

Patent Owner Caterpillar's Oral Argument, December 11, 2023

Wirtgen America, Inc. v. Caterpillar Inc.
Case No. IPR2022-01397 (U.S. Patent No. 9,975,538)

Overview of the '538 Patent

126 of the milling machine 100. In block 164-2, the controller 130 may additionally monitor or determine the current engine speed and current engine load of the milling machine 100, such as via a sensor 134 located at the engine output 136. Additionally, in block 164-3, the controller 130

EX1001 ('538 Patent), 5:3-7

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

EX1001 ('538 Patent), 5:7-17

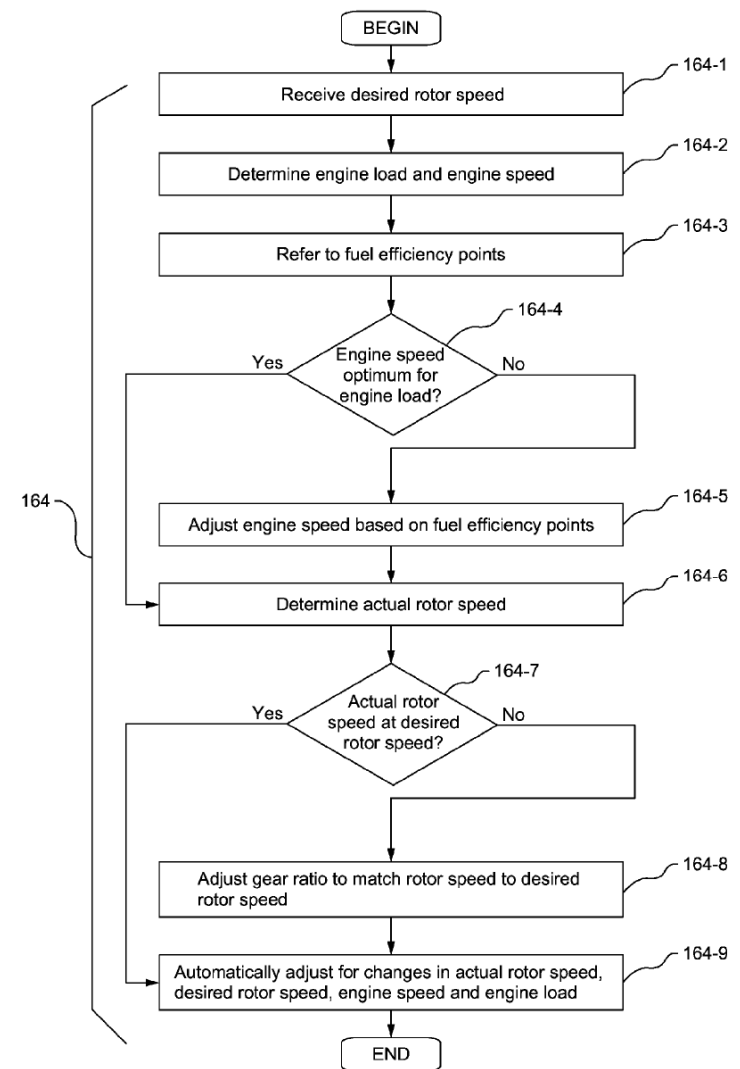


FIG.5

POR, 3-7; EX2001 (Kemal Decl.), ¶¶21-33

Overview of the '538 Patent

tables, maps, mathematical formulations, or the like. Moreover, using the efficiency points 162 as reference, the controller 130 may be able to control the engine 122 to output an engine speed that is not only appropriate for the determined engine load, but also the fuel efficient.

