

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WIRTGEN AMERICA, INC.
Petitioner

v.

CATERPILLAR INC.
Patent Owner

Case IPR2022-01397
Patent No. 9,975,538

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,975,538**

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TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	STATEMENT OF UNPATENTABILITY GROUNDS	3
A.	Statutory Grounds for the Challenge.....	3
B.	The Office Has Not Previously Considered the Applied Grounds	4
C.	The <i>Fintiv</i> Factors Do Not Support Discretionary Denial	5
III.	LEVEL OF SKILL IN THE ART	8
IV.	TECHNOLOGY BACKGROUND AND PRIOR ART OVERVIEW	8
A.	Milling Machines With Controllers That Coordinated Operation of an Engine and Variable Transmission to Drive a Coupled Rotor at a Desired Rotor Speed Were Known.	11
1.	Willis	11
2.	Laux.....	14
B.	Work Machines that Adjusted Engine Speed Based on Load and Optimum Fuel Consumption Rates While Maintaining Machine Performance Were Known.....	18
1.	Xing’s Teachings are Applicable to Milling Machines	18
2.	Xing’s Controller Adjusts Engine Speed for Fuel Efficiency	18
3.	Xing’s Controller, Like That of Laux, Uses the Work Machine’s Continuously Variable Transmission to Maintain Desired Performance	21
V.	OVERVIEW OF THE ’538 PATENT.....	24
VI.	CLAIM CONSTRUCTION (37 C.F.R. § 42.104(b)(3))	31
VII.	THE CHALLENGED CLAIMS ARE UNPATENTABLE (37 C.F.R. § 42.104(b)(4)).....	32
A.	Ground 1: The Combination of Willis and Xing Renders Obvious Claims 1-13 of the ’538 Patent.....	32
1.	Reasons and Motivations for Combining the Teachings of Willis and Xing.....	33
2.	Independent claim 1	35
3.	Claim 2: “The controller-implemented method of claim 1, wherein the desired rotor speed is received through an operator interface of the machine.”	

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

4. Claim 3: “The controller-implemented method of claim 1, wherein the engine load includes loads due to at least the rotor and a hydrostatic arrangement.”	54
5. Claim 4: “The controller-implemented method of claim 1, wherein the engine speed is automatically adjusted based on detected changes in the engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.”	57
6. Claim 5: “The controller-implemented method of claim 1, wherein the gear ratio of the variable transmission is automatically adjusted to maintain a rotor speed of the rotor at the desired rotor speed irrespective of changes in the engine speed.”	58
7. Independent Claim 6	59
8. Claim 7: “The machine of claim 6, wherein the variable transmission includes a gear set and a hydraulic motor configured to adjust a rotor speed of the rotor.”	66
9. Claim 8: “The machine of claim 7, wherein the gear set is a planetary gear set having a sun gear coupled to the engine, a carrier coupled to the rotor, and a ring gear coupled to the hydraulic motor.”	68
10. Claim 9: “The machine of claim 7, wherein the controller is configured to adjust the gear ratio through control of the hydraulic motor.”	70
11. Claim 10: “The machine of claim 6, wherein the controller is configured to determine the engine load as a sum of loads due to at least the rotor and a hydrostatic arrangement.”	71
12. Claim 11: “The machine of claim 6, wherein the controller is configured to automatically adjust the engine speed based on changes in the engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.”	71
13. Claim 12: “The machine of claim 6, further comprising an operator interface configured to at least receive the desired rotor speed from an operator of the machine, the controller being configured to receive the desired rotor speed from the operator interface.”	72
14. Claim 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 the control of a clutch.”	73

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

B.	Ground 2: Claims 8 and 13 Would Have Been Obvious over Willis in View of Xing, and Further in View of Laux.....	76
1.	Claim 8: “The machine of claim 7, wherein the gear set is a planetary gear set having a sun gear coupled to the engine, a carrier coupled to the rotor, and a ring gear coupled to the hydraulic motor.”	76
2.	Claim 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 the control of a clutch.”	78
C.	Analysis of Secondary Considerations.....	80
VIII.	MANDATORY NOTICES	80
A.	Real Party-in-Interest (37 C.F.R. § 42.8(b)(1)).....	80
B.	Related Matters (37 C.F.R. § 42.8(b)(2)).....	81
C.	Lead and Back-up Counsel (37 C.F.R. § 42.8(b)(3)).....	81
D.	Service Information (37 C.F.R. § 42.8(b)(4))	82
IX.	GROUND FOR STANDING.....	83
X.	STATEMENT OF PRECISE RELIEF REQUESTED FOR EACH CLAIM CHALLENGED.....	83

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 9,975,538
1002	U.S. Patent No. 9,975,538 file history
1003	Declaration of Jeffrey L. Stein, Ph.D., P.E.
1004	Curriculum Vitae of Jeffrey Stein
1005	U.S. Patent Application Pub. No. US 2010/0014917 A1 to Willis <i>et al.</i> (“Willis”)
1006	U.S. Patent No. 9,656,656 to Xing <i>et al.</i> (“Xing”)
1007	N. Beachley, A. Frank, <i>Continuously Variable Transmissions Theory and Practice</i> , (Lawrence Livermore Laboratory Report UCRL-15037, 1979)
1008	US Patent No. 8,622,871 to Hoff (“Hoff”)
1009	<u>rotor</u> , The Concise Oxford Dictionary of Current English, 9th Ed., 1995
1010	E. Orshansky, W Weseloh, <i>Characteristics of Multiple Range Hydromechanical Transmissions</i> , SAE International, SAE Transactions, (1972), Vol. 81
1011	A. Rosetti and A. Macor, <i>Multi-objective optimization of hydro-mechanical power split transmissions</i> , Mechanism and Machine Theory 62 (2013)
1012	U.S. Patent No. 9,864,347 to Laux <i>et al.</i> (“Laux”);
1013	U.S. Patent No. 8,465,105 to Parker <i>et al.</i> (“Parker”)
1014	U.S. Patent No. 8,781,694 to Sheidler <i>et al.</i> (“Sheidler”)
1015	U.S. Patent Pub. No. 2009/0118912 to Hugenroth <i>et al.</i> (“Hugenroth”)
1016	U.S. Patent Pub 2015/0091363 to Reuter <i>et al.</i> (“Schomaker”)
1017	U.S. Patent No. 8,167,378 to Busely <i>et al.</i> (“Busely”)
1018	William Ross, <i>Designing a Hydromechanical Transmission for Heavy Duty Trucks</i> , Society of Automotive Engineers paper 72075 (1972)

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

1019	Director Vidal Memorandum, “Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation,” June 21, 2022
1020	Dkt. 33, Amended Complaint, C.A. No. 17-770-RGA (Sept. 2, 2021)
1021	Dkt. 43, Answer to Amended Complaint and Counterclaims, C.A. No. 17-770-RGA-MPT (Oct. 14, 2021)
1022	Caterpillar Inc. v. Wirtgen Am., Inc., IPR2022-01264, Petition (P.T.A.B., July 22, 2022)
1023	Dkt. 92, Wirtgen Am., Inc. v. Caterpillar Inc., C.A. No. 17-770-RGA, Court’s Order Setting Claim Construction Hearing
1024	Dkt. 88, Stipulation Extending Fact Discovery Cutoff (Apr. 4, 2022)
1025	Federal Court Management Statistics (Mar. 31, 2022)
1026	Dkt. 56, <i>Wirtgen America, Inc. v. Caterpillar Inc.</i> , C.A. No. 17-770-RGA, (D. Del. Nov. 4, 2021) (“Motion to Sever and Transfer”)
1027	Dkt. 57, <i>Wirtgen America, Inc. v. Caterpillar Inc.</i> , C.A. No. 17-770-RGA, (D. Del. Nov. 4, 2021) (“Opening Brief in Support of Motion to Sever and Transfer”)

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

Petitioner Wirtgen America, Inc. (“Wirtgen”) requests *inter partes* review of claims 1-13 of U.S. Patent No. 9,975,538 (EX1001, “the ’538 Patent”), assigned to Caterpillar, Inc. (“Caterpillar”). Wirtgen seeks a determination that each of the challenged claims is unpatentable under 35 U.S.C. § 103.

I. INTRODUCTION

The ’538 Patent claims controller-implemented methods of controlling a machine having a rotor coupled to an engine through a variable transmission. It purportedly provides a solution for “maintaining a desired rotor speed” that “also takes fuel consumption or efficiency into consideration.” EX1001, 1:41-48. The claims recite (1) controlling engine speed based on predefined relationships between engine load and efficiency, including predetermined fuel consumption rates, and (2) maintaining a desired rotor speed by adjusting a gear ratio of the variable transmission. But the prior art already taught the use of variable transmissions in milling machines to maintain desired rotor speeds independent of engine speed. And the prior art also taught the advantage of doing so—the ability to control engine speed to optimize fuel efficiency. Accordingly, these claims would have been obvious many years before the ’538 Patent’s 2015 filing date.

The ’538 Patent acknowledges that prior-art milling machines, such as US Patent No. 8,465,105 (EX1013, “Parker”), “provide variable transmissions which allow for variations in engine speed without affecting rotor speed,” but claims that

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

“these conventional systems do not further address fuel efficiency.” EX1001, 1:26-48. Acknowledging during prosecution that Parker taught the limitations of the pending claims, Caterpillar amended them to require adjusting engine speed “based on predetermined fuel consumption rates” and load to overcome an anticipation rejection. EX1002, 99-101. Consideration of fuel consumption or efficiency when maintaining a desired rotor speed is the only purported advance captured by the claims of the ’538 Patent. EX1001, 1:26-48.

Work machines with powertrains and control systems that (1) controllably adjusted their engine speeds based on load and optimized fuel efficiency and (2) adjusted their variable transmission gear ratios to achieve desired output speeds were well-known. A Person of Ordinary Skill in the Art (POSITA) would have been motivated to adapt milling machines to include these powertrains and control systems to optimize fuel efficiency. Laux taught that the demand always existed for optimizing milling machine operation by obtaining “the lowest possible fuel consumption and, at the same time, the highest possible milling performance.” Laux, 1:23-37. And Laux taught that coupling the rotor to the engine through a variable transmission provided one way of doing so. Laux, 1:38-62. A POSITA would also have had a reasonable expectation of success in implementing these powertrains and control systems in a milling machine. Because they were universally applicable to a wide range of work machines, a POSITA would have known how to adapt such

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

powertrains and control systems to account for differences in their control systems and mechanical designs. As U.S. Patent No. 9,656,656 (EX1006, “Xing”) taught, control systems could “be operably coupled to any suitable type of work implement.” Xing, 4:33-37.

Implementing powertrain systems in milling machines with variable transmissions and controllers configured to optimize machine efficiency was desirable and would have been well-within the skill of ordinary artisans. Petitioner’s cited grounds, based on U.S. Patent Publication No. US2010/0014917 (EX1005, “Willis”), Xing, and U.S. Patent No. 9,864,347 (EX1012, “Laux”), exemplify such a combination of well-known methods and systems. The Board should find the challenged claims invalid as obvious.

II. STATEMENT OF UNPATENTABILITY GROUNDS

A. Statutory Grounds for the Challenge

Petitioner requests cancellation of claims 1-13 of the ’538 Patent on the following grounds:

Ground	Prior Art	Basis (Post-AIA)	Claims Challenged
1	Willis in view of Xing	35 U.S.C. § 103	1-13
2	Willis in view of Xing and Laux	35 U.S.C. § 103	8, 13

The references relied on qualify as prior art to the ’538 Patent for at least the following reasons. The effective filing date of the ’538 Patent is May 18, 2015. Accordingly, Willis (EX1005) qualifies as prior art under § 102(a)(1) because it

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

published on January 21, 2010, and no exception applies because that date is more than one year before the effective filing date of the claimed invention. Xing (EX1006) qualifies as § 102(a)(1) prior art because it published on June 26, 2014, and Caterpillar cannot show that any exception under § 102(b)(1) applies. Xing also qualifies as § 102(a)(2) prior art because it claims priority from provisional application No. 61/740,159 filed on December 20, 2012, and PCT application No. PCT /US2013/059659 filed September 13, 2013, such that it was effectively filed before the effective filing date of the claimed invention and because Caterpillar cannot show that any exception under § 102(b)(2) applies. Laux (EX1012) qualifies as § 102(a)(2) prior art because it claims priority under 35 U.S.C. §119 from German Patent Application No. 102014001885.7, filed Feb. 12, 2014, such that it was effectively filed before the effective filing date of the claimed invention and because Caterpillar cannot show that any exception under § 102(b)(2) applies.

B. The Office Has Not Previously Considered the Applied Grounds

The *Advanced Bionics* two-part test does not apply here. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (precedential). As to part one, the Petition does not “present[] to the Office the same or substantially the same art previously presented to the Office” because the USPTO cited but did not consider Willis and did not cite or consider Xing. Specifically, the USPTO cited Willis in the Examiner’s Search

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

Strategy and Results dated 1/23/2018, and also cited the related Willis patent (US Patent No. 8,408,838) in an IDS filed on 5/18/2015 but did not rely upon or otherwise address Willis in any rejections or objections during prosecution. The Examiner allowed the claims included in the issued '538 Patent because none of the prior art before the Examiner taught or suggested the limitation requiring predefined efficiency points “at least partially based on predetermined fuel consumption rates and providing optimum engine speeds for different engine loads,” which was imported from previously objected dependent claims. However, Xing, which was not prior art of record during prosecution, discloses this limitation. EX1002, 75–77.

As to part two, the Petition does not “present to the Office the same or substantially the same arguments previously presented to the Office” at least because the only rejection issued by the Examiner was an anticipation rejection over Parker (EX1002). Applicant overcame that rejection by adding the “predefined efficiency points” limitation and other related limitations, which the Examiner stated were not in the cited prior art. Petitioner, on the other hand, asserts that Xing discloses these limitations.

C. The *Fintiv* Factors Do Not Support Discretionary Denial

The *Fintiv* factors do not support discretionary denial of institution under 35 U.S.C. §314(a).

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

Factor 1 is neutral because no stay has yet been requested, although one may be requested. *See, e.g., Huawei Tech. Co., Ltd. v. WSOU Inv., LLC*, IPR2021-00225, Paper 11 at 7–8 (P.T.A.B. June 14, 2021).

Factor 2 favors institution. As the Interim Procedure explains, the Board will consider the “median time from filing to disposition of the civil trial for the district in which the parallel litigation resides.” EX1019, 3. Here, the median time to trial in the District of Delaware is 36.3 months. EX1025, 14. Since the Amended Complaint was filed September 2, 2021, the median time to trial places trial around mid-September 2024, well after the Board’s Final Written Decision would be due in this IPR. EX1020. Moreover, Caterpillar did not file its Counterclaim adding the ’995 patent to the parallel litigation until October 14, 2021. EX1021. Thus, Wirtgen has been at least as diligent in preparing this IPR as Caterpillar was in preparing its IPRs. Indeed, Caterpillar has recently argued *Fintiv* does not apply to its IPRs filed a mere week ago. EX1022.

Factor 3 favors institution because the litigation is still in its early stages. Indeed, claim construction briefing has not begun and the Court will not hold its claim construction hearing until January 24, 2023. EX1023. The fact discovery cutoff is not until March 31, 2023. EX1024. And expert reports are not due until after discovery.

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

Factor 4 favors institution because there is little overlap between issues raised in the petition and the parallel proceeding. Wirtgen expects to focus its district court invalidity showing on machine-based prior art which is not applicable here.

Factor 5 favors institution because the parties in this proceeding are identical to the parties in the related litigation and the Final Written Decision will likely issue before trial in the related litigation, and certainly before the median time to trial in the district.

Factor 6 favors institution because Wirtgen presents compelling evidence of unpatentability of the Challenged Claims. EX1019, 2 (“[T]he PTAB will not...discretionarily deny institution in view of parallel district court litigation where a petition presents compelling evidence of unpatentability.”) And the Board is best suited to address the technical issues raised in this proceeding.

Therefore, the Board should not deny institution based on parallel litigation.

* * * * *

Section VII below details the asserted ground. Petitioner has also submitted a Declaration of Dr. Jeffrey L. Stein (“Dr. Stein”), a technical expert with more than three decades of experience in machine and automotive system design and control, including vehicle control technologies. Stein Decl., ¶¶6-16.

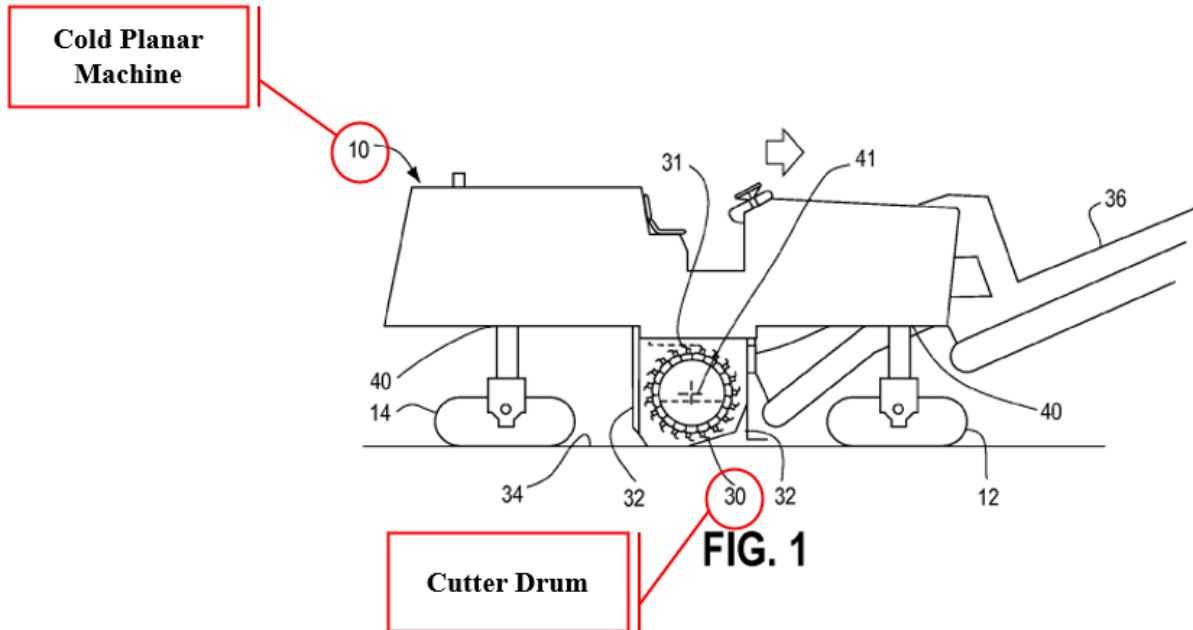
III. LEVEL OF SKILL IN THE ART

A POSITA typically would have had a bachelor's degree in mechanical engineering or an equivalent degree and two to five years of experience working on designing or developing machine powertrains in which a controller controls a powertrain's internal combustion engine and coupled transmission. Additional education may substitute for lesser work experience and vice versa. *See* Stein Decl., ¶¶21-24. Also, a POSITA may have worked as part of a multidisciplinary team and drawn upon not only their own skills, but of others on the team, e.g., to solve a given problem. *See* Stein Decl., ¶24. For example, an electrical or computer engineer may have been part of the team. *Id.*

IV. TECHNOLOGY BACKGROUND AND PRIOR ART OVERVIEW

Many prior-art machines had engines that drove rotatable components via variable transmissions, including farm tractors, harvesters, backhoe loaders, and cold planers. EX1008, 2:43-61; EX1003 47-48. Their powertrains had “universal applicability to any machine utilizing such an arrangement.” EX1008, 2:43-61. Cold planers (also called milling machines), such as those described in the '538 Patent, are road construction machines that use a rotor (or milling drum) to grind away layers of a roadway surface.

