TESTS TO DETERMINE THE FORM OF LATHE TOOL TO REMOVE MAXIMUM METAL WITH MINIMUM POWER FROM GRAY IRON.

BY

ARTHUR J. RHODES.

The object of the tests performed was to determine which form of lathe tool will remove, from gray iron, maximum metal with minimum power. That is to say, to ascertain approximately what should be the proper angle of rake and clearance for lathe tools, and whether the tool should be round or diamond nose, to remove the most metal with the least power.

To determine the power it would take to drive the lathe, a Briggs transmission dynamometer of the belt pattern was used. This dynamometer is from the K. S. A. C. laboratory, an elevation of this type of machine is given in figure (1). The power is transmitted through the dynamometer, to the machine performing the work, without being absorbed by the dynamometer.

When the dynamometer comes to rest, or is running with no outside resistance, the system will come into equilibrium with equal but opposite angles for both the lower and upper belt, provided the weight of the carrier pulleys (a & b) figure (1), the frame supporting same, and the weight of the belt are balanced.

It can be shown that the resultant of strain of the deflected belt varies as the cosine of the angle which the belt makes with the vertical; or $W = 2P \cos \alpha$ figure (2). The angle α of the belt is 75° 31', the cosine of which is .2503 or $\cos^{-1} 1/4 = 75° 30'$. Let $\cos \alpha = .250$ and the tension on the tight side of belt $= T_1$; and tension on slack side of belt $= T_2$; W = weight necessary to balance the vertical component of pull on both tight and slack sides of belt; the force transmitted = P. The force transmitted is equal to the difference of the tension on the two sides of the belt, or $T_1 - T_2 = P$. But $W = 2P \cos \alpha$ figure (2) or $W = 2P\,1/4$ ($\alpha = .250 = 1/4$) Therefore $P = 2W$.

Hence if we place a weight W on the scale beam or lever, there will be transmitted by the belt a force P = 2 W, in order to maintain the system in its central position; this weight is therefore a measure of the driving power of the belt.

The lathe equipment of the Kansas State Agricultural College shops consists of twelve 14" engine lathes and one 30" engine lathe, the latter having been built by the American Tool Works Co. of Cincinnati, Ohio. It was on this 30" lathe that the following described tests were made.

In making the tests two general forms of lathe tool were used, the diamond-nose and the round-nose tool. An idea of the form of these tools may be obtained from figures 3, 4, 5, 6, 7, & 8. These tools are of Rex self hardening steel, with one exception, in which case a tool of manganese steel was used. This was the diamond-nose tool, angle of rake 25°.

By angle of rake is meant the angle which the top surface of the tool forms with the horizontal. The angle of clearance is the angle the cutting face of the tool forms with a vertical line through cutting edge of tool. These angles are both illustrated in figures 5, 6, 7, & 8.

A 10° angle of clearance of the tools was maintained throughout the tests, except on the diamond-nose tool of 25° rake, in which case the angle of clearance was 8°.

The angle of rake for both forms of tool was varied, by 5° steps, from 5° to 25°, two series of tests being made for each angle of rake; one series in which the cut was maintained constant and the feed varied, and one in which the feed was maintained constant and the cut was varied.

The gearing for cutting threads was used to regulate the feed. The feed was varied from 1/16" to 1/10". The cut was varied from 1/128" to 5/128", taking from 1/64" to 5/64" from the diameter of the stock.

Before making the tests the dynamometer was calibrated, the data being given below. This was done by means of the Prony Brake, in the following manner:-

The dynamometer was balanced, while running, without the brake. The Prony Brake was then put on the dynamometer and its constant weight obtained, by running the dynamometer both ways, with result shown in log. Using the Prony Brake as the standard, the dynamometer was then calibrated, by making a series of nineteen runs. A given weight was put on the dynamometer scale beam, the brake was then tightened up so that the dynamometer balanced; the scale showing the pressure of the brake arm was then balanced and the weight noted, and at the same time the revolutions per minute of the brake pulley were taken. This data was recorded and another run was made as before, using a larger weight on the dynamometer scale beam. The series was continued until the weight shown on the dynamometer scale beam was 47.5 pounds and on the brake scale beam 24.5 pounds, the drive belt slipping at this point. The values for brake horse power were now obtained by substituting the values thus obtained in the formula, -

$$B.\ H.\ P. = \frac{2\pi L \times R.\ P.\ M. \times W}{33000}$$

in which L = length of brake arm, in feet; R. P. M. = revolutions per minute of brake pulley; W = weight indicated on brake scale beam.

The values for dynamometer horse power were obtained by substituting the values thus obtained in the following formula,

$$\text{Dyn. H. P.} = \frac{\pi (D + t) \times R.\ P.\ M. \times (T_1 - T_2)}{33000}$$

in which D = diameter of driven pulley, of dynamometer, in feet. t = thickness of belt, in feet. R. P. M. = revolutions per minute of driven pulley of dynamometer. $(T_1 - T_2) = P = 2\ W$ as shown above, where W is the weight indicated on the scale beam of dynamometer.

By plotting a curve (No. 1) with the brake horse power as abscissae and the dynamometer horse power as ordinates, we got a straight line at an angle of 45° with vertical and horizontal. This gives a value of unity for our calibration factor, in other words the dynamometer is practically correct. The data for curve No. 1 is given in table No. 1.

In the dynamometer horse power formula the factor $\frac{2\pi(D = t)}{33000}$ is a constant factor, called the dynamometer constant, its value being .0002598. The dynamometer horse power formula may, therefore, be reduced to the form,

Dyn. H. P. = W x R. P. M. x Dyn. constant x calibration factor (unity).

