

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Caterpillar Inc.

Petitioner

v.

Wirtgen America, Inc.

Patent Owner

Case IPR2022-01264

Patent No. 9,879,390

PETITION FOR INTER PARTES REVIEW

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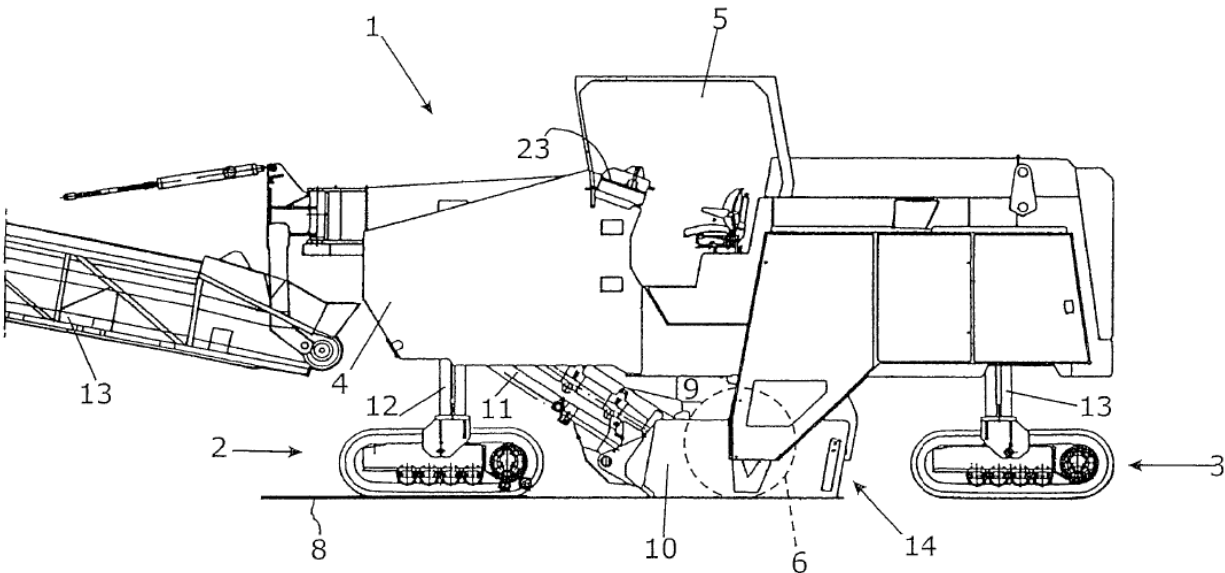
Exhibit No.	Description
1001	U.S. Patent No. 9,879,390
1002	PM-465 Cold Planer Operation & Maintenance Manual (“OMM”)
1003	PM-465 Cold Planer Grade & Slope Electronic Control System, Systems Operation Testing and Adjusting Manual (“SOTA”)
1004	U.S. Patent No. 6,450,048 (“ <i>Samuelson</i> ”)
1005	U.S. Patent No. 4,943,119 (“ <i>Zarniko</i> ”)
1006	Declaration of William Singhose, Ph.D. (“Singhose”) (Confidential and Non-Confidential Versions)
1007	Curriculum Vitae of William Singhose, Ph.D.
1008	Prosecution History for U.S. Patent No. 9,879,390.
1009	Reserved
1010	Reserved
1011	Dkt. 28, Scheduling Order (July 23, 2021)
1012	Dkt. 30, Scheduling Order Modification (Aug. 5, 2021)
1013	Dkt. 33, Amended Complaint (Sept. 2, 2021)
1014	Reserved
1015	Reserved
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1017	Dkt. 88, Stipulation Extending Fact Discovery Cutoff (Apr. 4, 2022)
1018	Dkt. 90, Order Reassigning to Judge Wolson (June 2, 2022)
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1020	Declaration of Mike Netka (Confidential and Non-Confidential Versions)
1021	Printout of GOMACO Website
1022	Printout of MOBA Website
1023	U.S. Patent No. 4,186,968 (“ <i>Barton</i> ”)
1024	U.S. Patent No. 4,270,801 (“ <i>Swisher</i> ”)
1025	Factory Notification List of Current Service Publications, Issue No. 337, May 2000 (Confidential and Non-Confidential Versions)
1026	Factory Notification List of Current Service Publications, Issue No. 343, November 2000 (Confidential and Non-Confidential Versions)
1027	Factory Notification List of Current Service Publications, Issue No. 344, December 2000 (Confidential and Non-Confidential Versions)

Exhibit No.	Description
1028	Factory Notification List of Current Service Publications, Issue No. 345, January 2001 (Confidential and Non-Confidential Versions)
1029	Factory Notification List of Current Service Publications, Issue No. 347, March 2001 (Confidential and Non-Confidential Versions)
1030	Factory Notification List of Current Service Publications, Issue No. 351, July 2001 (Confidential and Non-Confidential Versions)
1031	Reserved
1032	Factory Notification List of Current Service Publications, Issue No. 357, January 2002 (Confidential and Non-Confidential Versions)
1033	Factory Notification List of Current Service Publications, Issue No. 367, November 2002 (Confidential and Non-Confidential Versions)
1034	Factory Notification List of Current Service Publications, Issue No. 371, March 2003 (Confidential and Non-Confidential Versions)
1035	Reserved
1036	Caterpillar Corporate Procedure CP No. 1:13, Issue No. 5, August 28, 1991(Confidential and Non-Confidential Versions)
1037	U.S. Patent No. 5,309,407 (“ <i>Sehr</i> ”)
1038	Caterpillar Invoice for Serial No. 5ZS000153 (Confidential and Non-Confidential Versions)
1039	Caterpillar Invoice for Serial No. 5ZS000161 (Confidential and Non-Confidential Versions)
1040	Caterpillar Invoice for Serial No. 5ZS000167 (Confidential and Non-Confidential Versions)
1041	Caterpillar Invoice for Serial No. 5ZS000163 (Confidential and Non-Confidential Versions)
1042	Caterpillar Invoice for Serial No. 5ZS000169 (Confidential and Non-Confidential Versions)
1043	Caterpillar Invoice for Serial No. 5ZS000180 (Confidential and Non-Confidential Versions)
1044	Caterpillar Invoice for Serial No. 5ZS000168 (Confidential and Non-Confidential Versions)
1045	Caterpillar Invoice for Serial No. 5ZS000183 (Confidential and Non-Confidential Versions)
1046	Caterpillar Invoice for Serial No. 5ZS000186 (Confidential and Non-Confidential Versions)

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1047	Caterpillar Invoice for Serial No. 5ZS000187 (Confidential and Non-Confidential Versions)
1048	Caterpillar Invoice for Serial No. 5ZS000188 (Confidential and Non-Confidential Versions)
1049	Declaration of Michael B. Aldrich (Confidential and Non-Confidential Versions)
1050	U.S. Patent No. 6,152,648 to Gfroerer (“ <i>Gfroerer</i> ”)
1051	U.S. Patent No. 4,140,420 to Swisher (“ <i>Swisher 420</i> ”)
1052	Roadtec Parts Manual
1053	Roadtec Electrical Schematic
1054	Deposition Transcript of Timothy Lewis (Confidential and Non-Confidential Versions)
1055	Roadtec Equipment Proposal (Confidential and Non-Confidential Versions)
1056	Roadtec Service Report (Confidential and Non-Confidential Versions)
1057	EP0940274 (“ <i>Bitelli</i> ”)
1058	U.S. Pat. No. 7,828,309
1059	JPA-1991-276889
1060	JPA-1991-139408
1061	Reserved
1062	<i>Wirtgen Am., Inc. v. Caterpillar Inc.</i> , C.A. No. 17-770-RGA, Parties’ Preliminary Claim Construction Exchange
1063	<i>Wirtgen Am., Inc. v. Caterpillar Inc.</i> , C.A. No. 17-770-RGA, Court’s Order Setting Claim Construction Hearing

I. PRELIMINARY STATEMENT

Caterpillar Inc. requests *inter partes* review and cancellation of claims 1-22 of the '390 patent (Ex. 1001), assigned to Wirtgen America, Inc. The '390 patent relates to a road-milling machine for milling asphalt.



Ex. 1001, Fig. 1. Its purported invention “improve[s] the accuracy of measuring the milling depth” while milling and “thereby minimize[s] deviations” between the actual milling depth and the “predetermined milling depth” set by the operator. Ex. 1001, 1:64-67. The patent’s design largely uses sensors on the road-milling machine’s side plates to perform this functionality. Ex. 1001, 2:25-36.

The claimed designs in the '390 patent would have been obvious over the prior art, however. For example, the PM-465 Cold Planer Operation & Maintenance Manual (“*OMM*”; Ex. 1002) discloses a road-milling machine (the

PM-465) with sensors near the machine's side plates that continuously detect the ground position, and that information is used to determine whether the road-milling machine is milling at the intended depth set by the operator.

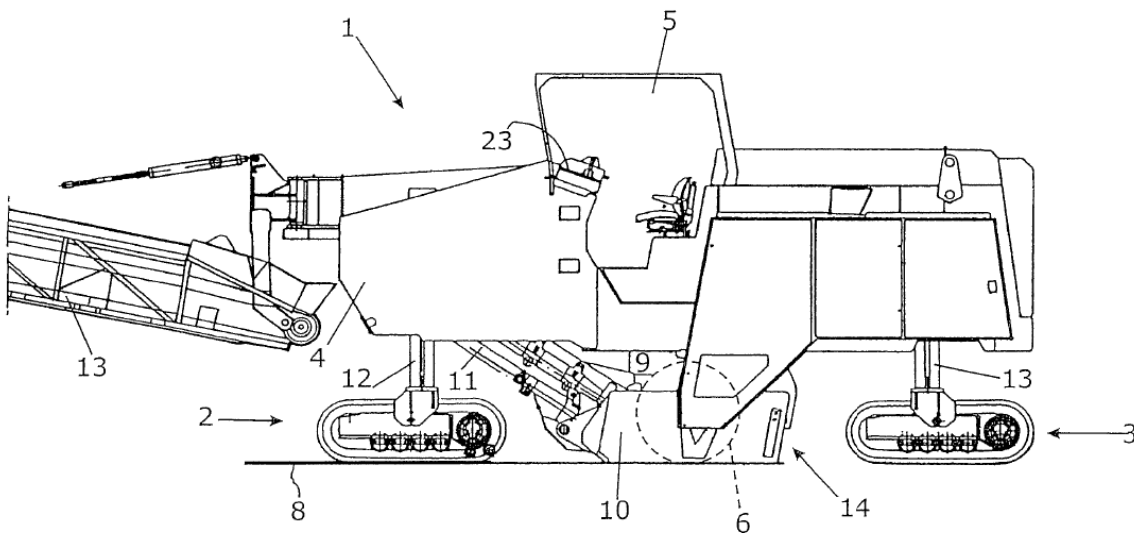
U.S. Patent No. 6,450,048 ("*Samuelson*"; Ex. 1004) discloses a design where a sensor mounted *inside* a hydraulic cylinder continuously measures the extension and retraction of the cylinder. This design allows one to always know the linear position of machine components attached to the hydraulic cylinder. *Samuelson* expressly intended for its sensor-integrated cylinders to be used on construction machines, like those at issue here.

It would have been obvious to update certain hydraulic cylinders on the PM-465 machine described in *OMM* (e.g., the cylinders on the side plates, scraper blade, and legs) with sensor-integrated cylinders like *Samuelson*'s. This would have provided a more robust design for the PM-465 machine and allowed it to perform several functionalities already on the machine with more efficiency and accuracy. It also would have been obvious to use the positions of the modified sensor-integrated side plates and the sensor-integrated scraper blade to determine the machine's milling depth. These designs and modifications render obvious the challenged claims—they are unpatentable under 35 U.S.C. §103 and should be cancelled.

II. THE '390 PATENT

A. Specification

The '390 patent's milling machine has a machine frame 4; two front chain tracks 2 and at least one rear chain track 3; lifting columns 12 and 13 that support the frame from the chain tracks; a milling roll 6 supported from the machine frame; a height-adjustable stripping means 14; and side plates 10. Ex. 1001, 4:7-29.



Ex. 1001, Fig. 1. Every feature described above is in the prior art, as the specification admits. *Id.*, 1:25-44; Singhose, ¶33. Regarding the patent's purported novelty, it describes designs where sensor-integrated hydraulic cylinders are used on the side plates, stripping means, and lifting columns to measure their vertical position, and where information from the sensors is used to perform various machine functionalities, such as positioning the machine frame in certain

orientations and ensuring the milling roller is milling at the depth initially set by the operator. *Id.*, 3:7-30, 4:13-17, 5:5-9; Singhose, ¶¶34-41.

B. Prosecution History

During prosecution, the examiner found—and the applicant never disputed—that the prior art taught “[a] self-propelled road milling machine,” “[a] machine frame,” “front and rear ground supports,” “a milling roller,” “first and second height adjustable side plates,” and a “height adjustable stripping plate.” Ex. 1008, 90. The examiner also found that certain limitations were “old and well known in the art,” including the limitations requiring a “controller operably associated to the position sensor,” “sensors . . . integrated in the hydraulic piston/cylinder units for lifting or lowering the side plates,” and “position sensors integrated in the lifting columns.” *Id.*, 91-95. Applicant asked the examiner to provide documentary evidence that supported this “well known in the art” conclusion, but the examiner opted instead to withdraw the objection. *See, e.g.*, Ex. 1008, 26-30, 57. This petition supplies the prior art evidence and argument that the examiner did not.

III. STATEMENT OF PRECISE RELIEF REQUESTED

Claims 1-22 are unpatentable and should be cancelled in view of the following prior art and grounds.

- PM-465 *OMM*; prior art under pre-AIA § 102(a)-(b), as explained in Section VI.A.1.b.
- U.S. Patent No. 6,450,048 (“*Samuelson*”), filed on February 22, 2000, and issued on September 17, 2002; prior art under pre-AIA § 102(a)-(b).
- U.S. Patent No. 4,943,119 (“*Zarniko*”), filed on November 22, 1988, and issued on July 24, 1990; prior art under pre-AIA § 102(a)-(b).

Ground	Challenged Claims	Basis	Prior Art
1	1-6, 8-17, 19-22	103	<i>OMM</i> and <i>Samuelson</i>
2	7, 18	103	<i>OMM</i> , <i>Samuelson</i> , and <i>Zarniko</i>

IV. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) pertinent to the ’390 patent would have had at least a four-year degree in mechanical engineering or a closely related field and at least two years of experience designing, developing, servicing or operating heavy machinery, including their components and control systems. Additional education could substitute for professional experience, and significant work experience—such as working with, servicing, or operating heavy machinery in the field—could substitute for formal education. Singhose, ¶23.