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.



EX1013, Fig. 1 (annotated)

Parker further taught that controller 42 coordinated control of engine 16 and variable transmission 20. EX1013, 5:41-44, Fig.2.

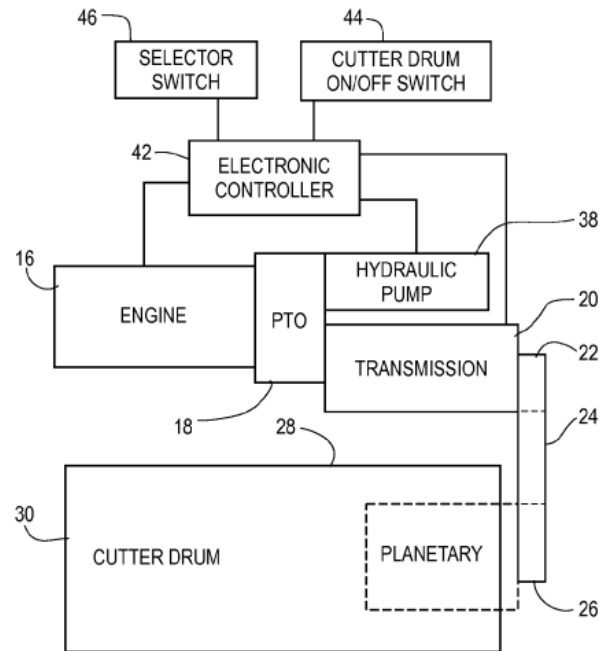


FIG. 2

EX1013, Fig. 2

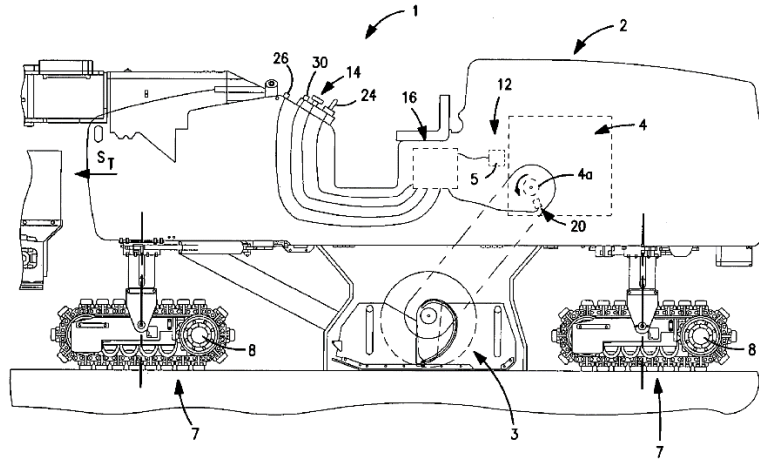
Other milling machine prior art, such as Laux, noted the existing demand for optimizing milling machine operation to obtain “the lowest possible fuel consumption and, at the same time, the highest possible milling performance.” Laux, 1:23-62. Laux recognized that optimal milling performance per fuel consumption is “not always achieved with higher rotational speed of the milling drum.” Laux, 1:23-62. It therefore suggested optimizing milling performance relative to milling efficiency by controllably adjusting rotor speed using a variable transmission. Laux, 1:23-62; Stein Decl., ¶¶60-63.

A. Milling Machines With Controllers That Coordinated Operation of an Engine and Variable Transmission to Drive a Coupled Rotor at a Desired Rotor Speed Were Known.

1. Willis

In early milling machines, like that taught by Willis, the engine drove the rotor directly through a direct drive train. Willis says “the engine 4 is preferably configured to directly drive the cutter drum 3” and he says the drive train may include components between the engine and cutter drum such as “a belt-and-pulley system or a gear train.”¹ Willis, ¶[0020]. A regulator adjusted engine speed to correspondingly adjust rotor speed. *Id.*

¹ For clarity, the Petition refers to a “direct drive train” with respect to direct drive systems like those taught by Willis. Absent additional components, a direct drive train transmits power to the rotor at a fixed ratio relative to engine speed. In contrast, when the remainder of the Petition refers to a “transmission” or a “variable transmission,” such references are intended to indicate an element of a drive train that may be adjusted to adjust the ratio of rotor speed relative to engine speed.



Willis, Fig. 3

The controller received a desired rotor speed via drum speed selector 14, where each of “buttons 21A, 21B, 21C, 21D...corresponds to a separate desired drum speed.”

Willis, ¶¶[0017]-[0018].

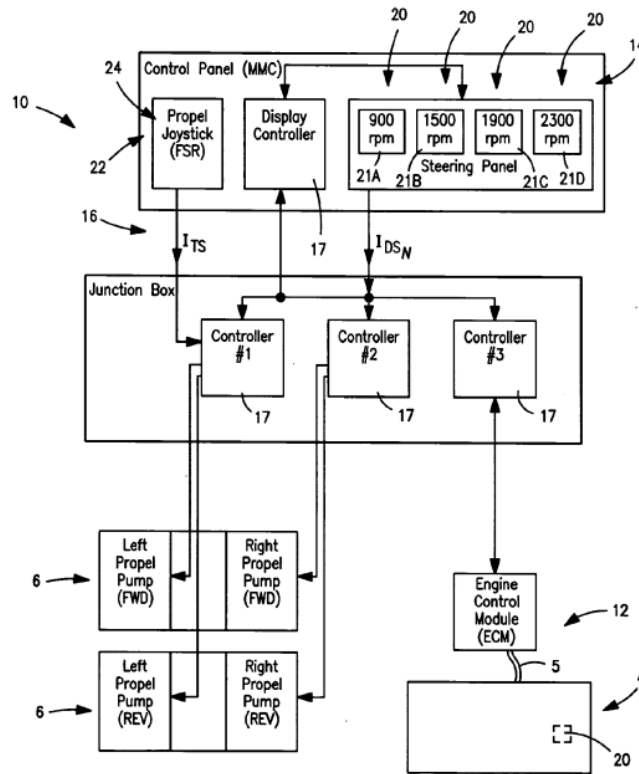


FIG. 1

Willis, Fig. 1

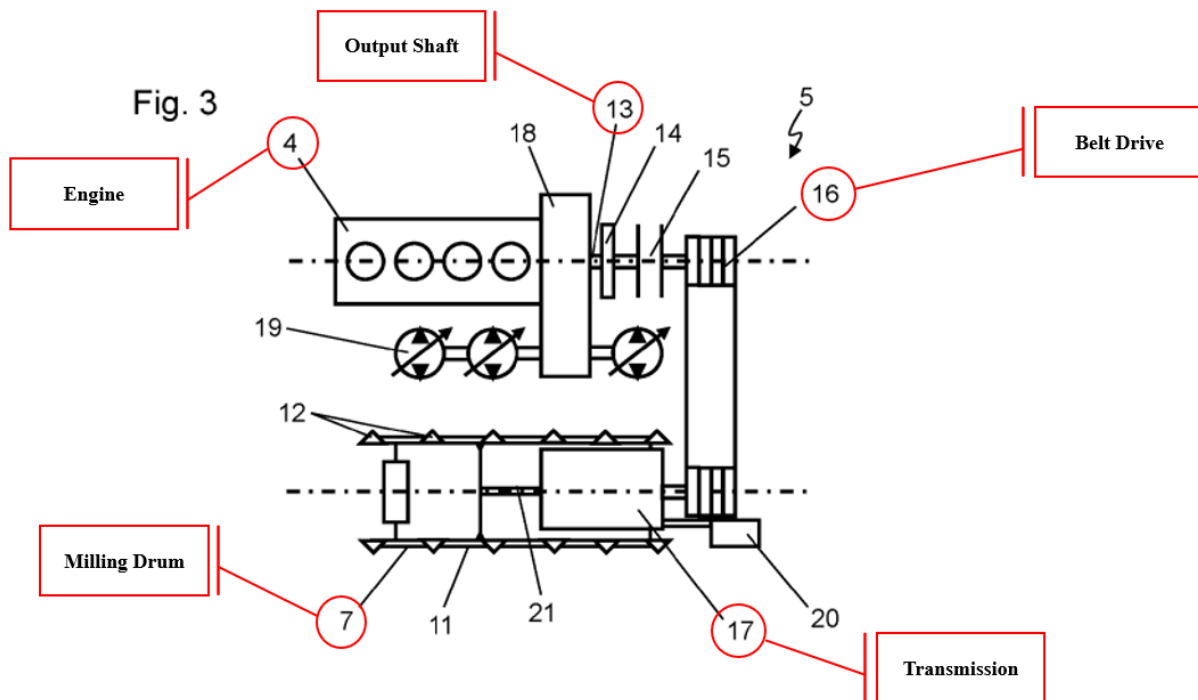
The controller also received information indicative of the actual rotor speed sensors in engine 4, on milling drum shaft 3a, or on rotor 3 itself. Willis, ¶[0021]. It then compared the actual rotor speed with the desired rotor speed and, via regulator 12, adjusted engine speed until the actual rotor speed corresponded to the desired rotor speed. Willis, ¶[0017], ¶[0022].

Willis's controller also provided a selectable load control mode, whereby the controller reduced travel speed if it was unable to adjust the actual rotor speed to equal the desired rotor speed. Willis, ¶¶[0023]-[0028]. Willis included a hydrostatic

drive for propelling crawler assemblies 7. *Id.* The controller reduced speed by adjusting the hydrostatic drive to reduce the speed of crawler motors 8, which reduced the load, thereby mitigating overloading of the rotor and engine. *Id.* Thus, Willis's controller controlled the engine load resulting from parasitic loads of the rotor and hydrostatic drive by (1) adjusting rotor speed via the engine and direct drive train and (2) by adjusting the travel speed via the hydrostatic drive.

2. Laux

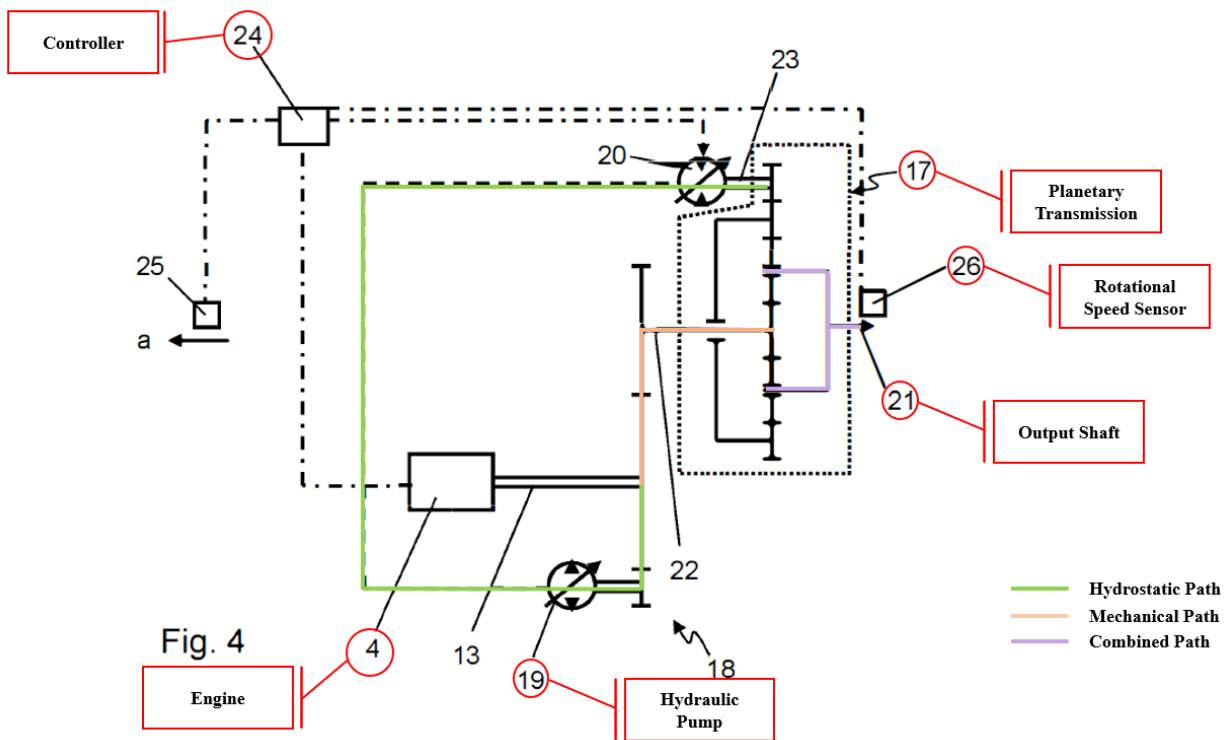
Laux taught a milling machine powertrain that included an engine that drove a rotor via a variable transmission and a controller that coordinated the operation of the engine and transmission to control rotor speed.



Laux, Fig. 3.

Engine 4 was coupled to belt drive 16 via output shaft 13. Laux, 8:60-9:28. Belt drive 16 was coupled to milling drum 7 via drive transmission 17. Control unit 24, an “essential feature,” was in electrical communication with rotational speed sensor 26 and controllably adjusted the rotational speed of milling drum 7. Laux, 9:29-46.

Laux’s drive train utilized a planetary unit to combine two power inputs (hydrostatic and mechanical) to drive a single transmission output. Stein Decl., ¶¶60-62. Laux’s drive transmission 17 was a planetary gear summation transmission (i.e., a variable transmission) that received drive input from engine 4 via shafts 13, 22, and drive input from hydraulic motor 20, via shaft 23, to rotate output shaft 21 based on the summation of the two inputs.



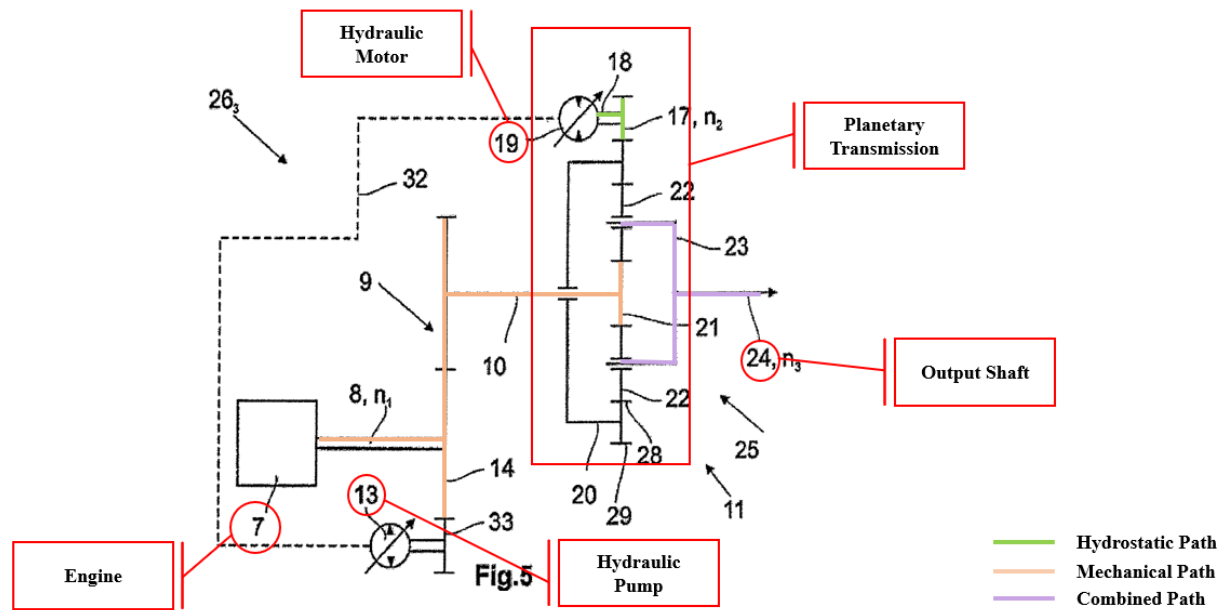
Laux, Fig. 4 (annotated).

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

By adjusting the speed of the hydraulic motor, controller 24 could continuously vary the speed of transmission output shaft 21 and thereby adjust rotor speed independently of engine speed. Laux, 5:61-6:24.

For further details regarding its variable transmission, Laux incorporated Schomaker by reference.² Laux, 1:38-43, 6:12-14. Schomaker also utilized a planetary unit to combine two power inputs (hydrostatic and mechanical) to drive a single transmission output. EX1016, ¶¶[0033]-[0034]; Stein Decl., ¶62. Schomaker details the well-known arrangement of its planetary gear 25, which combines rotational speeds n_1 (mechanical) and n_2 (hydrostatic) to vary speed n_3 of output shaft 24, which drives milling rotor 6. EX1016, ¶¶[0033]-[0037].

²Laux claims priority to German application DE102012006189.7 to Schomaker et al. (“Schomaker”). Schomaker was effectively filed February 12, 2014. Accordingly, Laux constitutes prior art under 35 U.S.C. § 102(a)(2). Laux also incorporates by reference Schomaker and its corresponding PCT application, PCT/EP2013/000686. US Application No. 2015/0091363 is a corresponding English language application that claims priority to and shares its disclosure with these German language Schomaker applications. Laux, 1:8-11, 1:38-43. Schomaker’s teachings are therefore “effectively part of [Laux] as if it were explicitly contained therein.” *Advanced Display Sys., Inc. v. Kent State Univ.*, 212 F.3d 1272, 1282 (Fed. Cir. 2000); *see also, e.g., Paice LLC v. Ford Motor Co.*, 881 F.3d 894, 906–07 (Fed. Cir. 2018) (determining that the Board erred in limiting incorporation by reference to certain disclosures because a broad incorporation of the entire disclosure could not be negated by other statements regarding the “applicability of certain features”); *Numodx Molecular, Inc. v. Handylab, Inc.*, No. IPR2020-01133, Paper No. 23, at 4–6 (P.T.A.B. Aug. 6, 2021) (relying on *Paice LLC*). For ease of reference, this Petition cites to U.S. Application No. 2015/0091363 (the “’363 Application”), which is an English language application corresponding to DE102012006189.7.



EX1016, Fig. 5 (annotated)

Laux taught that milling machine operation is “costly,” and customer demand required optimizing machine operation by minimizing milling machines’ fuel consumption whenever possible while maintaining desired milling performance. Stein Decl., ¶¶61-63; Laux, 1:33-37. Schomaker likewise taught that the “reduction in fuel consumption as well as the continuous adjustability of the second speed of rotation at which the milling rotor is driven result in more economical, faster, and safer milling of road surfaces compared with prior art construction machines.” EX1016, ¶[0024]. The powertrain system taught by Laux, which incorporated the teachings of Schomaker, allowed independent variation of engine speed and milling

drum speed by using a planetary summation transmission to continuously vary rotational speed. Laux, 2:5-15, 5:61-6:24.

B. Work Machines that Adjusted Engine Speed Based on Load and Optimum Fuel Consumption Rates While Maintaining Machine Performance Were Known.