In making the machine tool tests, the dynamometer was belted between the main driving shaft and the lathe counter shaft, the belt from the lathe counter shaft running on the dynamometer pulley from which the Prony Brake was taken. The tools were sharpened before each test, and the lathe and dynamometer were kept well oiled. The tests were made on castings from the K. S. A. C. foundry. The castings were of a hard variety and close ground, the rough skin being removed from the castings before the tests were made. The round nose tool was set so that its center line made an angle of 90° with the center line of the stock, while the diamond nose tool was set so that its cutting edge made an angle of 60° with the center line of the stock, except in one case, (angle of rake 5°) where this "cutting angle" was made 73° 30'.

In taking a heavy cut, the belt connecting the lathe with the counter shaft, would slip and although belt dressing was used, we could not take a much larger cut than 5/128". In most of the tests the back gears were used. The horse power per cubic inch of metal removed per minute, is determined by the formula,-

$$\text{H. P. (per cu. in. of metal removed per min.)} = \frac{\text{H. P.}}{\text{cu. in. of metal removed in one minute.}}$$

The denomination of the above fraction is equal to:

$$\text{cut} \times \text{feed} \times \pi \times \text{R. P. M. (of stock)} \times \frac{\text{original + final dia.}}{2} \text{(of stock)}$$

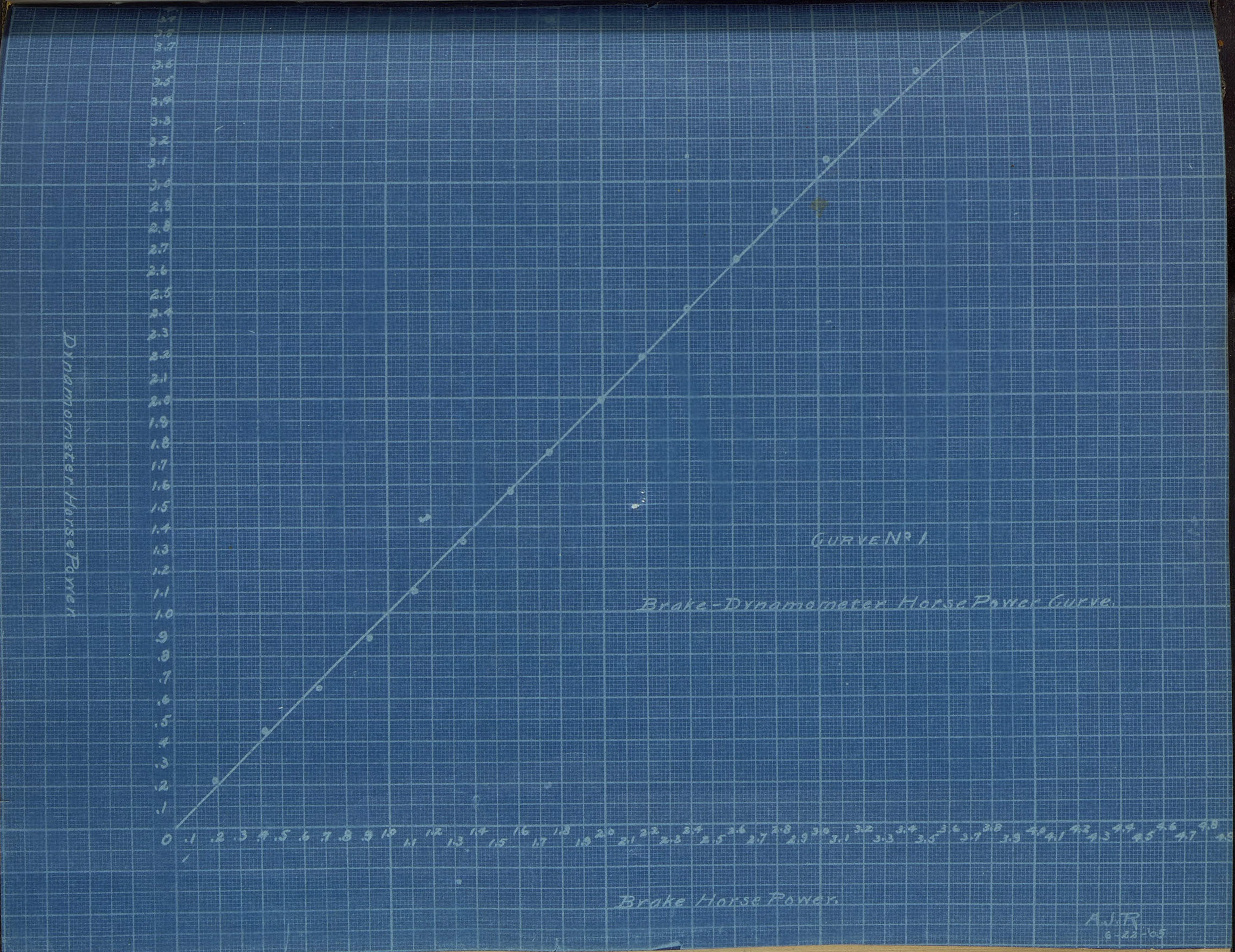
From the data obtained in these tests it will be seen, 1st that the best form of lathe tool to remove maximum metal with minimum power from gray iron, is the round-nose tool, angle of rake 20° and angle of clearance 10°. The diamond nose tool of the same angles gives results quite close to those of the round nose tool. 2nd that in most cases the same speed could be maintained on a cut 5/128" deep and 1/16" feed, as on a cut 1/128" deep and 1/16" feed, although in one case removing about five times as much metal as in the others.