V. CLAIM CONSTRUCTION

The prior art renders all challenged claims unpatentable under the plain and ordinary meaning of the claims. Caterpillar notes that the parties exchanged preliminary claim constructions in the parallel litigation on July 14, 2022. Ex. 1062. But the only construction identified for this patent was Caterpillar’s construction of “controller” as “a standard electronic controller.” *Id.* That construction is irrelevant to the outcome here and the Board thus need not address it. *See, e.g., Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

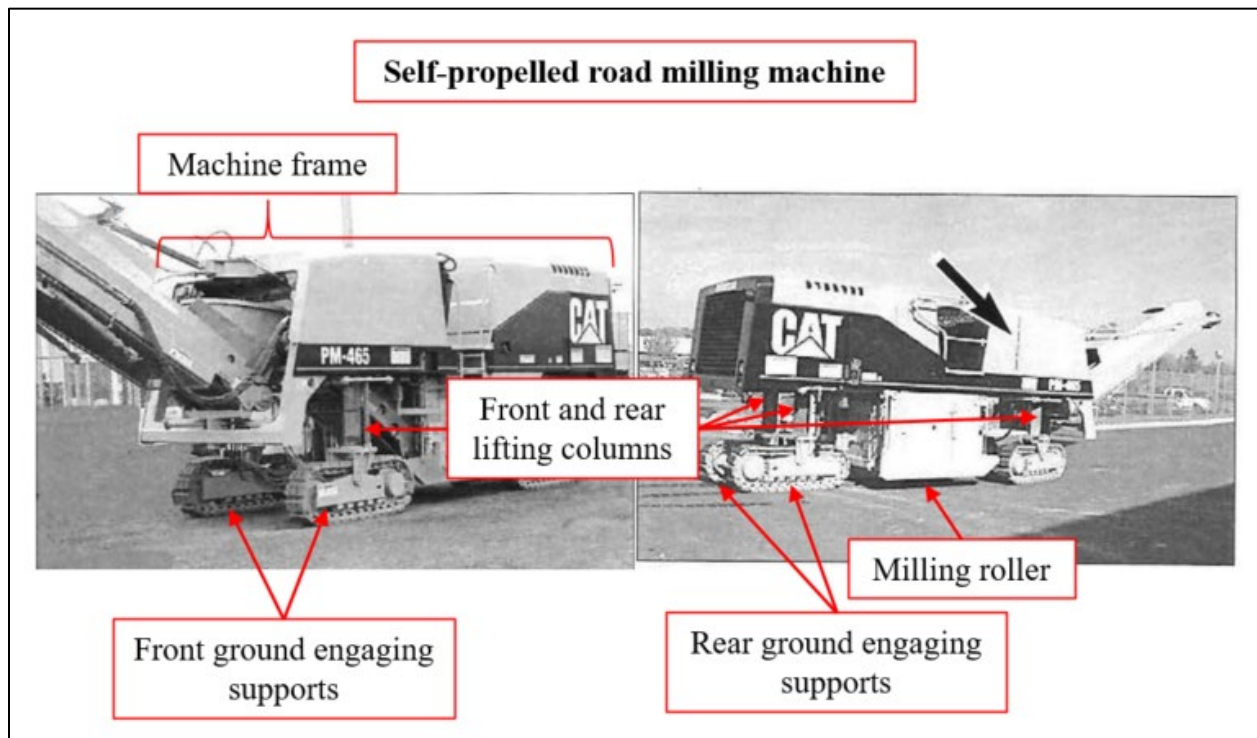
VI. DETAILED EXPLANATION AND EVIDENCE

A. GROUND 1: Claims 1-6, 8-17, and 19-22 Are Obvious over *OMM* and *Samuelson*

1. Summary of PM-465 *OMM*

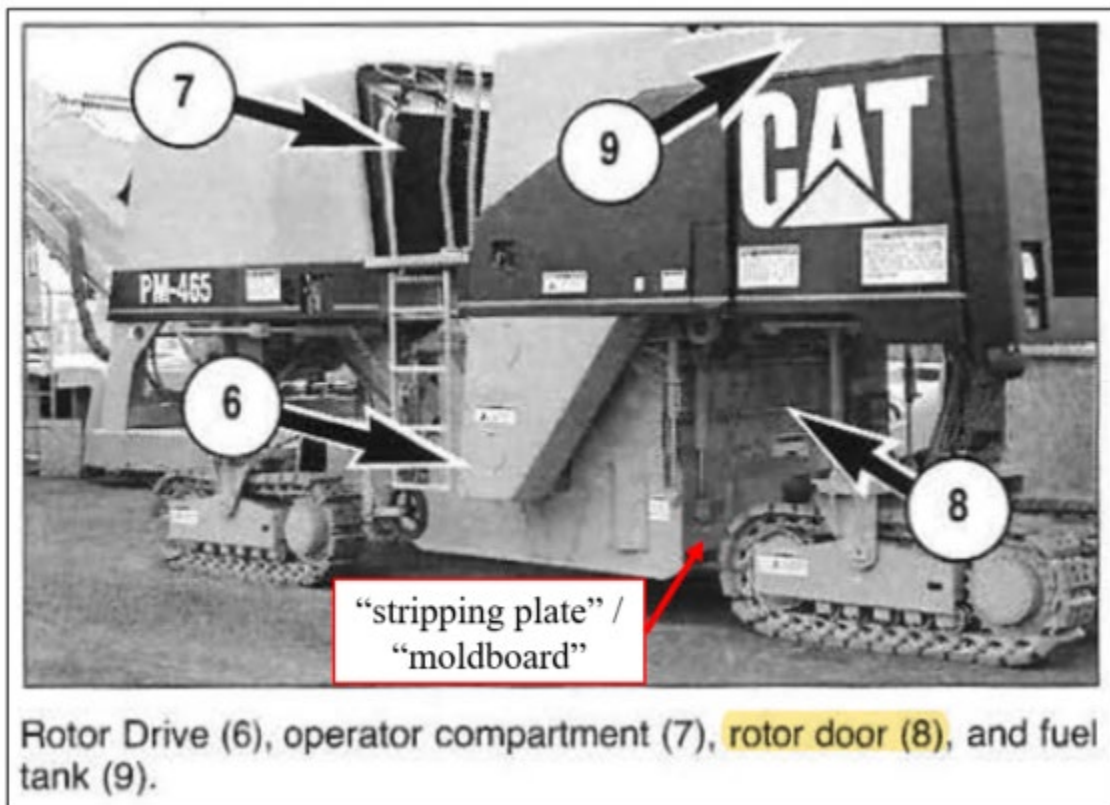
a. Technical Disclosure

The PM-465 *OMM* discloses a road-milling machine called the PM-465. *See OMM*, 2. The PM-465 has a height-adjustable mainframe (i.e., machine frame), front and rear track assemblies (i.e., ground-engaging supports), front and rear legs that raise and lower the machine frame (i.e., lifting columns), and a rotor drum (i.e., milling roller), as shown below:

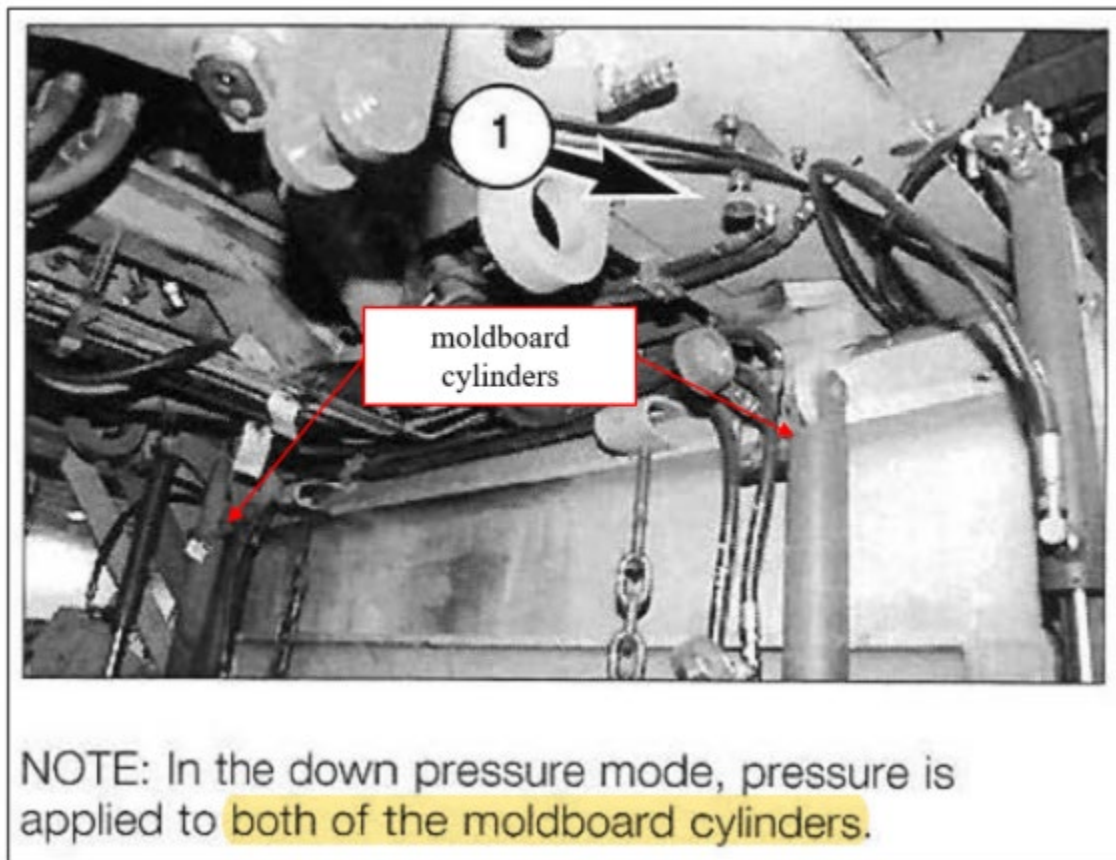


OMM, 2 and 40 (annotated); *see also id.*, 8, 13, 29-31, 134; Singhose ¶47.

OMM also discloses a height adjustable moldboard (i.e., stripping plate) that is arranged behind the rotor drum and is operable to be lowered during operation into a milling track generated by the milling roller. The moldboard, which is part of the rotor door, is shown below.

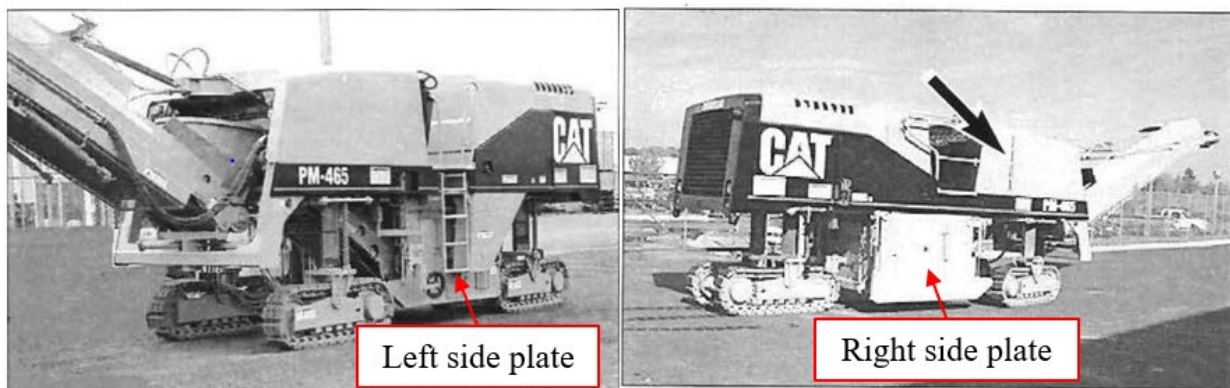


OMM, 14 (annotated); *see id.*, 38; Singhose ¶48. The moldboard is raised and lowered using the “moldboard cylinders”:



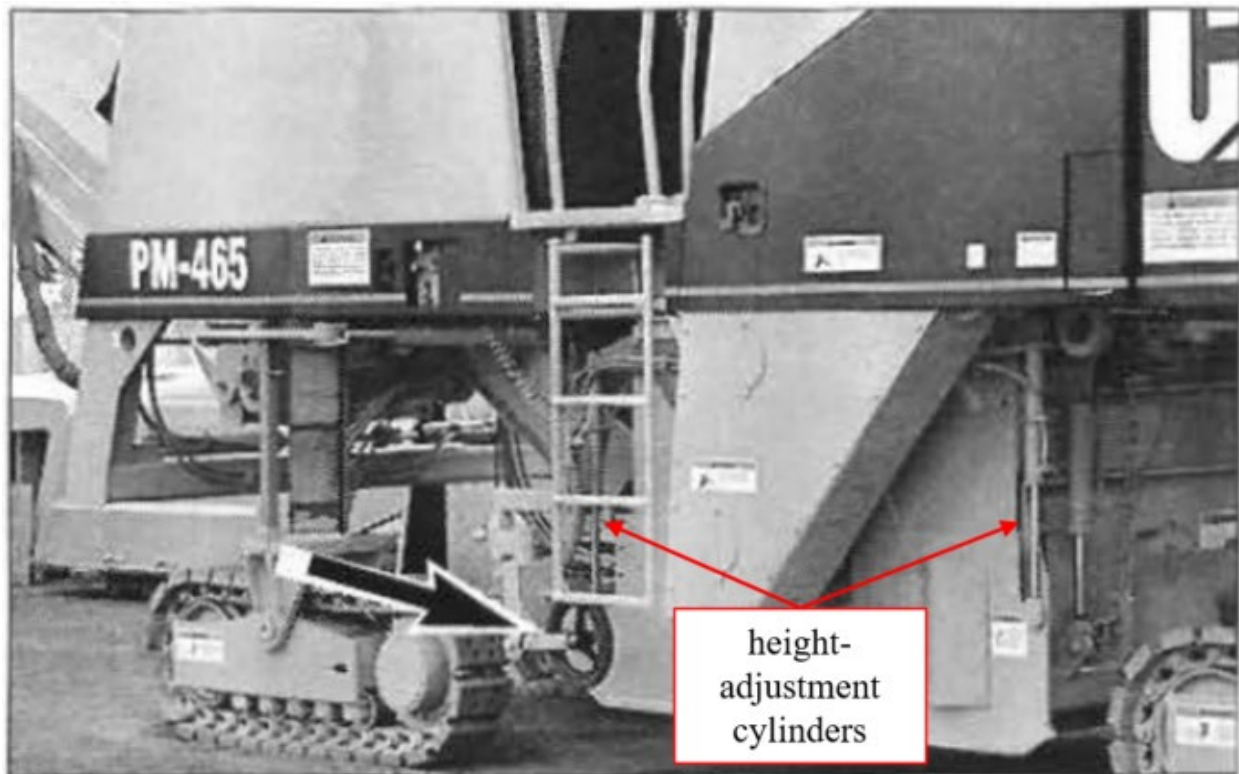
Id., 60 (annotated).

