ANGLO AMERICAN RESEARCH LABORATORIES (PTY) LTD

AARL PROJECT NO. S/94/1080 REPORT NO. 2

AUTOGENOUS MILLING TESTWORK ON PREMIER ORE USING PIN LIFTERS

1.0 INTRODUCTION

Pin lifter design is credited to Dr Vladimir G. Kotchner of Technique and Technology of Disintegration Co. Ltd., St Petersburg, Russia.

The liners consist of four different castings, each numbered. These different castings consist of rows of protruding pins, the pins in succeeding rows having different diameters and lengths compared to the preceding and following rows. The liners are thinner than conventional smooth liners and increased the mill volume by 1,05%.

The pin lifter liners are used without lifter bars since the pins act as lifters. They also serve to protect smaller liberated particles from further impact crushing.

The pin lifter liners are widely used on Russian diamond mines.

2.0 SAMPLE PREPARATION

Thirteen tons of -250 mm ROM Premier Ore was delivered to the Anglo American Pilot Plant in Verwoerdburg. It was sorted into five size fractions.

The feed size distribution that was reported in the AARL Project No. S/94/1080, Report No. 1 was used for this testwork.

3.0 MILLING CIRCUIT

The circuit was set up the same as for Tests T, U and V except that the mill was lined with pin lifters. The mill was run at an indicated 75% of critical speed but due to the pin lifters being slightly thinner the actual internal diameter of the mill was slightly larger and the per cent of critical speed was calculated at 76%.

The trommel screen oversize was screened into two fractions. The +8 -25 mm fraction was crushed in a jaw crusher to -10 mm and the +25 mm fraction was returned to the mill.

4.0 TESTWORK STRATEGY

The philosophy during the testwork was to maximise the steady state total mill throughput (new feed plus circulating loads) in order to minimise the retention time a liberated diamond would have in the mill. Power efficiency was not the prime concern. Another aim was to produce the maximum amount of -1mm material. This material is discarded and thus reduces the capacity requirements of the DMS plant.

5.0 RESULTS AND DISCUSSION

Details results are presented in Appendix I.

TABLE II

SUMMARY OF RESULTS

Test	Feed Rate (kg/h)	% of Feed to Vibrating Screen OS	% Circulating Load	Net Power (kW)	Energy Cons In Mill (kW.h/t)
1	1229	20,1	150,9	7,2	5,85
2	1229	21,2	147,2	7,2	5,85
3	1229	28.8	140.5	7,2	5,85
4	1229	27.6	124.6	7.2	5,85

The results show a 76% increase in throughput (700 kg/h with smooth liners) and a 55% decrease in energy consumption (13,0 kW.h/t with smooth liners). Approximately the same percentage of the feed reports to the vibrating screen oversize. The circulating load was lower than with the conventional smooth liners (> 200 %).

The empty mill power draught was 2,7 kW.

At the end of the test the mill load volume was measured and calculated to be 32.6%. The load was sized.

TABLE III

SIZE DISTRIBUTION OF THE MILL LOAD

Size (µm)	Mass (kg)	Per Cent
-150	72,8	7,98
-150 +100	227,2	24,91
-100 + 80	142,0	15,57
- 80 + 60	138,6	15,19
- 60 + 40	124,4	13,64
- 40 + 20	83,4	9,14
- 20	123,8	13,57
TOTALS	912,2	100,00

It is possible that the material received from Premier Mine was softer than that previously tested which would have contributed to the significant increase in throughput.

It was noted that the pin lifters lift the material higher causing more impact breakage than the smooth liners with lifter bars at the same mill speeds.

The size distribution of the mill load at the end of the run shows, as with the smooth liners and lifter bars, a slight build up of material in the +100mm size range. This is not as pronounced as with the smooth liners but the fraction may still have to be removed from the circuit to avoid a critical size build-up. Pebble crushing would then have to be implemented, since the normal solution of adding steel balls is not an option.

6.0 RECOMMENDATIONS

Large scale tests on both liner configurations are required to ascertain which promotes greater diamond liberation with minimum diamond breakage. Allowance must be made to feed sufficient material (almost double the feed rate) to the mill when pin lifters are tested. The installed power with conventional liners will be sufficient since the power draught when using pin lifters is considerably less.

Wear of the pins was not noticeable after this test run, however, after a 24 hour run with quartzite the edges of the pins had been rounded off. Only long term testwork will establish the wear rates of the pin lifters and smooth liners with kimberlitic material.