EX1001 ('538 Patent), 4:23-27

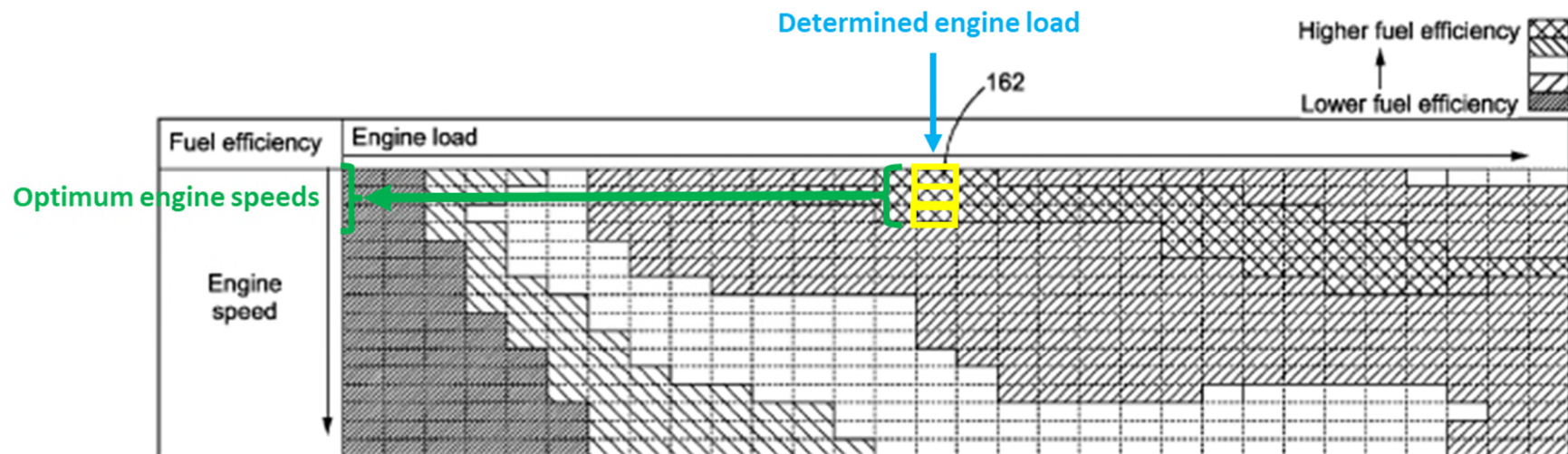


FIG. 4

EX1001, FIG. 4 (annotated)

POR, 3-7; EX2001 (Kemal Decl.), ¶¶21-33

Representative Claim 1

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

receiving a desired rotor speed;

determining an engine load of the engine;

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

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

Grounds of Challenge

Ground	Claims	Invalidity Theory	Prior Art
1	1-13	Obviousness	Willis in view of Xing
2	8, 13	Obviousness	Willis in view of Xing and Laux

Deficiencies in Instituted Grounds

Claims	Grounds	Deficiency
1-13	1	The Petition fails to show Xing discloses adjusting an engine speed based on the engine load
1-13	1	The Petition fails to show Xing discloses adjusting an engine speed based on predefined efficiency points providing optimum engine speeds for different engine loads
13	1	The Petition fails to show Xing discloses a controller configured to disengage the rotor from the engine through control of a clutch
13	2	The Petition fails to show Laux discloses a controller configured to disengage the rotor from the engine through control of a clutch
13	2	The Petition fails to show a POSA would have been motivated to combine Willis, Xing, and Laux as proposed

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Petition cites to Xing's Equation 1 for calculating current P_{load} :

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.

Pet., 46-47

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

Pet., 47

POR, 10-11

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Institution Decision cites to P_{load} :

load.” Prelim. Resp. 6 (citing Pet. 46–47). Instead, we agree with Petitioner that Xing teaches that its controller 116 determines an engine load or “current load power requirement (P_{load}) based on the relationship of Equation 1: ‘ $P_{engine} = P_{load} + P_{loss}$.’” Pet. 46–47 (citing Ex. 1006, 9:18–56); *see also*

Inst. Dec., 30

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Petitioner admits P_{load} is not the engine load:

Q. So just to be clear, the load power requirement in Xing is not the same thing as the engine load recited in the claims of the '538 patent, correct?

A. The load power requirement cited in Xing is the power that's going to the work to do useful work, and that is not the engine load. The engine load is higher than that, whether you're expressing it in torque or in power.

EX2003 (Stein Tr.), 52:3-11

speed adjustment, Xing discloses an adjusted speed based on P_{load} calculated from $P_{engine} - P_{loss}$, where P_{engine} is the measured current engine load. This is all that is

Pet. Reply, 4

POR, 11-13; PO Sur-reply, 1-2

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Xing adjusts engine speed based on P_{load} , not P_{engine} :

As shown in FIG. 4, at 202, a load power requirement for the work vehicle 10 may be determined. The load power

