Wirtgen America, Inc. v. Caterpillar, Inc. VV **Petitioner's Demonstratives** WIRTGEN

December 11, 2023

IPR2022-01397 U.S. Patent No. 9,975,538

Wirtgen Exhibit 1029 **Demonstrative Exhibit – Not Evidence**



	Challenged Claims	Asserted References
Ground 1	1-13	Willis (Ex. 1005), Xing (Ex. 1006)
Ground 2	8 and 13	Willis (Ex. 1005), Xing (Ex. 1006), and Laux (Ex. 1012)

US 9,975,538 – Milling Machine Fuel Efficiency Control System



Wirtgen EX1001 U.S. Patent No. 9,975,538 VV



US009975538B2

- /	Unite Aardem		ates Pa	tent		Patent Date of			975,5. May 22	38 B2 2, 2018
4)	MILLING		HNE FUEL E EM	FFICIENCY		1	B60W	50W 10/06; 2710/1038; 710/0644; B	B60W 27	10/1005
1)	Applicant:		PILLAR PAU UCTS INC., B	/ ING rooklyn Park, 1	MN Se	e applicati			7/088; F1	6H 47/0-
		1031			(56)		Referen	ices Cited		
2)	Inventor:	James . (US)	A. Aardema, P	lymouth, MN		U.S.	PATENT	DOCUME	NTS	
3)	Assignee:	Caterpi	illar Paving Pr	roducts Inc.,	6.92	1.230 B2*	7:2005	Selay	E0	
		Brookly	n Park, MN (U	JS)	7.43	4.889 B2*	10:2008	Moller		299.1. 3D 59:00
)	Notice:			ner, the term of adjusted under	this 8.40	6,838 B2+		Willis		299/1. 1C 23:08
			154(b) by 252			6,105 B2	6/2013	Parker		299.1.
					8.62	2,871 B2	1/2014	Hoff		
1)	Appl. No.	: 14/715,	204			7,446 B2* 26910 A1*		Killion Brome		ID 41/12
2)	Filed:	May 18	, 2015		2007/01	50166 AI	6:2007	Mino et al.		460.1
5)		Prior	Publication I	Data		73740 AI*		Parker	E0	1C 23/08 241-3
	US 2016/0					79999 AI 55212 AI*		Killion et al. Kato		16H 47/0
I)	Int. Cl.									475 5
	B60W 10/ B60W 10/		(2012.01) (2006.01)		* cited b	y examine	r			
	B60W 10/		(2006.01) (2012.01)		Primary	Examiner	- David	J Hlavka		
	B60W 30/		(2012.01)		(74) And	macy: Age	nt, or Fie	m – Miller.	Matthias	& Hull
	F16H 47A		(2006.01)		(57)		ABS	FRACT		
2)	F16H 37A U.S. Cl.	08	(2006.01)		A contro	ller-impler		ethod of cor	trolling a	machin
8)	CPC ((201 27/ Field of C	2013.01) 30/1 (3.01): Be 0/1038 (F16H	. B60W 10/115 1882 (2013.01); 50W 2710/1005 2013.01); F16F 2037/088 (201 (2013.01); F02 tion Scarch	501); B60W 16 5 (2013.01); B6 5 (2013.01); B6 5 (2013.01); B6 6 (2013.01); B6 6 (2013.01); B6 7 10/84 (2013.1 9 30/188; B6	www.self transmission GHV method r GHV mining a GHV speed of (11): speed of V56 of the va .01) the desir	aton is p may includ in engine the engin defined eff riable tran ed rotor sp	e receivin load of the c based of iciency p smission seed.	an engine t The contr ng a desired the engine, and on the engine outs, and add based on the Drawing Sh	roller-imp rotor spe djusting a e load ar justing a e engine s	demented ed, deter in engine id one o gear ratio
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Wirtgen EX1001 U.S. Patent No. 9,975,538

(57)

ABSTRACT

A controller-implemented method of controlling a machine having a rotor coupled to an engine through a variable transmission is provided. The controller-implemented method may include receiving a desired rotor speed, determining an engine load of the engine, adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points, and adjusting a gear ratio of the variable transmission based on the engine speed and the desired rotor speed.

EX1001, Abstract.

(54

US 9,975,538 – Focus of Claims

	Unite Aardem		ates Patent	(10) Patent No.: US 9,975,538 B (45) Date of Patent: May 22, 201
54)		G MACHI DL SYSTE	INE FUEL EFFICIENCY EM	10/115; B60W 10/06; B60W 2510/063 B60W 2710/1038; B60W 2710/100 B60W 2710/0644; B60W 10/02; F16
71)	Applicant	CATER	PILLAR PAVING CTS INC., Brooklyn Park, MN	2037/088; F16H 47/
		(US)	C15 LAC, BROOKIYII Park, MN	see apprearion the tot comprete search instory.
72)	Inventor:	James	. Aardema, Plymouth, MN	(56) References Cited
- art	an entor.	(US)	a real of the regenerating with	U.S. PATENT DOCUMENTS
73)	Assignee:		lar Paving Products Inc.	6.921,230 B2* 7:2005 Silay E01C 23:0
		Brooklyr	a Park, MN (US)	299/ 7,434,889 B2 * 10/2008 Moller
*)	Notice:	Subject t	o any disclaimer, the term of this	299. 5 8.408.528.02.4.40513.Willie E01C.23.0
			extended or adjusted under 35	5 299.1
		U.S.C. I	54(b) by 252 days.	8.465.105 B2 6/2013 Parker 8.622.871 B2 1/2014 Hoff
21)	Appl. No.	: 14/715,2	04	9.267.446 B2 * 2:2016 Killion F02D 29 2007/0026910 A1 * 2:2007 Brome A01D 41/1
22)	Filed.	May 18,	2015	46(
		•		2007/0150166 A1 6/2007 Mino et al. 2008/0173740 A1* 7/2008 Parker
65)			Publication Data	241- 2013/0079999 A1 3/2013 Killion et al.
	US 2016/	0339917 A	1 Nov. 24, 2016	2014/0155212 A1* 6/2014 Kato
51)				475
	B60W 10		(2012.01)	* cited by examiner
	B60W 10. B60W 10.		(2006.01) (2012.01)	Primary Examiner David J Hlavka
	B60W 30	188	(2012.01)	(74) Attorney, Agent, or Firm - Miller, Matthias & Hul
	F16H 47A F16H 37A		(2006.01) (2006.01)	(57) ABSTRACT
521	F16H 37A U.S. CL	0.0	(2005.01)	A controller-implemented method of controlling a machi
	CPC	2013.01): 30/18 13.01): B60 10/1038 (2) F16H . (10/103 (2013.01); B60W 10/06 B60W 10/115 (2013.01); B60W 82 (2013.01); B60W 5710/064W 872 (2013.01); B60W 5710/065 (2013.01); B60W 013.01); F16H 47/04 (2013.01); 2037/088 (2013.01); W07T 10/56 2013.01); W07T 10/34 (2013.01) ion Search	 minimission is provided into controller-impediation method may include receiving a desired rotor speed, det mining an engine load of the engine, adjusting an engine speed of the engine based on the engine load and one more predefined efficiency points, and adjusting a gazer ration of the engine based on the engine load and one
Jay			w 10/103; B60W 30/188; B60W	i 13 Claims, 4 Drawing Sheets
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			122	. 126
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Wirtgen EX1001 U.S. Patent No. 9,975,538

What is claimed is: a controller-implemented method of controlling a machine



FIG.2

EX1001, Fig. 2.