OMM also discloses two height adjustable side plates arranged on opposite sides of the rotor drum, as shown below:

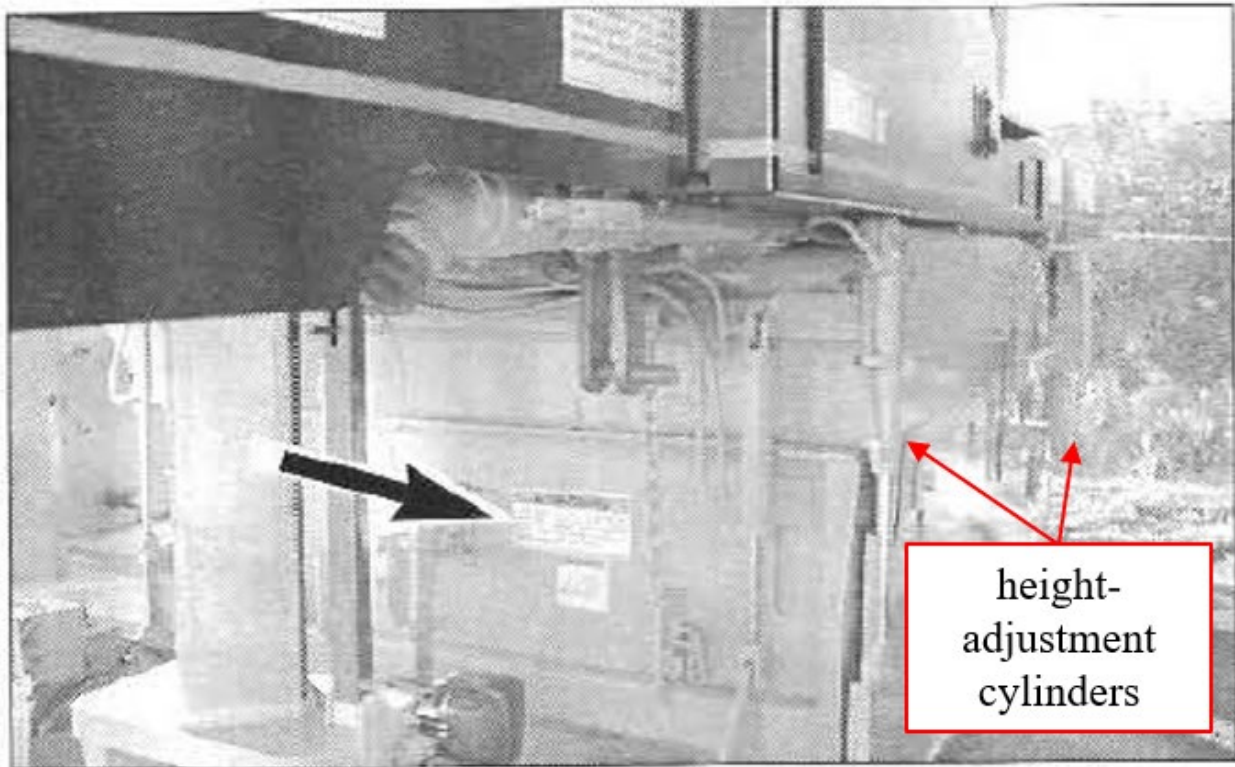


OMM, 2 and 40 (annotated).

Two hydraulic cylinders on each side plate allow the operator to adjust the height of the side plates. *Id.*, 40 (describing switches used to raise/lower the side plates); Singhose ¶ 50.

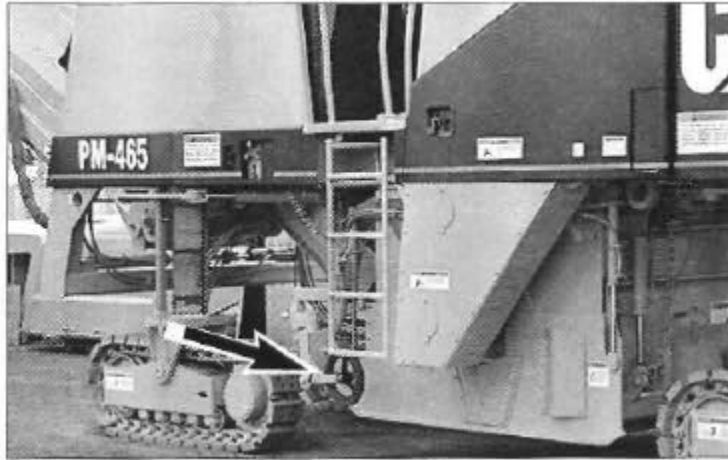


Id., 49 (annotated).



Id., 5 (annotated).

OMM also discloses a “Caterpillar Grade and Slope Electronic Control System” that uses contacting and/or noncontacting “grade sensor[s]” to detect changes in the position of the milling machine relative to the ground. *Id.*, 32. One type of contacting grade sensor described in *OMM* is a “grade slope wheel,” as shown below with the black arrow:



OMM, 49. The grade slope wheel rolls along the ground and “sends signals to the controller as the ground elevation varies.” *Id.* A POSITA would have known that this controller is a standard electronic controller. Singhose, ¶53.

For the non-contacting grade sensor options, *OMM* discloses “a sonic sensor” that “uses sound waves” to measure a distance to the ground. *Id.* *OMM* emphasizes the importance of positioning this grade sensor “on the centerline of the rotor to achieve an accurate cut. The further away from the center of the rotor, the less accurate the reading on the readout and the potential for less accurate cuts.” *Id.*, 48.

To accurately determine the distance between a point on the machine and the ground surface, the operator must zero out the grade sensors before milling. The first step in this procedure is to “[l]ower the front of the machine until the rotor just touches the surface to be cut.” *OMM*, 53. Then, the operator “[z]ero calibrate[s] the sensors” and sets the milling depth, which is shown on the display. *Id.* From there,

the automatic grade-and-slope control system can take over, which automatically raises and lowers the rotor (by raising and lowering the legs) to ensure the machine is milling at the intended depth. *Id.*, 48.

The PM-465 has *two* grade sensors, one on each side of the machine. *Id.*, 32. When the grade slope wheels are used, one wheel is attached near each side plate. *Id.*, 32, 48-49. The PM-465 also has a slope sensor in the middle of the machine. *Id.*, 32, 48. Grade is “controlled by the difference of the heights between the front and rear legs,” and slope is “controlled by the difference of the heights between the right-front and left-front legs.” *Id.*, 48. The PM-465’s automatic grade-and-slope system “makes adjustments to the heights of the legs” based on the information it receives from the grade-and-slope sensors to “control the grade and slope of the cut surface.” *Id.*

The grade-and-slope sensors are redundant in that only two of the three are used to perform milling operations. *Id.*, 32-33, 56. The operator must designate either the left grade sensor or slope sensor for the left side of the machine, and either the right grade sensor or slope sensor for the right side of the machine. *Id.*, 32-33, 56. Because there is only one slope sensor, if the operator designates the slope sensor for one side, the grade sensor must be selected for the other. *Id.*, 32. But the operator can also designate the grade sensor on each side and not use the slope sensor. *Id.*

b. *OMM* is a Publicly Accessible Printed Publication

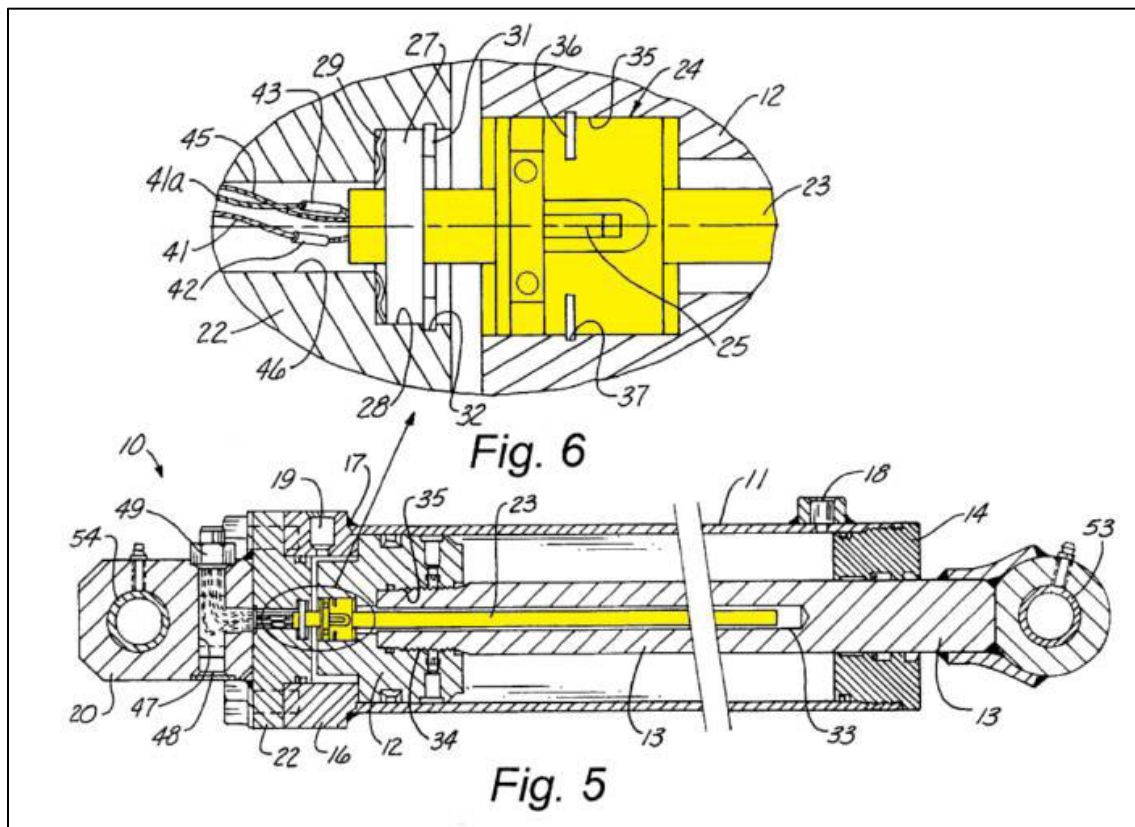
OMM published in January 1999 before the '390 patent's priority date and is a "printed publication" under 35 U.S.C. § 102. A reference is a printed publication if it is "publicly accessible," which requires "a satisfactory showing that such document has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it." *In re Wyer*, 655 F.2d 221, 226 (C.C.P.A. 1981).

Under Caterpillar Policy, each product when shipped must include an operation manual. Netka, ¶¶14-15, 21-22. Caterpillar also issued monthly Factory Notification Lists (FNLs), identifying the manuals shipped with Caterpillar machines. Netka, ¶¶16-17. FNLs issued between May 2000-March 2003 each list PM-465 *OMM* for shipment with a PM-465 machine. *Id.*, ¶¶18-20. Caterpillar shipped at least eleven PM-465 machines with *OMM*, including to U.S. customers during that time. *Id.*, ¶20. Further, anyone in the U.S., regardless of whether they purchased a PM-465 cold planer, could have purchased PM-465 *OMM* between May 2000-March 2003 from one of 50 Caterpillar dealers. Netka, ¶¶24-27. Thus, *OMM* was available to the relevant public and to POSITAs (e.g., people who work with, operate, and/or service heavy machinery) before the '390 patent's priority date.

The Board previously found that *OMM* was a publicly accessible printed publication based on the same evidence Caterpillar presents now. *Caterpillar Inc. v. Wirtgen Am., Inc.*, IPR2018-01091, Paper 49 at 53-59 (P.T.A.B. Nov. 27, 2019). The Board should do so again here. *See, e.g., Mobile Tech, Inc. v. Invue Sec. Prod. Inc.*, No. IPR2018-00481, 2019 WL 3208477, at *6 (P.T.A.B. July 16, 2019) (applying collateral estoppel on issue from previous IPR).

2. Summary of Samuelson

U.S. Patent No. 6,450,048 (“*Samuelson*”) discloses a sensor-integrated hydraulic cylinder having a “transducer (23) and (24)” (shown in yellow below), that measures “the position of the piston (12) and/or rod (13)” as they “move from one position to another within the cylinder.” *Samuelson*, 4:35-45; *see also* 3:21-4:35. A POSITA would understand that a “transducer” is a “sensor.” Singhose, ¶59.



Samuelson, Figs. 5 and 6 (annotated). *Samuelson* explains that the sensor shown in the figures is a “linear resistance type transducer” but that “other types of transducers, such as a magneto-restrictive type, can be used instead.” *Id.*, 4:35-40. The information on the piston’s position within the hydraulic cylinder is sent to and processed by a controller. *Id.*, 4:17-29.

Samuelson further explains that, before its disclosure, hydraulic actuators with integrated sensors were known in “highly specialized” industrial equipment such as “in-plant equipment” and “machine tools.” *Id.*, 1:19-34. But as controller technology “became more cost effective,” it became feasible to use transducers on

hydraulic cylinders in mobile construction equipment, as well. *Id.*, 1:35-49, 2:29-32. *Samuelson* took advantage of this development and used controllers and transducers to automate functionalities in mobile construction equipment. *Id.*, 1:35-55, 1:65-2:40. Notably, *Samuelson*'s assignee—GOMACO Corporation—builds road-construction machines. *See* Ex. 1021 (Printout of GOMACO Website).

Because *Samuelson*'s transducer is *inside* the hydraulic cylinder, it is protected “from damage and environmental degradation.” *Samuelson*, 1:45-49; *see also id.*, 4:48-52; Singhose, ¶62. *Samuelson* further explains older mobile construction machines can be retrofitted with its sensor-integrated cylinders, and that these updated cylinders can be easily serviced and maintained. *Samuelson*, 1:54-61, 4:58-5:1.