EX1006 (Xing), 9:18-19

Referring still to FIG. 4, at 204, a plurality of candidate engine speeds may be determined based on the load power requirement. Specifically, in several embodiments, the forecasted load power requirement may be analyzed to determine which combination of engine operating parameters, particularly engine speed, may be utilized to achieve the vehicle's load requirement. As is generally understood, a plurality of different combinations of engine torque and engine speed may be utilized to provide a specific power requirement. For example, FIG. 5 illustrates a chart provid-

EX1006, 10:16-25

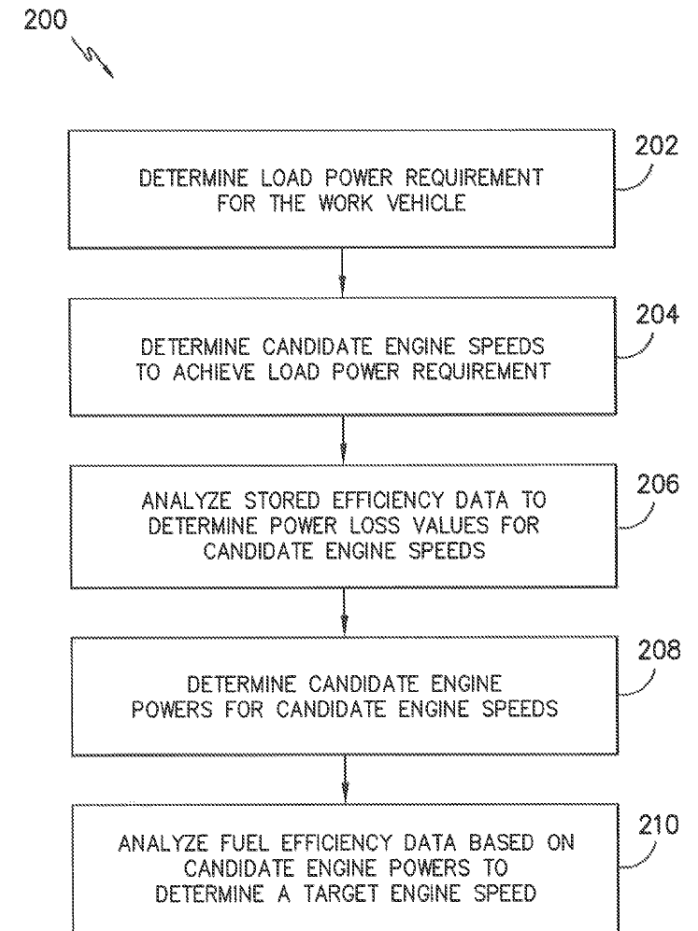


FIG. -4-

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Xing teaches P_{engine} is unnecessary for its speed adjustment:

In one embodiment, the current load power requirement for the work vehicle may be determined indirectly by calculating the current engine power (P_{engine}) and the current power loss (P_{loss}) for the work vehicle 10. For example, as

EX1006 (Xing), 9:37-40

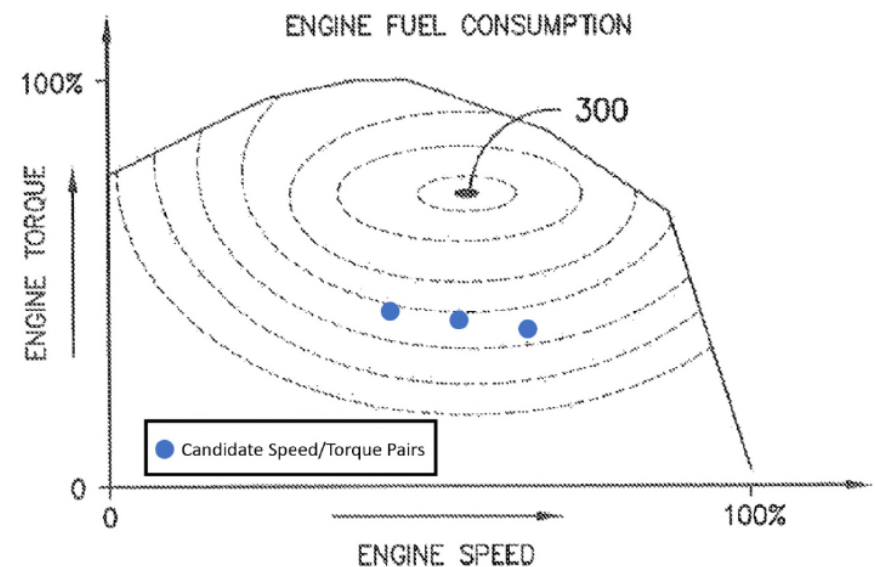
Alternatively, the power load requirement may be determined directly by monitoring the output torque and the output speed of the work vehicle 10. For example, as