Most experimenters give 22° 30' as the best angle of rake with angle of clearance anywhere from 5° to 15°, one experimenter especially giving the exact results given above - "Vandervoost" - Modern Machine and Shop Practice. In one instance an author gave 4° as the best top rake angle "Hutte" the German Engineers' Pocket-book.

Watson, in Modern Practice of American Machinists and Engineers, says, "The lathe tool should be built like a wedge, having a large angle of rake, say 25° to 30°. This makes the tool sharp and it will naturally cut the metal rather than scrape it off, as it would do with angle of rake say 5° or smaller". These tests seem to bear out this authors conclusions, as 20° is a fairly sharp angle of rake.

TABLE NO. 1.

No.	Brake H. P.	Dynamometer Horse Power	Brake Horse Power / Dynamometer H. Power
1	.1908	.2257	.8453
2	.4196	.4515	.9293
3	.6773	.6733	1.05
4	.9130	.8951	1.02
5	1.123	1.103	1.019
6	1.350	1.331	1.014
7	1.578	1.562	1.011
8	1.752	1.754	.9985
9	2.009	1.996	1.03
10	2.181	2.199	.9919
11	2.384	2.419	.9875
12	2.614	2.646	.9878
13	2.806	2.867	.9788
14	3.037	3.106	.9788
15	3.284	3.326	.9875
16	3.476	3.538	.9824
17	3.711	3.749	.9898
18	3.802	3.912	.9720
19	3.949	3.968	.9951


Curve No 1.
Brake-Dynamometer Horse Power Curve.
Dynamometer Horse Power
Brake Horse Power.
A.J.R.
6-22-'05

BRIGGS BELT-DYNAMOMETER.

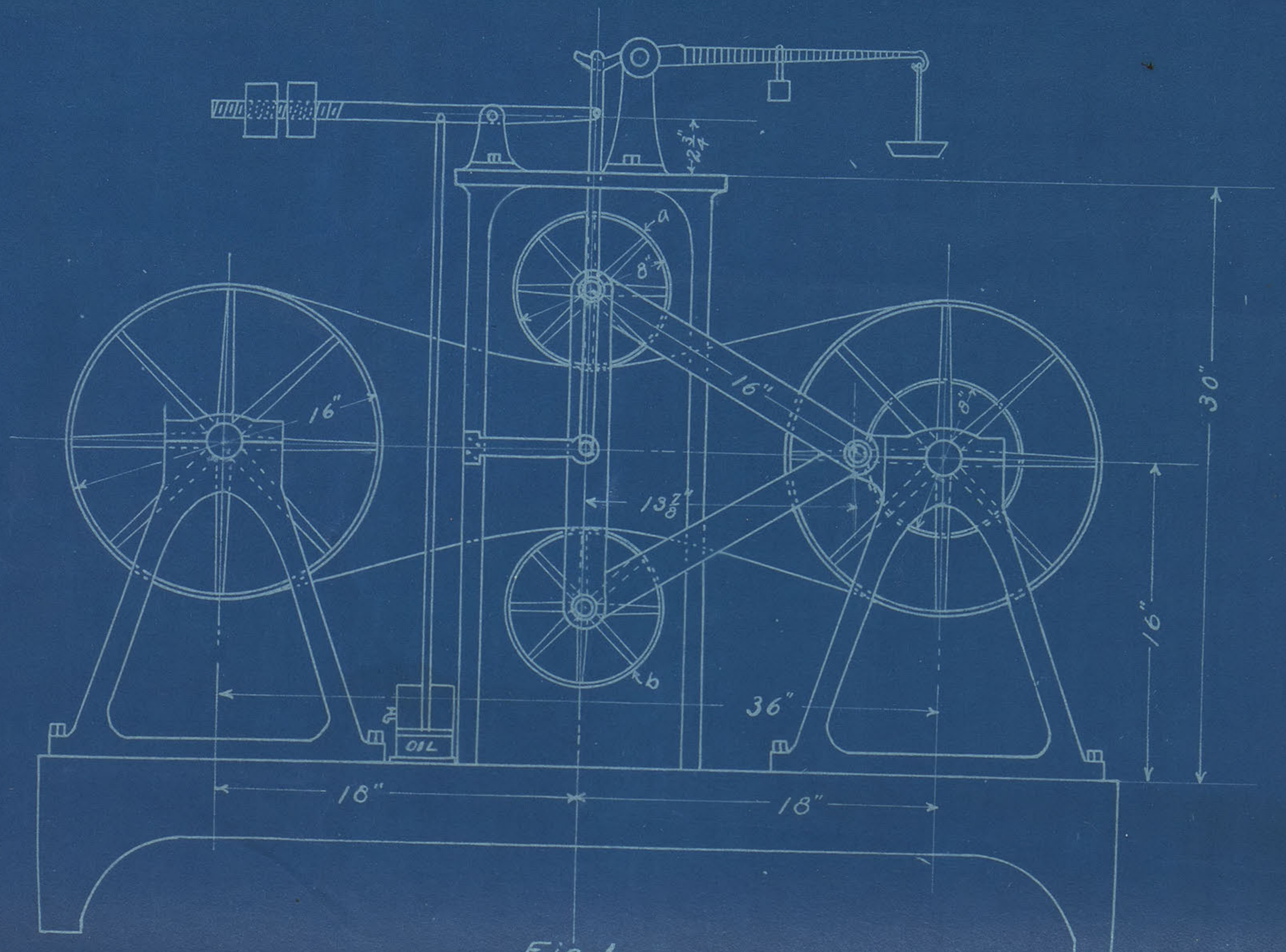


Fig. 1.