1. Xing's Teachings are Applicable to Milling Machines

Xing taught a control system and method for controlling a machine powertrain that adjusted engine speed to improve fuel consumption while also adjusting the gear ratio of a variable transmission to maintain desired machine performance and productivity. Although an exemplary embodiment coupled the variable transmission to the wheels in a farm tractor, Xing taught that such powertrain systems can be implemented in any "suitable work vehicle known in the art" to power any work implement. Xing, 2:34-50, 4:1-27, 4:33-37, 6:59-7:3. This is consistent with Hoff's teaching that CVTs have "universal applicability to any machine," including "a tractor" and "a cold planer." EX1008, 2:43-61. Thus, a POSITA would have understood Xing's teachings to apply to Willis's milling machine.

2. Xing's Controller Adjusts Engine Speed for Fuel Efficiency

Xing taught a controller and method that, based on engine load and predefined efficiency points, controlled engine speed to minimize fuel consumption.

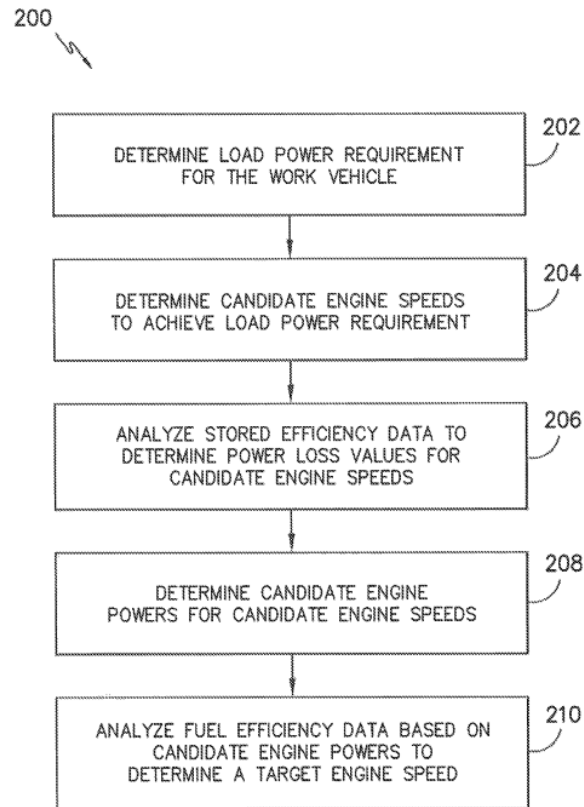


FIG. -4-

Xing, Fig. 4.

According to Xing:

[T]he method may allow for a candidate pool of engine settings (e.g., candidate engine speeds and/or torques) to be generated by analyzing both the load conditions of the work vehicle 10 and the individual efficiencies of various vehicle components. The candidate engine settings may then be analyzed to determine the specific engine settings at which the vehicle's fuel consumption is minimized. The engine operation may then be set to the specific engine settings and the transmission ratio may be adjusted such that the desired vehicle performance/productivity is maintained.

Xing, 8:59-9:3.

According to Xing's method, controller 116 first determined the engine's load power requirement, which "corresponds to the amount of power required for the vehicle 10 to finish useful work." Xing, 9:18-56. Xing's controller 116 was communicatively coupled to the engine 22, the variable transmission 24, shaft speed sensors 68, torque sensor 122, and engine speed sensor 124 to permit monitoring of operating parameters. Xing, 5:38-55, 7:22-32, 8:16-41, 8:53-9:3.

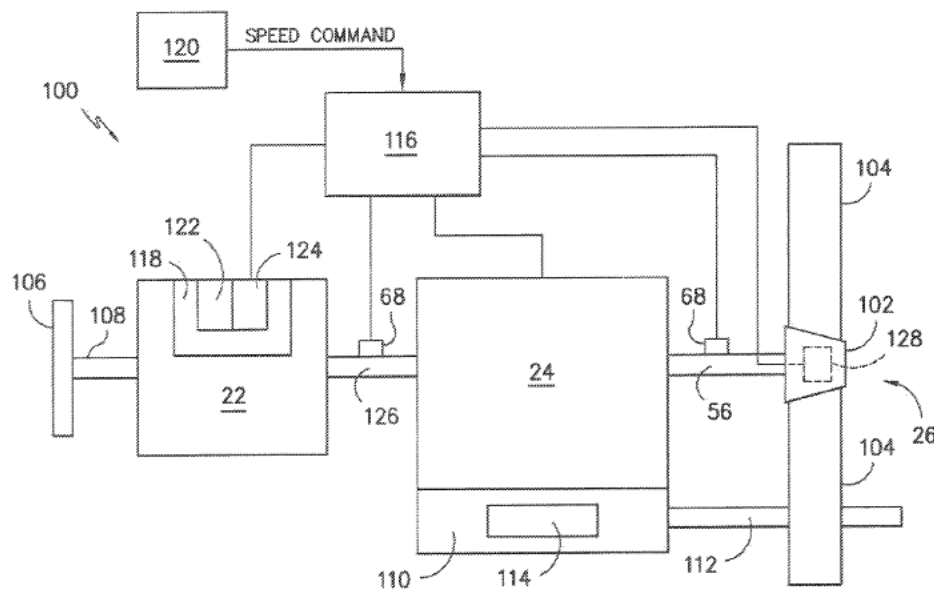


FIG. -3-

Xing, Fig. 3

Using signals indicating “the engine speed and the engine torque,” controller 116 calculated current engine power (P_{engine}). Xing, 9:18-56. Using “component efficiency data stored within its memory,” it also calculated current power loss (P_{loss}) based on “the current vehicle operating parameters.” From that data, it determined

the current load power requirement (P_{load}) according to Equation 1: " $P_{engine} = P_{load} + P_{loss}$." Xing, 9:18-56.

Based on the load power requirement, controller 116 then identified an engine speed that was sufficient to achieve the required power load and that would also provide optimal fuel efficiency. Specifically, controller 116 evaluated various candidate engine speeds and torques and their associated efficiency data using, e.g., a stored "fuel consumption map for an engine" for fuel efficiency determinations. Xing, 10:16-13:18 (identifying "optimal efficiency point 300").

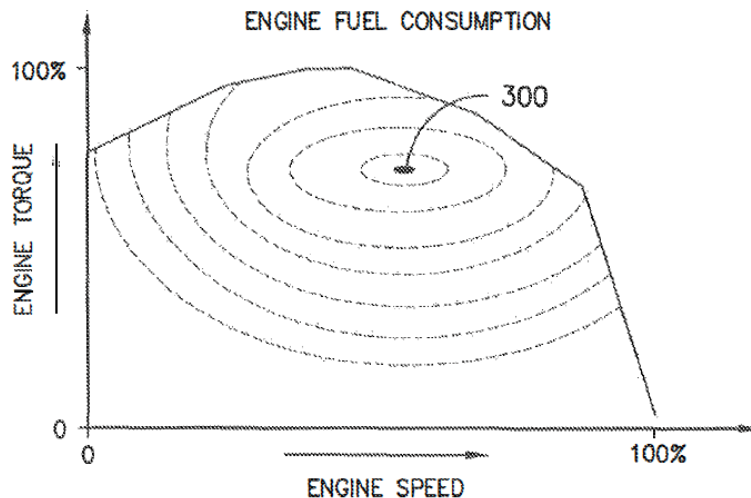


FIG. -11-

Xing, Fig. 11

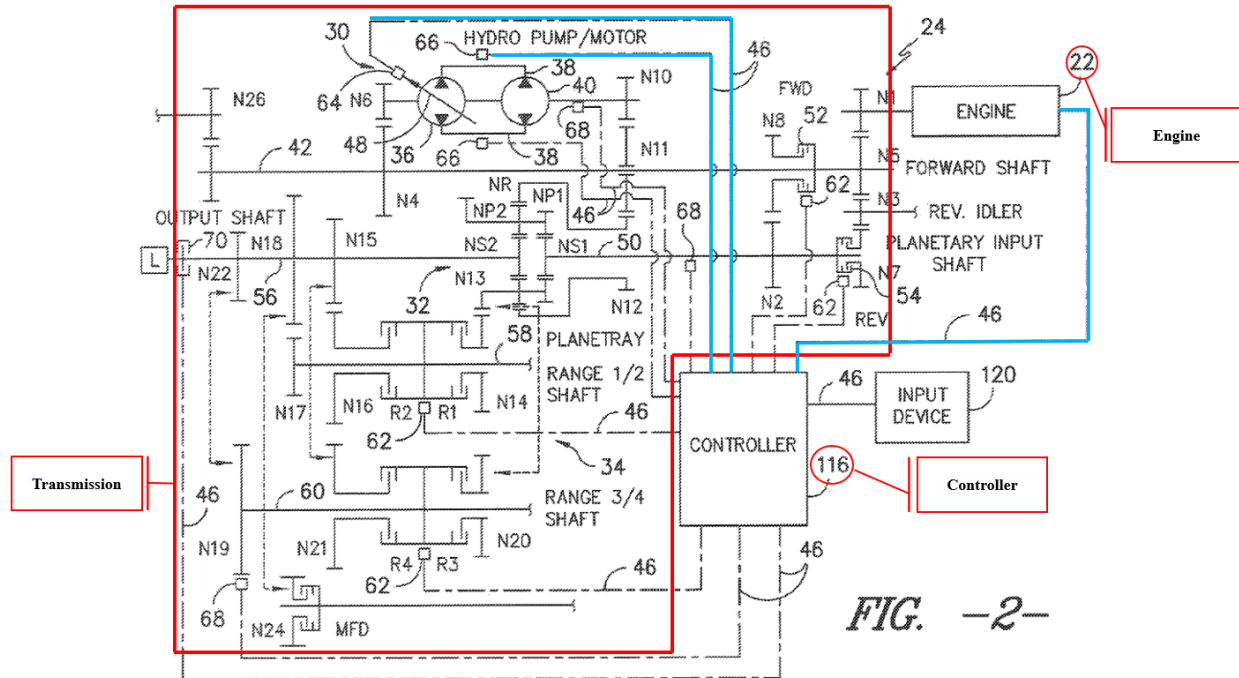
3. Xing's Controller, Like That of Laux, Uses the Work Machine's Continuously Variable Transmission to Maintain Desired Performance

Like Laux, Xing's controller adjusted the gear ratio of a variable transmission to control the rotational speed of a transmission output shaft. Both Laux's and Xing's

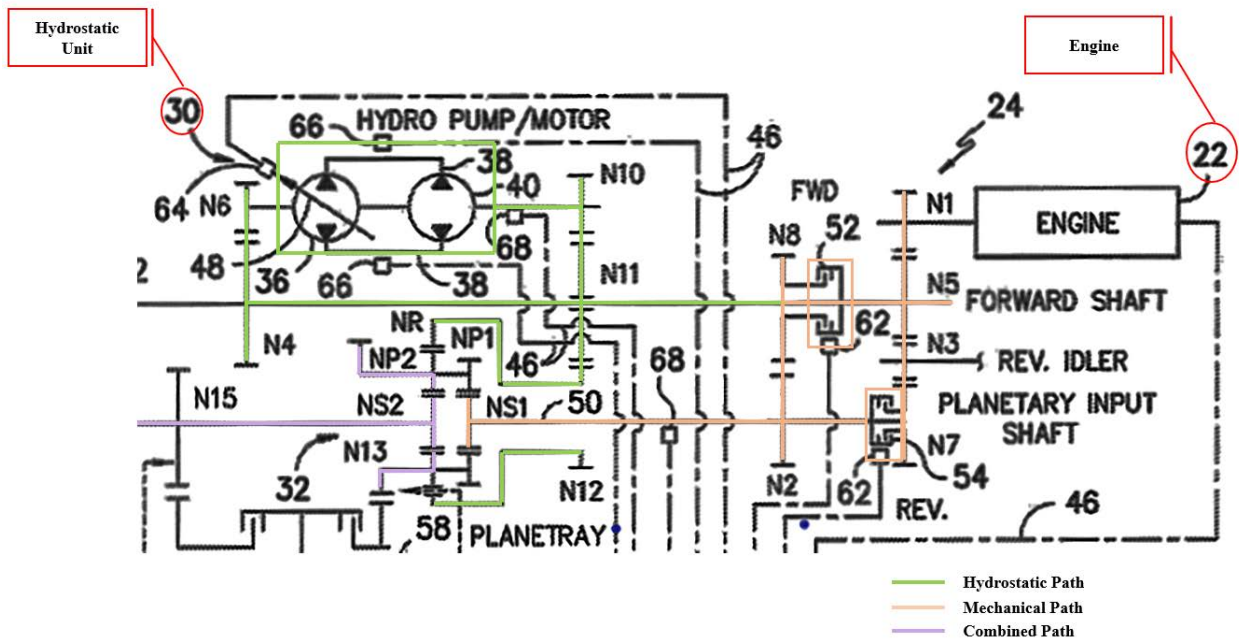
Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

variable transmissions were configured “such that power from the engine flows in parallel through both a hydrostatic branch and a mechanical branch.” Xing, 1:30-33; Stein Decl., ¶¶53-63. Although the output shaft of Laux’s transmission was coupled to a rotor and that of Xing’s was coupled to a tractor’s drive wheels, the principles of operation remained the same. Xing, 8:29-37, 13:19-35; Stein Decl., ¶¶53-54, ¶¶60-63, ¶66. Such arrangements that controlled engine speed and transmission output speed independently “minimize[d] fuel consumption while maintaining the desired performance productivity of the work vehicle.” Xing, 3:48-67, 6:47-58.

Like Laux, Xing’s drive train utilized a planetary unit to combine two power inputs to drive a single transmission output. Stein Decl., ¶¶54-58. Power from engine 22 flowed in parallel through a hydrostatic branch (green path) and a mechanical branch (orange path) to recombine through planetary unit 32 to drive one or more power consuming components, such as the drive wheels or “any other suitable load.” Xing 1:25-38, 4:33-7:33.



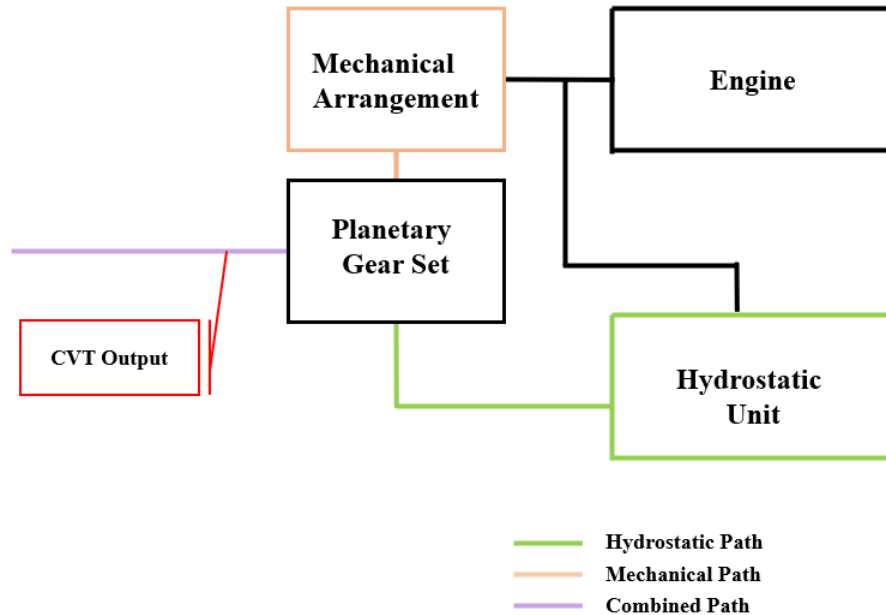
Xing, Fig. 2 (annotated)



Xing, Fig. 2 (excerpt annotated)

The following figure is a simplified version of Xing Fig. 2 showing the connection between the engine and the mechanical arrangement and the hydrostatic

arrangement. Both then connect to the planetary gear set to create the combined CVT output.

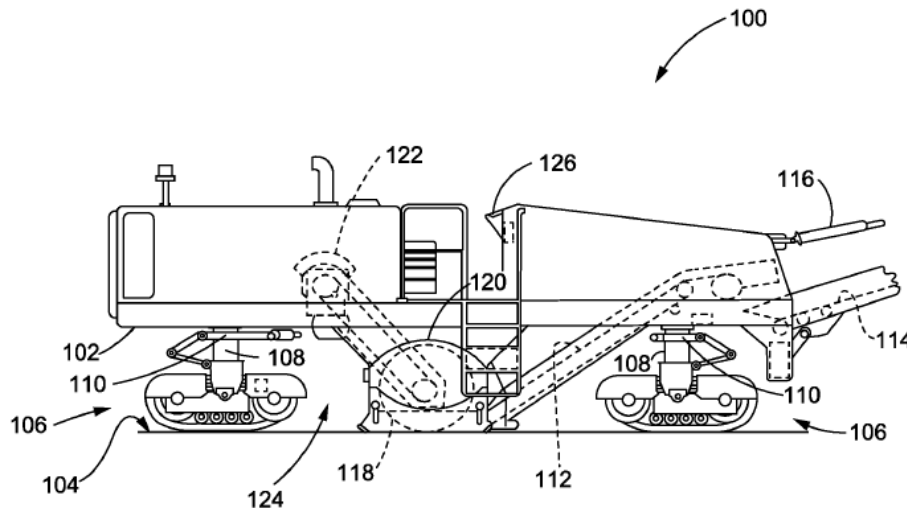


Representation of Xing, Fig. 2

V. OVERVIEW OF THE '538 PATENT

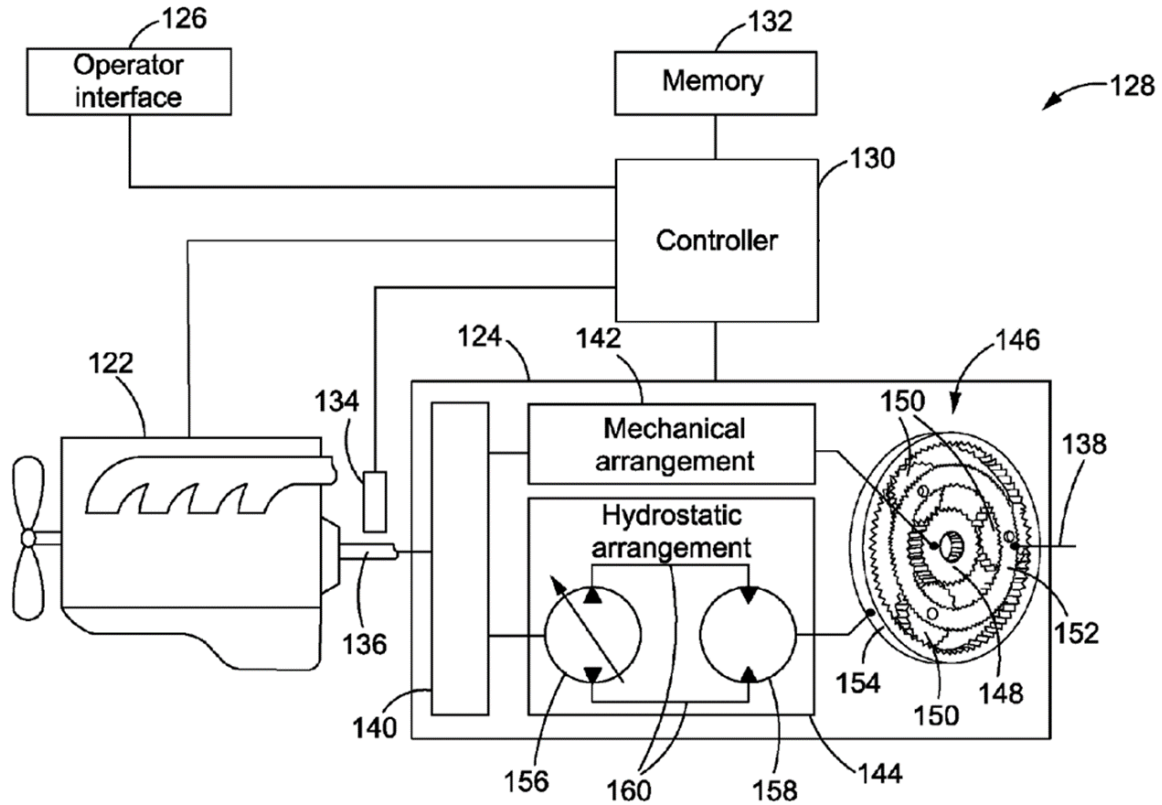
The '538 Patent, entitled "Milling Machine Fuel Efficiency Control System," describes "a control system for controlling a machine having a rotor coupled to an engine through a variable transmission." EX1001, 1:52-63. A controller is electrically connected to the engine, variable transmission, and rotor. EX1001, 2:6-18. The controller receives a desired rotor speed, determines the load on the engine, adjusts the engine speed based on the load and predefined efficiency points, and adjusts a gear ratio of the variable transmission based on the engine speed and the desired rotor speed. EX1001, 1:52-60, 4:48-63. Although the system and method

“find[] utility in various applications involving the use of machines,” the specification focuses on “industrial machines” such as the “road milling machine” depicted in Figure 1. EX1001, 1:13-17, 2:38-46, 4:48-59.