EX1006, 9:57-59

Xing's method determines candidate engine powers and torques:

Additionally, at 210, fuel efficiency data may be analyzed to determine a target engine speed for the work vehicle 10 based on the candidate engine powers. Specifically, in several embodiments, a candidate engine torque (as shown in FIG. 5) may be determined by the controller 116 for each pair of candidate engine powers and speeds (e.g., by dividing each candidate engine power by its associated engine speed). Each set of engine torques and engine speeds may then be utilized to determine the most fuel efficient engine settings for achieving the desired load power requirement.

EX1006, 12:26-35.



EX2001 (Kemal (Decl.), ¶50

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Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Petitioner oversimplifies Xing, ignoring multiple steps:

speed” step. POR, 13. Expressed mathematically, Caterpillar asserts that Xing discloses the following algorithm:

$$\text{Engine Speed} = P_{load} \% \text{ efficiency points}$$

Where:

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

Caterpillar has argued that this algorithm of calculations does not meet the Claims of the '538 Patent but is incorrect because P_{load} is derived from P_{engine} . POR, 13–14.

Pet. Reply, 8

Petitioner’s “one layer” construction highlights flaws in Petitioner’s reasoning:

supported or proper. Although the plain and ordinary meaning of “based on” may include some limit to the number of layers between the calculation returning the output (engine speed) and the recited input (engine load), one layer of separation cannot be seen as defeating the “based on” requirement. This is particularly true

Pet. Reply, 8

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Engine Load

Petitioner incorrectly frames issue as matter of embodiments:

power requirement. EX1028, 122:6–21. The obviousness analysis only requires that Xing disclose using the current engine load, even if only in one embodiment. Petition, 47–49. Although some embodiments may not rely on the engine load, some embodiments disclose the algorithm relying on the engine load to determine the engine speed. '538 Patent, 4:64–5:17. That is all that obviousness requires.

Pet. Reply, 9-10

Xing's speed adjustment is not based on P_{engine} even when measured:

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

19 the work vehicle, 10. So Xing describes a direct
20 method and then an indirect method, but it both
21 leads to the -- the -- what is needed in Xing's
22 method, which is a load power requirement.

EX1028 (Kemal Tr.), 110:19-22

EX2001 (Kemal Decl.), ¶45

POR, 14, 18-19; PO Sur-reply, 4-9

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed

Petition cites to Xing's FIGS. 5 and 11:

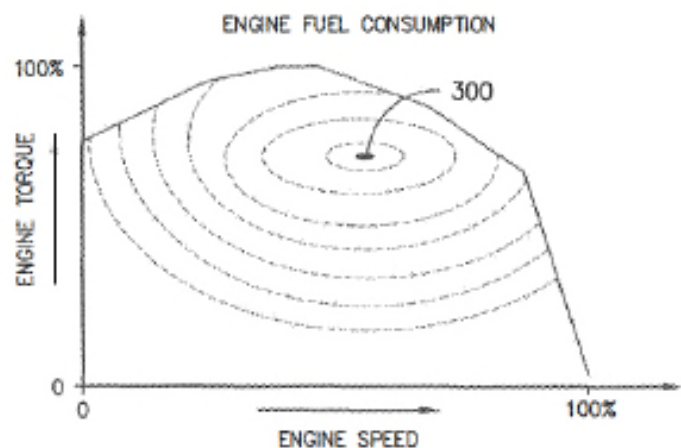


FIG. -11-

Pet., 49 (reproducing EX1006 (Xing), FIG. 11)

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

FIG. -5-

Pet., 48 (reproducing EX1006, FIG. 5)

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

Pet., 49

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed

Petitioner's expert relied on a visual comparison:

Q. So was that a "yes"? Is it your opinion that Xing's Figure 11 discloses the predefined efficiency points recited in claim 1?

A. So the language "predefined efficiency points" is not very clear to me, because the '538 doesn't really define them, other than it shows an example that it -- in its description. And I look at that figure and say: Okay. This is what they're doing with these predefined efficiency points based on fuel consumptions and the torque-speed map. Oh, that's what Xing has over here in his representation.