Scale 1½" = 1'

A. J. R.

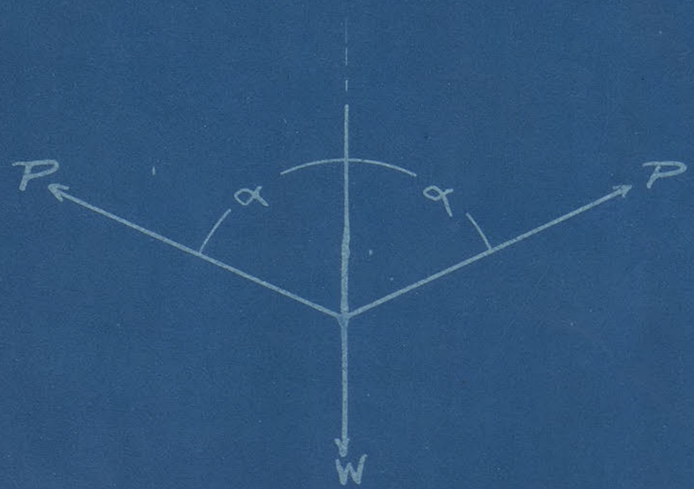


Fig. 2. $\alpha = 75°30'$

ANGLE of BELTS on DYNAMOMETER.

LATHE TOOLS.

Diamond Nose.

Fig. 3.

Round Nose.

Fig. 4.

A = Angle of Clearance.
R = Angle of Rake.

A. J. R.

TOOLS USED IN TESTS.

ROUND-NOSE.

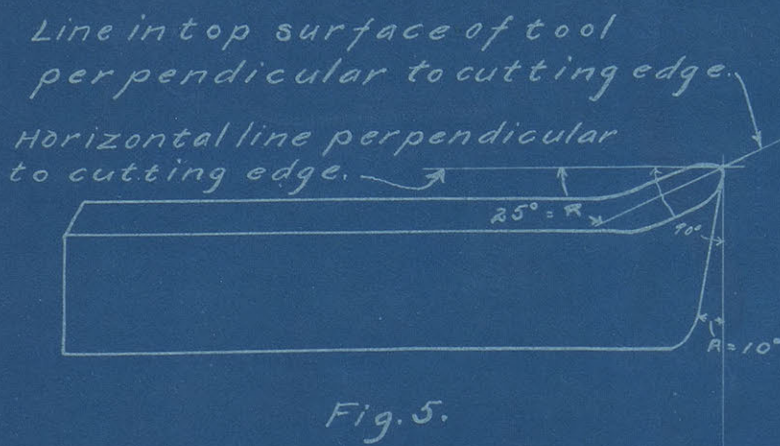


Fig. 5.

R = 25°

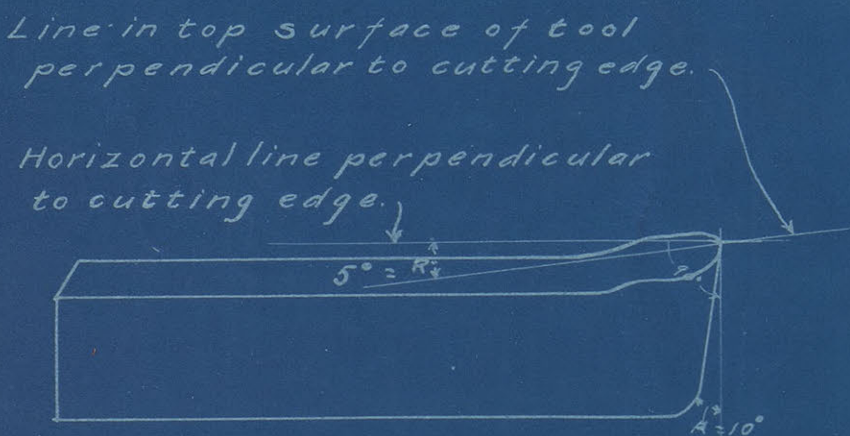


Fig. 6.

R = 5° = Angle of Rake.

DIAMOND-NOSE.

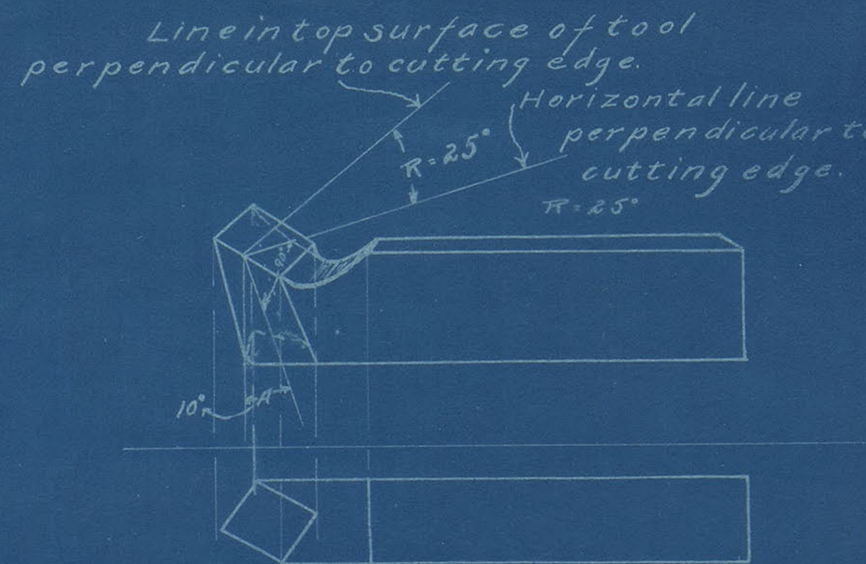
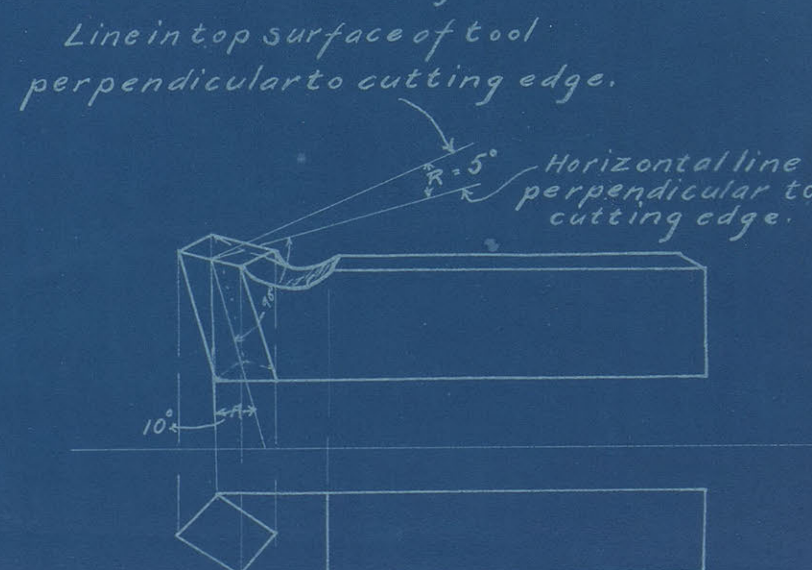