3. Rationale for Implementing Sensor-Integrated Cylinders Like *Samuelson*'s into PM-465 Machine Described in *OMM*

OMM and *Samuelson* are analogous art to the '390 patent because they are from the same field of endeavor as the '390 patent and are reasonably pertinent to the problem the '390 patent was trying to solve. *See, e.g., Wyers v. Master Lock Co.*, 616 F.3d 1231, 1237 (Fed. Cir. 2010). The '390 patent relates to “a road milling machine.” Ex. 1001, Abstract. The PM-465 machine described in *OMM* is a road-milling machine. *OMM*, 2. And *Samuelson* discloses a sensor-integrated

cylinder for use “in mobile equipment,” including construction equipment. *See Samuelson*, 1:35-63, 2:28-31; Singhose, ¶63.

The designs in the '390 patent, *OMM*, and *Samuelson* address a similar problem—measuring the precise location of various components on construction equipment. *OMM* describes a sensor-driven control system intended to increase the accuracy of milling cuts. *OMM*, 48-49, 52. Likewise, the sensor-integrated cylinders in *Samuelson* accurately measure the linear position of the piston as it extends/retracts inside the cylinder, and this information is sent to the controller for processing. *Samuelson*, 4:17-47. A POSITA would have understood that *OMM*'s Electronic Control Module (“ECM”)—a standard electronic controller—was designed to receive and process signals from a variety of sensors all at once, and that the ECM would be able to receive and process the position signals generated from a sensor-integrated cylinder like *Samuelson*'s. *OMM*, 32; Singhose, ¶64. A POSITA would have been motivated to implement sensor-integrated cylinders like *Samuelson*'s on the PM-465 machine and use them to monitor and change the positions of components attached to those cylinders. Singhose, ¶65.

a. Motivations to Use Sensor-Integrated Cylinders on Side Plates

As *OMM* describes, the machine's grade-and-slope system has controllers that receive signals from multiple sensors, and this information is used to control

the drum's milling depth by adjusting the "heights of the legs." *OMM*, 32, 48-49. *Samuelson*'s built-in sensor generates signals associated with the hydraulic cylinder's position that are sent to and processed by a controller. *Samuelson*, 4:17-57. Thus, *Samuelson*'s design is processor-ready and in a state where it can be integrated easily with the PM-465's controllers. Singhose, ¶66.

Moreover, *Samuelson*'s sensor-integrated cylinders can be retrofitted on machines that already have existing cylinders, and should be "designed for the equipment rather than modifying the equipment design to accept the cylinder." *Samuelson*, 1:54-63, 4:58-62. A POSITA would have understood that retrofitting a sensor-integrated cylinder in the PM-465 would require nothing more than simple reprogramming to enable the ECM to read incoming signals from the sensor-integrated cylinder. Singhose, ¶67. The state of the art recognizes that "[t]hose skilled in the art can readily write software for implementing" sensors in road-milling machines. U.S. Patent No. 6,152,648 to Gfroerer (Ex. 1050). A POSITA viewing these disclosures would have been motivated to not only use sensor-integrated cylinders on newly manufactured PM-465 machines (instead of existing cylinders), but also to retrofit previously manufactured machines by replacing existing cylinders with sensor-integrated cylinders. Singhose, ¶68. As *Samuelson* explained, because of improvements in controller technology, over time it became cost effective and easier to use sensor-integrated cylinders in mobile construction

equipment—yet another motivation for using sensor-integrated cylinders on the PM-465. *See Samuelson*, 1:35-45; Singhose, ¶¶61, 81.

A POSITA would have been motivated to use *Samuelson*'s sensor-integrated cylinders (instead the of the grade slope wheel) near the PM-465's side plates to sense the ground and determine if the machine is milling at the intended depth. Singhose, ¶69. A POSITA would have known that side plates make excellent ground sensors on road-milling machines. The side plates are one of the few components on a milling machine that can move vertically relative to the milling drum—most other relevant components (e.g., the machine frame) are fixed relative to the drum and thus move up and down only when the drum moves up and down, which occurs when the legs are raised/lowered. *Id.*

Moreover, during prior-art milling operations, side plates routinely rode on top of the ground in “float mode,” meaning that the hydraulic cylinders apply no down pressure on the side plates, and they are free to move up or down relative to the rotor drum as they traverse the ground surface. Singhose, ¶70; *OMM*, 39-40. The side plates are located *right next to the rotor drum*, and as *OMM* explains, having the ground sensors near the centerline of the rotor drum improves accuracy, which is “vital” to milling. *OMM*, 48-49. The location and ability of side plates to undulate with the ground profile make them ideal candidates to use as ground

sensors in grade-and-slope systems for road-milling machines, and a POSITA would have known that. Singhose, ¶70.

It was well known in the art to use components near side plates as ground sensors in road-milling machine grade-and-slope systems. Singhose, ¶71. The PM-465's grade slope wheel is one example. It attaches near the side plate and moves up and down as it rolls along the ground, sensing ground-elevation changes as it goes. *OMM*, 2, 48-49; Singhose, ¶71. The state-of-the-art confirms this operation of the grade slope wheel. *See* PM-465 Cold Planer Grade & Slope Electronic Control System, Systems Operation Testing and Adjusting Manual ("*SOTA*"), 35-36.¹ Specifically, the *SOTA* manual shows that the arm on which *OMM*'s grade slope wheel is mounted is affixed to a vertical member and engaged with a sensor

¹ The *SOTA* was a publicly accessible printed publication under 35 U.S.C.

§ 102(b). As Mr. Netka explained, any person, including those interested in and knowledgeable about cold planers, could purchase this manual from one of 50 Caterpillar dealers in the U.S. Netka, ¶26-27. The public accessibility of the *SOTA* was also confirmed by Blake Aldrich who used the *SOTA* to provide service and support for a customer's PM-465 machine. Aldrich, ¶4-11. At a minimum, *SOTA* shows the state-of-the-art before the '390 patent's priority date.

that “monitors the distance from a fixed point on the machine to a reference point” such as the ground surface. *Id.*, 36. The *SOTA* further confirms that the signal generated by grade slope wheel disclosed in *OMM* measures the deviation from a “predetermined setpoint value,” and that the PM-465 can make adjustments “to compensate for any deviations.” *Id.*

Regarding other state-of-the-art machines that have sensors near the side plates, U.S. Patent No. 4,186,968 to Barton (“*Barton*”; Ex. 1023) describes a road-milling machine with a sensing ski near the side plate that runs along the ground, and a control system that uses data from that ski sensor to position the rotor drum (“planing cylinder 50”). *Barton*, 9:48-61. Additionally, U.S. Patent No. 4,270,801 to Swisher (“*Swisher*”; Ex. 1024) discloses two side plates (“skid plate 610” and “skid plate 630”) on a road-milling machine and components that travel along the ground, as well as a mechanical sensing system associated with the side plates that the machine uses to determine the “desired depth of cut.” *Swisher*, 38:27-41:20. The state-of-the-art even suggests that *the side plate itself* can be used as a grade sensing apparatus on a road-milling machine. *SOTA*, 15 (explaining that the contacting grade position sensor on the PM-465 “*can be actuated*” by a “*side plate of the machine*”) (emphasis added).

A POSITA viewing the prior art would have been motivated to consider different ways to use side plates as ground sensors in milling machines. Singhose,

¶76. Upon seeing the disclosures in *Samuelson*, a POSITA would have been further motivated to incorporate sensor-integrated cylinders into the side plates and to use those side plates as sensors by having the sensor-integrated cylinders monitor the extent to which the side plate moves up and down as it traverses the ground. *Id.* It would have been obvious to a POSITA to make this modification on the PM-465 machine described in *OMM. Id.*

A POSITA would have known that an externally mounted mechanical sensor such as the PM-465's grade slope wheel is exposed to the environment. Such sensors can be damaged by debris generated during milling and other obstacles in the surrounding environment. Singhose, ¶77; Netka, ¶35. As *Zarniko* explains, a "mechanical sensor for sensing the road surfacing can easily be damaged under the rough conditions which normally exist in road repair work." *Zarniko*, 1:23-45. That said, *Zarniko* still concludes that mechanical sensors are preferable over non-contact sensors such as ultrasonic sensors because ultrasonic sensors can be compromised "by the temperature, flow and humidity of the ambient air, by the operating voltage, [and] by the momentary atmospheric pressure." *Id.*, 1:52-68; Netka, ¶35; Singhose, ¶77.

Samuelson solves these problems identified in *Zarniko* by disclosing *robust* mechanical sensors—*Samuelson*'s transducer sensor is *inside* the hydraulic cylinder, and is thus protected "from damage and environmental degradation."

Samuelson, 1:45-49; *see also id.*, 4:48-52. Moreover, the PM-465 was already primed to receive *Samuelson*'s design—*OMM* shows that each side plate on the PM-465 has two existing side-plate cylinders that raise and lower the side plate. *OMM*, 40, 49, 59 (showing two cylinders on each PM-465 side plate and describing "Raise/Lower" commands for the side plates). A POSITA would have been motivated to replace the PM-465's existing side-plate cylinders with sensor-integrated cylinders like *Samuelson*'s, and then use those sensor-integrated cylinders to measure each side plate's elevation as it travels along the ground in float mode. Singhose, ¶78.

In this scenario, the side-plate sensing apparatus would be used similar to the grade slope wheel in the PM-465—i.e., signals on ground position would be sent to the grade-and-slope controllers and used to position the rotor drum during milling by moving the machine's legs. In view of the prior art (especially *Zarniko*), however, a POSITA would have been motivated to use sensor-integrated cylinders on the side-plates instead of the grade slope wheel because the sensor-integrated cylinder design is a *robust* design where the sensors are protected inside the hydraulic cylinders, and *OMM*'s grade slope wheel is susceptible to damage and wear. Singhose, ¶80. Moreover, because the PM-465 already has two hydraulic cylinders on each side plate and is programmed to process signals from a ground sensor in its grade-and-slope system, the framework is in place to add the sensor-

integrated cylinders to the side-plates as described above, and there would be a reasonable expectation of success with this modification. *Id.*

Further, *Samuelson* provides additional motivations to combine involving ripeness. *Samuelson* teaches that it was known to use linear transducers on hydraulic actuators in plant and industrial equipment but not on mobile construction equipment because of cost issues. *Samuelson*, 1:19-49. But eventually, controller technology “became more cost effective,” and it became easier to use transducers on hydraulic cylinders in mobile construction equipment, as well. *Id.* These *Samuelson* teachings did not become available until after PM-465 was designed. *Compare Samuelson* (original application filed Feb. 11, 2000) with *OMM* (January 1999 copyright date). A POSITA would have known to consider the technological advances in the art and to look for ways to improve the PM-465 machine’s design by implementing those advances (e.g., by using sensor-integrated hydraulic cylinders on the machine). *Singhose*, ¶81; *Leapfrog Enters. v. Fisher-Price, Inc.*, 485 F.3d 1157, 1161 (Fed. Cir. 2007) (explaining that “[a]pplying modern electronics to older mechanical devices has been commonplace in recent years” and that it would have been obvious to “[a]ccommodat[e] a prior art mechanical device” in “modern electronics”).

A POSITA would have also recognized that the sensor-integrated cylinder side-plate modification would result in more accurate ground position measuring

and thus a more accurate milling profile. Singhose, ¶82. Replacing the existing side-plate cylinders on each PM-465 side plate with sensor-integrated cylinders would allow the resultant design to accomplish grade-averaging, as known in the art, which would minimize the variation caused by readings taken by *a single sensor*. Singhose, ¶82; U.S. Patent No. 4,140,420 at 10:22-38 (“Swisher 420”) (describing calculating an average between two elevations sensed by two elevation sensors on a road-milling machine). Under the designs described in *OMM*, there is only one grade sensor on each side of the machine, so minor undulations in the ground surface could cause the machine to make overreactive height adjustments. Singhose, ¶83. A POSITA would recognize that two sensor measurements in the direction of milling would allow the machine to take the average of the two measurements (the grade average) and to base height-adjustment off that average measurement. *Id.* This would minimize overreactive height adjustments and provide for more accurate milling. *Id.*

Further, using sensor-integrated cylinders as described eliminates the potential error caused by humans positioning grade sensors on the machine before milling. *OMM* instructs the operator to “position the sensors as close to the centerline of the rotor for the most accurate cut.” *OMM*, 52; *see also id.*, 48. A POSITA would recognize that *Samuelson*’s sensor-integrated cylinders would replace the two standard cylinders on each side plate and would, therefore, reside

at fixed locations on each side plate. Singhose, ¶84. This would eliminate variability resulting from poor sensor placement—i.e., rather than relying on an operator to place a sensor, the PM-465’s control system would know the position of milling rotor’s centerline relative to the two sensor-integrated cylinders on the side plates (through simple geometry), which means a grade-averaged value factoring in the centerline of the machine could be used in Caterpillar’s proposed combination. Singhose, ¶84. For these reasons, it would have been obvious to replace the two existing side-plate cylinders on each PM-465 side plate with sensor-integrated cylinders, to use the built-in sensors to measure the vertical position of the side plate as the side plate travels along the ground, and to have grade-and-slope controllers use the information from the sensors to properly position the rotor drum while milling. *Id.*

b. Motivations to Use Sensor-Integrated Cylinders on the Moldboard

Next, a POSITA would have been motivated to use sensor-integrated cylinders like *Samuelson*’s on the PM-465’s moldboard (i.e., stripping plate), either when designing a machine anew or by retrofitting the cylinders as described in *Samuelson*. Singhose, ¶87; *Samuelson*, 1:54-63, 4:58-62. Ordinarily during milling, the material milled from the road surface remains trapped by the side plates and moldboard within the drum housing so the material can be loaded onto

the milling machine's conveyor belt and moved to a dump truck for removal. Netka, ¶36. But sometimes (e.g., when milling country roads), it is desirable to leave the milled material in place, mix it with additional materials, and use it to form a base onto which new asphalt is laid. *Id.* In these situations, the moldboard must be raised so that the milled material is left in place and *graded* by the moldboard rather than scraped away. *Id.*

OMM's "In Place Milling" feature performs this type of milling. *OMM*, 58. The operator uses chains to "chain up" the moldboard at a fixed height above the milled surface, which "prevent[s] material from building up in the milling housing." *Id.* A POSITA would have recognized, however, that it is burdensome and time-intensive to physically affix chains to the moldboard. Singhose, ¶88; Netka, ¶37. A POSITA would have further recognized that *OMM*'s chain design has limitations in that the moldboard could only be held by the chains at fixed positions, making it more difficult to accurately grade the "in place" milled material. Singhose, ¶88; Netka, ¶37. Therefore, a POSITA would have been motivated to find a more precise, efficient, and less cumbersome way to hold the moldboard above the milled surface while performing "in place" milling. Singhose, ¶88.