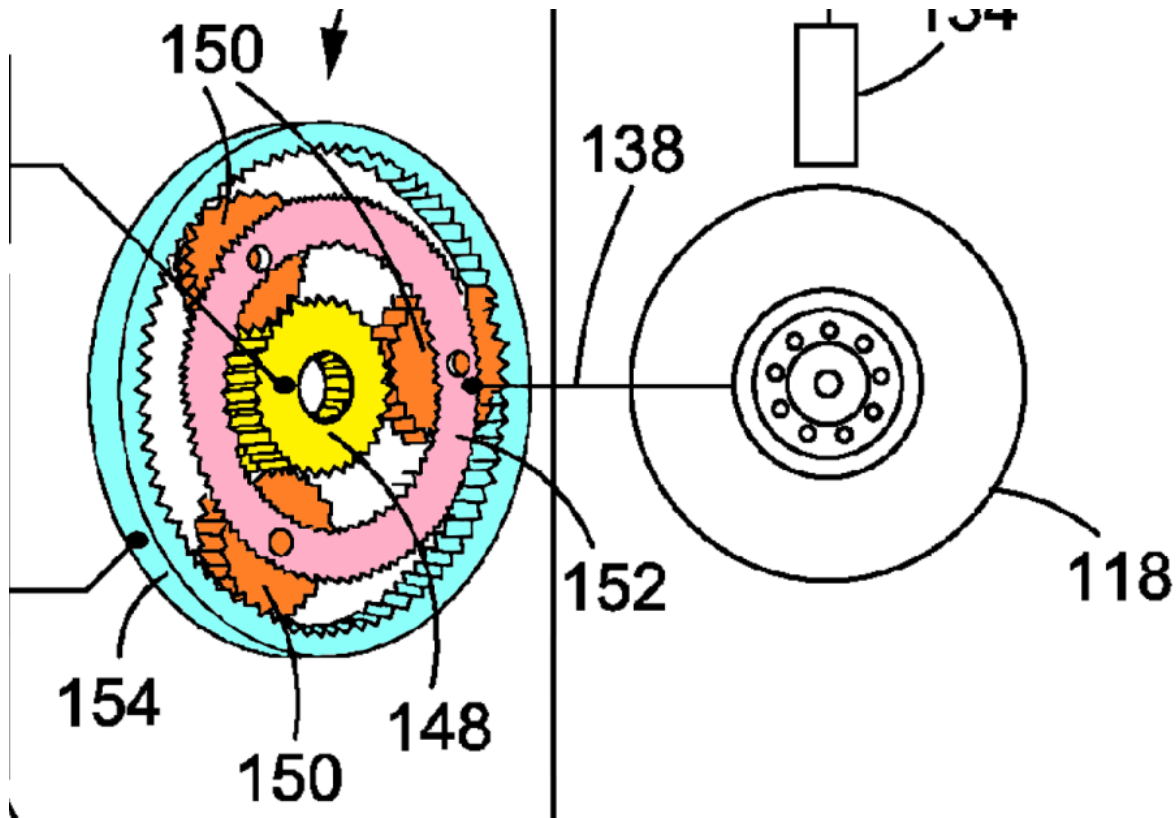
EX1001, Fig. 1

An exemplary control system includes engine 122 that drives CVT 124. CVT 124 includes clutch 140, which couples engine output 136 to mechanical arrangement 142 and hydrostatic arrangement 144. EX1001, 2:24-25. Power from engine 122 flows in parallel through hydrostatic arrangement 144 (green path) and mechanical arrangement 142 (orange path) to recombine through planetary gear set 146. EX1001, 3:30-50.



EX1001, Fig. 2

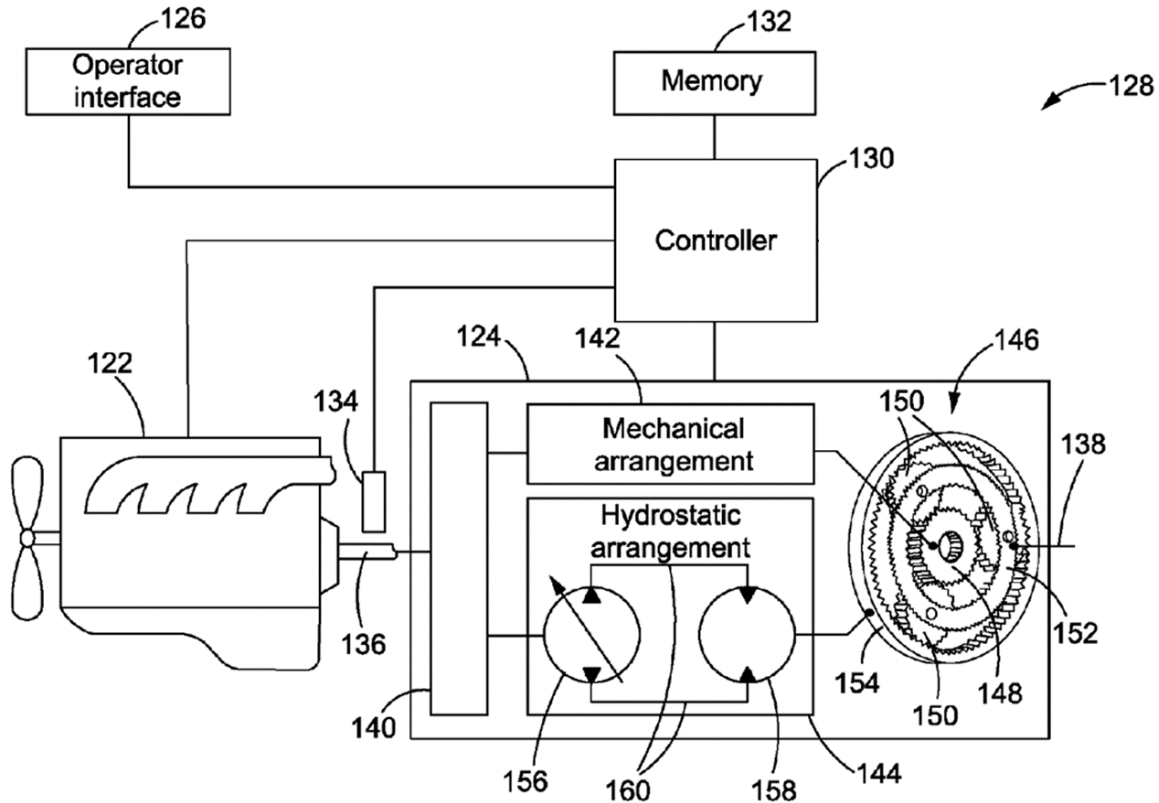
Planetary gear set 146, which drives CVT output 138, is conventional. *Id.*



EX1001, Fig. 2 (excerpt annotated)

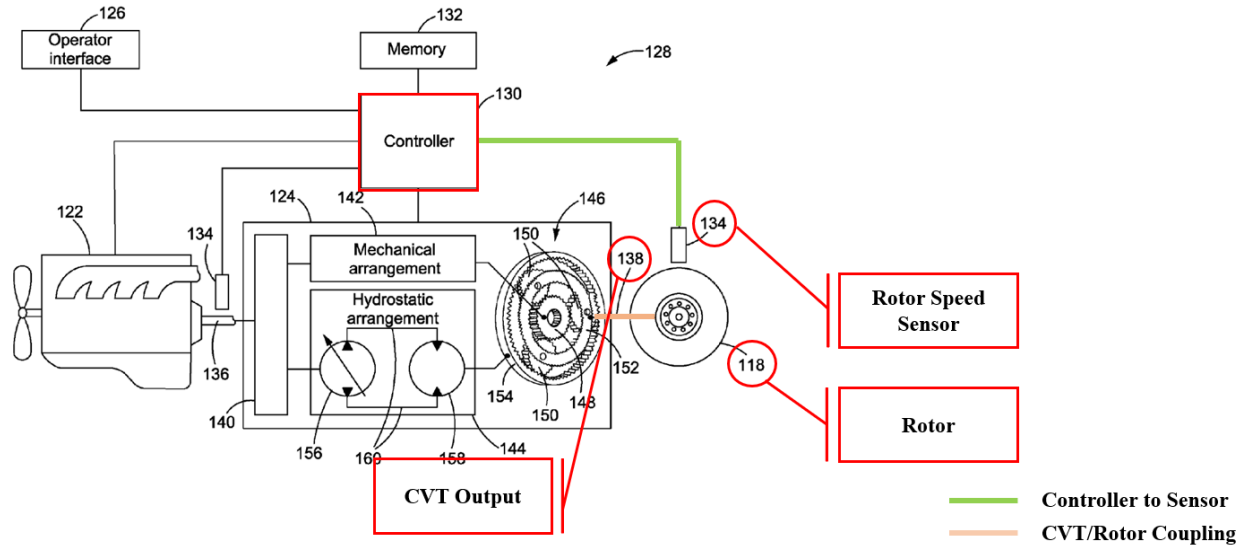
By varying the speeds of the hydraulic motor and engine, and thereby varying the speeds of the ring gear (light blue) and sun gear (yellow), the controller continuously adjusts the gear ratio, i.e., the ratio between the engine output 136 and the CVT output 138 provided by the planetary gears (orange) and carrier (pink). EX1001, 3:51-4:8.

Generic controller 130 controls the operation of engine 122 and CVT 124. EX1001, 3:8-29. Controller 130 is in electrical communication with memory 132, operator interface 126, engine 122, CVT 124, and sensors, such as sensor 134 for determining engine speed via engine output 136. *Id.*



EX1001, Fig. 2

In one embodiment, rotor 118 is coupled to CVT output 138, permitting “control [of] at least the rotor 118 in response to input received via the operator interface 126.” EX1001, 3:8-30. In that embodiment, controller 130 receives signals from another sensor 134 for determining “rotor speed via a CVT output 138.” EX1001, 3:8-30.



EX1001, Fig. 2 (annotated)

In an exemplary method, “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.” EX1001, 4:4-6:9.

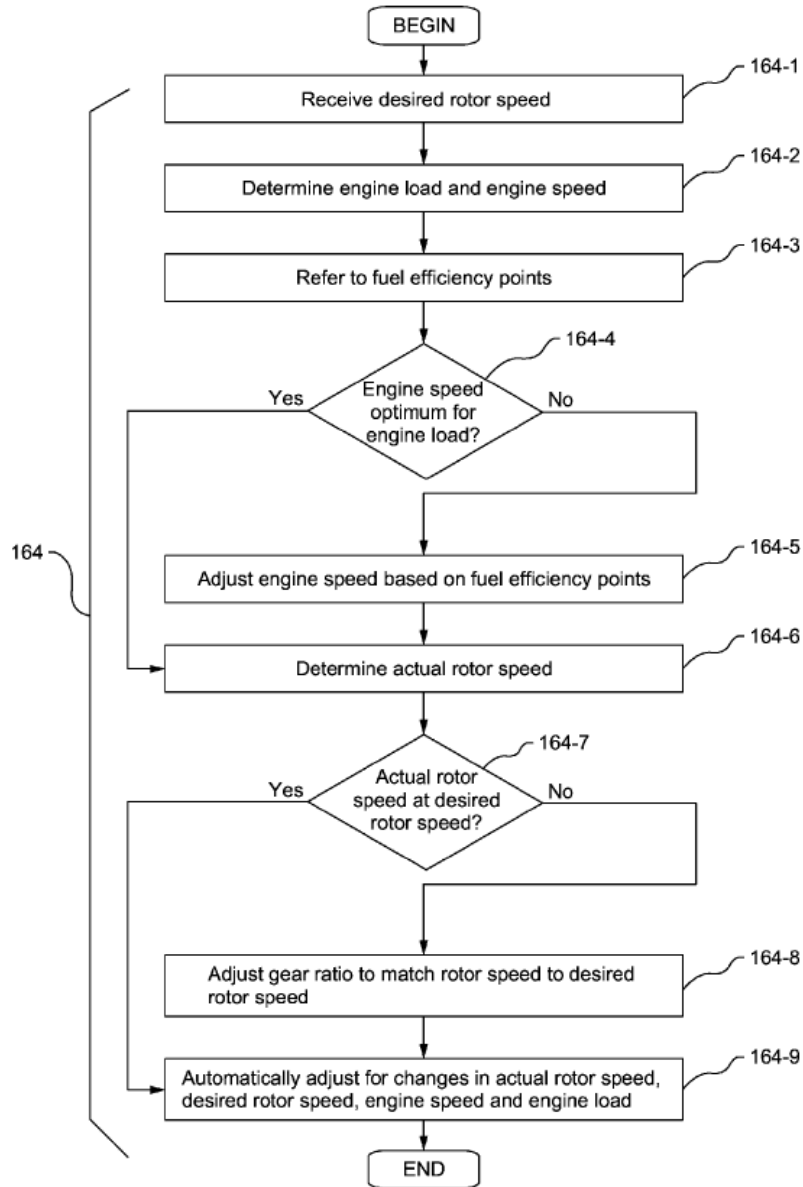


FIG.5

EX1001, Fig. 5

The predetermined efficiency points, stored in the controller's memory, are combinations of engine speed and engine load expected to provide relatively better fuel economy. EX1001, 4:4-27.

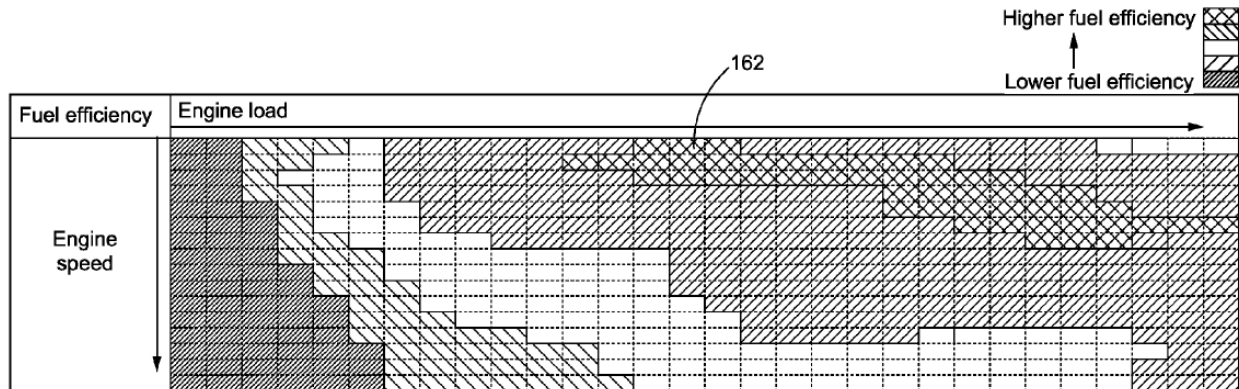


FIG.4

EX1001, Fig. 4

Using this information, controller 130 “adjust[s] engine speed based on changes in the engine load and predefined efficiency points 162 for better fuel economy” and “continuously adjust[s] the gear ratio...in a manner which substantially maintains the rotor speed at the desired rotor speed specified by the operator irrespective of changes in the engine speed.” EX1001, 3:52–4:44.

VI. CLAIM CONSTRUCTION (37 C.F.R. § 42.104(b)(3))

Claim terms in IPRs “shall be construed using the same claim construction standard that would be used to construe the claim in a civil action.” 37 C.F.R. §42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005). Petitioner does not believe any specific constructions are required at this time. In this Petition, all terms of the ’538 Patent claims have been given their ordinary and customary meaning as understood by one of ordinary skill in the art in light of the specification and the prosecution history pertaining to the patent, in accordance with §42.100(b).

VII. THE CHALLENGED CLAIMS ARE UNPATENTABLE (37 C.F.R. § 42.104(b)(4))

The asserted prior art references teach or suggest all the limitations claimed, rendering invalid as obvious each challenged claim of the '538 Patent. The claimed invention consists of no more than using a controller to operate prior-art milling machines “in a manner that provides optimum fuel efficiency or in a manner constrained based on predetermined fuel consumption rates.” EX1001, 1:41-2:18, 4:4-8. Although the specification purports to provide “improved solutions for controlling and maintaining a desired rotor speed of a milling machine,” it concedes that prior-art reference Parker already utilized a variable transmission to adjust the gear ratio to provide a desired rotor speed independent of engine speed. EX1001, 1:26-48. Caterpillar conceded the same during prosecution. EX1002, 99–101. To overcome an anticipation rejection over Parker, Caterpillar amended the claims to require that the controller adjusts engine speed based on “fuel consumption rates.” *Id.* But Xing, which was not before the Examiner, already taught such a method.

A. Ground 1: The Combination of Willis and Xing Renders Obvious Claims 1-13 of the '538 Patent

The '538 Patent claims the combination of known milling machine components and powertrain systems with known controller-implemented methods for optimizing fuel efficiency while maintaining a desired rotor speed. Willis teaches a milling machine with a powertrain that includes an engine coupled to a rotor via a

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

direct drive train. Numerous prior art references, including Parker, Laux, and Schomaker, taught that implementing a variable transmission and control system in a milling machine powertrain system would permit control of rotor speed independently of engine speed to maintain a desired rotor speed, leading to improved fuel efficiency. Stein Decl., ¶66. Xing taught an improved method of controlling a similar powertrain system to maintain a desired transmission output speed while optimizing engine fuel efficiency. Stein Decl., ¶¶53-59, ¶¶65-66. Accordingly, a POSITA would have been motivated to modify Willis with the teachings of Xing and Laux and would have had a reasonable expectation of success in modifying Willis with Xing's teachings to arrive at the claimed invention. Stein Decl., ¶¶65-66. Willis, in view of Xing, renders all the '538 Patent claims obvious.