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EX1001 ('538 Patent), Fig. 2



The '538 Patent admits the claims are aimed at adding consideration of fuel consumption/efficiency to controlling the rotor speed

variations in the rotor speed. Some milling machines, such as in U.S. Pat. No. 8,645,105 ("Parker"), provide variable transmissions which allow for variations in the engine speed without affecting rotor speed. However, these conventional systems do not further address fuel efficiency, which is another concern that can be adversely affected by variations in engine speed and engine load.

Accordingly, there is a need for improved solutions for controlling and maintaining a desired rotor speed of a milling machine, which also takes fuel consumption or efficiency into consideration. The present disclosure is

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This focus is confirmed by the prosecution history

Parker discloses a cold planer machine including an engine coupled to an infinitely variable transmission via a power take off shaft. Furthermore, the transmission is connected to a drive mechanism which is associated with a cutter drum mounted on the underside of the machine and the rotational speed of the cutter drum is dictated by the output of the infinitely variable transmission. (*See* paragraphs [0023] and [0024] of *Parker*). Additionally, the machine of *Parker* may include a controller that coordinates the control of the infinitely variable transmission to bring the cutter drum speed up to a preset speed. However, the control system of *Parker* is concerned with providing control of the cutter drum speed in relation to the overall travel or ground speed of the machine. (*See Parker*, paragraph [0006]).

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This focus is confirmed by the prosecution history

However, while the drum speed/ground speed ratio may assist in maintaining the cutter drum speed of the machine, *Parker* is silent as to adjusting the engine speed based on engine load and one or more predefined efficiency points that may be at least partially based on predetermined fuel consumption rates. Furthermore, the drum speed/ground speed ratio of *Parker* is focused on maintaining a desired pattern cut into the road. As such, *Parker* is silent as to the drum speed/ground speed ratio being concerned with maintaining a desired rotor speed while also optimizing fuel efficiency. Accordingly, *Parker* fails to disclose "adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads," as now required by amended independent claims 1 and 13 of the present application.



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(12)	Unite Aardem	d States Patent	(10) Pate (45) Date			US 9,975,538 B t: May 22, 201
(54)		G MACHINE FUEL EFFICIENCY AL SYSTEM			B60W	50W 10/06; B60W 2510/063 2710/1038; B60W 2710/100
(71)	Applicant:	CATERPILLAR PAVING PRODUCTS INC., Brooklyn Park, MN	6			710/0644: B60W 10/02: F16 2037/088: F16H 47/
		(US)				r complete search history.
(72)	Inventor:	James A. Aardema, Plymouth, MN	(56)		Referen	ices Cited
1.1415	in callor.	(US)		U.S. 1	ATENT	DOCUMENTS
(73)	Assignee:	Caterpillar Paving Products Inc., Brocklyn Park, MN (US)				Silay
			7.434,889	B2*	10:2008	Moller
(*)	Notice:	Subject to any disclaimer, the term of this patent is extended or adjusted under 35	8.408,838			Willis
		U.S.C. 154(b) by 252 days.	8.465,105 8.627,871	B2 B2	6/2013	Parker Hoff
(21)	Anni No	14/715.204	9.267.446	B2.4	1/2014 2/2016	Killion
(61)	Abbi teas	14715204	2007/0026910	AI^{*}	2/2007	Brome A01D 41/1
(22)	Filed:	May 18, 2015	2007/0150166	AL	6/2007	460 Mino et al.
(65)		Prior Publication Data	2008/0173740		7/2008	Parker E01C 23/0 241
	US 2016/0	0339917 A1 Nov. 24, 2016	2013:0079999 2014:0155212		3:2013 6:2014	Killion et al. Kato F16H 47
(51)	Int. Cl. B60W 10/	(2012.01)	* cited by exa	miner		475
	B60W 10/		Primary Exan	iner -	- David	1 Hlavka
	B60W 10/					m – Miller, Matthias & Hul
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		102 100 104 124 110	120	Ð		114 10 106
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Wirtgen EX1001 U.S. Patent No. 9,975,538 What is claimed is:

1. A controller-implemented method of controlling a machine having a rotor coupled to an engine through a variable transmission, comprising:

receiving a desired rotor speed;

determining an engine load of the engine;

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

adjusting a gear ratio of the variable transmission based on the engine speed and the desired rotor speed.

EX1001, 6:19-31.

The'538 Patent acknowledges that the engine's power output must meet parasitic loads and rotor loads

More specifically, the estimated fuel consumption rates for a given milling machine 100 and an associated engine 122 may be predetermined for different combinations of engine speed and engine load, where the engine load may include loads due to the rotor 118, the hydrostatic arrangement 144, and other parasitic loads. As graphically represented in FIG.



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Paper 1 (Petition), 29; EX1001 ('538 Patent), Fig. 2.

US 9,975,538 – Planetary Gear Overview



Paper 1 (Petition), 26, 27; EX1001 ('538 Patent), Fig. 2.

Demonstrative Exhibit - Not Evidence

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US 9,975,538 – Algorithm Overview



US 9,975,538 – Predetermined Efficiency Points Based on Engine Load and Engine Speed



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Paper 1 (Petition), 31; EX1001 ('538 Patent), Fig. 4.

US 9,975,538 – Predetermined Efficiency Points Based on Engine Load and Engine Speed



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Paper 12 (Patent Owner's Response), 6; EX1001 ('538 Patent), Fig. 4 (annotated).

US2010/0014917 ("Willis") Prior Art



Wirtgen EX1005 U.S. Patent No. 9,975,538



Petition, 36; EX1005, Fig. 3 (annotated).

Willis taught a direct drive train described as "engine 4 may drive the drum 3 through a transmission, such as a belt-and-pulley system or a gear train." ... The controller (control 16) was configured "to compare sensed drum speed DS_S with desired drum speed DS_D , and to operate the regulator 12" Petition, 36; EX1005, ¶¶ [0020]-[0021].

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Paper 1 (Petition), 36; EX1005 (Willis), 99 [0020]-[0021], Fig. 3 (annotated).