The PM-465's moldboard already had two hydraulic cylinders that raise and lower the moldboard. *OMM*, 60, 38. A POSITA would have been motivated to

replace these cylinders with *Samuelson*'s sensor-integrated cylinders and would have had a reasonable expectation of success in making this modification.

Singhose, ¶89. Doing so would have allowed the operator to *automatically* raise the moldboard to varying and precise heights, and to use the control system to *automatically* keep the moldboard at the desired elevation during milling, eliminating the time-intensive and cumbersome step of manually affixing chains to the moldboard. *Id.* The operator would no longer be confined to setting the moldboard at a fixed position dictated by the chains and could grade the milled material accurately. *Id.*

**c. Motivations to Use Sensor-Integrated Cylinders
Inside the PM-465's Legs**

A POSITA would have been further motivated to add sensor-integrated cylinders like *Samuelson*'s to the legs of the PM-465 machine, either when designing a machine anew or by retrofitting the cylinders as described in *Samuelson*. Singhose, ¶90; *Samuelson*, 1:54-63, 4:58-62. First, a POSITA would have known from *OMM* that the PM-465 had hydraulic cylinders inside all four legs. *See, e.g., OMM*, 32 (describing the “two front raise and lower solenoids on the front hydraulic manifold” that each control one of the front legs’ hydraulic cylinders and the “rear raise and lower solenoid on the rear hydraulic manifold” that controls the hydraulically coupled hydraulic cylinders in the two rear legs);

Singhose, ¶90; *see also* *SOTA*, 7, 39-40 (describing “front raise” and “front lower” solenoids that “control the hydraulic flow” to the front legs, and “rear raise” and “rear lower” solenoids that control “the hydraulic flow to the rear legs,” which “move simultaneously” because they are hydraulically coupled).

Next, *OMM* describes a “[s]ervice height sensor” that detects when the PM-465’s legs have extended enough to raise the machine to service height. *OMM*, 66, 108. *OMM* further describes “sensors at the right-rear corner of the engine compartment” that “are used to sense the elevation of the rear legs.” *Id.*, 112 (showing proximity sensor/switch for detecting the presence of a lifting column component within its sensor field); Netka, ¶38; Singhose, ¶91. Thus, the PM-465 is already equipped to process leg position signals. Singhose, ¶91.

OMM recognizes, however, that the operability of the PM-465’s leg-elevation sensors can be compromised by dust and debris, and they thus require cleaning. *OMM*, 109, 112; Netka, ¶38. Given this, a POSITA would have been motivated to find more robust leg-sensor designs requiring less maintenance. Singhose, ¶91.

Samuelson provides a solution. Its sensor components are inside the hydraulic cylinder, so there is “very little chance” of damage. *Samuelson*, 4:48-57; *id.*, 1:45-49. A POSITA would have been motivated to modify the PM-465’s design by using sensor-integrated cylinders like *Samuelson*’s in the legs instead of

the PM-465's existing leg sensors, which require extensive cleaning. Singhose, ¶92. Notably, the PM-465—like virtually all road-milling machines—already uses hydraulic cylinders to raise/lower the legs. A POSITA would have had a reasonable expectation of success in replacing the existing leg cylinders with sensor-integrated cylinders. *Id.*

Indeed, it was known before the '390 patent's priority date to use leg sensors on the front and rear legs of a road-milling machine. The Roadtec RX-500 had this feature in 2003. Ex. 1052, ROADTEC000192-211 (parts manual dated 2003 showing that RX-500 had leg sensors and display values associated with those sensors on the operator console); Singhose, ¶94; Ex. 1053, ROADTEC000017-18 (electrical schematic showing electrical connection between leg sensors and console display values). [REDACTED]. The RX-500's leg sensors and the values associated with them shown on the display panel could be used by the operator when calibrating the sensors before milling and to position the machine frame parallel to the ground from left to right *and front to back*. [REDACTED]

[REDACTED]
[REDACTED]; *see also* [REDACTED]

[REDACTED]. A POSITA's knowledge of the RX-500 would have further motivated them to use sensor-integrated cylinders like *Samuelson's* on the front and rear legs of the PM-465 machine described in *OMM*. Singhose, ¶¶94-95.

Moreover, a POSITA would have known that (and had a reasonable expectation of success in) implementing sensor-integrated cylinders in all four legs would have allowed for sensed leg-elevation adjustments to both the front and the rear of the machine, which, in turn, would allow the operator to manually or automatically hold the machine's frame parallel to the ground in the direction of travel. Singhose, ¶97. A motivation for holding a road-milling machine frame parallel to ground is provided in U.S. Patent No. 5,309,407 to Sehr ("*Sehr*"; Ex. 1037). This reference discloses ultrasonic sensors placed down the side of a road-milling machine lengthwise that produce signals used to calculate an "average distance" to a reference plane (e.g., the ground). *Sehr*, Fig. 1, 2:23-43. Sehr explains that its control system uses the sensed information to adjust the front and rear legs to control "parallelism." *Sehr*, 3:45-65 (explaining that *Sehr*'s control system "facilitates the work of the operator" by "holding the road grooving machine in a parallel position"); *see also* Ex. 1059 (JPA-1991-276889), 2 (recognizing benefits of keeping a large piece of mobile machinery parallel "relative to the crawlers"). A POSITA would have known that keeping a road-milling machine's frame parallel to the ground promotes machine stability and operator comfort while milling (as compared to a milling operation where the front

of the machine was either nose-up or nose-down and more prone to tip over, especially on uneven terrain). Singhose, ¶¶97.²

The prior art would have also motivated a POSITA to use the leg sensors to position the machine frame parallel to a *horizontal plane* in the direction of travel. Ex. 1060 (JPA-1991-139408), 2 (recognizing benefits of keeping large mobile machinery horizontal). This orientation also promotes machine stability and operator comfort, especially when a machine is traversing hills. Singhose, ¶¶98-100.

Regarding stability, a POSITA would have understood that a road-milling machine can become unstable if the elevation between the front and rear legs differs too much, especially on uneven terrain. *See, e.g.*, Ex. 1057 (EP0940274), ¶¶0022-25 (recognizing that controlling the extension of the legs on a milling machine can prevent instability); Ex. 1058 (U.S. Pat. No. 7,828,309), 2:4-12, 3:1-9 (explaining that failing to properly control the extension of legs on milling machines can be “detrimental to the stability of these machines”). A POSITA would have been motivated to solve this problem by using sensor-integrated

² As yet another motivation, a parallel-to-ground orientation promotes efficient milling by forcing the milled pavement up into the rotor housing and less into the unmilled pavement. Singhose, ¶¶97.

cylinders like *Samuelson's* in all four of the road-milling machine's legs so that the extension/retraction of each leg be measured, and the machine can be stabilized by keeping the legs at elevations where the machine frame is parallel to the ground (from front to back) or a horizontal plane (from front to back). Singhose, ¶100.

A POSITA would have known that using leg sensors in all four legs to achieve the parallelisms and stability described above provides a more robust and accurate control system as compared to other options (e.g., the *Sehr* system, which relies on less reliable ultrasonic sensors). Singhose, ¶99. A POSITA would have known that after the operator performs the pre-milling calibration function where the rotor is brought down to the ground and the sensors are calibrated, the machine can begin operation and the controller can compare the values from all four leg sensors to the calibration values and continually position the machine frame at the desired parallel orientation, maximizing the stability of the machine (even on uneven terrain). Singhose, ¶55, 100-101.

4. Claim-by-Claim Analysis

a. Independent Claim 1

i. [1pre]: “A self-propelled road milling machine, comprising:”

OMM discloses this. See *OMM*, 2 (“This machine is equipped with a 3406 diesel engine.”); *id.*, 27 (describing “lever” that the operator uses to move the machine in forward and reverse); Singhose, ¶102.

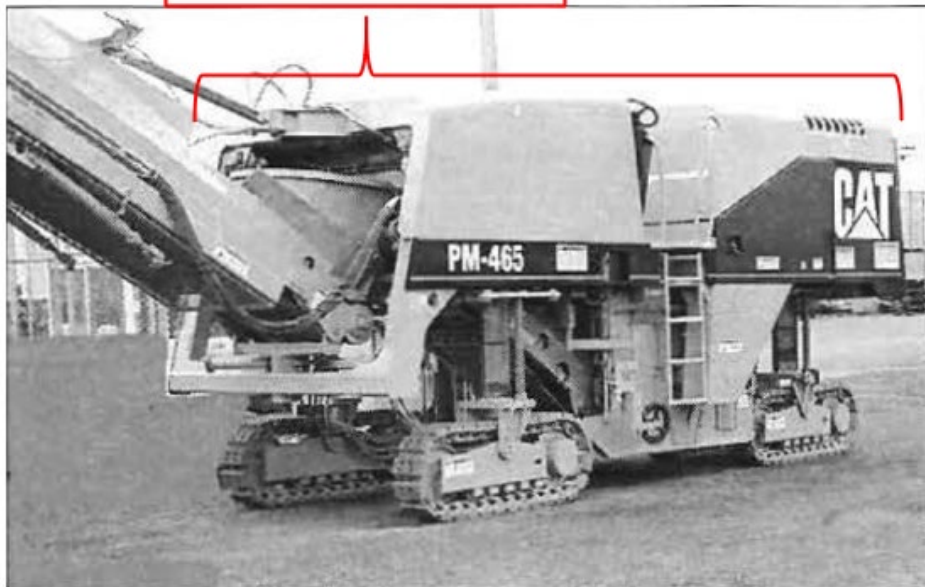


OMM, 2.

ii. [1a]: “a machine frame;”

OMM discloses a machine frame.

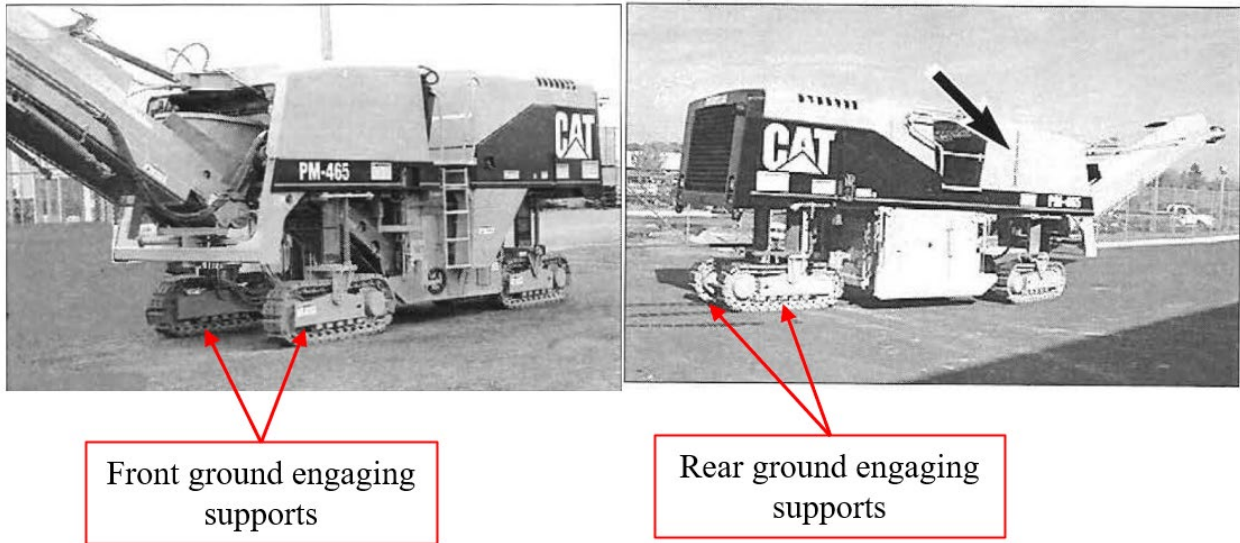
Machine frame



OMM, 2 (annotated); *see also id.*, 8 (“Raise the mainframe to the full UP position and install all four leg supports.”).