1. Reasons and Motivations for Combining the Teachings of Willis and Xing

A POSITA would have been motivated to include a system and method like that taught by Xing in Willis's milling machine. A POSITA would have known that milling machines were costly to operate and wanted to minimize fuel consumption to lower operating cost without sacrificing performance. Stein Decl., ¶63, ¶65; Laux, 1:33-37-45, 3:32-45, 7:16-26; EX1013, 3:18-59. As acknowledged in the prior art, a POSITA would have appreciated the widely understood benefits of reducing fuel consumption while maintaining machine performance. *Supra* IV.A.2. Moreover, it was known that implementing a variable transmission in a milling machine could

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

improve fuel efficiency. *Supra* IV.A.2. A POSITA would have recognized that using a hydromechanical CVT permitted controlling an engine to a speed that minimizes fuel consumption for a given load while controlling transmission gear ratios to achieve desired transmission output speeds that maximize machine performance. Stein Decl., ¶66. Parker, Laux, and Schomaker taught the advantages of implementing an electronically controlled variable transmission in a milling machine, e.g., that a desired rotor speed could be achieved independent of engine speed. *Supra* IV, IV.A.2; Stein Decl., ¶66. And Xing taught a method of controllably adjusting a CVT to further improve fuel efficiency without impacting machine performance. *Supra* IV.B. Thus, implementing a CVT and control method like that taught by Xing in Willis's milling machine would have been a matter of combining prior art elements according to known methods to yield predictable results. Stein Decl., ¶66.

Because CVTs had universal applicability, a POSITA would have expected to successfully incorporate Xing's teachings, including those related to CVTs, engines, transmission control algorithms, and associated sensors, into Willis's milling machine. Stein Decl., ¶66; EX1008, 2:43-61. Such a combination would have amounted to combining prior art elements according to known methods to yield predictable results. Stein Decl., ¶¶65-66. This combination would further apply a known technique and hardware to a known device that was ready for improvement,

predictably yielding the result of the expected improvement. A POSITA would have expected that such a combination would improve the fuel consumption and energy efficiency of Willis's milling machine, while maintaining desired rotor speed during operation. Stein Decl., ¶¶65-66.

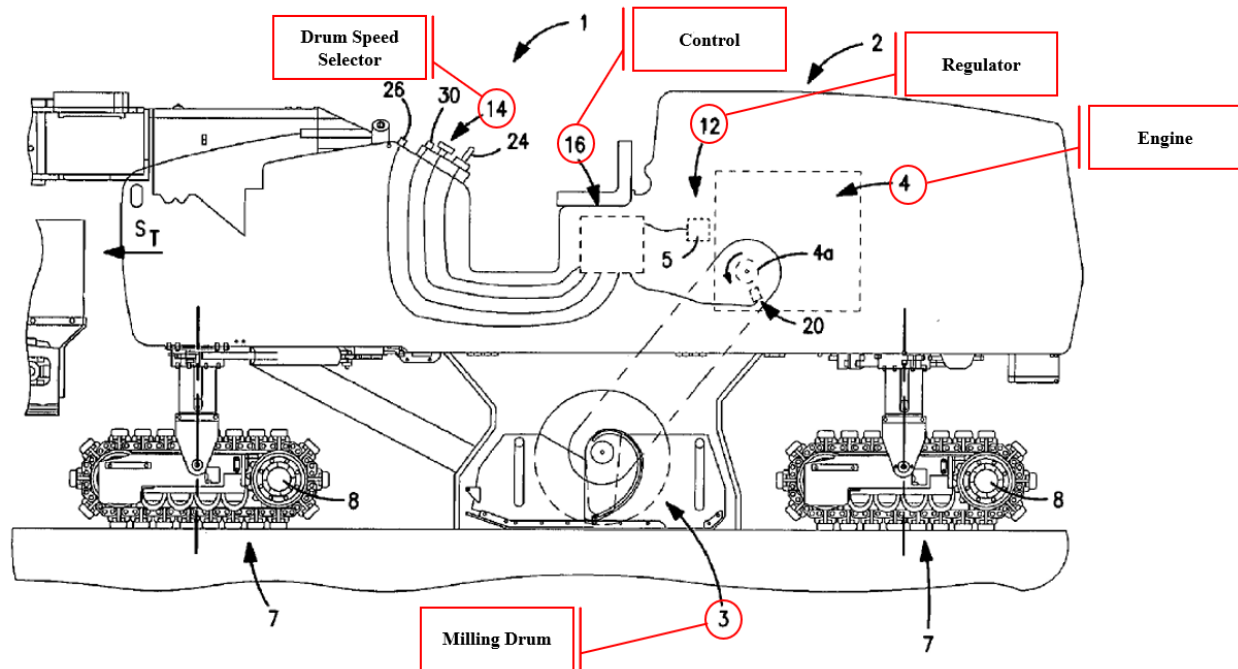
2. Independent claim 1

The combination of Willis and Xing renders claim 1 obvious.

a) [p] “A controller-implemented method of controlling a machine having a rotor coupled to an engine through a variable transmission, comprising:”

(1) Willis taught a controller for controlling an engine in a milling machine

Willis taught milling machine 1 with engine 4 coupled to rotor 3, under control of a drum speed control system. Willis, ¶[0017].



Willis, Fig. 3 (annotated)

The drum speed control system included controller 16 that received a desired drum cutting speed input from speed selector 14 and operated a regulator 12 to adjust the drum cutting speed to the desired speed. Stein Decl., ¶¶67-68; Willis, ¶[0003], ¶[0017]. 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.” Willis, ¶[0021]; Stein Decl., ¶68. 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 such that the sensed drum speed DS_S is generally equal to the desired drum speed DS .” Willis, ¶[0021]. The regulator could be any regulator capable of adjusting engine speed to correspondingly vary or adjust cutter drum speed DS . Willis,

¶[0020]; Stein Decl., ¶68. Thus, Willis taught a controller for controlling an engine and rotor speed in a milling machine.

(2) Willis and Xing taught a controller for the combined control of an engine and variable transmission in a milling machine

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, 4:8-54, Figs. 2 and 3 (showing controller 116 connected to both engine 22 and transmission 24); Stein Decl., ¶69; *supra* IV.B. Xing's transmission was a CVT. Xing, 4:38-42.

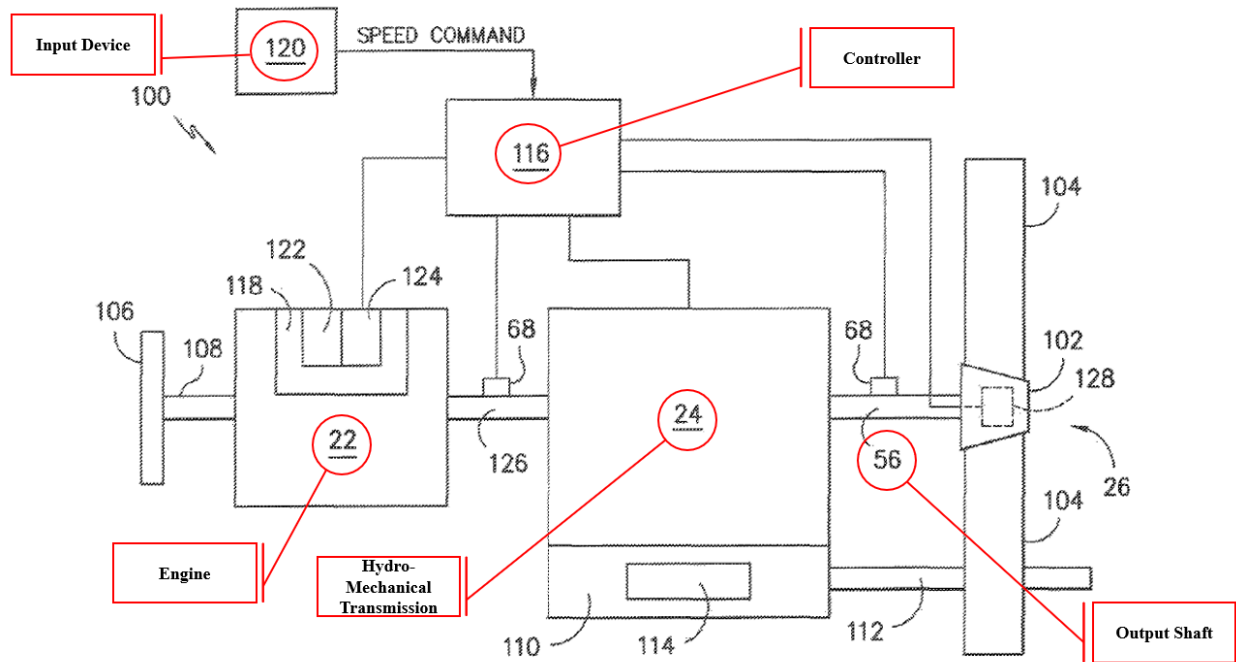


FIG. -3-

Xing, Fig. 3 (annotated)

Xing's work machine had a control system which included controller 116 connected to sensors for determining current transmission output speed, engine speed, and engine load, and a control algorithm designed to optimize fuel efficiency while maintaining desired performance. Stein Decl., ¶¶53, ¶¶55-59, ¶¶69-70; Xing, 5:38-55, 7:22-32, 8:16-41, 8:53-9:3. Controller 116 also communicated with external circuits and modules, such as engine speed governor 118 and communicative link 46, to control engine 22 and transmission 24. Xing, 5:2-9, 5:38-55, 7:56-59. Using its CVT and control system, Xing practiced method 200, which allowed "for a work vehicle 10 to be controlled in a manner that minimizes fuel

consumption while maintaining the desired vehicle performance/productivity.” Xing, 8:56-59.

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.

As discussed *supra* IV.A.2, there was a general well-established desire in industry to minimize milling machine operating costs by minimizing fuel consumption, while achieving desired milling performance. Stein Decl., ¶63, ¶65. Using hydromechanical CVTs with internal combustion engines was a recognized way to enable independent control of an engine without sacrificing machine performance. Stein Decl., ¶63, ¶65, ¶70, ¶72; *supra* IV.A.2, IV.B.3. Schomaker, for example, explained that its CVT allowed “reduction in fuel consumption as well as the continuous adjustability of the second speed of rotation at which the milling rotor is driven result in more economical, faster, and safer milling of road surfaces compared with prior art construction machines.” EX1016, ¶[0024]. Xing expressly taught that its system and method “may allow for a work vehicle 10 to be controlled

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

in a manner that minimizes fuel consumption while maintaining the desired vehicle performance/productivity.” Xing, 8:54-9:3; *see also* Xing, 3:48-67 (“Specifically, the disclosed system and method may be utilized to minimize fuel consumption while maintaining the desired performance productivity of the work vehicle.”), 12:26-13:50 (teaching that, “by considering the various individual component efficiencies, engine settings may be selected that minimize fuel consumption without impacting vehicle performance and/or productivity”); Stein Decl., ¶70.

A POSITA would have had a reasonable expectation of successfully modifying Willis to include a variable transmission and control system like that taught by Xing to improve fuel consumption and machine energy efficiency. Stein Decl., ¶¶71-72. As the ’538 Patent admits, milling machines with variable transmissions that allowed for variations in engine speed without affecting rotor speed, such as those taught by Parker, were known in the art. EX1001, 1:34-37. And Laux, Schomaker, and Xing taught how to implement and control such variable transmission in milling machines.

For these reasons and those discussed *supra* VII.A.1, this limitation would have been obvious. In addition to Willis’s teaching, Xing taught that a work machine, such as Willis’s milling machine, could include a continuously variable transmission and a controller that coordinates control of the work machine’s engine

and transmission to reduce fuel consumption. Xing, 1:18-20, 3:64-4:8, 4:38-53, 7:22-32.

b) [a] “receiving a desired rotor speed;”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that received a desired rotor speed. Willis taught that its controller receives a desired rotor speed input from a milling drum speed selector. Willis, ¶[0003], ¶[0005], ¶[0017]. The drum speed selector was an operator interface electrically connected to the controller through which an operator could input different desired drum cutting speed commands that the interface transmitted to the controller. Stein Decl., ¶73. For example, Willis Fig. 1 discloses an exemplary interface where the operator may select the desired drum speed. Willis, ¶[0017].

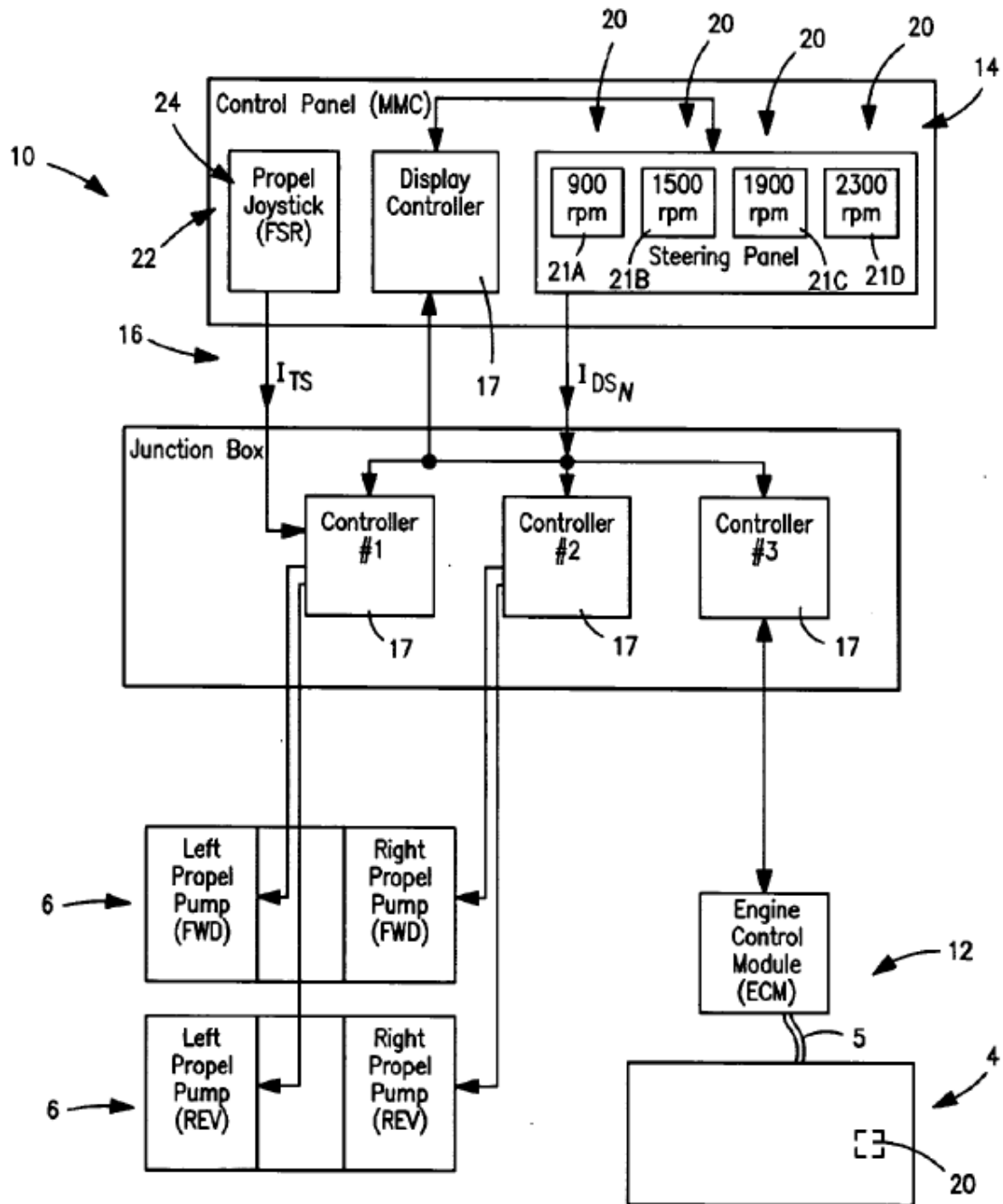


FIG. 1

Willis, Fig. 1

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

This interface transmits the input from the interface to control 16. Willis, ¶[0017]. Willis designated this input as I_{DS} , “corresponding to a desired drum cutting speed DS_D . Willis, ¶[0017]. Control 16 was configured to receive the desired drum speed and “to compare sensed drum speed DS_S with desired drum speed DS_D , and to operate the regulator 12 such that the sensed drum speed DS_S is generally equal to the desired drum speed DS .” Willis, ¶[0021].

A POSITA adapting Willis’s controller to run Xing’s algorithm would have expected to successfully modify Xing’s algorithm to utilize the desired drum speed DS_D (corresponding a desired rotor speed) input (I_{DS}) received by Willis’s controller from Willis’s speed selector rather than the desired ground speed that Xing teaches. Stein Decl., ¶¶74-75. In Willis, the rotor is coupled to the output of the direct drive train. In Xing, the drive shaft for the wheels is coupled to the output of the CVT transmission. The proposed modification would couple Willis’s rotor to the output of Xing’s transmission. Thus, a POSITA would have understood that in the proposed combination, the desired rotor speed of Willis’s rotor, like the desired ground speed of Xing, would be dictated by the speed of Xing’s output shaft 56. It was well-known that powertrain control systems were universally applicable to a wide range of work machines including milling machines. For example, as discussed with respect to Parker and Laux, *supra* IV, POSITAs knew how to adapt milling machine

controllers to control rotor speed based on a desired milling drum rotor speed. Stein Decl., ¶76; EX1013, 6:55-67, 8:9-23; Laux, 2:5-9; EX1008, 2:43-61.

c) [b] “determining an engine load of the engine;”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that determined an engine load of the engine because Xing’s algorithm was already configured to “determine an engine load” during operation. Xing taught a conventional controller that stores algorithms for performing a method of optimizing fuel efficiency, as described, e.g., in Xing’s Figure 4. Xing, 7:33-56.

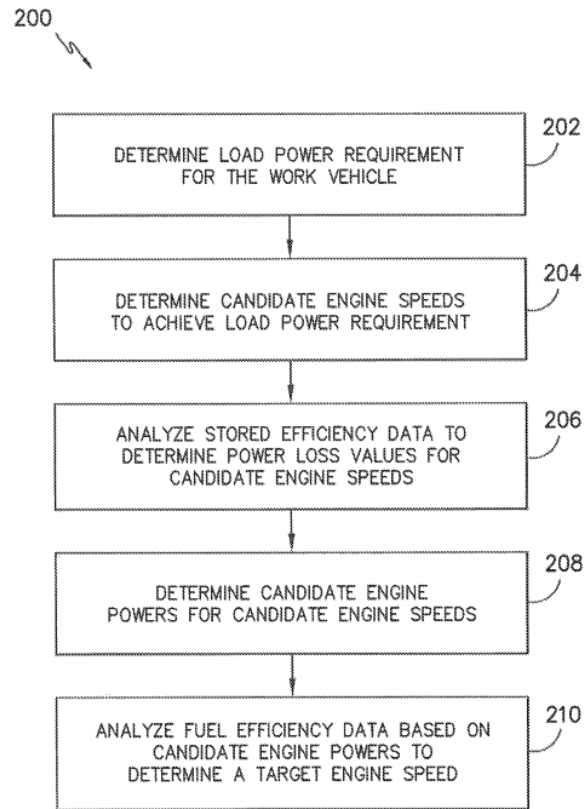


FIG. -4-

Xing, Fig. 4

Xing’s algorithm configured the controller to optimize the operation of the work machine as a whole and minimize the machine’s fuel consumption. Stein Decl., ¶¶53-59, ¶¶69-70; Xing, 13:36-50. The controller received signals from sensors communicatively coupled to the controller, such as torque sensor 122 and engine speed sensor 124. Xing, 8:16-40. Willis’s controller already received signals from sensors indicating “the rotational speed of the engine shaft 3a” and “the drum speed.” Willis, ¶[0021]; Stein Decl., ¶50. However, to the extent additional sensors were required to determine engine load, such as Xing’s torque sensor 122, a POSITA

would have been motivated to incorporate such sensors to take advantage of Xing's algorithm. Xing 8:17-28 (teaching that the controller is "communicatively coupled to various sensors, such as a torque sensor 122 and/or a speed sensor 124, mounted on and/or within the engine 22 for monitoring the engine torque loads and/or the engine speed."); Stein Decl., ¶58. And a POSITA would have had a reasonable expectation of success in doing so, as such sensors were well-known in the art. Stein Decl., ¶¶78-79. Based on those signals, the controller in Xing evaluated power losses from the transmission and other power consuming components at different candidate operating speeds, measured engine load to determine the work output demanded of the machine, and independently set engine speeds and transmission ratios to minimize fuel consumption while achieving desired performance. *See, e.g.*, Xing, 8:67-9:3, 9:9-17.