US 9,656,656 ("Xing") Prior Art





SPEED COMMAND Controll 116 104 68 68 102 128 24 56 126 26 104 112 **Output Shaft** 114 110 FIG. -3-Xing, Fig. 3 (annotated)

Willis combined with Xing taught this limitation. Stein Decl., ¶67-72. Xing taught a work machine control system in which a controller controlled an output speed of a variable transmission's output shaft by adjusting the variable transmission's gear ratio as well as the speed of the machine's coupled engine. Xing,

Petition, 37.

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Paper 1 (Petition), 37-38; EX1006 (Xing), Fig. 3.

Xing's Controller-Implemented Fuel Efficiency Algorithm



FIG. -4-

Wirtgen Exhibit 1029 Demonstrative Exhibit - Not Evidence ¹⁸

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Paper 1 (Petition), 19; EX 1006 (Xing), Fig. 4.

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A POSITA would have been motivated to modify Willis to include a variable transmission and control system like that taught by Xing to improve fuel consumption and machine energy efficiency while maintaining desired machine performance. Stein Decl., ¶71-72. This would have involved coupling a CVT between Willis's engine and rotor and configuring Willis's controller with Xing's algorithm, sensors, and control devices necessary to implement Xing's algorithm. Xing, 7:51-8:2.

Petition, 39.

In implementing Xing's CVT in Willis's milling machine, a POSITA would have modified Willis's milling machine so that the output of the CVT (e.g., Xing's transmission output shaft 56) drives Willis's rotor.³ Stein Decl., ¶119. A POSITA would have understood from Parker and Laux that the variable transmission could be implemented at different locations within the drive train. *Supra* IV, IV.A.2, Laux, 6:47-7:3. Accordingly, a POSITA would have understood that the rotor could be

Petition, 63-64.

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Xing's Transmission Outputs to Willis's Drive Pulley



Parker, discussed in the Background of the '538 Patent, taught a milling

machine wherein a CVT drove the milling drum. EX1013, 4:39-5:9.

Petition at 8.

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Dr. Stein Wirtgen Expert Witness

variable transmission 20. The output of the infinitely variable transmission 20 is connected to a sheave or a sprocket 22, which drives a v-belt or chain drive 24. The v-belt or chain drive 24 is, in turn, connected to a sheave or sprocket 26 on a planetary gear assembly 28, which is associated with a cutter drum 30 mounted on an underside of the machine 10. It Petitioner contends that Xing's fuel-efficiency method discloses an identical process, but, as detailed more below, Xing's method relies on a starting point—the determination of a "load power requirement"—that is distinct from the engine load recited in the claims. Because Xing uses a different starting point in its fuelefficiency method, any existing load on the engine (whether determined by the system or not) is ultimately irrelevant to Xing's selection of engine parameters at

which the engine will operate, including selection of engine speed. Instead, Xing

a target *load* on the engine for fuel-efficiency purposes. As a result of this

distinction, Xing's method fails to "adjust an engine speed based on the engine

load" nor does it "adjust an engine speed" based on "predefined efficiency points"

that "provid[e] optimum engine speeds for different engine loads." EX2001, ¶40.

POR, 10.

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

Engine speed adjustment is based on

(1) engine load,

(2) one or more predefined efficiency points.

Predefined efficiency points are at least partially based on

(1) predetermined fuel consumption rates,

(2) providing optimum engine speeds for different engine loads

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However, as described further below, while Xing may disclose that one means for indirectly determining the load power requirement (P_{load}) is through the measurement of a current engine torque or engine power. Xing nevertheless uses *the load power requirement*—and not any measured engine torque or engine power (and, thereby, any *engine load* according to Dr. Stein's testimony)—as a basis for defining the set of engine operating parameters from which to choose for fuel-efficiency purposes. EX2001, ¶45.

POR, 13-14.

engine speed to achieve the load power requirement, not an engine load. As evidence of this, to the extent that Xing may measure what Dr. Stein identified as an engine load as one way to calculate the load power requirement, Xing also describes starting its method by directly measuring the load power requirement. That is, Xing's speed adjustment cannot be based on the engine load, where the

method need not even involve a determination of such a load. Further, the engine

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Xing's Engine Speed Adjustment Is Based on P_{load}, P_{loss} & ▶ P_{engine}



Xing's Engine Speed Adjustment Is Based on P_{load}, P_{loss} & P_{engine}



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Xing's Engine Speed Adjustment Is Based on P_{load}, P_{loss} & P_{engine}



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The relationship between the load power requirement and the power produced by the engine **22** of the work vehicle **10** is provided below in Equation 1.

EX1006, 9:27-29.

 $P_{engine} = P_{load} + P_{loss}$

EX1006, Equation 1.

 $P_{load} = P_{engine} - P_{loss}$

- P_{load} = useful work
- P_{engine} = current measured engine power
- P_{loss} = internal power losses at current engine speed

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Current Load Power Requirement from P_{engine}, not Candidates

$Measured \neq Candidate$

CANDIDATE ENGINE SPEEDS (RPM)	FORECASTED LOAD POWER REQUIREMENT (Kw)	ASSOCIATED SYSTEM POWER LOSS (Kw)	CANDIDATE ENGINE POWER (Kw)	CANDIDATE ENGINE TORQUE (Nm)	ENGINE BSFC EFFICIENCY (g/Km-h)	FUEL CONSUMPTION (g/h)
1500	150	15	165	1050	212	34980
1600	150	24	174	1038	200	34800
1700	150	33	183	1028	205	37515
		•			,	
· ·	· ·			•		
:		1	,			

Xing, Fig. 5

EX1006, Fig. 5.

<u>Xing</u>

It should be appreciated that, as an alternative to utilizing the forecasted load power requirement, the controller **116** may be configured to utilize the current load power requirement as the basis for determining the candidate engine speeds. It should also be appreciated that the data provided in the chart shown in FIG. 5 is simply provided for purposes of describing one embodiment of the disclosed method **200** and, thus, should not be interpreted as limiting the present subject matter in any manner.

EX1006, 10:34-42.

Adjusted engine speed is affected by the measured value of P_{engine} . Xing derives the current load power requirement (P_{load}) from the measured current value of engine load (P_{engine}). Because engine speed adjustment is based on P_{load} it is also affected by the measured value of P_{engine} .

Moreover, although P_{load} can be measured directly, there is no dispute that Xing teaches that P_{load} is derived from engine load (P_{engine}). Of course, the Claims require that engine load be expressly determined by the controller, which Xing discloses as one embodiment. But to argue that P_{load} is not affected by engine load is nonsensical. The fact there are ways to bypass explicitly determining the engine load in some embodiments does not make P_{load} any less rooted in the engine load. Xing adjusts an engine speed based on the engine load and one or more predefined efficiency points

Current /Measured

P_{engine} - P_{loss}

CANDIDATE ENGINE SPEEDS (RPM)	FORECASTED LOAD POWER REQUIREMENT (Kw)	ASSOCIATED SYSTEM POWER LOSS (Kw)	CANDIDATE ENGINE POWER (Kw)	CANDIDATE ENGINE TORQUE (Nm)	ENGINE BSFC EFFICIENCY (g/Km-h)	FUEL CONSUMPTION (g/h)
1500	150	15	165	1050	212	34980
1600	150	24	174	1038	200	34800
1700	150	33	183	1028	205	37515
		•	•	•		
	· ·					· ·
		,				
			,			

FIG. -5-

Xing, Fig. 5

Petition, 48; EX1006, Fig. 5.