- iii. [1b]: “at least two front ground engaging supports, and at least one rear ground engaging support;”

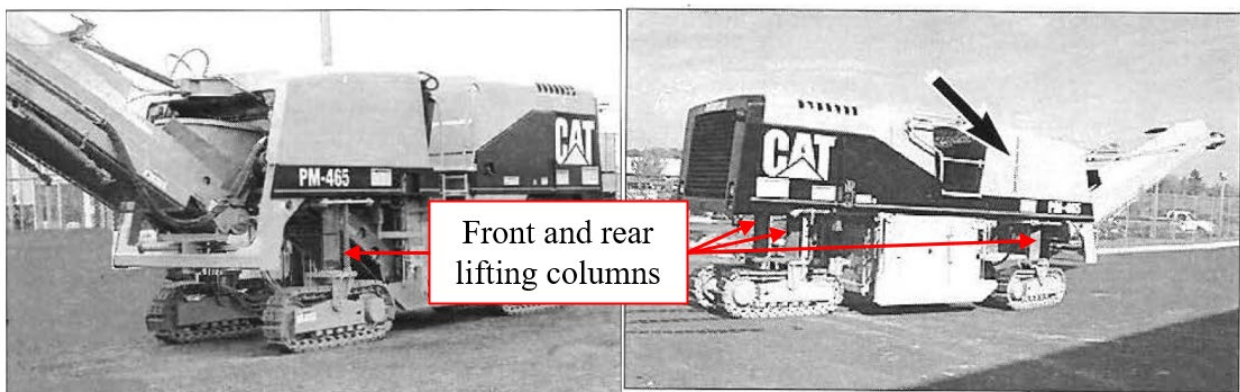
OMM discloses this. Singhose, ¶104. Specifically, *OMM* discloses two front tracks and two rear tracks (i.e., “ground engaging supports”) that support the PM-465, as shown below:



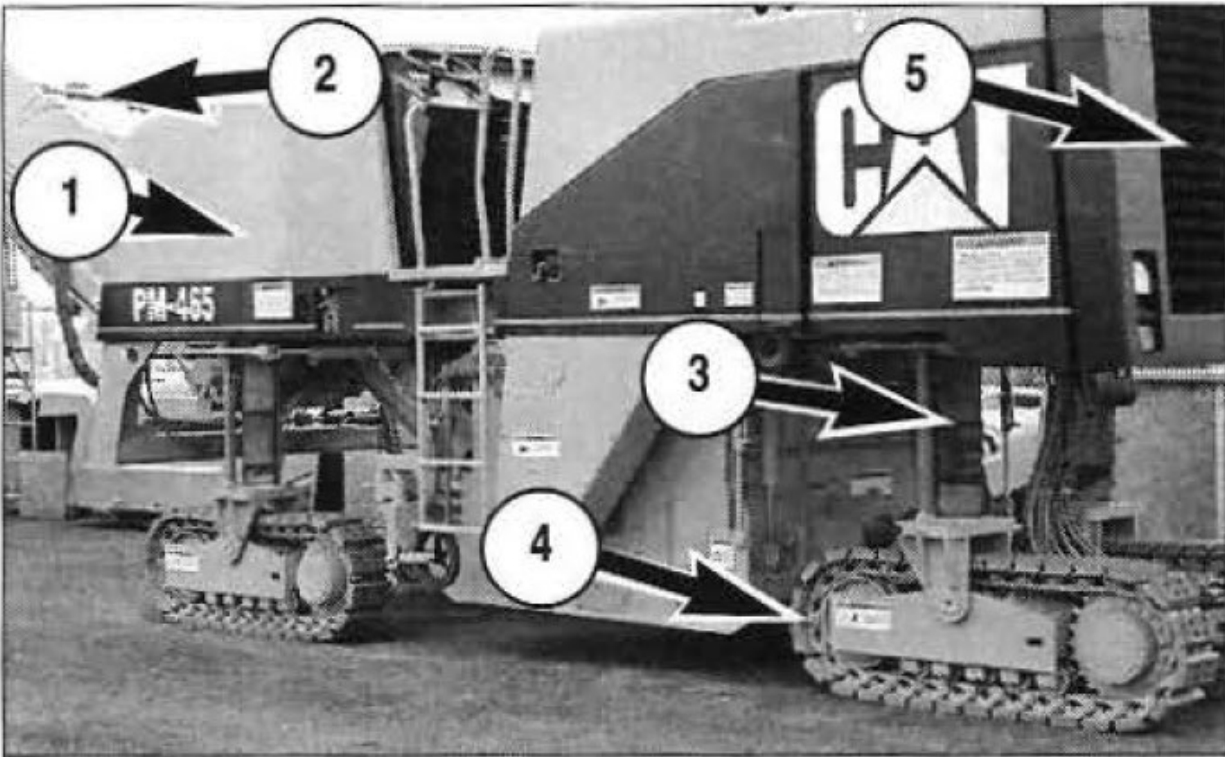
OMM, 2 and 40 (annotated); *id.*, 29 (referring to “front tracks” and “rear tracks”).

iv. [1c]: “front and rear lifting columns supporting the frame from the ground engaging supports;”

OMM discloses this. Singhose, ¶105. Specifically, *OMM* discloses four legs (i.e., “lifting columns”)—two that support the PM-465’s frame from the front tracks and two that support the frame from the rear tracks.



OMM, 2 and 40 (annotated); *id.*, 30-31 (describing raising and lowering the legs).

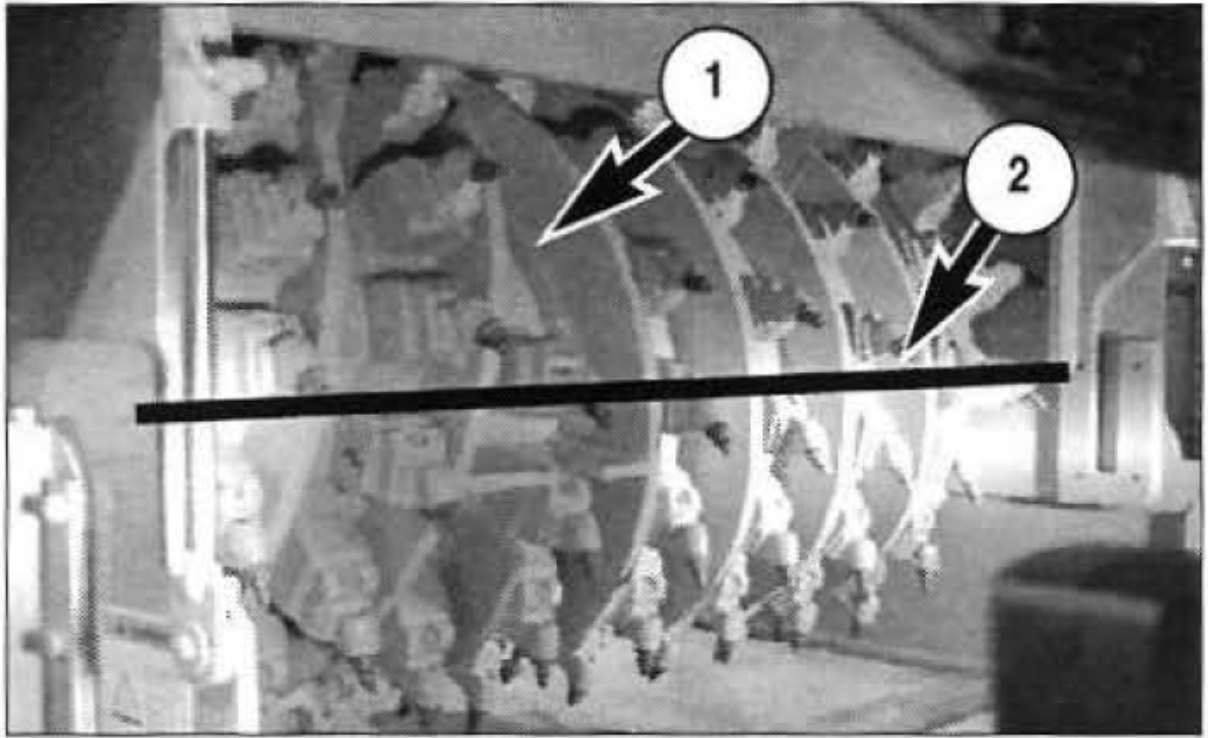


Water tank (1), second stage conveyor (2), leg (3), track (4), and radiator (5).

Id., 14 (annotated).

- v. [1d]: “a milling roller supported from the frame for treatment of a ground surface;”

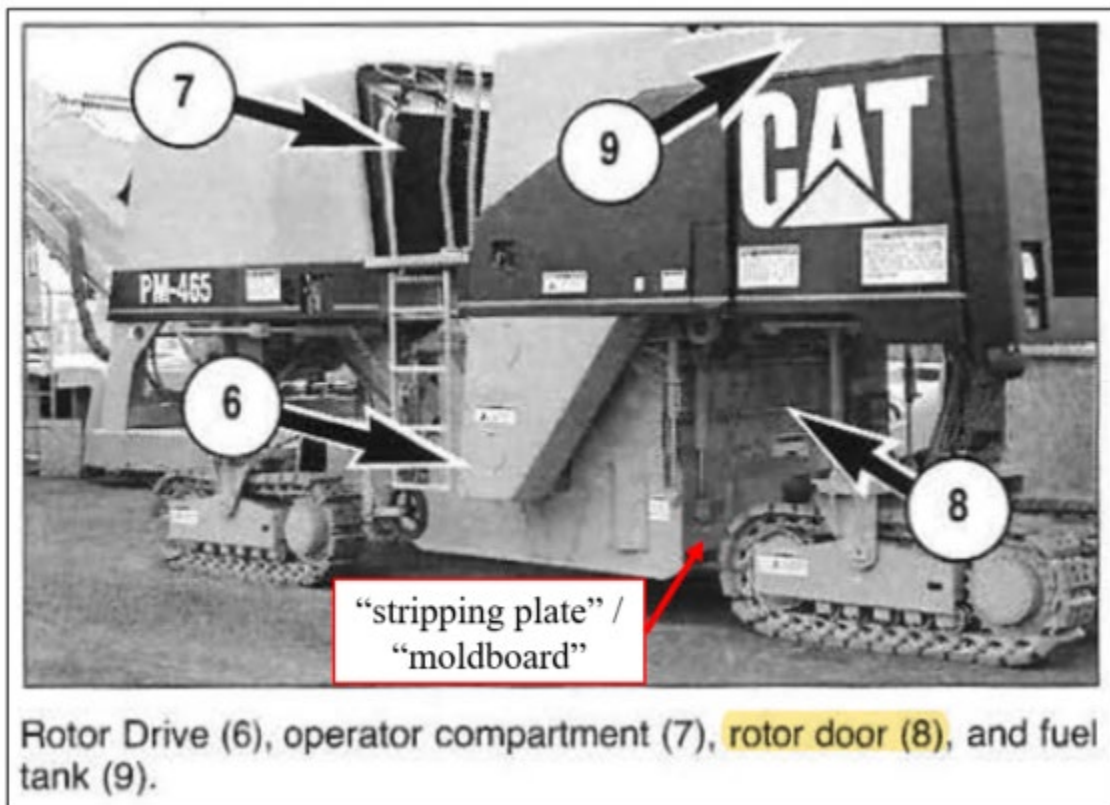
OMM discloses this. Singhose, ¶¶107-8. Specifically, *OMM* discloses a rotor drum (i.e., “milling roller”) that is supported from the frame and that is used to treat a ground surface:



OMM, 134; *id.*, 117 (showing that “Support Bearing” for “Rotor Drum” is connected to machine frame); *id.*, 32 (explaining that the machine attains its “desired surface profile” by moving the legs); *id.*, 51 (explaining details of the “rotor bits” being used to “cut[] asphalt”); *id.*, 12, 111.

- vi. [1e]: “a height adjustable stripping plate arranged behind the milling roller and operable to be lowered, during operation, into a milling track generated by the milling roller;”

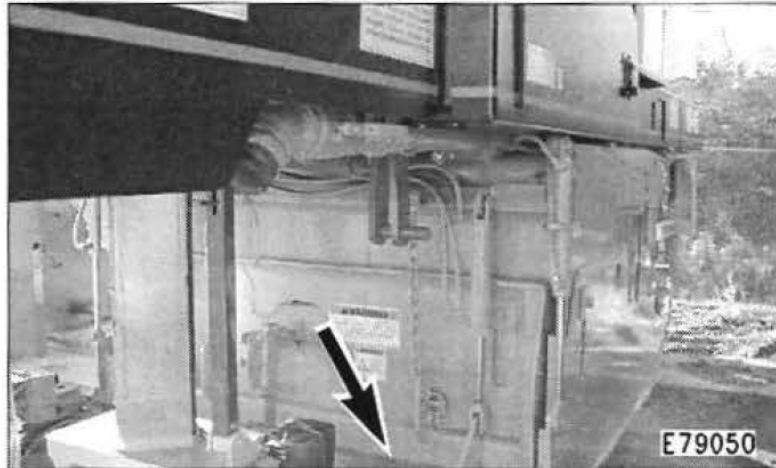
OMM discloses this. Singhose, ¶109-11. Specifically, *OMM* discloses a moldboard (i.e., “height-adjustable stripping plate”), which is the bottom portion of the rotor door.



OMM, 14 (annotated).

Moldboard Blade

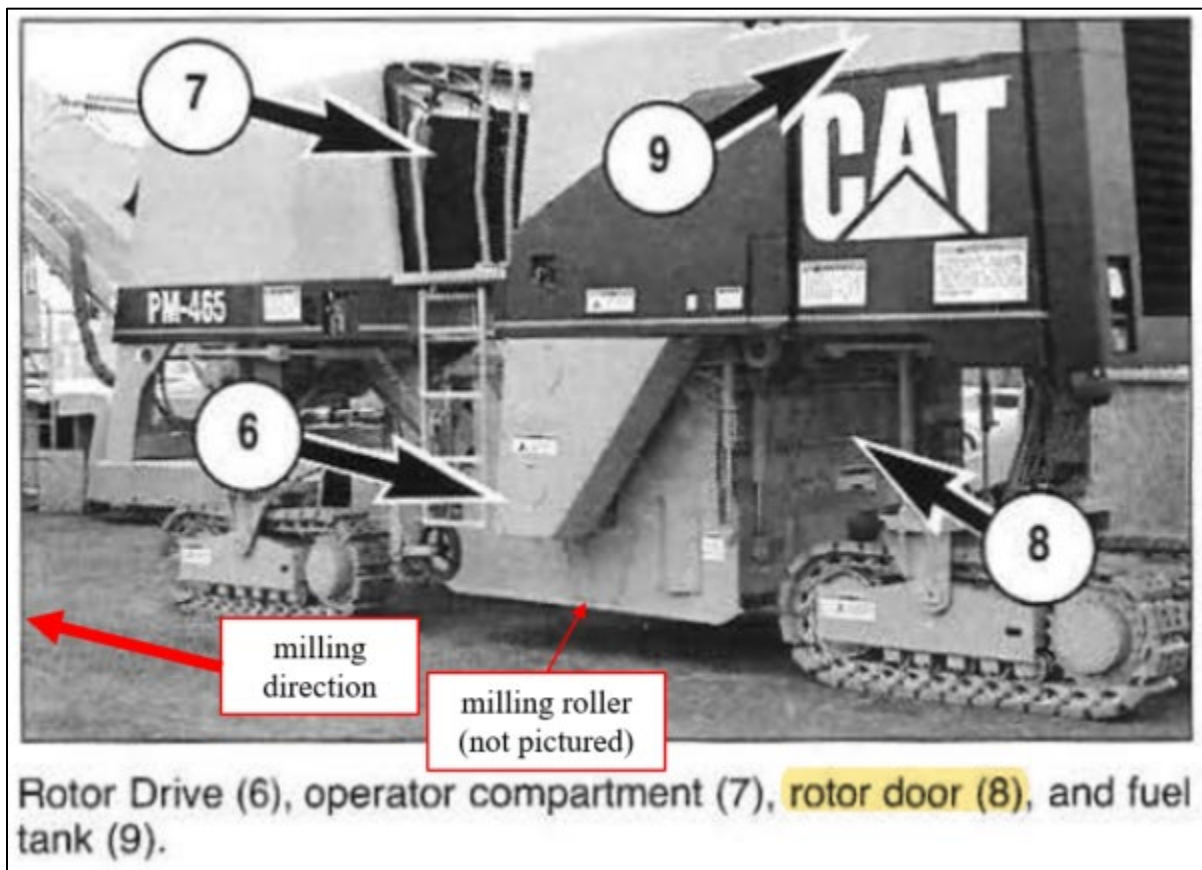
Inspect



1. The moldboard, cutting edge blade and wear plates should be checked for excessive wear and for loose connecting bolts. Tighten any loose bolts.