Fig. 7.



R = Angle of Rake = 5°

Fig. 8.

Note:– A = Angle of Clearance = 10° for all tools. – Only angle of Rake R = 25° and R = 5° given above.

A. J. R. -7-10-05.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

LOG OF ~~ROPE~~ PRONY BRAKE.

Test made at K.S.A.C. Laboratory

On Dynamometer

Date April, 11-14 '05

CONSTANTS OF BRAKE.

Length of Arm ~~Radius of pulley~~ 2.632 ~~in~~ ft.

Weight of brake 40 ~~lbs.~~ ozs.

Weight on brake 31 ~~lbs~~ ozs.

Brake constant 35.5 ozs.

OBSERVER~~S~~: A.J. Rhodes.

Number of Reading.	R. P. M.	Balance Reading. lbs. ozs.	B. H. P.	Remarks.
1	348	3 - 5	.191	35.5 ozs. tobe subtracted from
2	348	4 - 10	.421	each Balance Reading.
3	346	6 - 2	.677	
4	345	7 - 8	.913	
5	340	8 - 13	1.123	
6	342	10 - 1½	1.35	
7	344	11 - 6	1.578	
8	338	12 - 9	1.752	
9	342	13 - 15	2.00	
10	339	15 - 1	2.181	
11	339	16 - 5	2.39	
12	340	17 - 9	2.61	
13	340	18 - 11	2.806	
14	342	19 - 15	3.037	
15	342	21 - 5½	3.284	
16	341	22 - 9	3.476	
17	340	24 -	3.711	
18	335	25 - 8	3.802	
19	322	26 - 11	3.949	
	348			Running Idle.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

CALIBRATION LOG ~~OF ROPE~~ WITH PRONY BRAKE.

Test made at K.S.A.C. Laboratory

On Dynamometer

Date April, 11-14.-'05

CONSTANTS OF BRAKE.

~~Radius of pulley~~ .... in.

~~Weight of brake~~ .... lbs.

~~Weight on brake~~ .... lbs

~~Brake constant~~ ....

OBSERVERS: A.J. Rhodes.

Number of Reading.	R. P. M. Dynamometer	Scale. ~~Balance~~ Reading. (lbs.)	B. H. P. / Dyn. H.P.	Dynamometer H.P.	Remarks.
1	348	2.5	.845	.226	Angle of belt on the Dynamom-
2	348	5.	.929	.452	eter = 75° 30'.
3	346	7.5	1.00	.673	
4	345	10.	1.02	.895	
5	340	12.5	1.02	1.103	Effective Diameter of Wheel = 16.36"
6	342	15.	1.01	1.331	
7	344	17.5	1.01	1.562	
8	338	20.	.998	1.754	Diameter of Wheel = 16.16"
9	342	22.5	1.03	1.996	Thickness of belt = .20"
10	339	25	.992	2.199	16.36"
11	339	27.5	.989	2.419	
12	340	30	.988	2.646	
13	340	32.5	.979	2.867	
14	342	35.	.979	3.106	
15	342	37.5	.987	3.326	
16	341	40.	.982	3.538	
17	340	42.5	.989	3.749	
18	335	45.	.972	3.912	
19	322	47.5	.995	3.968	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MACHINE-TOOL TEST.

MADE AT Manhattan Kansas.
K.S.A.C. Laboratory
ON 30" Lathe. (MACHINE AND SIZE.)
DATE No. (1.2) May 27, (3) May 24, (4) May 25, '05 Hard Cast Iron, Close Grain. (KIND AND NATURE OF MATERIAL.)

OBSERVERS: A.J. Rhodes.