Predefined Efficiency Points



Xing, Fig. 11

Petition, 49; EX1006, Fig. 11.

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Paper 1 (Petition), 48, 49; EX1006 (Xing), Figs. 5 and 11.

Xing's Engine Speed Adjustment Based on Predefined Efficiency Points



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CANDIDATE ENGINE SPEEDS (RPM)	FORECASTED LOAD POWER REQUIREMENT (Kw)			
1500	150			
1600	150			
1700	150			

FIG. -5-

Xing, Fig. 5

Engine Speed Based on Engine Load, Efficiency Points



Demonstrative Exhibit - Not Evidence

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method need not even involve a determination of such a load. Further, the engine load (*i.e.*, in Dr. Stein's view, the total torque or power at the engine output) will vary for each of the candidate speed/torque combinations in Xing. As such, Xing's speed adjustment is independent of, and not based on, a determined engine load.

not a determined engine load. As noted above, the method described and claimed by the "538 patent starts with a determination of the engine load as a reference point from which predefined efficiency points are retrieved for that given load, which then provide optimum engine speeds at which to operate the engine at the determined engine load to achieve fuel efficiency. *See* EX1001, 5:7-12; EX2001, ¶46 (explaining the '538 patent's process of moving from engine load to efficiency points to optimal engine speed). In contrast, Xing describes a different process for selecting target engine parameters, such as target engine speed: it begins with an identification of a set of candidate (or possible) engine speeds for achieving the load power requirement, from which a set of corresponding candidate (or possible)

Xing's Calculations and Terms

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CANDIDATE ENGINE SPEEDS (RPM)	FORECASTED LOAD POWER REQUIREMENT (Kw)	ASSOCIATED SYSTEM POWER LOSS (Kw)	CANDIDATE ENGINE POWER (Kw)	CANDIDATE ENGINE TORQUE (Nm)	ENGINE BSFC EFFICIENCY (g/Km-h)	FUEL CONSUMPTION (g/h)
1500	150	15	165	1050	212	34980
1600	150	24	174	1038	200	34800
1700	150	33	183	1028	205	37515
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	· · ·	•			,	
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•		•			•	

FIG. -5-



EX1006, Fig. 5.



Dr. Kemal **Caterpillar Expert** Witness

- "Q. So in Figure 5, the 6
- 7 forecasted load power requirement
- in the second column on the left 8
- 9 can be replaced by the current
- 10 load power requirement;
- 11 correct?")
- 12 THE WITNESS: In one teaching of Xing, it
- can use a current load power requirement. 13
- Alternatively, the power load requirement may be 14
- determined directly as it's stated in Xing, Column 15
- 9, starting on Line 57. 16
- 17 But alternatively, the load power
- 18 requirement may be determined directly by monitoring
- the output torque and the output speed of the work 19
- vehicle. And as I mentioned earlier, forecasted 20
- load power requirements may also be used. 21

EX1028, 122:6-21.

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EX1006 (Xing), Fig. 5; EX1028 (Kemal Depo.), 122:6-21.

The Parties dispute what the plain and ordinary meaning is. <u>That is a dispute of the claim construction.</u>

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<u>Wirtgen</u>

art. Despite asserting that the plain and ordinary meaning applied (at 7–8), Caterpillar appears to rely on unarticulated claim constructions (mostly of the "adjusting engine speed" step) importing new limitations to distinguish the Claims from Xing. Reply, 4.

Caterpillar's improperly narrow construction's is apparent in Caterpillar's rejection of Xing's algorithm. Caterpillar argues that Xing fails to teach the "adjusting engine speed" step because Xing's algorithm expressly recites P_{load}. POR, 13. Caterpillar asserts that "to the extent Xing describes determining an engine load, it is in service of calculating the load power requirement," which is in turn used to determine the engine speed, and that this does not disclose the "adjusting engine speed" step. POR, 13. Expressed mathematically, Caterpillar asserts that Xing Reply, 8.

<u>Caterpillar</u>

Reply, 1, 5-6, 11-13. For instance, Petitioner portrays Caterpillar as arguing that the claims require "the engine load to be explicit in the calculation that returns the determined engine speed" and "multiple ordered steps" that Petitioner must construct from an illustrative point made in the response.¹ Reply, 6, 11 (citing POR, 14-15). Contrary to Petitioner's contentions, however, Caterpillar's arguments are rooted in the plain language of the claims.

Specifically, the claims do indeed recite the "two inputs" Petitioner acknowledges as part of its method. *E.g.*, Reply, 1, 5. As Caterpillar explained, the claims specify the particular form of the inputs (*i.e.*, the determined engine load and a specific type of predefined efficiency points) and the particular effect of those inputs in the method (*i.e.*, an adjustment of an engine speed "based on" the inputs). POR, 14-24. As explained below, while Petitioner seeks to diminish the

Sur-Reply, 3-4.

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Paper 17 (Petitioner's Reply), 4, 8; Paper 22 (PO Sur-Reply), 3-4.


supported or proper. Although the plain and ordinary meaning of "based on" may include some limit to the number of layers between the calculation returning the output (engine speed) and the recited input (engine load), one layer of separation cannot be seen as defeating the "based on" requirement. This is particularly true where, as in Xing, the explicit parameter (P_{load}) is used to refine the engine load to provide a more meaningful input to the calculation. '538 Patent, 1:36–50. A more data-rich load parameter for the system (e.g., P_{load}) must still use the determined engine load (P_{ensine}) as a starting point.



adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1001, 6:25-29.

power (Pengine). See EX1006, 9:37-56. Thus, according to the testimony of Petitioner's expert and Xing's disclosure, to the extent Xing describes determining an engine load, it is in service of calculating the load power requirement. Pet., 46; EX1003, ¶78; see also EX2001, ¶¶43-44.

However, as described further below, while Xing may disclose that one means for indirectly determining the load power requirement (Pload) is through the measurement of a current engine torque or engine power. Xing nevertheless uses the load power requirement-and not any measured engine torque or engine power (and, thereby, any engine load according to Dr. Stein's testimony)-as a basis for defining the set of engine operating parameters from which to choose for fuel-efficiency purposes. EX2001, ¶45.

> Wirtgen Exhibit 1029 Demonstrative Exhibit - Not Evidence

EX1001 ('538 Patent), 6:25-29; Paper 12 (Patent Owner's Response), 13-14.

