Wind and Tread Powers, Breeders' Gazette, yr.1896, page 147.			
Wind Power,	"	"	106.
"	Mich. Farmer	" 1897	" 158. Feb. 27
"	"	"	" 37. Jan. 16
"	"	" 1898	" 117. Feb. 13
"	"	" 1897	" 177. Mar. 6
"	"	"	" 278. Apr. 10
"	"	"	" 297. " 17
"	"	"	" 337. May 1
"	"	"	" 398. " 22
"	"	"	" 438. June 8
"	"	"	" 458. " 12
"	"	"	" 497. " 26
"	"	"	" 81. Aug. 7
A Well Arranged Farm Mill"			Dec. 4
Wind Power	"	" 1898	" 282. Apr. 9
Steam Power	"	" 1897	" 91. Aug. 7
Gasoline Engine	"	"	" 374. Nov. 20
Home-made Horse Power	"	"	Dec. 11
Tread Power	Breeders' Gazette	" 1896	" 50
Tread Power vs. Sweep Power	"	"	" 206.
Gas Engine	"	"	" 107

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099

The following is a list of addresses of the leading
windmill manufacturing companies in the United States:

United States Wind, Engine and Pump Co., Batavia, Ill.
Appleton Mfg., Co., Batavia, Ill.
The Challenge Windmill Co., Batavia, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Aermotor Co., Chicago, Ill.
E. B. Wineger, Chicago, Ill.
American Wheel Works, Aurora, Ill.
Perkins Windmill Co., Mishawaka, Ind.
Flint & Walling, Kendallville, Ind.
Mast, Foos & Co., Springfield, O.
Althouse Wheel Co., Waupun, Wis.
S. Freeman & Sons Mfg., Co., Racine, Wis.
Maud-S Windmill Co., Lansing, Mich.
Phelps & Bigelow Windmill Co., Kalamazoo, Mich.
Eureka Windmill Co., Kalamazoo, Mich.

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