INVESTIGATED AND REPORTED BY:

D.R. Cutmore

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PROJECT LEADER : COMMINUTION

DRC/SGK/MLC/lor/open

Trommel screen undersize

	1		2		3		4	
Size (um)	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%
+2362	20.58	100.00	19.83	100.00	23.82	100.00	18.81	100.00
-2362+1651	5.54	79.41	4.18	80.17	5.28	76.18	4.30	81.19
-1651+1168	5.59	73.99	4.28	75.99	5.14	70.90	4.24	76.89
-1168+833	5.93	68.40	4.55	71.71	5.14	65.76	4.54	72.65
-833+589	5.86	62.47	5.15	67.16	5.28	60.62	4.67	68.11
-589+417	7.11	56.61	6.78	62.01	6.94	55.34	6.67	63.44
-417+295	6.26	49.50	6.80	55.23	6.06	48.40	6.50	56.77
-295+208	5.09	43.25	5.30	48.43	4.63	42.34	5.83	50.27
-208+147	4.72	38.16	5.68	43.13	4.40	37.71	6.00	44.44
-147+104	4.05	33.44	4.55	37.45	3.82	33.31	5.34	38.44
-104+74	2.76	29.39	3.10	32.90	2.67	29.49	3.60	33.10
-74+53	3.34	26.63	4.58	29.80	3.92	26.82	4.12	29.50
-53+43	1.32	23.29	1.63	25.22	1.18	22.90	1.47	25.38
-42+37	0.78	21.97	1.05	23.59	0.64	21.72	0.97	23.91
-37	21.19	21.19	22.54	22.54	21.08	21.08	22.94	22.94

Trommel screen oversize

	1		2		3		4	
Size (mm)	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%
+35	10.52	100.00	9.57	100.00	6.81	100.00	8.25	100.00
-35+20	58.13	89.48	53.24	90.43	60.90	93.19	53.58	91.75
-20+14	5.65	31.35	7.62	37.19	7.78	32.29	7.86	38.17
-14+10	7.90	25.70	9.44	29.57	8.42	24.51	10.61	30.31
-10+6	13.24	17.8	16.27	20.13	13.25	16.09	16.21	19.7
-6	4.56	4.56	3.86	3.86	2.84	2.84	3.49	3.49