POR, 13-14.

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adjusting an engine speed of the engine based on the EX1001, 6:25-29. engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

not a determined engine load. As noted above, the method described and claimed by the '538 patent starts with a determination of the engine load as a reference point from which predefined efficiency points are retrieved for that given load, which then provide optimum engine speeds at which to operate the engine at the determined engine load to achieve fuel efficiency. See EX1001, 5:7-12; EX2001, ¶46 (explaining the '538 patent's process of moving from engine load to efficiency points to optimal engine speed). In contrast, Xing describes a different process for selecting target engine parameters, such as target engine speed: it begins with an identification of a set of candidate (or possible) engine speeds for achieving the load power requirement, from which a set of corresponding candidate (or possible) engine torques is calculated, which are then compared to efficiency values to find

the candidate speed-torque pair associated with the lowest value. EX2001, ¶47 POR. 14-15. Wirtgen Exhibit 1029

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adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1001, 6:25-29.

candidate engine speed. EX1006, 10:16-18, 12:28-33; EX2001, ¶59. To the extent that, for any particular candidate engine torque, an "efficiency point" designating an "optimum engine speed" theoretically could be identified (e.g., the speed at which that torque can be most efficiently achieved), that speed is not necessarily the candidate engine speed that is paired with the given candidate engine torque. EX2001, ¶59. Indeed, the candidate engine speed determines the candidate engine torque by establishing the power loss associated with that candidate speed, by which the candidate torque is calculated. EX1006, 10:16-18, 12:18-33. In this respect, Xing does not "adjust an engine speed" based on such an optimal point because Xing instead adjusts the engine speed by selecting one of the engine speed-torque pairings based on its efficiency relative to the other pairs. EX2001, Wirtgen Exhibit 1029

POR, 23.

Caterpillar's claim construction reads in a preferred embodiment:

- 1. Explicitly reciting the claimed parameters in the calculation returning the claimed output;
- 2. A specific sequence of underlying steps; and
- 3. Output engine speed must be optimized

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and "Based on" does not require explicit, direct use of a parameter in the calculation returning the claimed output

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

Caterpillar's First Claim Construction Requirement— Explicit Recitation



Caterpillar's position essentially means the identified parameters must be *explicitly recited* in the calculation returning the recited output.

The specification does not require such a limited scope.

optimizing fuel efficiency. Specifically, the controller **130** communicates with the engine **122** to adjust engine speed based on changes in the engine load and predefined efficiency points **162** for better fuel economy. The controller EX1001, 4:31-34.

126 of the milling machine 100. In block 164-2, the controller 130 may additionally monitor or determine the current engine speed and current engine load of the milling machine 100, such as via a sensor 134 located at the engine output 136. Additionally, in block 164-3, the controller 130 may retrieve, recall and/or refer to predefined fuel efficiency points 162, or any other predetermined information pertaining to the fuel consumption characteristics of the milling machine 100 stored in memory 132, to determine an optimum engine speed for the given engine load. Once the optimum engine speed, or the engine speed expected to provide the optimum fuel efficiency, has been determined for the given engine load, the controller 130 in block 164-4 may compare the actual engine speed to the optimum engine speed.

If the actual engine speed is not at the optimum engine speed as derived from the predefined fuel efficiency points 162 in block 164-4 of FIG. 5, the controller 130 may increase or decrease the engine speed in block 164-5 until the optimum engine speed is substantially achieved. Once

EX1001, 5:3-22.

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EX1001 ('538 Patent), 4:31-34, 5:3-22.

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126 of the milling machine 100. In block 164-2, the controller 130 may additionally monitor or determine the current engine speed and current engine load of the milling machine 100, such as via a sensor 134 located at the engine output 136. Additionally, in block 164-3, the controller 130 may retrieve, recall and/or refer to predefined fuel efficiency points 162, or any other predetermined information pertaining to the fuel consumption characteristics of the milling machine 100 stored in memory 132, to determine an optimum engine speed for the given engine load. Once the optimum engine speed, or the engine speed expected to provide the optimum fuel efficiency, has been determined for the given engine load, the controller 130 in block 164-4 may compare the actual engine speed to the optimum engine speed.

If the actual engine speed is not at the optimum engine speed as derived from the predefined fuel efficiency points 162 in block 164-4 of FIG. 5, the controller 130 may increase or decrease the engine speed in block 164-5 until the optimum engine speed is substantially achieved. Once



Caterpillar Admits that Engine Speed Is Adjusted Based On P_{load}

<u>Caterpillar repeatedly states in the Sur-Reply that the adjustment is based</u> on P_{load}

 P_{loss} . Reply, 2-4. According to Petitioner, merely because this relationship can be exploited as a means to indirectly determine P_{load} (which Xing uses to make its speed adjustment. *see* EX1006, 10:16-18), then this must mean that the adjustment made to engine speed in Xing's fuel-efficiency method is "based on" the engine load (*i.e.*, P_{engine}, according to Petitioner). Petitioner's arguments relying on this

Sur-Reply, 4.

replaced by a current engine load, which is not the case. As explained above, even when a current load power requirement is used, the ultimate speed adjustments are based on that load power requirement rather than any engine load (P_{engine}) that may have been measured to determine the load power requirement.⁴ *See* POR, 15-17; *supra*, section II.A.2.

very factor Xing seeks to optimize.² Just as with Pengine, these parameters merely

Sur-Reply, 11.

serve as a means to an end in Xing—the determination of Pload, which is the basis

for which Xing adjusts its engine speed.

Sur-Reply, 6.

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Paper 22 (Patent Owner's Sur-Reply), 4, 6, 11.

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If the engine speed is "based on" P_{load} , then the only question left is the one posed by Wirtgen-does one layer of separation make the engine speed not based on P_{engine} ?

Caterpillar's remaining arguments about candidates and order of operations are irrelevant if engine speed is based on P_{load}

$$P_{engine} = P_{load} + P_{loss}$$

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Dr. Kemal misunderstands the role of embodiments in a patent specification



Dr. Kemal Caterpillar Expert Witness

45. However, while Xing may describe that one means for determining the load power requirement (P_{load}) is indirectly through measurement of a current engine torque or engine power, Xing nevertheless uses the load power requirement—not the measured engine torque or engine power (or any "engine load," according to Dr. Stein)—as a basis for defining the set of engine operating parameters from which to choose for fuel-efficiency purposes. As I explain more

14	A. So what I mean is, there is also methods
15	that are discussed in Xing that also teach that
16	alternatively, the power load requirement, which is
17	the constant here, may be determined directly by
18	monitoring the output torque and the output speed of
19	the work vehicle, 10. So Xing describes a direct
20	method and then an indirect method, but it both
21	leads to the the what is needed in Xing's
22	method, which is a load power requirement.