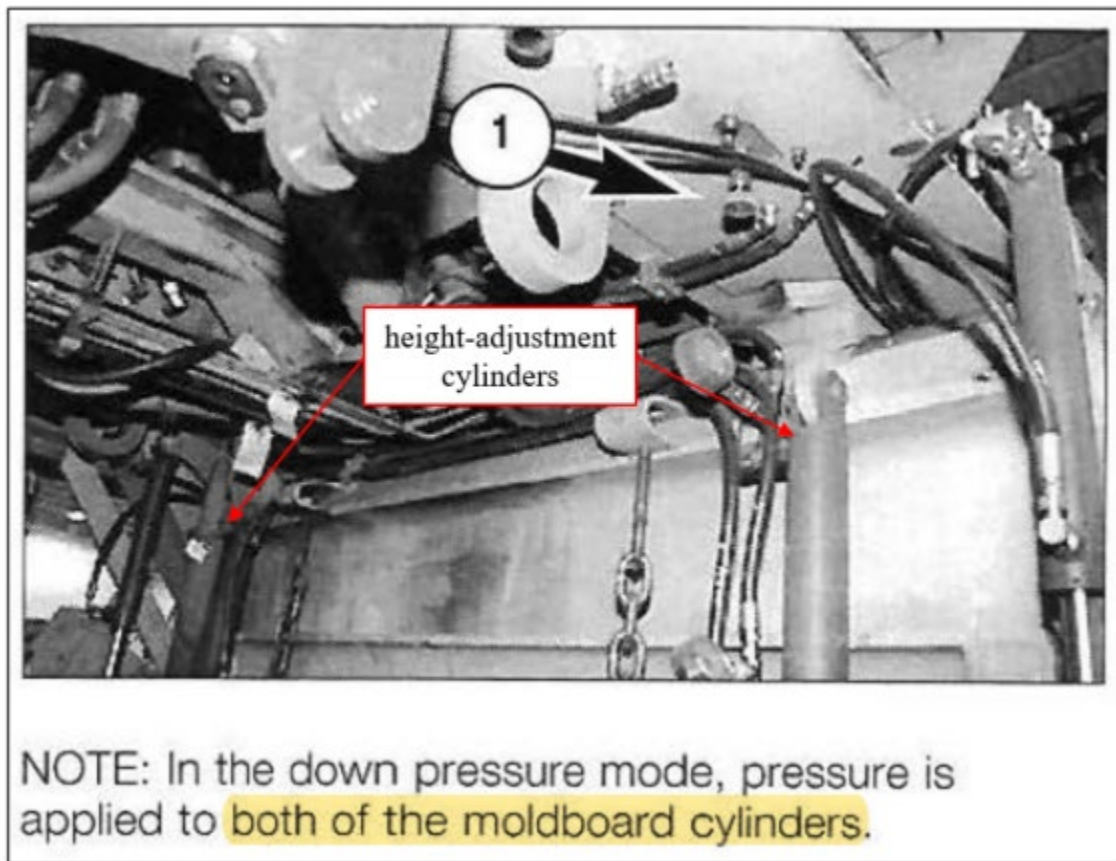
Id., 118.

The moldboard is located behind the milling roller (relative to the milling direction):



OMM, 14 (annotated).

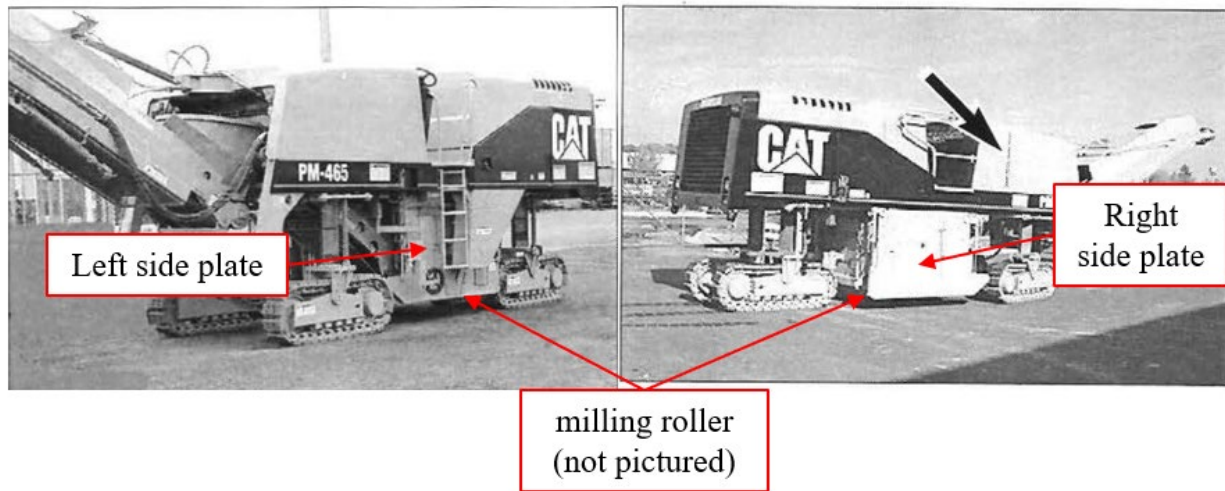
OMM further discloses that the moldboard is operable to be lowered during milling operations into a milling track generated by the milling roller. *Id.*, 38 (“The moldboard control consists of a selector switch for manual or automatic control, three raise/lower switches that control the height of the moldboard, and a down pressure adjustment knob that controls the amount of down pressure on the moldboard in the automatic mode.”).



Id., 60 (annotated). A primary purpose of the moldboard is to scrape away the milled material generated by the milling drum during milling operations. *Id.* (“If the moldboard leaves rubble behind, the down pressure can be adjusted upward.”). Netka, ¶36.

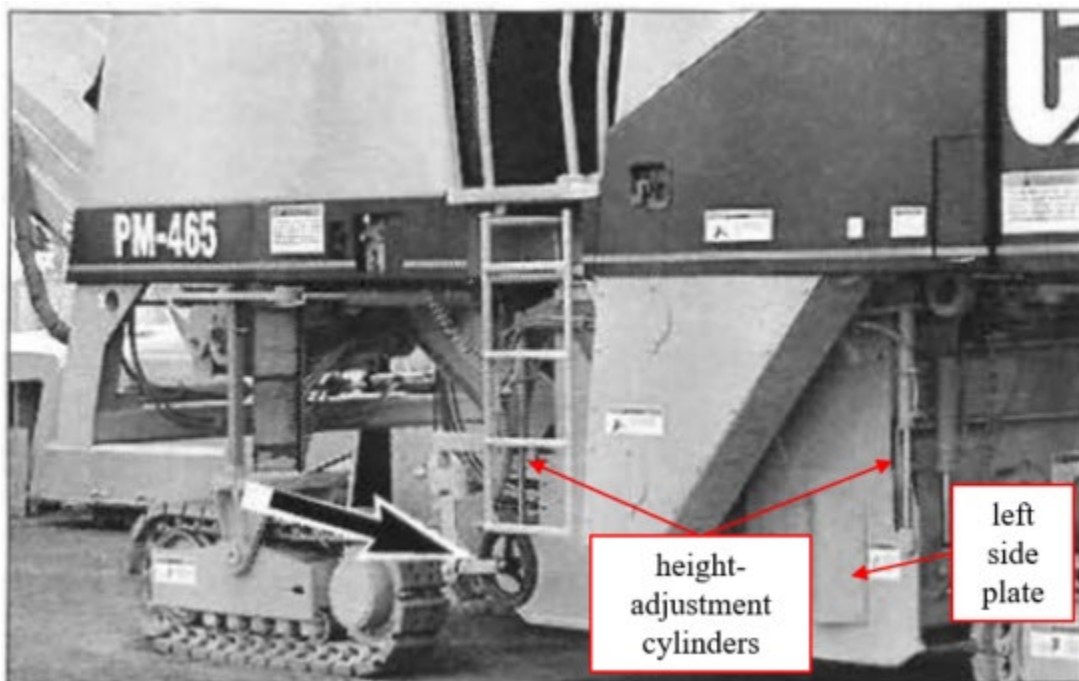
- vii. [1f]: “first and second height adjustable side plates arranged on opposite sides of the milling roller; and”

OMM discloses this. Singhose, ¶112-14.

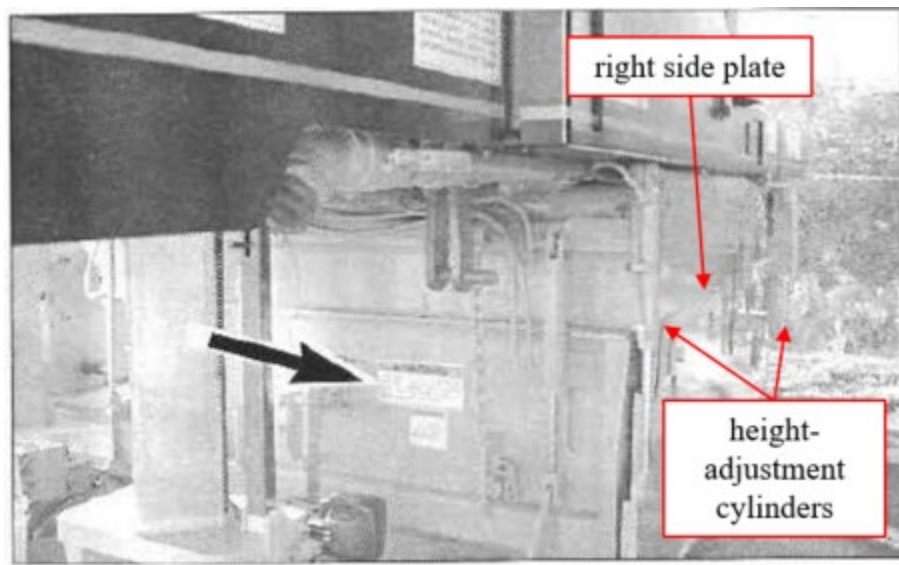


OMM, 2, 40 (annotated).

These side plates are height-adjustable via two hydraulic, height-adjustment cylinders on each side plate.



Id., 49 (annotated).



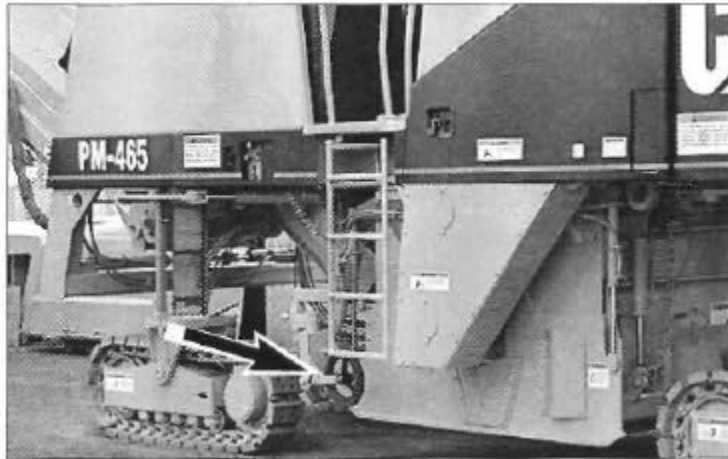
Id., 59 (annotated).

The side-plate cylinders allow the operator to raise/lower the side plates vertically. *Id.*, 40 (describing “Side Plate Raise/Lower Valve” and switches used to “raise” and “lower” the side plates).

- viii. [1g]: “a plurality of position sensors, each of the first and second side plates including at least two of the position sensors spaced apart in a traveling direction of the milling machine, wherein each position sensor generates position signals representing changes in position for a respective side plate.”

OMM in view of *Samuelson* teaches this. Singhose, ¶¶115-20. *OMM* discloses various “position sensors,” including grade sensors (contacting or noncontacting) on both sides of the machine that generate position signals representing the distance between the milling machine and the ground. *OMM*, 32,

48-49. Regarding the contacting sensors, *OMM* discloses the “grade slope wheel,” positioned near the side plate:



Id., 49; *id.*, 2, 62. The grade slope wheel obtains information on ground elevation as it rolls along the ground. *Id.*, 48-49. The noncontacting sensor can be “a sonic sensor” that “uses sound waves to monitor the distance” to the ground. *Id.* The ground position information obtained by the PM-465’s grade sensors is used by the machine’s grade-and-slope system to ensure the milling roller is actually milling at the desired elevation. *OMM*, 32, 48-49.