They are -- I don't exactly know what fuel efficiency points are based partially on fuel consumption, except I understand that the embodiment that they provide that presumably is consistent with that claim language is also found in Xing.

EX2003 (Stein Tr.), 90:7-24

Q. So is it your opinion that Xing's Figure 11 discloses the predefined efficiency points because Figure 11 is used for the same purpose as the '538 Figure 4?

A. I'm saying that Figure 4 is used by the '538 patent to represent the information or the procedure, the control algorithm that's described in the claim language and the claim element that we're talking about.

And I understand that claim with some difficulty, because of the lack of -- because of the language or the lack of description of fuel efficiency points in the specification of the '538, except that it gives this nice Table 4, which is a common way of representing engine efficiencies in the form of a torque-speed map. And once I saw that, I said: Okay. That's what -- this is at least what they mean, the '538, and that's exactly what I find in the -- in Xing.

And so that's how I understand -- have come to understand that claim element.

MR. SEKYI: Counsel, we've been going for about --

EX2003, 90:25-91:22

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed

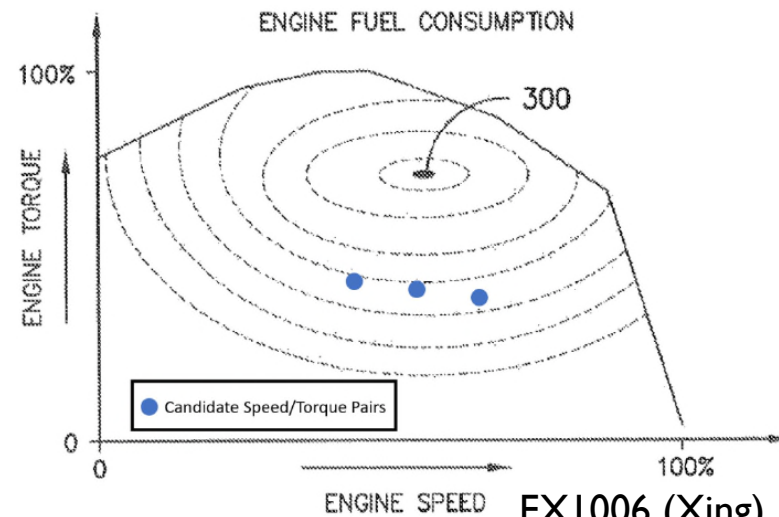
Candidate torque/speed pairs of FIG. 11 fail to provide optimum engine speeds for different engine loads:

61. Second, for similar reasons, to the extent each of Xing's candidate engine speed-torque pairings could be said to correspond to a "predetermined efficiency point" (e.g., on Xing's FIG. 11) that serves as a basis of an efficiency assessment and subsequent speed adjustment, those points do not constitute *optimum* engine speeds for different engine loads. This is due to Xing's process, which first identifies candidate engine speeds *before* candidate engine torques are calculated. Thus, each candidate speed-torque pairing cannot be said to provide *optimum* engine speeds for the candidate engine torques because the candidate engine speeds are already determined before any candidate torque is identified.

EX2001 (Kemal Decl.), ¶61



Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed



EX1006 (Xing), FIG. 11 (annotated)