- In other words, any measurement of the load
- 2 at the engine can be bypassed entirely by directly
- 3 measuring the variable of interest, P load, at the
- 4 source, where the useful work is occurring.

EX1028, 110:14-111:4.

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EX2001, ¶ 45.

Caterpillar's Expert's Misunderstanding



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Caterpillar alleges the "adjusting an engine speed" claim limitation requires a combination of ordered steps.

points...providing optimum engine speeds for different engine loads": (1) to the extent Xing's FIG. 11 (or any other similar fuel efficiency table) includes points that identify an optimum speed for a given torque value, they are not the points (*e.g.*, the candidate speed-torque pairings) that Xing uses as a basis for adjusting the engine speed; and (2) conversely, any points that do serve as a basis for VV

Caterpillar's Second Claim Construction Requirement— Multiple, Ordered Steps

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Caterpillar explicitly distinguished the '538 Patent *Claims* and Xing relying on the order of steps in the '538 Patent method not a determined engine load. As noted above, the method described and claimed

by the 538 patent starts with a determination of the engine load as a reference point from which predefined efficiency points are retrieved for that given load, which then provide optimum engine speeds at which to operate the engine at the determined engine load to achieve fuel efficiency. See EX1001, 5:7-12; EX2001, ¶46 (explaining the '538 patent's process of moving from engine load to efficiency points to optimal engine speed). In contrast, Xing describes a different process for selecting target engine parameters, such as target engine speed; it begins with an identification of a set of candidate (or possible) engine speeds for achieving the load power requirement, from which a set of corresponding candidate (or possible) engine torques is calculated, which are then compared to efficiency values to find the candidate speed-torque pair associated with the lowest value. EX2001, ¶47 (noting Xing's process of moving from candidate engine speed to candidate engine torque to efficiency value).

Caterpillar's Second Claim Construction Requirement— Multiple, Ordered Steps

The claimed algorithm's single step does not read in a preferred embodiment that requires multiple, ordered steps.



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EX1001 ('538 Patent), Fig 5 (annotated); Paper 17 (Petitioner's Reply), 13.

Xing's candidate parameters do meet the claim limitations

In one embodiment, the current load power requirement for the work vehicle may be determined indirectly by calculating the current engine power (Pengine) and the current power loss (P_{loss}) for the work vehicle 10. For example, as indicated above, the controller 116 may be configured to continuously monitor the engine speed and the engine torque (via sensors 122, 124), thereby allowing for the current engine power to be calculated by the controller 116. Additionally, as will be described below, the controller 116 may include component efficiency data stored within its memory that permits the controller 116 to calculate the current power loss for the work vehicle 10 based on the current vehicle operating parameters, such as the engine speed, ground speed, pressure differential within the hydrostatic unit 30, displacement ratio of the hydrostatic unit 30, the axle temperature and/or various other monitored and/or calculated operating parameters. As such, by determining the current engine power and the current engine power loss, the current power load requirement may be calculated using Equation 1.

EX1006, 9:37-56.

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1001, 6:25-29.

Caterpillar's Second Claim Construction Requirement— Multiple, Ordered Steps

Caterpillar alleges that Wirtgen did not rebut its argument that Xing Fig. 11's points are not used as a basis for adjusting the speed. (Sur-Reply, 12 (citing Reply 16-18).

points...providing optimum engine speeds for different engine loads": (1) to the

extent Xing's FIG. 11 (or any other similar fuel efficiency table) includes points

that identify an optimum speed for a given torque value, they are not the points

(e.g., the candidate speed-torque pairings) that Xing uses as a basis for adjusting

the engine speed; and (2) conversely, any points that do serve as a basis for

Sur-Reply, 12.

In reply, Petitioner does not dispute the first issue. Reply, 16-18. Petitioner,

Sur-Reply, 12.

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Wirtgen rebuts this point at Reply 17-18

Xing discloses an algorithm that determines the engine speed using the engine load and the efficiency points, and states that "the controller 116 may select the candidate engine speed/torque pair that maximizes fuel efficiency (i.e., the pair intersecting closest to the optimal fuel efficiency point 30) as the target engine speed and target engine torque for producing the engine power necessary to achieve the lower power requirement." EX1006, 12:58-63. Xing specifically states that the controller selects the engine speed/torque pair that maximizes fuel efficiency, and then clarifies which pair that would be the one that intersects closest to the optimal fuel efficiency point 30. Thus, it is unclear how Xing does not select an engine speed "based on...one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads."

Caterpillar's Third Claim Construction Requirement— Optimizing Engine Speed

Caterpillar alleges that the engine speed must be optimized.

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1001, 6:25-29.

First, the claimed method is directed to a process that determines an "engine

load," then refers to one or more "predefined efficiency points," which each

identifies an optimum engine speed, to adjust the engine's speed for the given

engine load. In contrast, Xing bases its efficiency determination on the load power

POR, 1-2.



Dr. Kemal Caterpillar Expert Witness

56. In addition, because of Xing's different approach to efficiency

assessment, Xing also does not adjust an engine speed based on predetermined fuel

efficiency points that provide optimum engine speeds for different engine loads.

EX2001, ¶56.

Paper 12 (Patent Owner's Response) at 1, 2; EX1001 ('538 Patent), 6:25-29; EX2001 (Kemal Decl.) ¶56.

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The claims do not require adjusting the engine to the most fuel-efficient speed

efficiency data. Thereafter, the controller **116** may select the candidate engine speed/torque pair that maximizes fuel efficiency (i.e., the pair intersecting closest to the optimal fuel efficiency point **30**) as the target engine speed and target engine torque for producing the engine power necessary to achieve the load power requirement.

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1006, 12:58-63.

The controller then selects the candidate engine speed/torque pair that minimizes fuel consumption (i.e., the pair intersecting closest to the optimal fuel efficiency point) as the target engine speed and target engine torque. Xing, 12:58-63. The controller may then set the engine to operate based on the target engine speed. Xing, 3:58-67, 8:64-9:3. EX1003, ¶80.





Dr. Stein Wirtgen Expert Witness

Caterpillar's Third Claim Construction Requirement— Optimizing Engine Speed

Caterpillar argues that "most optimum" is redundant, but then also argues it is not important to find the most efficient speed.

dependent on reading limitations into the claims. The issue does not turn on whether the most efficient overall speed is selected. Rather, the claims are plain on their face: an engine speed of the engine is adjusted based on "predefined efficiency points" that, in addition to being based on fuel consumption rates, provide "*optimum* engine speeds *for* different engine loads." Caterpillar showed that the candidate engine speeds in Xing are not disclosed to be the optimum speed for the particular torque they are paired with. POR, 21-22, 24; *cf. id.*, 5-6 (citing

Sur-Reply, 13.