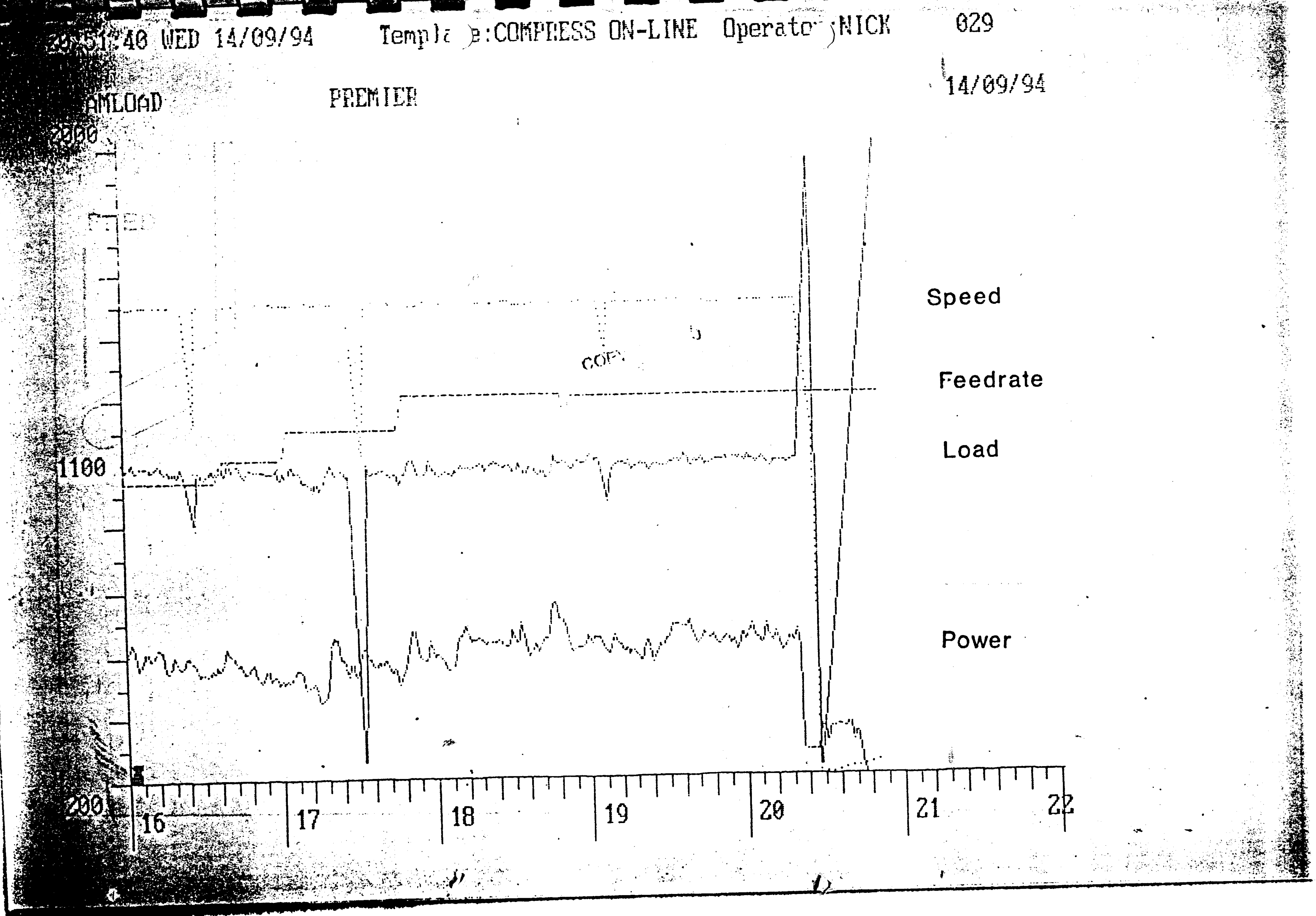
Vibrating screen undersize

	1		2		3		4	
Size (um)	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%
+1651	0.09	100.00	0.03	100.00	0.00	100.00	0.03	100.00
-1651+1168	0.17	99.91	0.13	99.97	0.05	100.00	0.06	99.97
-1168+833	0.51	99.74	0.36	99.84	0.32	99.95	0.33	99.91
-833+589	4.91	99.23	4.17	99.48	4.07	99.63	4.54	99.58
-589+417	9.07	94.32	8.47	95.31	9.04	95.56	9.50	95.04
-417+295	11.25	85.25	9.53	86.84	2.00	86.52	9.89	85.54
-295+208	9.79	74.00	8.77	77.31	9.69	76.47	8.68	75.65
-208+147	7.88	64.21	8.93	68.54	9.64	66.78	8.09	66.97
-147+104	7.77	56.33	7.91	59.61	8.03	57.14	7.23	58.88
-104+74	4.40	48.56	5.23	51.70	4.65	49.11	4.57	51.65
-74+53	6.58	44.16	6.45	46.47	7.70	44.46	5.75	47.08
-53+43	1.88	37.58	1.98	40.02	2.00	36.76	2.20	41.33
-42+37	1.57	35.70	1.55	38.04	1.73	34.76	1.38	39.12
-37	34.13	34.13	36.49	36.49	33.03	33.03	37.74	37.74