No.	Dimensions of Stock. (Diameter or thickness.)		Cut.	Feed.	R. P. M.			Scale Reading. (lbs.)	H. P.		Remarks.
	Original.	Final.			Dyn.	Counter Shaft.	Spindle.		Total.	Per cubic inch metal removed per minute.	
(1.) 1					283			.00			Rex Tool Round Nose.
2	8 21/64	8 20/64	1/128"	1/16	283		10	1.6	.119	1.022	Angle of Clearance 10° (80°)
3	8 20/64	8 18/64	1/64	"	282		10.5	2.4	.176	.697	" " Rake 5° (85°)
4	8 18/64	8 15/64	3/128	"	289		11.	3.4	.255	.687	Angle of cutting edge with axis of
5	8 15/64	8 11/64	1/32	"	284		10.5	4.5	.332	.642	stock = 90°.
6	8 11/64	8 6/64	5/128	"	287		10.5	5.4	.403	.694	Diameter of Round-nose = 9/16"
(2.) 1					287			.00			
2	8 6/64	8 2/64	1/32	1/16	287		10.5	4.55	.336	.672	Angle of Clearance 10° (80°)
3	8 6/64	8 2/64	"	1/14	289		10.5	4.9	.368	.630	" " Rake 5° (85°)
4	8 6/64	8 2/64	"	1/13	285		10.5	5.15	.378	.603	3 cuts horizontally 1/32" deep — in six
5	8 2/64	7 62/64	"	1/12	284		10.	5.4	.398	.622	trials diameter was decreased
6	8 2/64	7 62/64	"	1/11	285		10.5	5.7	.422	.570	only 8/64".
7	8 2/64	7 62/64	"	1/10	282		10.25	6.1	.447	.558	
(3) 1					290			.00			Rex Tool Diamond Nose.
2	4 26/64	4 25/64	1/128"	1/16	290		44.5	2.8	.211	.777	Angle of Clearance 10° (80°)
3	4 25/64	4 23/64	1/64	"	283		41	3.9	.288	.553	" " Rake 5° (85°)
4.	4 23/64	4 20/64	3/128	"	280		43	5.3	.386	.508	Angle of cutting edge with
5	4 20/64	4 16/64	1/32	"	280		41	7.2	.524	.506	axis of stock 73°30'.
6	4 16/64	4 11/64	5/128	"	293		44.5	8.4	.639	.504	
(4.) 1					275			.00			
2	4 28/64	4 24/64	1/32	1/16	273		43	4.00	.285	.281	Angle of Clearance - 10° (80°)
3	4 24/64	4 20/64	"	1/14	268		43	4.40	.306	.246	" " Rake 5° (85°)
4	4 20/64	4 16/64	"	1/13	275		43	4.60	.329	.249	
5	4 16/64	4 12/64	"	1/12	278		42.5	4.70	.339	.240	
6	4 12/64	4 8/64	"	1/11	275		42.75	5.60	.400	.256	
7	4 8/64	4 4/64	"	1/10	275		42.5	5.80	.414	.245	

DEPARTMENT OF MECHANICAL ENGINEERING., K. S. A. C.

MADE AT Manhattan Kansas.
K.S.A.C. Laboratory
ON 30" Lathe.
(MACHINE AND SIZE.)

MACHINE-TOOL TEST.

OBSERVERS:
A. J. Rhodes.

DATE No (1, 2) May 27, (3, 4) May 25-'05 Hard Cast Iron Close Grain
(KIND AND NATURE OF MATERIAL.)

No.	Dimensions of Stock. (Diameter or thickness.)		Cut.	Feed.	R. P. M.			Scale Reading. (lbs.)	H. P.		Remarks.
	Original.	Final.			Dyn.	Counter Shaft.	Spindle.		Total.	Per cubic inch metal removed per minute.	
(1.) 1					278			.00	.072	Empty	Rex Tool Round Nose.
2	6 59/64	6 58/64	1/128"	1/16	277		10.5	1.6	.115	1.14	Angle of Clearance 10° (80°)
3	6 58/64	6 56/64	1/64	"	281		10.5	2.0	.146	.699	" " Rake 10° (80°)
4	6 56/64	6 53/64	3/128	"	277		10.5	3.0	.216	.742	Angle of cutting edge with
5	6 53/64	6 49/64	1/32	"	277		10.5	3.4	.245	.583	axis of stock 90°
6	6 49/64	6 44/64	5/128	"	288		10.5	3.7	.277	.582	Diameter of Round-nose 9/16"
(2.) 1					286			.00			
2	6 44/64	6 40/64	1/32	1/16	284		10.5	3.0	.221	.531	Angle of Clearance 10° (80°)
3	6 44/64	6 40/64	"	1/14	285		10.5	3.3	.244	.508	" " Rake 10° (80°)
4	6 44/64	6 40/64	"	1/13	294		11	3.6	.275	.509	3 horizontal cuts 1/32" deep.
5	6 40/64	6 36/64	"	1/12	289		10.5	4.2	.315	.571	
6	6 40/64	6 36/64	"	1/11	281		10.	4.8	.350	.606	Angle of cutting edge with axis
7	6 40/64	6 36/64	"	1/10	277		10.5	5.0	.360	.537	of stock 90°.
(3.) 1					275			.00			Rex Tool Diamond Nose.
2	4 4/64	4 3/64	1/128"	1/16	275		39	11.1	.793	3.58	Angle of Clearance 10° (80°)
3	4 3/64	4 1/64	1/64	"	270		42.75	7.4	.519	1.03	" " Rake 10° (80°)
4	4 1/64	3 62/64	3/128	"	273		45	5.0	.355	.494	Angle of cutting edge with axis of
5	3 62/64	3 58/64	1/32	"	278		44	3.4	.246	.242	Stock 60°.
6	3 58/64	3 53/64	5/128	"	280		40	13.3	.967	.942	Trial (4) was checked - same results.
(4.) 1					286			.00			
2	3 25/32	3 23/32	1/32	1/16	281		44.5	5.5	.402	.408	Angle of Clearance 10° (80°)
3	3 23/32	3 21/32	"	1/14	280		44	5.85	.426	.380	" " Rake 10° (80°)
4	3 21/32	3 19/32	"	1/13	280		43	6.2	.451	.391	
5	3 19/32	3 17/32	"	1/12	279		43	6.4	.464	.378	Angle of cutting edge with
6	3 17/32	3 15/32	"	1/11	287		45.5	7.1	.529	.378	axis of stock 60°.
7	3 15/32	3 13/32	"	1/10	287		45	7.7	.577	.391	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT Manhattan Kansas.
K.S.A.C. Laboratory

MACHINE-TOOL TEST.