The processor calculated a current load power requirement (P_{load})—the amount of power for the machine to accomplish work—by measuring the current engine power (P_{engine}) and estimating current power loss (P_{loss}). Xing, 9:37-56. In block 202 of Figure 4, controller 116 calculated P_{engine} , based on signals indicating "the engine speed and the engine torque." Xing, 9:18-56. Using "component efficiency data stored within its memory," it calculated P_{loss} based on "the current vehicle operating parameters." *Id.* Then, controller 116 used this data to determine the current load power requirement (P_{load}) based on the relationship of Equation 1:

“ $P_{engine} = P_{load} + P_{loss}$.” *Id.* As described below for limitation 1[c], controller 116 used the current load power requirement to determine a target engine speed that provided optimal fuel efficiency. Xing, 9:53-56.

d) [c] “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”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that adjusted engine speed based on load and predefined efficiency points, as claimed. The controller would have implemented the step of adjusting an engine speed of the engine based on engine load and engine maps that provide optimum engine speeds for different engine loads.

The Xing controller-implemented method adjusted the engine to run at a speed that minimizes fuel consumption based on the current load on the engine. Xing, 2:9-12, 3:50-67, 11:65-12:11. As explained for limitation 1[b], Xing’s algorithm determined the current engine load to calculate the machine’s power load requirement. Xing, 9:37-56. For example, in blocks 204 to 208 of Figure 4, controller 116 calculated a plurality of candidate engine settings (i.e., pairs of specific engine speeds and engine torques) based on the power load requirements and the estimated power loss due to the machine’s components. Xing, 10:16-12:25.

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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.	.	.	.	.	.	.

FIG. -5-

Xing, Fig. 5

In block 210 of Figure 4, controller 16 determined which engine settings may be used for minimizing fuel consumption based on a fuel consumption maps (such as the one shown in Figure 11) or other suitable fuel efficiency data (such as that shown in Figure 5 above). Xing, 3:58-63, 12:26-13:18.

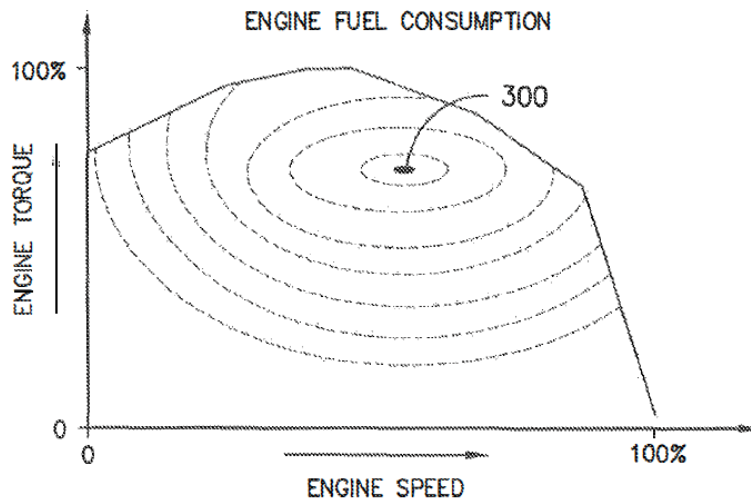


FIG. -11-

Xing, Fig. 11

The controller then adjusted the engine to operate at the target engine speed. Xing, 3:58-67, 8:64-9:3.

In implementing Xing's algorithm in Willis's controller, a POSITA would have incorporated Xing's engine map data and fuel efficiency data to determine an optimal engine speed for minimizing fuel consumption. A POSITA would have had a reasonable expectation of success because storing such standard data structures for use by machine controllers was universally applicable to different machines, including milling machines. Stein Decl., ¶¶80-81; *see also* EX1008, 5:12-6:59, 7:6-13.

e) [d] “adjusting a gear ratio of the variable transmission based on the engine speed and the desired rotor speed.”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that adjusted the CVT’s gear ratio based on engine speed and desired rotor speed as claimed. Xing’s variable transmission was operatively coupled to the engine. *Supra* IV.B.3. The drive axle assembly of Xing’s work machine connected the CVT output shaft to the machine’s wheels, such that the output shaft’s rotational speed dictated the machine’s ground speed. Xing, 6:47-58. To maintain desired ground speed once the engine had been controlled to its optimum speed, Xing’s controller adjusted the transmission gear ratio and thereby controlled the speed of the CVT output shaft 56. Xing, 6:53-58; *supra* IV.B. 3.

[T]he controller 116 may be communicatively coupled to an engine governor 118 in order to control and/or monitor the speed of the engine 22. Similarly, as indicated above, the controller 116 may be coupled to various components of the transmission 22 (e.g., the clutch actuators 62 and/or the swash plate actuator 64) in order to control the transmission 24 in a manner that provides a continuously variable transmission ratio.

Xing, 7:25-31.

The candidate engine settings may then be analyzed to determine the specific engine settings the specific settings at which the vehicle’s fuel consumption is minimized. The engine operation may then be set to the specific engine settings and the transmission ratio may be adjusted such that the desired vehicle performance/productivity is maintained.

Xing, 8:64-9:3. Thus, the controller adjusted both the engine to run at the most fuel-efficient speed and the CVT transmission ratio to maintain the desired machine performance/productivity. Xing, 8:64-9:3.

A POSITA would have been motivated to modify Willis to include a variable transmission and control system like that taught by Xing to “maintain a desired rotor speed.” Stein Decl., ¶¶85-87. A POSITA would have understood that the CVT could be controlled to maintain a desired rotational speed of the CVT output shaft. Stein Decl., ¶¶65-66, ¶¶82-87. As in Parker and Laux, the modification would have coupled the output of the variable transmission to Willis’s rotor so as to maintain a desired rotor speed in Willis’s milling machine. Stein Decl., ¶83. And implementation of Xing’s control system in Willis’s milling machine would confer Xing’s stated benefit of minimizing fuel consumption while maintaining desired machine performance, i.e., constant rotor speed. Stein Decl., ¶86.

A POSITA would have had a reasonable expectation of successfully making such a modification. Parker already taught a milling machine wherein the engine is coupled to the rotor via a variable transmission. A POSITA would have understood that installing a CVT between Willis’s engine and milling rotor requires using a different coupling between the transmission output shaft and the milling rotor than between the output shaft and wheels of Xing’s work machine. Stein Decl., ¶87. Although the CVT’s output shaft speed in the proposed combination would remain

proportional to and determine the rotational speed of Willis's milling drum, a POSITA would have understood how to modify algorithm parameters to account for changes in the coupling design. Stein Decl., ¶87; EX1008, 2:43-61. A POSITA would have understood that Xing's powertrain was universally applicable to a wide range of work machines including milling machines. A POSITA would have known how to adapt controllers of Xing's work machine to control Willis's desired milling drum rotor speed. Stein Decl., ¶87; EX1013, 6:55-67, 8:9-23; Laux, 2:5-9; EX1008, 2:43-61. Accordingly, a POSITA would have expected to be able to successfully adapt a control system like that taught by Xing to Willis's machine to use the desired rotor speed input from Willis's speed selector. Stein Decl., ¶¶82-87.

* * * * *

For the reasons discussed *supra* VII.A.1-A.2, claim 1 would have been obvious over Willis in view of Xing.

3. Claim 2: “The controller-implemented method of claim 1, wherein the desired rotor speed is received through an operator interface of the machine.”

Willis's machine, modified to include Xing's algorithm and CVT, would have resulted in a controller that received a desired rotor speed through an operator interface of the machine. As Willis taught, the drum speed selector could include buttons an operator pressed to generate different inputs or a knob that an operator

turned to generate different inputs, each of which represented a different desired milling drum rotational speed. *Id.*; Stein Decl., ¶¶90.

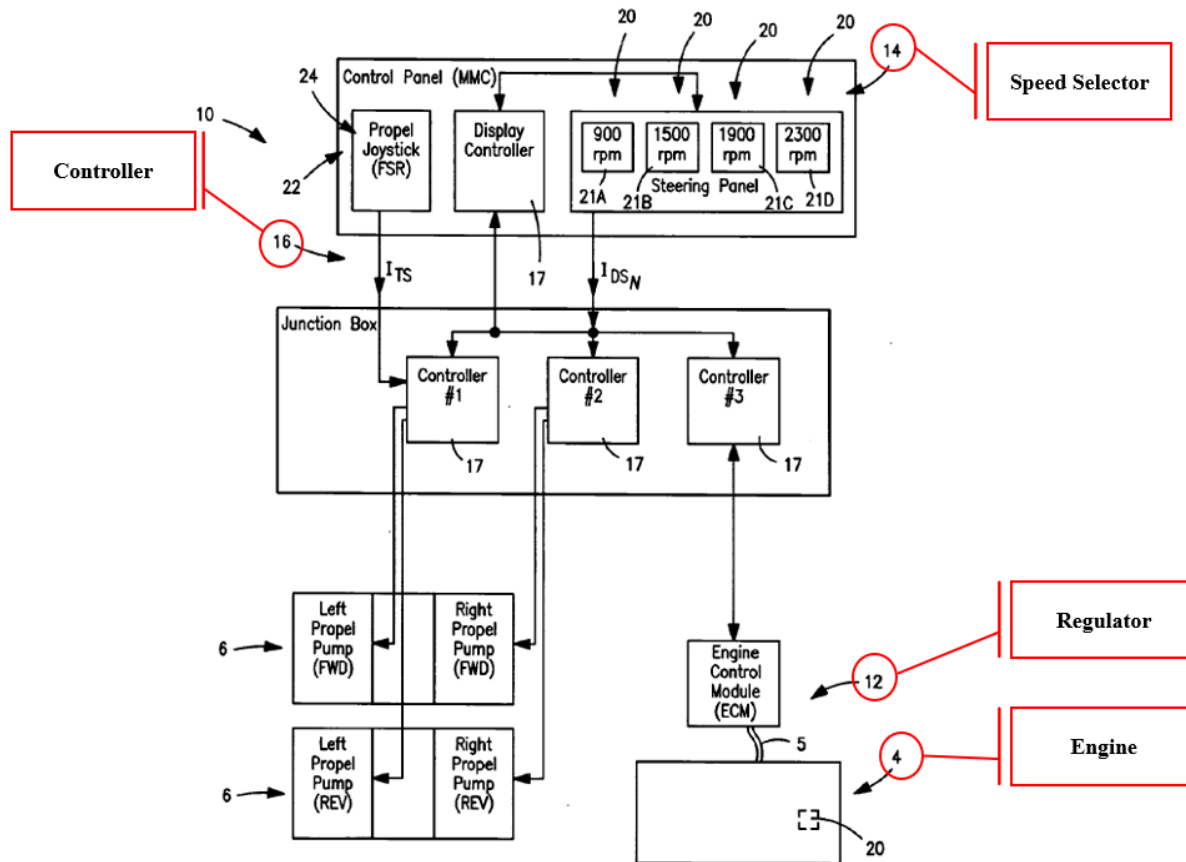


FIG. 1

Willis, Fig. 1 (annotated)

Willis's controller was electrically connected to the speed selector to receive the desired milling drum speed input from the drum speed selector. Willis, ¶¶[0017]-[0022]; Stein Decl., ¶¶91.

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

Because Willis's controller was already configured to receive a desired rotor speed from an operator interface of the machine and for the same reasons as discussed for claim 1, claim 2 would have been obvious over Willis in view of Xing.

4. Claim 3: "The controller-implemented method of claim 1, wherein the engine load includes loads due to at least the rotor and a hydrostatic arrangement."

Willis's milling machine, modified to include Xing's algorithm and CVT, would have resulted in a controller that determined an engine load that includes loads due to at least the rotor and a hydrostatic arrangement. The load measured by the controller would have resulted from load due to the rotor and at least to two separate hydrostatic arrangements, 1) Willis's hydraulic pump 6 and motors 8 that drive crawler tracks to propel the milling machine and 2) the hydrostatic unit 30 of Xing's CVT.

Willis's engine drives rotatable cutter drum 3 and hydraulic pumps 6, which "operatively drive" crawler motors 8 to propel the milling machine. Willis, ¶[0004], ¶[0017], ¶[0023]; Stein Decl., ¶94. The hydraulic pumps 6 and crawler motors 8 represent a hydrostatic arrangement. Stein Decl., ¶94.

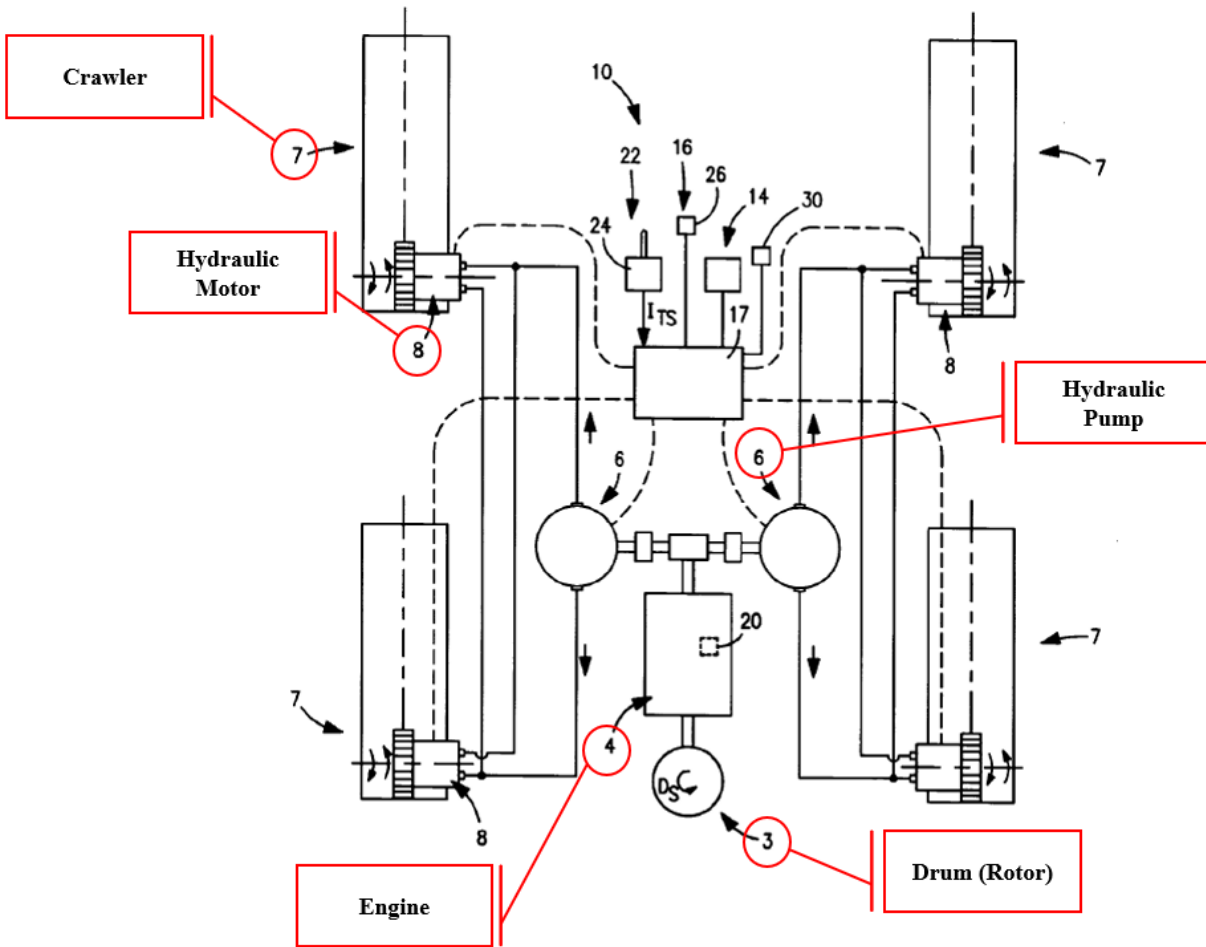


FIG. 4

Willis, Fig. 4 (annotated)

Thus, the engine load already included a load due to the hydrostatic arrangement that propelled Willis's milling machine.

As explained above for limitations 1[p] and 1[a], Willis teaches that the milling machine's engine can be configured to drive the milling drum via a transmission such that the engine load includes loads due to the rotor. Stein Decl., ¶95. A POSITA would have understood that, in Willis's milling machine, modified to include Xing's CVT transmission, the engine load would still include loads due

to the rotor. Particularly, the engine load would include loads due to both the CVT mechanical arrangement and CVT hydrostatic arrangement that combine to drive the rotor. Stein Decl., ¶¶95-96.

As explained for limitation 1[b], Willis's controller, modified to include Xing's algorithm, would have determined the total load on the engine through torque and speed sensors on the engine. A POSITA would have understood that these load measurements from the torque load sensors would have included engine loads due to the hydrostatic arrangement in Xing's CVT and loads on output shaft of the CVT due to the pump and crawler motor hydrostatic arrangement. Stein Decl., ¶¶96-97.

As Xing, Laux, and Parker suggested, a POSITA would have wanted to incorporate Xing's CVT into Willis's milling machine such that the CVT couples Willis's engine and milling drum. *See, e.g., supra* VII.A.1, 2.a, b. And, as Xing suggested, a POSITA would have wanted to further incorporate Xing's algorithm into Willis's controller to obtain the benefit of improved fuel efficiency while maintaining optimum milling performance. Because the engine load in Willis's milling machine, as modified to incorporate Xing's CVT, was due to both the rotor and a hydrostatic arrangement, and for the reasons discussed for claim 1, a POSITA would have found claim 3 obvious over Willis in view of Xing.

5. Claim 4: “The controller-implemented method of claim 1, wherein the engine speed is automatically adjusted based on detected changes in the engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.”

As discussed for limitation 1[c] above, Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that automatically adjusted engine speed based on changes in engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.

Xing’s controller adjusted engine speed based on continuously measuring engine load for change. Specifically, as Xing Fig. 4 depicts, the controller determined the current engine load by “continuously monitor[ing] the engine speed and the engine torque.” Xing 9:37-56, Fig. 4. Based on the continuously monitored engine loads, the controller calculates a plurality of candidate engine settings using efficiency data such as fuel consumption maps. Xing 3:58-63, 12:12-25, 12:48-58. Once the controller has identified candidate engine settings, 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.” Xing, 12:58-63. The controller, which is communicatively coupled to an engine governor, then adjusts the engine speed.