Vibrating screen oversize

	1		2		3		4	
Size (um)	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%	Percent	Cum.%
+2362	67.87	100.00	59.44	100.00	56.90	100.00	57.92	100.00
-2362+1651	9.02	32.13	11.36	40.56	13.80	43.10	13.88	42.08
-1651+1168	9.15	23.11	11.06	29.20	12.01	29.30	12.13	28.20
-1168+833	9.08	13.96	11.73	18.14	10.97	17.29	10.39	16.07
-833+589	3.58	4.88	4.72	6.41	4.59	6.32	4.29	5.68
-589+417	0.93	1.30	1.20	1.69	1.20	1.73	1.10	1.39
-417+295	0.24	0.37	0.27	0.49	0.27	0.53	0.20	0.29
-295+208	0.07	0.13	0.10	0.22	0.07	0.26	0.03	0.09
-208+147	0.03	0.06	0.03	0.12	0.03	0.19	0.03	0.06
-147+104	0.03	0.03	0.03	0.09	0.03	0.16	0.03	0.03
-104+74	0.00	0.00	0.03	0.06	0.07	0.13	0.00	0.00
-74+53	0.00	0.00	0.03	0.03	0.03	0.06	0.00	0.00
-53+43	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00
-42+37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1	2	3	4
Feed kg/h	1229	1229	1229	1229
Vs u/s	933	853	728	947
Vs o/s	334	260	354	339
Tr u/s	1413	1050	1080	1237
Tr o/s	1854	1809	1726	1532
% to Vs o/s	20.1	21.2	28.8	27.6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14/09/94
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16
17
18
19
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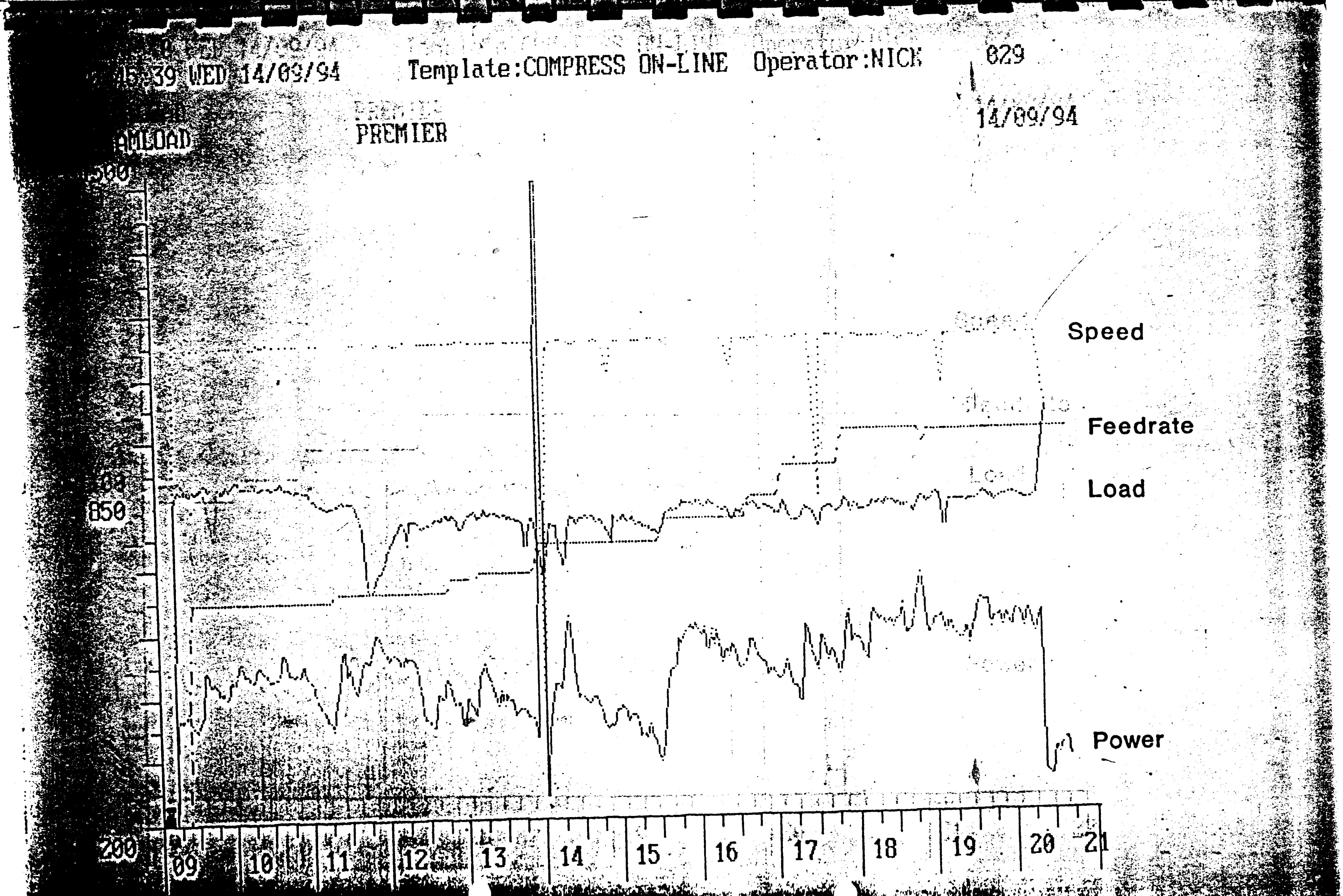
Speed
Feedrate
Load
Power