Petitioner, the claimed optimum engine speeds extend to suboptimum speeds because the claims do not recite the "most optimum" speed. Reply, 17 (arguing Caterpillar's expert interprets the claims to "require selecting the most optimum engine speed."). Adding "most" to "optimum" is redundant. Petitioner's argument Wirtgen Exhibit 1029

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The claims only require the *adjusted to* engine speed to rely on the optimized efficiency point

adjusting an engine speed of the engine based on the engine load and one or more predefined efficiency points at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads; and

EX1001, 6:25-29.

Caterpillar's Third Claim Construction Requirement— Optimizing Engine Speed

The *adjustment* (selected parameters) is made based on the most efficient speed and torque

lower power requirement." EX1006, 12:58-63. Xing specifically states that the

controller selects the engine speed/torque pair that maximizes fuel efficiency, and then clarifies which pair that would be-the one that intersects closest to the optimal

fuel efficiency point 30. Thus, it is unclear how Xing does not select an engine speed

Reply, 17-18.	14	Q. So is it your understanding,
	15	then, that in claim 1, it need not be the
	16	predefined efficiency points specifically that
	17	provide optimum engine speeds for different engine
	18	loads?
	19	A. The fuel consumption at a given
	20	torque-speed combination is what determines how
	21	efficiently you can operate at. So the the
	22	idea is to choose an engine torque-speed pair that
	23	will allow the machine to meet its engine
	24	requirements, but also do so at minimum fuel
EX2003, 83:14-25.	25	consumption. Just like Xing was trying to do.

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Claim 13 does not exclude a controller additionally configured to perform other functions to disengage rotor from engine.

13. The machine of claim 6, further comprising a clutch disposed between the engine and the rotor, the controller being configured to selectively disengage the rotor from the engine through control of the clutch.

EX1001, 7:21-24.

6. A machine, comprising:

an engine;

- a variable transmission operatively coupled to an output of the engine;
- a rotor operatively coupled to an output of the variable transmission; and
- a controller in electrical communication with one or more of the engine, variable transmission, and the rotor, the controller being configured to determine an engine load, adjust an engine speed based on the engine load and one or more predefined efficiency points being based at least partially on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads, and adjust a gear ratio of the variable transmission based on the engine speed to maintain a desired rotor speed.

EX1001, 6:49-64.

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Caterpillar's improperly narrowed construction requires disengaging rotor from all engine power only using clutch

(the rotor) from another component (the engine). Petitioner's argument that claim 13 includes the limitations of claim 6, which is broad enough to encompass other methods of powering the rotor after the clutch is disengaged (Reply, 19), ignores the fact that claim 13 is a narrowing dependent claim. Claim 13 goes beyond a mere requirement that one flow of power from the engine to the rotor is cut off through disengagement of the clutch; it instead recites that specific components themselves are disengaged from one another: the rotor from the engine.

Xing's controller is configured to disengage the load from the engine

clutch 54. In addition, the planetary unit 32 may be configured to be selectively coupled to the load L, coupled to the hydrostatic unit 30 and selectively coupled to the engine 22, all under automatic control of the controller 116. For

EX1006, 5:14-17.



EX1006, Fig. 2.

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EX1006 (Xing), 5:14-17, Fig. 2.

Xing's controller is configured to actuate forward and reverse clutches 52, 54 to disengage the load from the engine

Forward

Clutch

NS1 mounted on a planetary input shaft **50**. As shown, the planetary input shaft **50** may be coupled to the engine **22** via a forward directional clutch **52** or a reverse directional clutch **54**. In addition, the planetary unit **32** may be config-

EX1006, 5:11-14.

planetary unit 32 via gears N1, N8, and N2. Alternatively, the transmission 44 may be operated to have a pure hydrostatic power flow by disengaging both of the directional clutches 52, 54. Regardless, the transmission 24 may pro-

EX1006, 6:3-6.



Xing's Controller Disengages Load from Engine using Forward & Reverse Clutches and Pump Swash Plate

When pump swash plate angle is zero, Xing's forward/reverse clutches disengage all power from the engine to the rotor

clutches 52, 54. Regardless, the transmission 24 may provide a seamless transition between ranges to provide work/ road configurations as desired. In particular, speed changes from zero to the maximum speed within each speed range of the transmission 24 may be achieved in a smooth and continuous manner by automatically changing the swash plate angle of the pump 36 via control signals transmitted from the controller 116.

EX1006, 6:6-13.



EX1006, Fig. 2.

Paper 1 (Petition), 23; EX1006 (Xing), 6:6-13, Fig. 2 (excerpt annotated).

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Xing's Engine Is Isolated from Load when Parking Brake is Engaged



Engine does not drive load L and is disengaged when the parking brake 70 is engaged and load is parked.

Referring still to FIG. 2, the transmission 24 may also include a parking brake 70 operably positioned on the load shaft 56. In several embodiments, the parking brake 70 may be communicatively coupled to the controller 116 (via a suitable communicative link 46) for automatic control thereof. For example, the controller 116 may be configured to proportionally or gradually engage the parking brake 70 as well as gradually release or disengage the parking brake 70. In such embodiments, the pressure of the hydraulic fluid

EX1006, 6:14-23.





Alternative Xing Embodiment for Driving Load via PTO Clutch



FIG. -3-

⁴ Alternatively, Xing's transmission could be configured so that the transmission output shaft 56 is connected indirectly (through PTO 110) to a load, such as a milling drum, via PTO shaft 112 and a third clutch set, PTO clutch 114, under control of controller 116. Xing, 4:42-53, 5:38-55, 6:47-7:3, 7:21-23, Fig. 3. A POSITA would have modified Willis's milling machine so that the output of Willis's engine was connected to the input shaft of Xing's CVT, and PTO shaft 112 was connected to Willis's milling drum. Stein Decl., ¶¶151-152. In this arrangement, PTO clutch 114

Petition, 75 n.4.

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PTO Clutch Disengages the Rotor From the Engine

work vehicle 10). Alternatively, the hydrostatic unit 30 and the planetary unit 32 may be coupled to any other suitable load L, such as loads that include a track drive or a separate operating system of the work vehicle 10 (e.g., a power take-off (PTO)).

EX1006, 4:49-53.

of the work vehicle **10**. Moreover, the system **100** may also include a power take-off (PTO) **110** configured to transfer power from the engine **22** to one or more implements via a PTO shaft **112**. For instance, as shown in FIG. **3**, in one EX1006,6:64-67.

embodiment, the PTO **110** may form part of the transmission **22** and may be configured to be engaged via a PTO clutch **114**.

EX1006, 7:1-3.

Caterpillar Misunderstands Dr. Stein's Testimony for the PTO

Caterpillar asserts that Dr. Stein's reference to the PTO clutch and Laux meant the PTO clutch operates like Laux's clutch

whole. *Id.*, 32. Furthermore, Petitioner does not even attempt to respond to Caterpillar's observation that the evidence cited by Petitioner as illustrating Xing's PTO clutch 114 arrangement—Dr. Stein's testimony that Laux taught the same clutch arrangement—directly contradicts any conclusion that Xing's PTO clutch meets the claimed limitations because Laux's clutch arrangement fails to "disengage" a load *(e.g.,* a milling drum from the engine). *Id.*, 32-33 (citing EX2001, ¶76 ("Laux teaches connecting a transmission in this manner.")).