OBSERVERS: A.J. Rhodes.

ON 30" Lathe. (MACHINE AND SIZE.)

DATE No. (1.2) May 27 (3) May 25 (4) May 26 -'05 Hard Cast Iron Close Grain. (KIND AND NATURE OF MATERIAL.)

No.	Dimensions of Stock (Diameter or thickness.) Original.	Final.	Cut.	Feed.	R. P. M. Dyn.	Counter Shaft.	Spindle.	Scale Reading. (lbs.)	H. P. Total.	Per cubic inch metal removed per minute.	Remarks.
(1.) 1					290			.00			
2	7 18/64	7 17/64	1/128	1/16	287		11	1.0	.075	.668	Rex Tool Round Nose.
3	7 17/64	7 15/64	1/64	"	287		11	1.7	.127	.636	Angle of Clearance 10° (80°)
4	7 15/64	7 12/64	3/128	"	287		11	2.2	.164	.506	" " Rake 15° (75°)
5	7 12/64	7 8/64	1/32	"	284		11	2.8	.207	.445	Angle of cutting edge with axis of stock 90°
6	7 8/64	7 3/64	5/128	"	285		11	3.1	.230	.433	Diameter of Round-nose 9/16".
(2.) 1					283			.00			
2	7 3/64	6 63/64	1/32	1/16	283		10.5	3.0	.221	.507	
3	7 3/64	6 63/64	"	1/14	287		10.5	3.3	.246	.484	Angle of Clearance 10° (80°)
4	7 3/64	6 63/64	"	1/13	283		10.5	3.75	.276	.505	" " Rake 15° (75°)
5	6 63/64	6 59/64	"	1/12	284		10.5	4.0	.295	.508	Angle of cutting edge with axis of stock 90°
6	6 63/64	6 59/64	"	1/11	280		10.5	4.2	.306	.478	3 horizontal cuts 1/32" Dia. decreased only 8/64
7	6 63/64	6 59/64	"	1/10	282		10.75	4.75	.348	.482	Diameter of Round-nose 9/16
(3.) 1					280			2,00 - Power to run lathe-carriage empty			
2	3 26/64	3 25/64	1/128"	1/16	288		45.75	1.5	.113	.525	Rex Tool Diamond Nose.
3	3 25/64	3 23/64	1/64	"	290		45.75	2.85	.215	.481	Angle of Clearance 10° (80°)
4	3 23/64	3 20/64	3/128	"	288		46.5	3.95	.296	.469	" " Rake 15° (75°)
5	3 20/64	3 16/64	1/32	"	287		46.5	5.1	.380	.435	Angle of cutting edge with axis of stock 60°.
6	3 16/64	3 11/64	5/128	"	287		46	5.95	.444	.444	
(4.) 1					280			.00			
2	3 11/64	3 7/64	1/32	1/16	280		44	3.8	.276	.339	
3	3 7/64	3 3/64	"	1/14	283		43.5	4.55	.335	.362	Angle of Clearance 10° (80°)
4	3 3/64	2 63/64	"	1/13	277		44	4.95	.356	.362	" " Rake 15° (75°)
5	2 63/64	2 59/64	"	1/12	278		44.5	5.2	.376	.361	Angle of cutting edge with axis of stock 60°.
6	2 59/64	2 55/64	"	1/11	281		45	5.5	.402	.355	
7	2 55/64	2 51/64	"	1/10	280		43	5.9	.429	.368	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT Manhattan Kansas
K.S.A.C. Laboratory
ON 30" Lathe.
(MACHINE AND SIZE.)

MACHINE-TOOL TEST.

OBSERVERS: A.J. Rhodes.

DATE No(1,2) May 27 (3,4) May 26-'05 Hard Cast Iron Close Grain.
(KIND AND NATURE OF MATERIAL.)