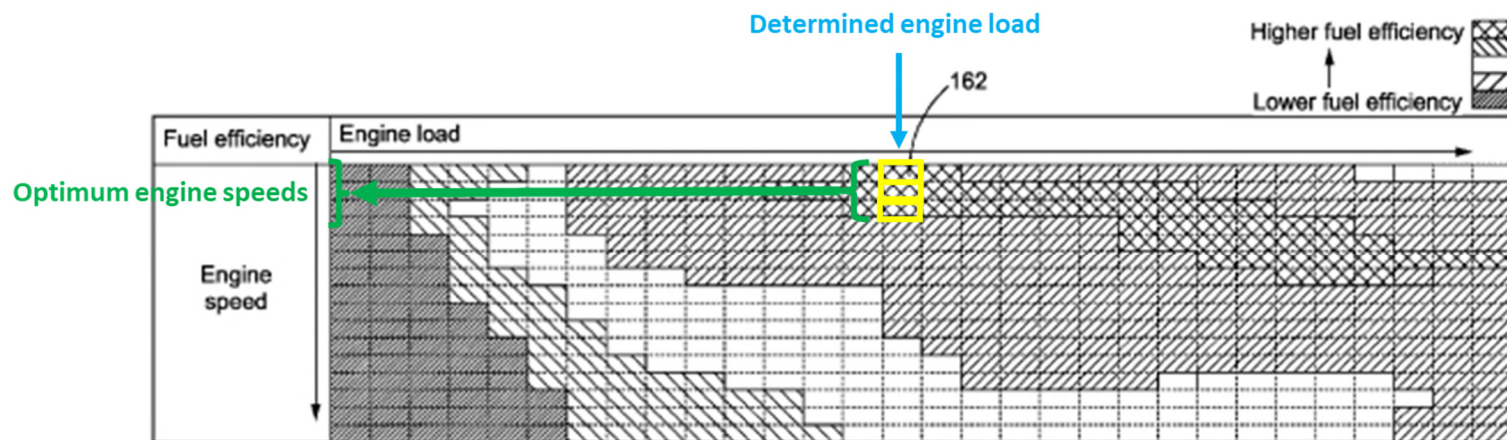


FIG.4 EX1001 ('538 patent), FIG. 4 (annotated)

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed

Petitioner reads out multiple aspects of the claim limitations:

Claims. Although Caterpillar may now wish the Claims required the controller to optimize the engine speed to the *most* fuel-efficient setting, Caterpillar does not identify any requirement that the engine speed be the most efficient engine speed or specifying what the engine speed should be optimized for. The Claims only state that

Pet. Reply, 16

EX1028, 51:14–54:4. Dr. Kemal could not (or would not) identify a basis for his position that the Claims require selecting the most optimum engine speed. This is because the Claims include no such limitation and instead recites plural “optimum engine speeds.”

Pet. Reply, 17

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***

PO Sur-reply, 12-15

Petitioner Fails to Show Xing Adjusts Engine Speed Based on Predefined Efficiency Points as Claimed

Petitioner's reliance on the selected speed/torque pair is insufficient:

lower power requirement.” EX1006, 12:58–63. Xing specifically states that the controller **selects the engine speed/torque pair that maximizes fuel efficiency, and then clarifies which pair that would be—the one that intersects closest to the optimal fuel efficiency point 30.** Thus, it is unclear how Xing does not select an engine speed

Pet. Reply, 17-18

Petitioner Fails to Show Unpatentability of Dependent Claim 13

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

Claim 13: Petitioner Fails to Show Xing's Clutches 52, 54 Disengage a Rotor from the Engine

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

Pet., 74-75

from the engine. In fact, Xing discloses the opposite—the load connected to the engine would still be engaged with the engine even when directional clutches 52, 54 are disengaged because the directional clutches only operate to direct engine power output through the hydrostatic branch of the transmission alone or both the hydrostatic and mechanical branches to drive the connected load.

EX2001 (Kemal Decl.), ¶66

Claim 13: Petitioner Fails to Show Xing's Clutches 52, 54 Disengage a Rotor from the Engine

Petitioner reads out claim limitations:

Caterpillar improperly interprets Claim 13 to require the clutch to disengage all power, not just the power flowing through the clutches, from the engine. But

Pet. Reply, 19

the controller being configured to selectively **disengage the rotor from the engine** through control of the clutch

Claim 13: Petitioner Fails to Show Xing's Clutches 52, 54 Disengage a Rotor from the Engine

Petitioner's devised scenario fails to disclose claim limitation:

through the hydrostatic branch.⁴ Thus, when the controller adjusts the hydrostatic unit's swash plate for zero power flow, disengaging both of the directional clutches 52, 54 disengages all power from the engine to the output of Xing's transmission. With the engine isolated from the transmission output and the load, Xing's controller actuates parking brake 70 to hold the load in place. EX1006, 6:15–35. Xing therefore

Pet. Reply, 21

Q. And so that can go from zero to max; correct?

A. It is typically not zero. There is always some fuel flow that go through it, but it can be reduced and increased.

Q. To --

A. So there is always some power going through the -- the hydrostatic unit.

EX1028 (Kemal Tr.), 81:19-82:4

Willis's milling drum) and the engine. Rather, those skilled in the art would have understood that the load would still be connected to the engine and that the parking brake 70, when engaged, would merely exert a torque on the output shaft 56 to prevent unwanted movement when the vehicle is parked. In fact, such a

EX2001 (Kemal Decl.), ¶74

POR, 29-31; PO Sur-reply, 18-19

Claim 13: Petitioner Fails to Show Xing's PTO Clutch 114 Disengages a Rotor from the Engine

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

Pet., 75 n.4

output shaft 56 and the engine. Willis ¶[0020]; Xing 4:33-37, 4:42-53, 6:47-7:3. As additional support for this combination, Laux teaches connecting a transmission in this manner. Laux, 6:45-7:3.