Sur-Reply, 19-20.

Caterpillar does not argue that the PTO would not "disengage" the rotor except through Caterpillar's comparison with the Laux clutch.

Paper 22 (Patent Owner's Sur-Reply), 19-20.

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Dr. Stein referred to Laux when discussing the PTO to note that a transmission could be attached to the milling drum.

output shaft 56 and the engine. Willis ¶[0020]; Xing 4:33-37, 4:42-53, 6:47-7:3. As

additional support for this combination, Laux teaches connecting a transmission in

this manner. Laux, 6:45-7:3.

EX1003, ¶151.



Dr. Stein Wirtgen Expert Witness

Cited portion of Laux (6:45-7:3) was used to support connecting the milling drum to a CVT.

the working direction. Furthermore, a drive train is provided, which transmits drive energy from the drive unit to the milling drum. This drive train can comprise multiple transmission steps, for example, a shift transmission and/or a belt transmission or chain gear, etc. Furthermore, the ground milling machine has a unit for ascertaining and monitoring an operating function to be optimized, for example, the advance velocity. This unit is implemented

EX1012, 6:59-66.

The cited portion of Laux (6:45-7:3) does not discuss a PTO or any limitations thereof.

EX1003 (Stein Decl.), ¶151; EX1012 (Laux), 6:45-7:3.

Willis Modified by Xing and Laux





Laux, Fig. 3.

EX1012, Fig. 3 (annotated).

As noted *supra* VII.A.14, Willis combined with Xing teaches this arrangement. However, to the extent a POSITA would have found Xing's teachings insufficient to permit disengagement of the rotor from the engine through the control of a clutch, Laux taught a milling machine powertrain in which clutch 15 was disposed between the engine and the rotor to selectively disengage the rotor from the engine. Stein Decl., ¶157; *supra* IV.A.2 (describing Laux's drive train). Engine Paper 1 (Petition) at 78.

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Willis Modified by Xing and Laux





EX1012, Fig. 3 (annotated).

the engine. Stein Decl., ¶157; supra IV.A.2 (describing Laux's drive train). Engine

4 was coupled to belt drive 16 via output shaft 13 and shift clutch 15. Laux, 9:3-10.

Clutch 15 could disengage engine 4 from belt drive 16, drive transmission 17, and

rotor 7, Laux, 9:3-10. Thus, the combination of Willis, Xing, and Laux teaches all

Petition, 78-79.

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Paper 1 (Petition), 78-79; Stein Decl., ¶157; EX1012 (Laux), 9:3-10, Fig. 3 (annotated).

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However, to the extent a POSITA would have found Xing's teaching regarding how to support gears NP1 and NP2 of the planetary unit 32 and harness their orbital motion to drive the transmission's output insufficient, Laux, by referencing and incorporating Schomaker, taught a solution that was commonly used in planetary Petition, 76. transmissions. Stein Decl., ¶155. Schomaker's planetary gears were mounted on To the extent the combination of Willis, in view of Xing, failed to render obvious the additional limitation of claim 8, a POSITA would have been motivated to incorporate Laux's carrier into Xing's planetary unit 32 to harness the planetary gears' orbital motion and couple the planetary unit's output to the transmission's Petition. 77. output shaft 56 either directly or via Xing's range gears. Indeed, Xing's CVT was arrangement. However, to the extent a POSITA would have found Xing's teachings insufficient to permit disengagement of the rotor from the engine through the control of a clutch, Laux taught a milling machine powertrain in which clutch 15 was disposed between the engine and the rotor to selectively disengage the rotor from Petition, 78. the engine. Stein Decl., ¶157; supra IV.A.2 (describing Laux's drive train). Engine

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Combination would have included clutch as the last drive train element between Xing's transmission, adjacent to Willis's drive pulley.

In this case, Laux discloses that a shift clutch 15 in a milling machine drive train can be located as the last drive train element immediately adjacent the belt drive 16 in part of the drive train between engine 4 and belt drive 16. Petition, 59–64, 78– 79 (citing EX1012, 9:3–10). When implemented in the proposed combination. Laux's shift clutch 15 would have been located as the last drive train element between Xing's transmission and adjacent Willis's drive pulley "belt-and-pulley system" at the output of Xing's transmission. Petition, 11 (citing EX1005, ¶[0020].) Reply.23.

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Combination would have included controller-operated clutch for disengaging the rotor from the engine



EX1012, Fig. 3.

clutch 54. In addition, the planetary unit 32 may be configured to be selectively coupled to the load L, coupled to the 15 hydrostatic unit 30 and selectively coupled to the engine 22, all under automatic control of the controller 116. For EX1006, 5:14-17.

A POSITA would have been motivated to incorporate Laux's clutch into Willis's milling machine that has been modified to include Xing's CVT and algorithm. Milling drum tools 12 frequently wear down during milling and, are typically replaced manually by machine operators. Conventionally, a POSITA would have understood that, for safety reasons, the milling drum needed to be disengaged from the engine to avoid unexpected startup and possible injury. See, e.g., EX1017 (US Patent No. 8,167,378 ("Busely")), 1:34-47. In such milling machines, this was conventionally achieved using a clutch between the rotor and the engine. See, e.g., EX1017, 3:66-67, Fig. 2. Because a POSITA would have wanted to retain this safety feature from conventional milling machine, a POSITA would have been motivated to incorporate Laux's clutch. A POSITA would have had a

Petition, 79-80.

Xing Places the Transmission Before the Driving Elements



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Xing Places the Transmission Before the Driving Elements



EX1006 (Xing), Fig. 3; EX1012 (Laux), Fig. 3.

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Xing Places the Transmission Before the Driving Elements



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Caterpillar incorrectly asserts that a pulley system is replaced.

⁶ In addition, Petitioner's new modification contradicts the combination as proposed in the petition. Specifically, Petitioner overlooks that the petition proposed *replacing* Willis's belt-and-pulley system with the variable transmission of Xing. See Pet., 11 (arguing that "[i]n early machines, like that taught by Willis," the rotor was driven "through a direct drive train," which, in Willis, "include[s] components between the engine and cutter drum such as 'a belt-andpulley system or a gear train" (emphasis added)), 36, 43 (arguing that "[i]n Willis, the rotor is coupled to the output of the direct drive train." but "[t]he proposed modification would couple Willis's rotor to the output of Xing's transmission" (emphasis added)), 59-63. Petitioner's newly asserted modification, which now relies on components of Willis's direct drive train, is thus contrary to the petition.