Xing, 7:25-31; *see also* Xing, 8:13-16 (“[T]he controller 116 may be configured to regulate the engine speed and/or the transmission ratio to adjust the speed of work vehicle 10 to the commanded ground speed.”), 9:9-14 (“[U]pon receipt of speed command signal, the controller 116 may be configured to initially control the operation of the engine 22 and/or the transmission 24 (e.g., by regulating the engine speed and/or the transmission ratio) to adjust the vehicle’s speed to the desired ground speed.”); Stein Decl., ¶¶101-103. Thus, changes in engine load, which Xing’s controller continuously monitors, will result in the controller selecting new target engine settings and adjusting to new target engine speeds.

For the reasons discussed for claim 1, Willis, in view of Xing, would have rendered claim 4 obvious.

6. Claim 5: “The controller-implemented method of claim 1, wherein the gear ratio of the variable transmission is automatically adjusted to maintain a rotor speed of the rotor at the desired rotor speed irrespective of changes in the engine speed.”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a controller that adjusted the gear ratio of the CVT to maintain a desired rotor speed irrespective of changes in the engine speed. Xing’s algorithm instructed the controller to automatically adjust the gear ratio of the CVT to rotate the CVT output shaft at a speed that propelled Xing’s machine at the desired ground speed irrespective of the engine speed. Xing, 8:54-9:3, 13:26-35. Specifically, having controlled the speed of the machine’s engine based on the currently

determined engine load, the controller “adjust[ed] the transmission ratio of the transmission 24 to ensure that the desired ground speed is maintained,” under command of Xing’s algorithm. *Id.*; Stein Decl., ¶¶106-107. Accordingly, in Willis’s modified milling machine, Xing’s algorithm would have instructed the controller to automatically adjust the gear ratio of the CVT to rotate the CVT output shaft at a speed that maintained the desired rotor speed irrespective of changes in engine speed.

For the reasons discussed for claim 1, Willis, in view of Xing, would have rendered claim 5 obvious.

7. Independent Claim 6

The combination of Willis and Xing renders this claim obvious.

a) [p] “A machine, comprising:”

Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2.a.

b) [a] “an engine;”

Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2.a.

c) [b] “a variable transmission operatively coupled to an output of the engine;”

Willis, in view of Xing, renders this limitation obvious. Stein Decl., ¶¶112-116. As discussed *supra* VII.A.2.a, Willis teaches an engine with an output that drives the milling drum through a direct drive train. Xing teaches a work machine with a variable transmission operatively coupled to an output of the engine. Xing,

4:8-54, Figs. 2 and 3; Stein Decl., ¶¶113-114. Modification of Willis to include a variable transmission (along with sensors for determining current rotor speed, engine speed, and engine load and a control algorithm designed to optimize fuel efficiency based on rotor speed, engine speed, and engine load) like that taught by Xing would have resulted in a milling machine having “a variable transmission operatively coupled to an output of the engine.”

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. Stein Decl., ¶¶114-116. As discussed *supra* IV.A.2, VII.A.1, A.2.a, there was a general well-established desire in industry to minimize milling machine operating costs and to optimize machine operation by minimizing milling machines’ fuel consumption whenever possible while achieving desired milling performance. Stein Decl., ¶63, ¶65. Using hydromechanical CVTs with internal combustion engines was a recognized way to enable independent control of an engine in such machines to speeds that minimize fuel consumption for a given load while controlling transmission gear ratios to achieve desired transmission output speeds and maximize machine performance. Stein Decl., ¶63, ¶65, ¶70, ¶72. Indeed, it was known that implementing variable transmissions and associated control algorithms can improve fuel efficiency in work machines, including milling machines. *Supra* IV.A.2, VII.A.1, 2.a, b. Xing expressly teaches

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

that its system and method “may allow for a work vehicle 10 to be controlled in a manner that minimizes fuel consumption while maintaining the desired vehicle performance/productivity.” Xing, 8:54-9:3; *see also* Xing, 3:48-67 (“Specifically, the disclosed system and method may be utilized to minimize fuel consumption while maintaining the desired performance productivity of the work vehicle.”), 9:65-10:14 (teaching that the controller may also be configured to forecast future load power requirements to advantageously “enhance the vehicle’s fuel efficiency”), 12:26-13:50 (teaching that, “by considering the various individual component efficiencies, engine settings may be selected that minimize fuel consumption without impacting vehicle performance and/or productivity”); Stein Decl., ¶70, ¶116.

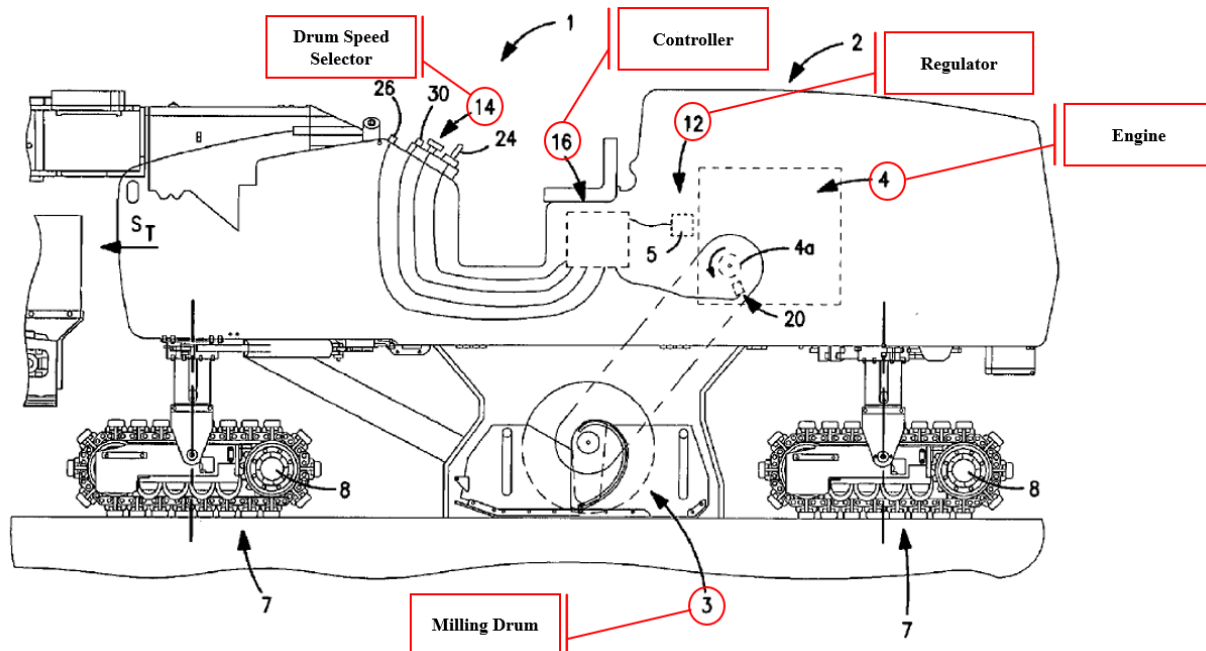
A POSITA would have had a reasonable expectation in modifying Willis to include a variable transmission and control system like that taught by Xing to improve fuel consumption and machine energy efficiency. Stein Decl., ¶¶115-116. As the ’538 Patent admits, milling machines with variable transmissions that allow for variations in engine speed without affecting rotor speed, such as those taught by Parker, were known in the art. EX1001, 1:34-37. And Laux, Schomaker, and Xing teach how to implement and control such variable transmission in milling machines. Stein Decl., ¶63, ¶65.

For these reasons and those discussed *supra* VII.A.1, 2, this limitation would have been obvious. Stein Decl., ¶¶112-116.

d) [c] “a rotor operatively coupled to an output of the variable transmission; and”

Willis, in view of Xing, renders this limitation obvious. Stein Decl., ¶¶117-120.

Willis teaches a milling machine with an engine coupled to a rotatable milling drum (a “rotor”) via a direct drive train. Willis, ¶[0020]; Stein Decl., ¶117. Willis further teaches that its milling machine can include a regulator “to controllably vary the drum speed DS.” Willis, ¶[0020]; Stein Decl., ¶117.



Willis, Fig.3 (annotated).

Xing teaches a work machine with a variable transmission operatively coupled to an output of the engine. Xing, 4:8-54, Figs. 2 and 3; Stein Decl., ¶118. Xing further teaches that the output of its continuously variable transmission can both propel the work machine but also power various power consuming components

and implements of the machine via various transmission output rotor shafts, represented as a load L on the transmission output shaft. Xing, 4:38-53, 5:13-23, 6:59-7:3, Figs. 2, 3; Stein Decl., ¶118.

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

³ Xing teaches alternative ways a load, such as a machine's drive system or implements such as a rotor, can be coupled to the variable transmission so that implements can be isolated from all engine power for added safety and efficiency when unused, while other machine components remain selectively connected to engine hydraulic or mechanical power. Xing, 2:34-50, 4:1-27, 4:33-37, 6:59-7:3. Xing teaches that such powertrain systems can be implemented in any "suitable work vehicle known in the art" to power any work implement and POSITAs understood how to adjust the designs for competing benefits of safety and convenience. Xing 4:1-27, *supra* IV. Based on Xing, a POSITA would have modified Willis's machine to couple rotor to Xing's variable transmission either (1) directly via the CVT output shaft or (2) indirectly to the CVT via a PTO, PTO clutch, and PTO shaft. Stein Decl., ¶119. This modification would have resulted in a milling machine having "a rotor

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 coupled to the variable transmission at least either (1) directly via the CVT output shaft or (2) indirectly to the CVT via a PTO, PTO clutch, and PTO shaft. Stein Decl., ¶119. This modification would have resulted in a milling machine having “a rotor operatively coupled to an output of the variable transmission.”

A POSITA would have expected to be able to successfully modify Willis in view of Xing’s teachings without undue experimentation. Stein Decl., ¶120. For example, Xing teaches that the engine, transmission, and controller may be used in various work machines to power and control their propulsion system, as well as to power and control other components and implements driven from the variable transmission. Considering the prior-art teachings regarding implementing variable transmissions in milling machines, a POSITA would have recognized that the rotor in Willis’s milling machine constitutes one of those other components or implements. Stein Decl., ¶¶117-120.

operatively coupled to an output of the variable transmission.” For simplicity, the remainder of the Petition discusses the variable transmission’s output shaft, but unless otherwise noted, such discussions apply equally to the PTO shaft.

e) [d] “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.”

Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2;
Stein Decl., ¶¶121-124.

(1) [d][i] “a controller in electrical communication with one or more of the engine, variable transmission, and the rotor”

Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2.

(2) [d][ii] “the controller being configured to determine an engine load”

As discussed with respect to limitation 1[b], Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2.

(3) [d][iii] “the controller being configured to...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”

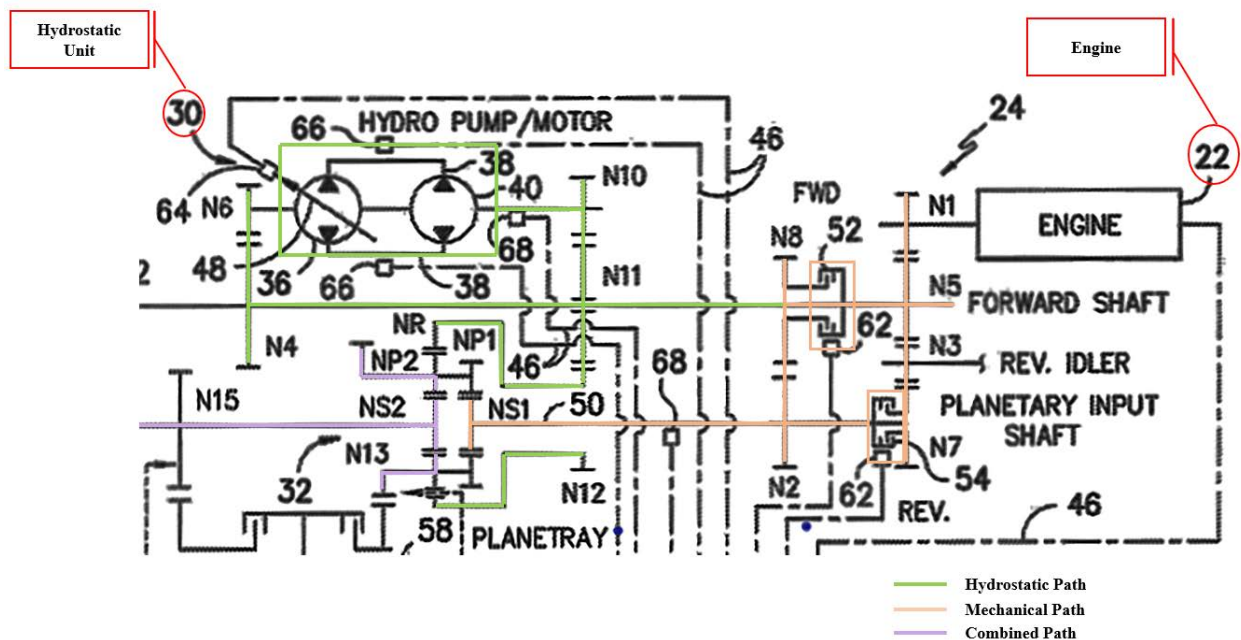
As discussed with respect to limitation 1[c], Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2.

(4) [d][iv] “the controller being configured to...adjust a gear ratio of the variable transmission based on the engine speed to maintain a desired rotor speed”

As discussed with respect to limitation 1[d], Willis, in view of Xing, renders this limitation obvious. *Supra* VII.A.1-A.2 and A6.

8. Claim 7: “The machine of claim 6, wherein the variable transmission includes a gear set and a hydraulic motor configured to adjust a rotor speed of the rotor.”

Xing’s variable transmission included a gear set (planetary unit 32) and a hydrostatic unit 30 comprising a hydraulic pump 36 coupled to a hydraulic motor 40. Stein Decl., ¶127.



Xing, Fig. 2 (excerpt annotated)

Hydrostatic unit 30 was coupled to planetary unit 32, which was in turn coupled to output shaft 56 of the transmission. Stein Decl., ¶127. Controller 116 controlled

hydrostatic unit 30 to adjust the gear ratio of the planetary unit 32, which in turn adjusted the rotational speed of output shaft 56 via hydraulic motor 40.

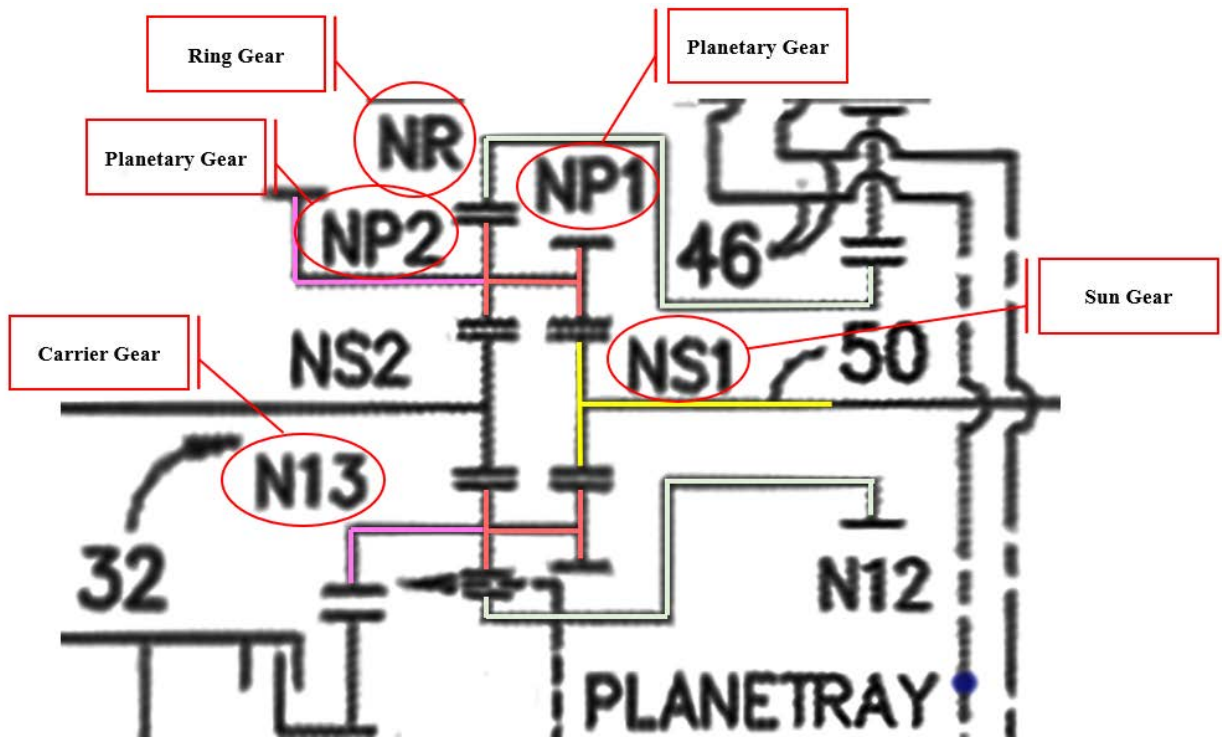
[T]he controller 116 may be communicatively coupled to the pump 36 via a suitable communicative link 46 so that the angle of a swash plate of the pump 36 (the swash plate being denoted by a diagonal arrow 48 through pump 36) may be adjusted through a range of positions, thereby adjusting the transmission ratio of the transmission 24.

Xing, 5:2-8. For any given engine speed, the adjustment of the transmission ratio adjusted the rotational speed of the output shaft 56. This allowed the engine speed to be selected for maximum fuel efficiency while allowing the output shaft speed to be controlled to achieve desired rotational speed of the load. In Xing, the desired rotational speed was the rotational speed of the drive wheels, whereas, in Willis, the desired rotational speed was the milling rotor speed. Thus, Willis, as modified by Xing, would have had a variable transmission that included a gear set and a hydraulic motor configured to adjust a speed of the rotor.

As explained above with respect to claims 1 and 6, a POSITA would have been motivated to incorporate Xing's CVT and control algorithm in Willis's milling machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.7. Accordingly, Willis, in view of Xing, renders claim 7 obvious.

9. Claim 8: “The machine of claim 7, wherein the gear set is a planetary gear set having a sun gear coupled to the engine, a carrier coupled to the rotor, and a ring gear coupled to the hydraulic motor.”

Xing taught the claimed arrangement. Xing’s gear set (planetary unit 32) included sun gear NS1 coupled to engine 22 via planetary input shaft 50, which was coupled to the engine. Xing, 5:9-11; Stein Decl., ¶131. Planetary unit 32 included ring gear NR coupled to hydraulic motor 40. Xing’s planets or planetary gears NP1, NP2 were mounted on a carrier (“gear N13”). Xing, Fig. 2; Stein Decl., ¶131. Depending on the relative rotational speeds of the “sun” and the “ring gear,” the planets revolved together with the carrier gear N13 about the sun. Xing, Fig. 2; Stein Decl., ¶131. The carrier was coupled to transmission output shaft 56 via range gear set 34. Xing, 5:14-30; Stein Decl., ¶131.