	No.	Dimensions of Stock. (Diameter or thickness.) Original.	Final.	Cut.	Feed.	R. P. M. Dyn.	Counter Shaft.	Spindle.	Scale Reading. (lbs.)	H. P. Total.	Per cubic inch metal removed per minute.	Remarks.
(1.)	1					275			.00			Rex Tool Round Nose.
	2	7 39/64	7 38/64	1/128"	1/16	286		10.5	1.1	.082	.737	Angle of Clearance 10° -(80°)
	3	7 38/64	7 36/64	1/64	"	284		10.5	1.7	.125	.545	" " Rake 20° -(70°)
	4	7 36/64	7 33/64	3/128	"	281		11	2.1	.153	.454	Angle of cutting edge with axis
	5	7 33/64	7 29/64	1/32	"	281		11	2.4	.175	.361	of stock 90°.
	6	7 29/64	7 24/64	5/128	"	286		10.5	2.8	.208	.395	Diameter of Round-nose 9/16".
(2.)	1					285			.00			
	2	7 24/64	7 20/64	1/32	1/16	284		10.5	2.0	.148	.324	Angle of Clearance 10° (80°)
	3	7 24/64	7 20/64	"	1/14	286		10.5	2.5	.186	.349	" " Rake 20° (70°)
	4	7 24/64	7 20/64	"	1/13	287		10.5	3.1	.231	.405	Angle of cutting edge with axis
	5	7 20/64	7 16/64	"	1/12	282		10.5	3.35	.245	.401	of stock 90°
	6	7 20/64	7 16/64	"	1/11	287		10.5	3.7	.276	.400	3 horizontal cuts 1/32" deep - de-
	7	7 20/64	7 16/64	"	1/10	295		10.5	4.2	.322	.434	creasing diameter of stock 8/64
(3.)	1					286			.00			Rex Tool Diamond Nose.
	2	2 44/64	2 43/64	1/128"	1/16	284		45	0.8	.059	.358	Angle of Clearance 10° (80°)
	3	2 43/64	2 41/64	1/64	"	280		44.5	2.0	.146	.428	" " Rake 20° (70°)
	4	2 41/64	2 38/64	3/128	"	280		44	2.9	.211	.457	Angle of cutting edge with
	5	2 38/64	2 34/64	1/32	"	280		44	3.45	.251	.365	axis of stock 60°.
	6	2 34/64	2 29/64	5/128	"	277		44	4.2	.302	.413	
(4.)	1					278			.00			
	2	2 29/64	2 25/64	1/32	1/16	277		44	3.25	.234	.374	Angle of Clearance 10° (80°)
	3	2 25/64	2 21/64	"	1/14	285		44.5	3.3	.244	.339	" " Rake 20° (70°)
	4	2 21/64	2 17/64	"	1/13	280		110	13.3	.966	.520	Increased speed of lathe - stock small.
	5	2 17/64	2 13/64	"	1/12	290		112	13.4	1.01	.506	Angle of cutting edge with
	6	2 13/64	2 9/64	"	1/11	286		110	14.2	1.06	.503	axis of stock 60°.
	7	2 9/64	2 5/64	"	1/10	286		74	7.	.520	.344	Decreased speed one cone.

DEPARTMENT OF MECHANICAL ENGINEERING., K. S. A. C.

MADE AT Manhattan Kansas K.S.A.C. Laboratory

MACHINE-TOOL TEST.

OBSERVERS: A.J. Rhodes.

ON 30" Lathe (MACHINE AND SIZE.)

DATE No. 1, 2, 3, 4 May 26 May 27 - 1905 Hard Cast Iron Close Grain (KIND AND NATURE OF MATERIAL.)

	No.	Dimensions of Stock. (Diameter or thickness.)		Cut.	Feed.	R. P. M.			Scale Reading. (lbs.)	H. P.		Remarks.
		Original.	Final.			Dyn.	Counter Shaft.	Spindle.		Total.	Per cubic inch metal removed per minute.	
(1.)	1					290			.00			Rex Tool Round Nose.
	2	7 62/64	7 61/64	1/128"	1/16	290		10.5	1.3	.098	.846	Angle of Clearance 10° (80°)
	3	7 61/64	7 59/64	1/64	"	290		10.5	2.95	.222	.923	" " Rake 25° (65°)
	4	7 59/64	7 56/64	3/128	"	289		10.5	4.3	.323	.961	Angle of cutting edge with
	5	7 56/64	7 54/64	1/32	"	293		10.25	5.7	.434	.918	axis of stock 90°
	6	7 54/64	7 47/64	5/128	"	293		10.25	7.1	.540	1.00	Diameter of Round-nose 9/16.
(2.)	1					275			.00			
	2	7 47/64	7 43/64	1/32	1/16	280		11	3.2	.233	.467	Angle of Clearance 10° (80°)
	3	7 47/64	7 43/64	"	1/14	275		10.5	3.3	.236	.423	" " Rake 25° (65°)
	4	7 47/64	7 43/64	"	1/13	276		10.	4.5	.323	.568	3 horizontal cuts 1/32" deep.
	5	7 43/64	7 39/64	"	1/12	277		10.	5.3	.381	.626	Angle of cutting edge with
	6	7 43/64	7 39/64	"	1/11	271		10.	6.0	.422	.630	axis of stock 90°.
	7	7 43/64	7 39/64	"	1/10	273		10.	6.8	.482	.652	
(3.)	1					285			.00			Manganese Tool Diamond Nose.
	2	8 28/64	8 27/64	1/128"	1/16	286		10.5	1.5	.112	.905	Angle of Clearance 8° (82°)
	3	8 27/64	8 25/64	1/64	"	295		11	2.15	.165	.615	" " Rake 25° (65°)
	4	8 25/64	8 22/64	3/128	"	288		11	2.3	.172	.458	Angle of cutting edge with axis
	5	8 22/64	8 18/64	1/32	"	292		10	3.2	.243	.495	of stock 60°.
	6	8 18/64	8 13/64	5/128	"	287		10.5	3.9	.291	.495	
	7	8 13/64	8 7/64	3/64	"	285		10.5	9.0	.666	.895	1/64 Taken off after the 3/64 cut.
(4.)	1					292			.00			Manganese Tool Diamond Nose
	2	8 6/64	8 2/64	1/32	1/16	286		10	2.45	.182	.382	Angle of Clearance 8° (82°)
	3	8 6/64	8 2/64	"	1/14	288		10	2.85	.213	.383	" " Rake 25° (65°)
	4	8 6/64	8 2/64	"	1/13	285		11	3.0	.222	.338	Angle of cutting edge with
	5	8 2/64	7 62/64	"	1/12	286		11	3.4	.253	.358	axis of stock 60°
	6	8 2/64	7 62/64	"	1/11	284		10.5	3.6	.266	.362	3 horizontal cuts 1/32 deep - in
	7	8 2/64	7 62/64	"	1/10	270		10.5	4.3	.302	.370	6 trials only decreasing Dia. 8/64"