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Operator:NICK
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14/09/94
AMLOAD
PREMIER
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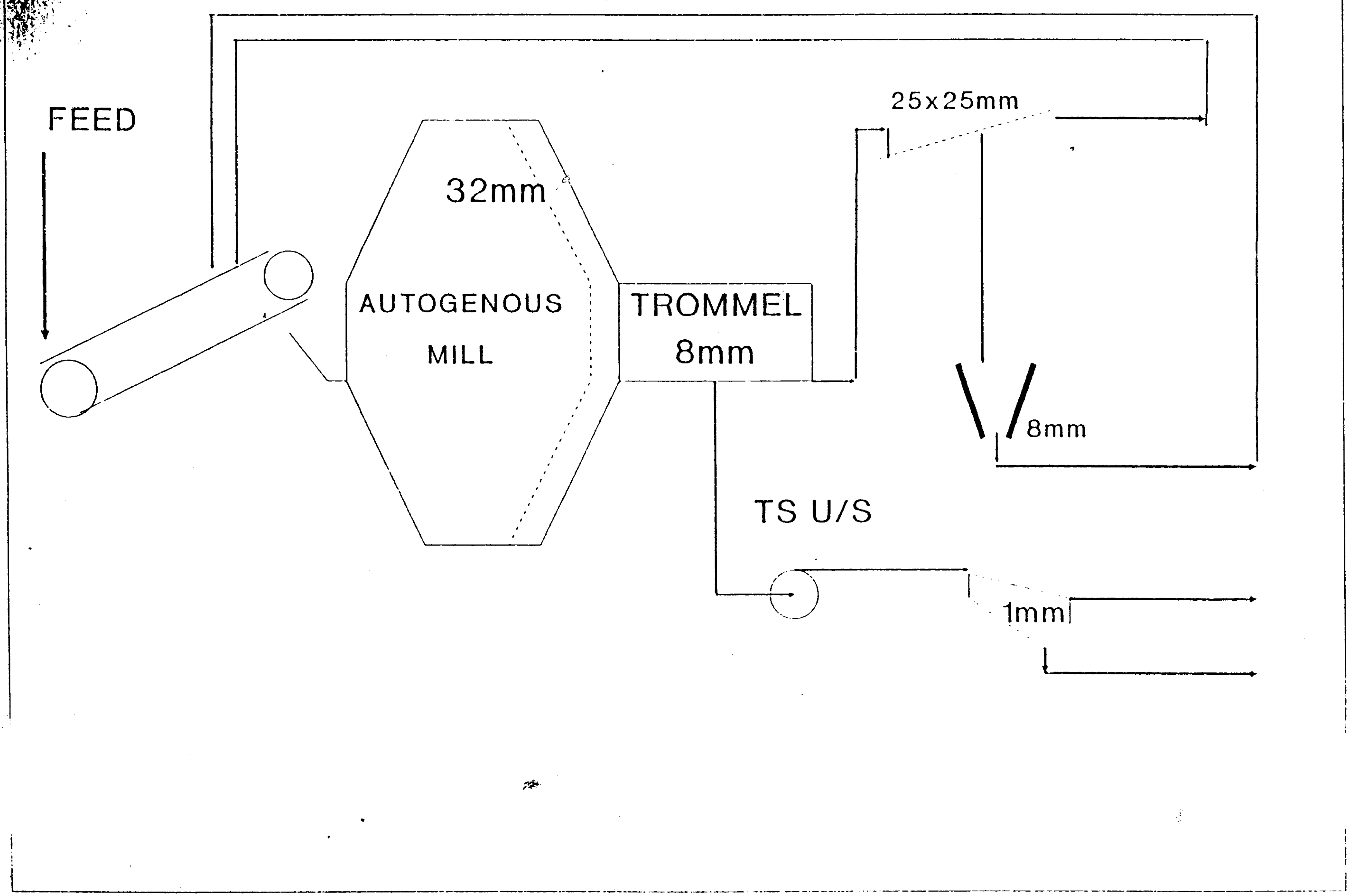
Speed
Feedrate
Load
Power


FEED
32mm
AUTOGENOUS
MILL
TROMMEL
8mm
25x25mm
8mm
TS U/S
1mm

SUMMARY OF RESULTS

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