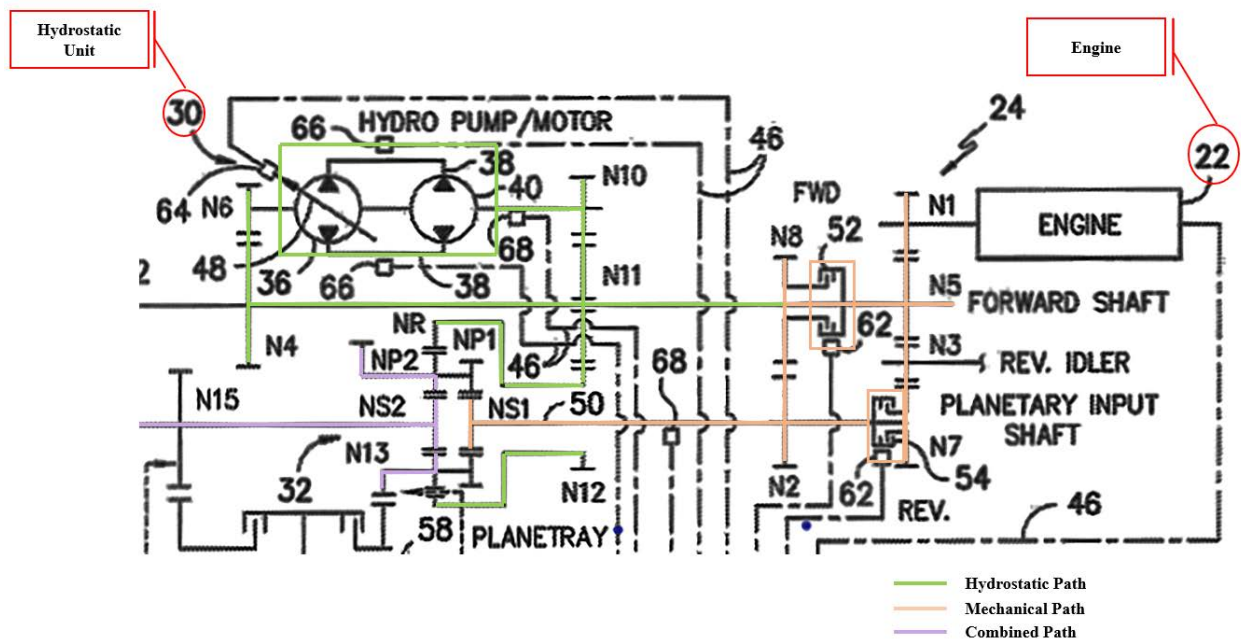
Xing, Fig. 2 (excerpt annotated)

A POSITA would have understood that, by implementing Xing's CVT in Willis's milling machine, a carrier of the planetary gear set would have been coupled to the rotor via the output shaft of the variable transmission.

As explained above with respect to claims 1, 6, and 7, a POSITA would have been motivated to incorporate Xing's CVT and control algorithm in Willis's milling machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.8. Accordingly, Willis, in view of Xing, renders claim 8 obvious. Stein Decl., ¶¶131-133.

10.Claim 9: “The machine of claim 7, wherein the controller is configured to adjust the gear ratio through control of the hydraulic motor.”

Xing’s CVT included a gear set and a hydrostatic unit comprising a hydraulic pump fluidly coupled to a hydraulic motor. Stein Decl., ¶136. The hydrostatic unit was coupled to the planetary unit, which was in turn coupled to an output shaft of the transmission. Stein Decl., ¶136.



Xing, Fig. 2 (excerpt annotated)

Xing’s controller adjusted the pump’s output to the hydraulic motor and, thereby, the transmission’s gear ratio as explained above regarding claim 7. Stein Decl., ¶136.

As explained above with respect to claims 1, 6, and 7, a POSITA would have been motivated to incorporate Xing’s CVT and control algorithm in Willis’s milling machine and would have had a reasonable expectation of success in doing so. *Supra*

VII.A.1-A.2, VII.A.7, A.8. Accordingly, Willis, in view of Xing, renders claim 9 obvious. Stein Decl., ¶¶136-137.

11. Claim 10: “The machine of claim 6, wherein the controller is configured to determine the engine load as a sum of loads due to at least the rotor and a hydrostatic arrangement.”

Willis, in view of Xing, renders this claim obvious. *Supra* VII.A.1-A.2, A.4, A.7.

As described for limitation 1[b], Xing’s controller was configured to determine an engine load. And as described for claim 3, that engine load was due to at least the rotor and a hydrostatic arrangement.

As explained above with respect to claim 6, a POSITA would have been motivated to incorporate Xing’s CVT and control algorithm in Willis’s milling machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.4, A.7. Accordingly, Willis, in view of Xing, renders claim 10 obvious.

12. Claim 11: “The machine of claim 6, wherein the controller is configured to automatically adjust the engine speed based on changes in the engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.”

Willis, in view of Xing, renders this claim obvious. *Supra* VII.A.1-A.2, A.5, A.7.

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

As described for limitation 1[c], Xing's controller was configured to adjust engine speed based on load and predetermined efficiency points. And as described for claim 4, Xing's controller was configured to automatically adjust the engine speed based on changes in the engine load according to one or more predetermined relationships providing a plurality of the predefined efficiency points.

As explained above with respect to claims 1 and 6, a POSITA would have been motivated to incorporate Xing's CVT and control algorithm in Willis's milling machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.5, A.7. Accordingly, Willis, in view of Xing, renders claim 11 obvious.

13. Claim 12: "The machine of claim 6, further comprising an operator interface configured to at least receive the desired rotor speed from an operator of the machine, the controller being configured to receive the desired rotor speed from the operator interface."

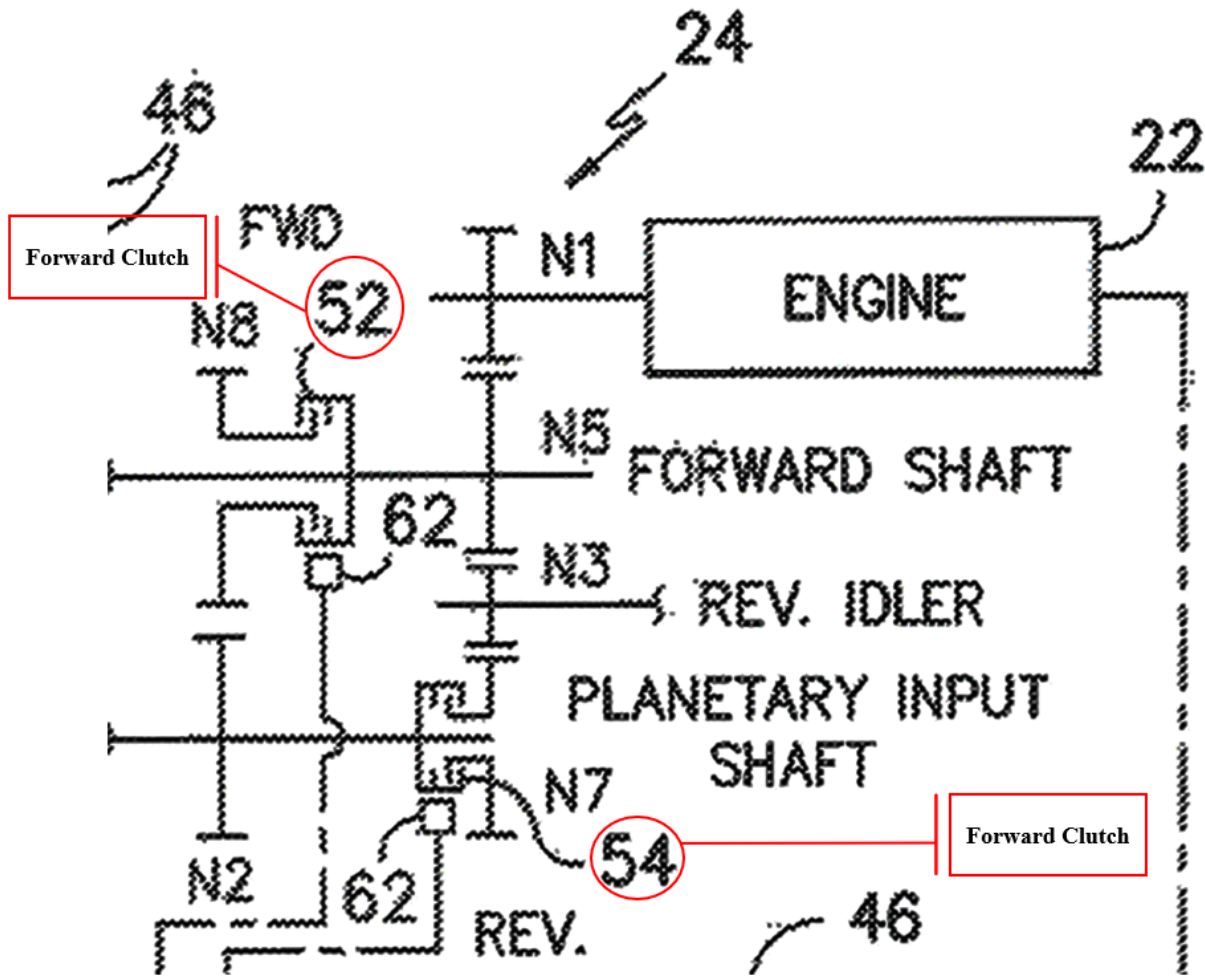
As discussed for limitation 1[a] and claim 2, Willis's milling machine, modified to include Xing's algorithm and CVT, would have resulted in a milling machine having an operator interface configured to receive a desired rotor speed from an operator of the machine, wherein the controller was configured to receive the desired rotor speed from the operator interface.

As explained above with respect to claims 1, 2, and 6, a POSITA would have been motivated to incorporate Xing's CVT and control algorithm in Willis's milling

machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.3, A.7. Accordingly, Willis, in view of Xing, renders claim 12 obvious.

14. Claim 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 the control of a clutch.”

Willis’s milling machine, modified to include Xing’s algorithm and CVT, would have resulted in a milling machine having directional clutches that the controller controlled to disengage a load connected through transmission output shaft 56, such as the milling drum, from the engine. Xing, 5:11-17, 6:53-7:3. Xing’s control algorithm used the controller to actuate directional clutches to disengage a load from the engine when the transmission output shaft 56 was connected to the load.



Xing, Fig. 2 (excerpt annotated)

Xing taught that forward directional clutch 52 and reverse directional clutch 54 selectively couple the engine to its planetary gear. Xing, 5:11-17, 6:3-6. Controller 116 could disengage both directional clutches 52, 54 from planetary unit 32. Xing, 6:3-6. By actuating parking brake 70, output shaft 56 and its connected load

remained mechanically isolated and disengaged from the engine. Xing, 6:14-34; Stein Decl., ¶150.⁴

In either arrangement, a POSITA would have modified Willis's milling machine so that the output of Willis's engine was coupled to the input shaft of Xing's CVT transmission and the transmission's output was coupled (directly or indirectly) to Willis's milling drum, because these are the methods Xing teaches for coupling its engine to a load via its CVT. Willis, ¶[0020]; Xing, 4:46-53, 6:53-7:3, Fig. 2 (showing load on shaft 56). The proposed combination includes two alternative ways

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 would have connected PTO shaft 112—and Willis's milling drum—to transmission output shaft 56 and the engine. Willis ¶[0020]; Xing 4:33-37, 4:42-53, 6:47-7:3; see also footnote 3 *supra*.

of selectively disengaging the engine from a load exerted by a rotor by disengaging the clutches in Xing's transmission. Xing 5:14-17, 5:32-37, 6:3-6.

As explained above with respect to claims 1 and 6, a POSITA would have been motivated to incorporate Xing's CVT and control algorithm in Willis's milling machine and would have had a reasonable expectation of success in doing so. *Supra* VII.A.1-A.2, A.7. Accordingly, Willis, in view of Xing, renders claim 13 obvious.

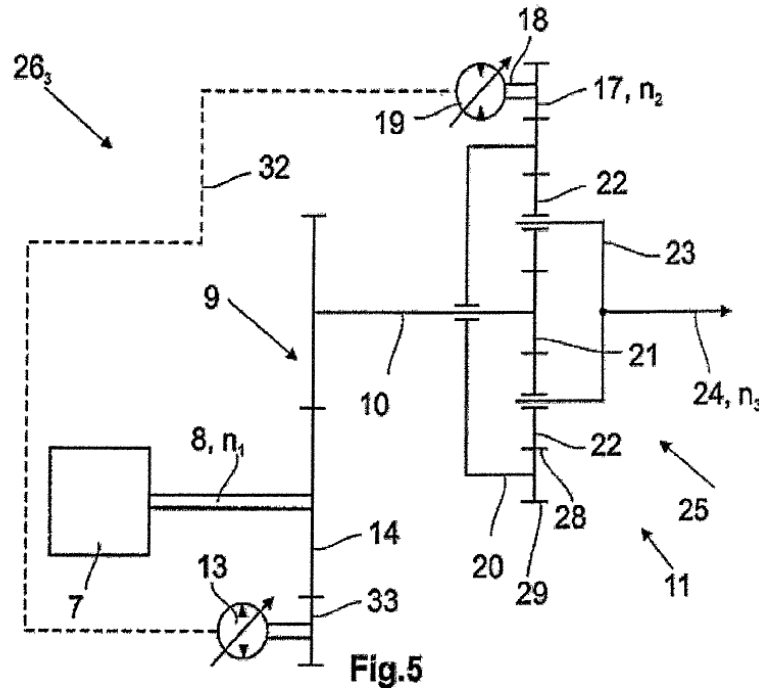
B. Ground 2: Claims 8 and 13 Would Have Been Obvious over Willis in View of Xing, and Further in View of Laux.

As detailed below, Willis, Xing, and Laux together teach every limitation of claims 8 and 13, and these claims would have been obvious over the combination of Willis, Xing, and Laux.

1. Claim 8: "The machine of claim 7, wherein the gear set is a planetary gear set having a sun gear coupled to the engine, a carrier coupled to the rotor, and a ring gear coupled to the hydraulic motor."

As noted *supra* VII.A.9, Willis combined with Xing teaches this arrangement. 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 transmissions. Stein Decl., ¶155. Schomaker's planetary gears were mounted on carrier 23, which coupled planetary gears 22 to output shaft 24. EX1016, ¶[0035], ¶[0037]. Carrier 23 transferred the orbital motion of planetary gears 22 around sun

gear 21 to output shaft 24, thereby rotating output shaft 24. EX1016, ¶[0035], ¶[0037].



EX1016, Fig. 5

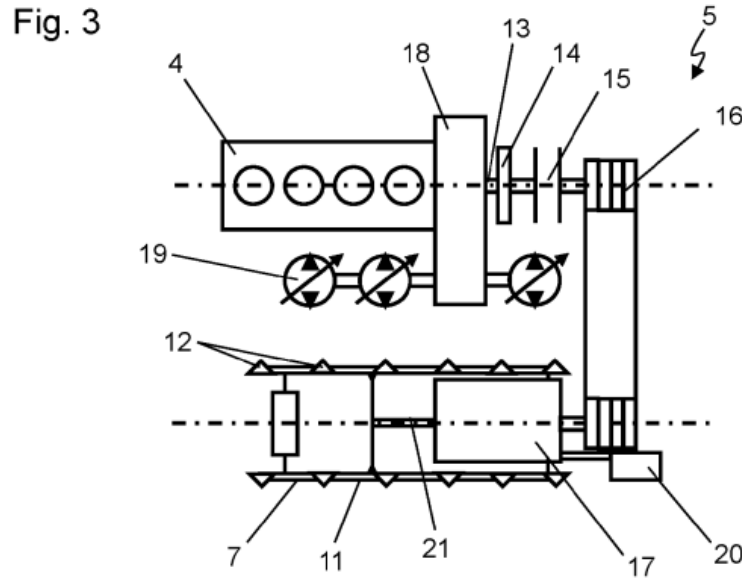
Thus, the combination of Willis, Xing, and Laux teach all the limitations of claim 8.

As discussed *supra* VII.A.8, Willis, in view of Xing, renders claim 7 obvious. 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 output shaft 56 either directly or via Xing's range gears. Indeed, Xing's CVT was designed to use a planetary gear to combine the power output from the CVT's mechanical and hydrostatic paths to rotate output shaft 56. Laux's planetary gear

arrangement provided a known way to do so. A POSITA would have had a reasonable expectation of success in doing so because Xing's CVT already included the necessary components to provide such an arrangement. Accordingly, and for the reasons provided *supra* VII.A.1, 2, and 7-9, claim 8 would have been obvious over Willis, in view of Xing, and in further view of Laux.

2. Claim 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 the control of a clutch.”

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



Laux, Fig. 3

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 the limitations of this claim.

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

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

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 reasonable expectation of success in doing so because clutches were well-known and Laux taught a successful way to implement a clutch in a milling machine wherein the engine was coupled to the rotor via a CVT.

Accordingly, and for the reasons provided *supra* VII.A.1, 2, 7, and 14, claim 13 would have been obvious over Willis, in view of Xing, and in further view of Laux.

C. Analysis of Secondary Considerations

Patent Owner carries the burden to provide evidence of secondary considerations of non-obviousness regarding the claims of the '538 Patent. Petitioner is not aware of any such evidence or information that could have any nexus to the claims of the '538 Patent. Petitioner, however, reserves its right to respond to any assertion of secondary considerations of non-obviousness that Patent Owner advances.

VIII. MANDATORY NOTICES

A. Real Party-in-Interest (37 C.F.R. § 42.8(b)(1))

The real parties in interest are Wirtgen America, Inc. and Wirtgen GmbH.

Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

B. Related Matters (37 C.F.R. § 42.8(b)(2))

Caterpillar Inc. has asserted the '538 Patent against Wirtgen America, Inc. in a civil action in the U.S. District Court for the District of Delaware, *Wirtgen America, Inc. v. Caterpillar Inc.*, C.A. No. 17-770-RGA. Specifically, Caterpillar has asserted permissive counterclaims for patent infringement of the '538 Patent, along with two other patents, in response to Wirtgen America's claims for infringement in its Amended Complaint. *See* EX1020, 5-134 (¶¶14-401); EX1021, 45-54 (¶¶7-35). Pending before the U.S. District Court for the District of Delaware is a motion to sever and transfer Caterpillar's permissive counterclaims for patent infringement of the '618 Patent, along with the other two patents, from the District of Delaware to the U.S. District Court for the District of the Middle District of the Tennessee. *See* EX1026, EX1027.

C. Lead and Back-up Counsel (37 C.F.R. § 42.8(b)(3))

The lead counsel for Petitioner is:

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The back-up counsel for Petitioner are:

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Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

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D. Service Information (37 C.F.R. § 42.8(b)(4))

Petitioner consents to electronic service by email. Please direct all correspondence regarding this proceeding to the lead and back-up counsel at the addresses listed above.

IX. GROUNDS FOR STANDING

Wirtgen certifies the '538 Patent is available for *inter partes* review and that Wirtgen is not barred or estopped from requesting *inter partes* review of the '538 Patent challenging the patent claims on the grounds identified in this Petition.

X. STATEMENT OF PRECISE RELIEF REQUESTED FOR EACH CLAIM CHALLENGED

For the reasons provided above, Wirtgen requests *inter partes* review and cancellation of claims 1-13 of the '538 Patent.

Respectfully submitted,

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Date: August 10, 2022

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Petition for *Inter Partes* Review of U.S. Patent No. 9,975,538

CERTIFICATION OF SERVICE (37 C.F.R §§ 42.6(e) and 42.105(a))

The undersigned hereby certifies that, on August 10, 2022, true and correct copies of the foregoing **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 9,975,538**, the accompanying Power of Attorney, and all associated exhibits were served in their entirety on the following parties via FedEx® Express:

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Date: August 10, 2022

**CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME
LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE
REQUIREMENTS**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 12,801 words, excluding the parts exempted by 37 C.F.R. §§ 42.24(a), 42.8.
2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a), and has been prepared using Microsoft® Word for Microsoft® 365 in 14-point Times New Roman.

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