EX1003 (Stein Decl.), ¶151

EX1012 (Laux), 6:45-7:3). However, Dr. Stein's citation to Laux does not describe a clutch that is controlled to "disengage" a load (*i.e.*, a milling drum) from the engine. Instead, as I describe in greater detail below with respect to Ground 2, Laux discloses a similar clutch arrangement as that of Xing in that the clutch of Laux also fails to "disengage" the load from the engine. *See infra*, section VIII.

POR, 31-33; PO Sur-reply, 19-20

EX2001 (Kemal Decl.), ¶76

Claim 13: Petitioner Fails to Show Laux's Clutch 15 Disengages a Rotor from the Engine

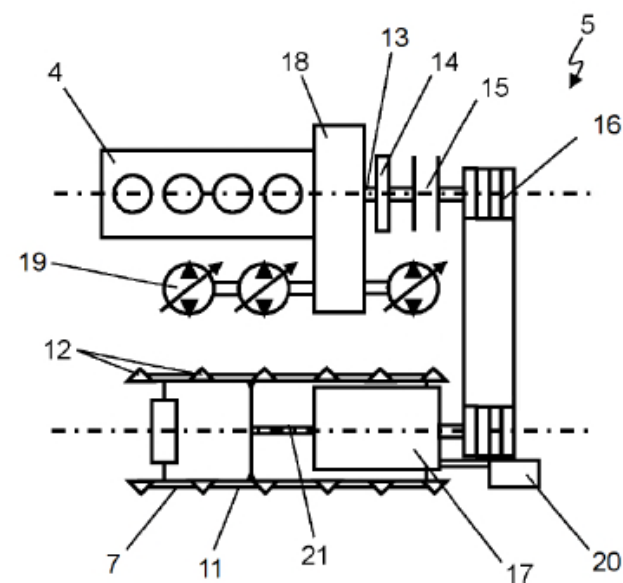
of a clutch, Laux taught a milling machine powertrain in which clutch 15 was disposed between the engine and the rotor to selectively disengage the rotor from the engine. Stein Decl., ¶157; *supra* IV.A.2 (describing Laux's drive train). Engine 4 was coupled to belt drive 16 via output shaft 13 and shift clutch 15. Laux, 9:3-10. 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.

Pet., 78-79

9:10-13. Due to this arrangement, a person of ordinary skill would have understood that, even with clutch 15 disengaged, the transmission 17 (and thus the rotor 7) would still be connected to the engine 4 via the hydrostatic path (*i.e.*, auxiliary drive 20 and hydraulic pumps 19). Given this connection, a person of

EX2001 (Kemal Decl.), ¶180

Fig. 3



EX1012 (Laux), FIG. 3

Claim 13: Petitioner's Reply Pivots to New Modification Not Taught by the References

Petitioner's reply modifies Laux's clutch position to the transmission output:

79 (citing EX1012, 9:3–10). When implemented in the proposed combination, Laux's shift clutch 15 would have been located as the last drive train element between Xing's transmission and adjacent Willis's drive pulley "belt-and-pulley system" at the output of Xing's transmission. Petition, 11 (citing EX1005, ¶[0020].)

Pet. Reply, 23

Petition relied on Laux's clutch position between the engine and transmission:

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.

Pet., 79

Claim 13: Petitioner's Insufficient Motivation to Combine Laux with Willis and Xing

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*,

Pet., 79

In other words, those skilled in the art would have understood Laux's clutch 15 to be a component that directs power flow from the engine to the rotor, not a "safety feature."

EX2001 (Kemal Decl.), ¶85

disengage the drum from the engine. Those skilled in the art would have understood that, by relying on a computerized component such as a controller to control the clutch to disengage the drum from the engine, any controller error may inadvertently engage the clutch, and thus, re-engage the drum to the engine, or fail to disengage the clutch entirely. This would thus run into the same issues that a person of ordinary skill would have sought to avoid according to Dr. Stein—*i.e.*, unexpected startup and possible injury. As such, to the extent that those skilled in

POR, 38-39; PO Sur-reply, 23-24

EX2001, ¶87