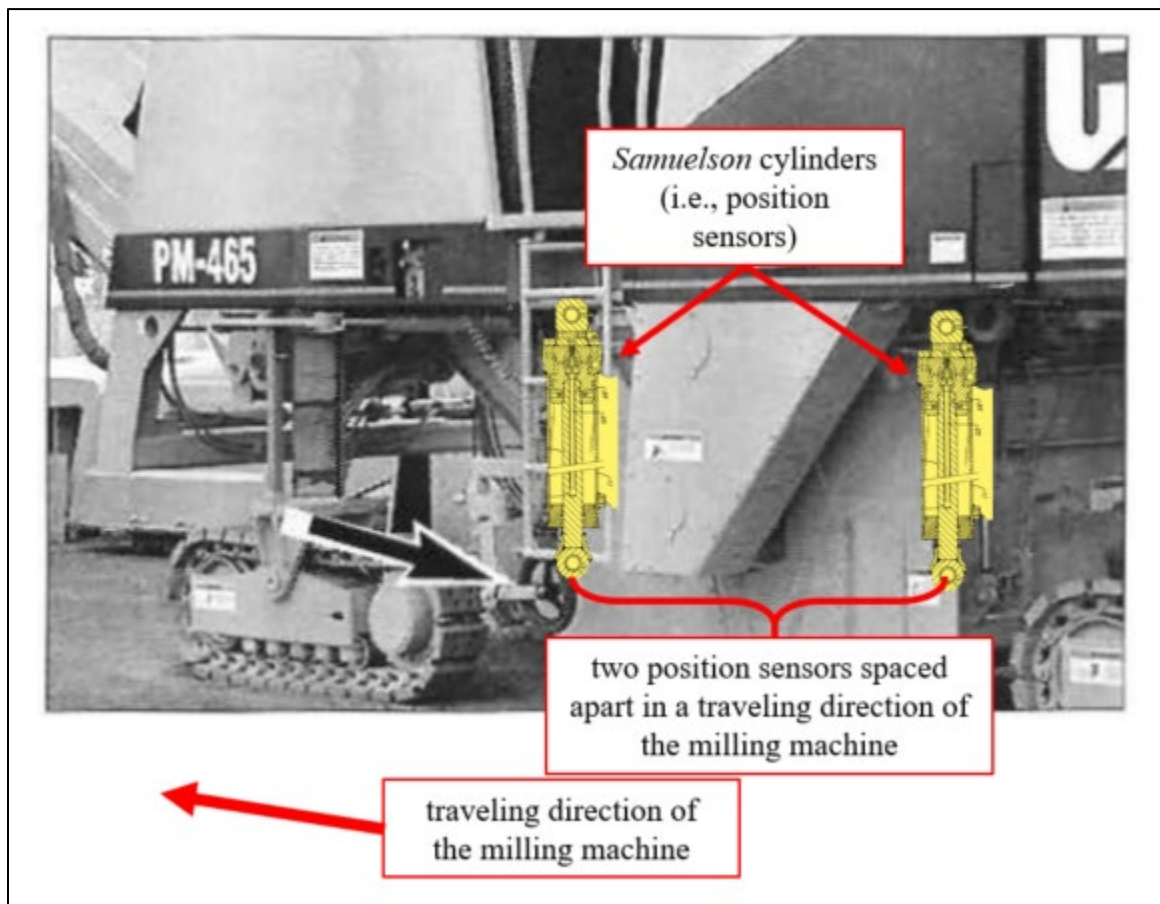
As described in Section VI.A.3, a POSITA would have been motivated to consider different grade sensors that were not grade slope wheels or ultrasonic sensors. The prior art explained that mechanical wheel sensors (like the grade slope wheel) were “easily . . . damaged under the rough conditions which normally exist in road repair work.” *Zarniko*, 1:23-45. And ultrasonic sensors were even more problematic because they were easily compromised “by the temperature, flow and

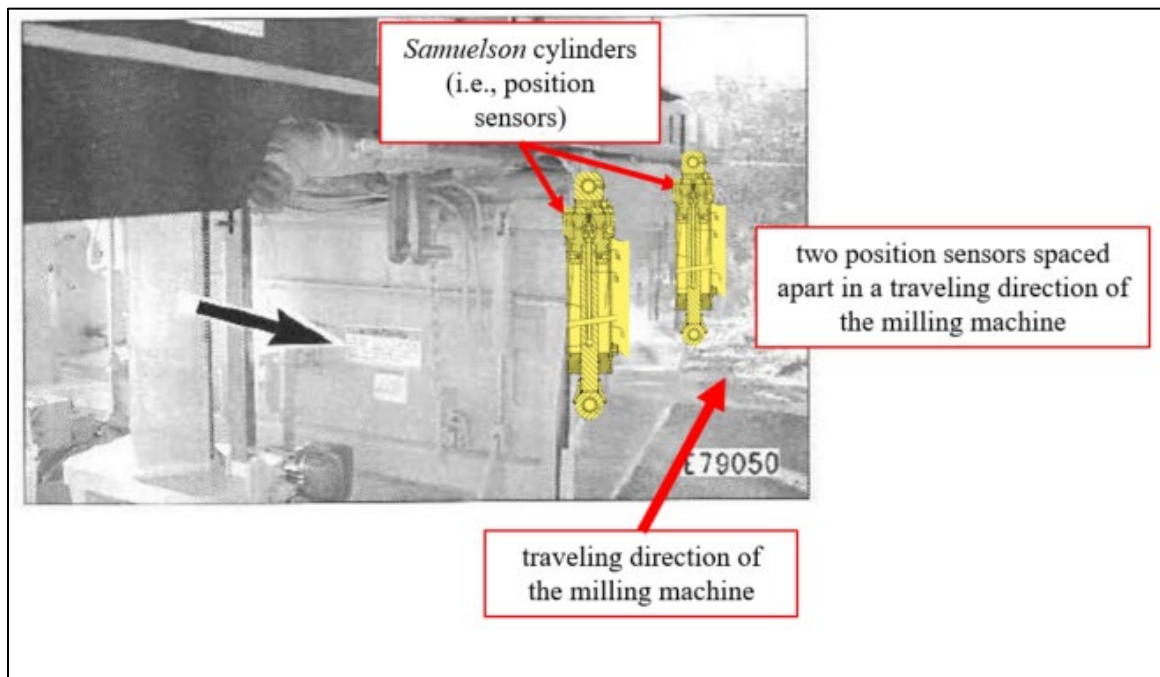
humidity of the ambient air, by the operating voltage, [and] by the momentary atmospheric pressure.” *Id.*, 1:52-68.

Samuelson solved this problem by disclosing its *robust* sensor-integrated cylinder, which could be easily incorporated onto the PM-465 machine’s side plates in a way that monitored ground position. *See* Section VI.A.2. As mentioned, it was well known in the art to use side plates and components attached on and around them as ground sensors. *See* Section VI.A.3; Singhose, ¶118; *OMM*, 32, 48-49; *Barton*, 9:48-61; *Swisher*, 38:27-41:20. The state-of-the-art even suggested using *the side plate itself* to actuate sensors used in a grade-and-slope control system. *SOTA*, 15 (explaining that a grade-position sensor can be “actuated by” the “side plate of the machine”).

Notably, the ’390 patent contemplates and claims approaches for “including” the position sensors in the side plates, which involve *attaching* sensors to the side plates. *See, e.g.*, Ex. 1001, 2:39-45 (“[T]he measuring means may comprise cable lines coupled with the side plates[.]”); 5:36-40 (explaining that the “side plates 10 themselves can be used as first sensor means by monitoring their position” with “piston/cylinder units 30, 32” that have “integrated position sensing means”); claim 3 (“wherein the plurality of position sensors are integrated with the hydraulic piston/cylinder units for lifting or lowering the respective side plates”).

The PM-465 already included two hydraulic cylinders on each side plate. See Section VI.A.4.a.vii. A POSITA would have been motivated to replace these hydraulic cylinders with robust sensor-integrated cylinders like *Samuelson's*, as shown below.





Because the sensor-integrated cylinders in Caterpillar’s modified machine are included on the side plates, they constitute “a plurality of position sensors” (on the side plates) that are “spaced apart in a traveling direction of the milling machine,” as required by limitation [1g]. Singhose, ¶119.

A POSITA would have been motivated to make this sensor-integrated cylinder modification because it provides for a *robust* ground sensing device that *directly contacts the ground*. See Section VI.A.3. That is, the in-cylinder position sensors would continuously measure the side plates’ changes in vertical position as the side plates float along the ground. *Id.* Thus, under the modified design, the sensor-integrated cylinders are “position sensor[s]” that “generate[] position signals representing changes in position for a respective side plate.” Singhose,

¶120. The grade-and-slope controllers already on the PM-465 would then process the side-plate position signals and ensure that the rotor drum is actually milling at the depth set by the operator. A POSITA would be even further motivated to make this proposed modification because it would allow for more accurate sensing through grade averaging, since there are two sensor locations on each side plate instead of one. *See* Section VI.A.3. In sum, *OMM* in combination with *Samuelson* discloses limitation [1g] and renders it obvious.

- b. Claim 2: “The self-propelled road milling machine of claim 1, further comprising a controller operably associated with the position sensors and configured to measure, based at least in part on the position signals from the position sensors, displacement of the side plates with respect to the machine frame.”**

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 1. *See* Section VI.A.4.a. Next, the combination also teaches the additional limitations in claim 2. Singhose, ¶¶121-22. In particular, *OMM* discloses a grade-and-slope control system having a controller that continuously receives information on ground position from the PM-465’s grade sensors. *OMM*, 32, 48-49. Based on the information the controller receives from the sensors, it positions the rotor drum at the milling depth preset by the operator. *OMM*, 32, 48-49; *see* Sections, VI.A.1, VI.A.3.

Under the *OMM/Samuelson* combination, the two sensor-integrated cylinders included on each of the two side plates measure the vertical displacement of the side plates relative to the machine frame as the side plates traverse the ground in float mode and move up and down (relative to the machine frame). *See* Sections VI.A.3 and VI.A.1; Singhose, ¶122. Thus, the sensor-integrated cylinders (“position sensors”) on the side plates of the combined machine generate “position signals” indicative of the “displacement of the side plates with respect to the machine frame,” which are then processed and measured by the PM-465’s controller, as required by claim 2. The controller uses these side-plate displacement signals (which would be grade averaged as described above in Section VI.A.3.a) to position the milling roller at the milling depth preset by the operator. *Id.*

Accordingly claim 2 is obvious in view of *OMM* and *Samuelson*.

- c. **Claim 3: “The self-propelled road milling machine of claim 2, wherein the plurality of position sensors are integrated with hydraulic piston/cylinder units for lifting or lowering the respective side plates.”**

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 2. *See* Sections VI.A.4.a-b. Next, the combination also teaches the additional limitations in claim 3. Singhose, ¶123. In particular, the four sensor-integrated cylinders that Caterpillar relies on in its *OMM/Samuelson* combination have transducers, or sensors (“plurality of position sensors”) that measure the extension

and retraction of the two hydraulic cylinders on each side plate. *See* Sections VI.A.2-3; Singhose, ¶123. These same sensor-integrated cylinders serve the additional purpose of “lifting and lowering” the side plates on the PM-465 machine (i.e., two sensor-integrated cylinders lift and lower the left side plate, and two lift and lower the right side plate). *See* Sections VI.A.2-3. A POSITA would have been motivated to use the sensors in the sensor-integrated cylinders to measure the PM-465’s side plate position as the sensor-integrated cylinders lift and lower the side plates relative to the machine frame. *See* Section VI.A.2-3. Thus, the *OMM/Samuelson* combination discloses a “plurality of position sensors” that are “integrated with hydraulic piston/cylinder units for lifting or lowering the respective side plates,” as required by claim 3. *See* Sections VI.A.1-3.

d. Claim 4: “The self-propelled road milling machine of claim 2, wherein the controller is configured to control the milling depth of the milling roller by generating control signals to vertically adjust one or more of the lifting columns.”

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 2. *See* Sections VI.A.4.a-b. Next, the combination also teaches the additional limitations in claim 4. Singhose, ¶¶124-25. *OMM* discloses a grade-and-slope system with a controller that receives information from various sensors, including the grade sensors that measure the ground, and then positions the rotor drum at the correct milling depth by sending signals that move the machine’s legs. *OMM*, 32,

48-49; *id.*, 48 (“The sensors will detect and follow a string line, curb, etc., and the electronic control system makes adjustments to the heights of the legs to control the grade and slope of the cut surface.”).

Under the *OMM/Samuelson* combination, the sensor-integrated cylinders on the PM-465’s side plates would provide the side-plate position signals to the PM-465’s grade-and-slope control system. *See* Section VI.A.3. The PM-465’s control system would then process those signals and position the rotor drum in the correct location by moving the legs—just as it does now (but with more accuracy because of the improved ground sensing system). *Id.* Accordingly, the *OMM/Samuelson* combination discloses the “controller” of claim 2 (*see* Section VI.A.4.b) and further teaches that this controller is “configured to control the milling depth of the milling roller by generating control signals to vertically adjust one or more of the lifting columns.” Thus, claim 4 is obvious. *See* Section VI.A.3.

- e. **Claim 5: “The self-propelled road milling machine of claim 1, wherein the stripping plate comprises one or more position sensors configured to generate position signals representing changes in position for the stripping plate.”**

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 1. *See* Section VI.A.4.a. Next, the combination teaches the additional limitations in claim 5. Singhose, ¶¶126-28. Regarding claim 5’s requirement that the “stripping plate comprise[] one or more position sensors,” the ’390 patent

explains that an “integrated position sensing system” can be used on the hydraulic “piston/cylinder units” that lift/lower the stripping plate. Ex. 1001, 5:3-9.

Here, *OMM* discloses a moldboard (i.e., “stripping plate”) with two height-adjustable cylinders that raise and lower it. *See* Section VI.A.4.a.vi. A POSITA would have been motivated to replace these existing moldboard cylinders with sensor-integrated cylinders like *Samuelson*’s. *See* Section VI.A.3. Doing so would have allowed the POSITA to perform the “In Place Milling” feature, but with more accuracy and less burden. *OMM*, 58; Singhose, ¶128.

The “In Place Milling” operation is burdensome—it requires a human to affix chains to a raised moldboard that hold the moldboard in place at a fixed height above the milled surface. *OMM*, 58; *see* Section VI.A.3. A POSITA would have been motivated to find a better way to hold the moldboard above the milled surface. *See* Section VI.A.3. Replacing the two existing moldboard cylinders on the PM-465’s moldboard with sensor-integrated cylinders provides an obvious solution with a reasonable expectation of success and substantial benefits. Singhose, ¶89. Specifically, the sensor-integrated cylinders (“position sensors”) would produce signals representing changes to the moldboard’s vertical position (“position signals representing changes in position for the stripping plate”), and these signals would be sent to the controller. The controller would then process the signals, and the machine (or the operator) would measure the moldboard’s vertical

position relative to the machine frame and *automatically* raise the moldboard to *varying* and precise heights desired by the operator, *and then keep it there*. See Section VI.A.3.b. This would eliminate the need to perform the time-intensive and cumbersome step of manually affixing chains to the moldboard. *Id.* A POSITA would also have been motivated to position the moldboard at precise heights because doing so would improve the ability of the moldboard to effectively grade the material being left in place during milling (i.e., the recycled road base). *Id.* Accordingly, the *OMM/Samuelson* combination renders claim 5 obvious.

f. Claim 6: “The self-propelled road milling machine of claim 5, wherein the stripping plate further comprises one or more piston/cylinder units integrating the one or more position sensors.”

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 5. See Sections VI.A.4.a, VI.A.4.e. Next, the combination teaches the additional limitations in claim 6. Singhose, ¶129. As mentioned in Section VI.A.4.e, the two sensor-integrated hydraulic cylinders being used on the PM-465’s moldboard in the proposed *OMM/Samuelson* combination have internal “position sensors” that measure the extension and retraction of the hydraulic cylinders (and thus the vertical elevation of the moldboard). Thus, the *OMM/Samuelson* combination teaches a stripping plate having “one or more

piston/cylinder units” with “one or more position sensors” integrated. Accordingly, the *OMM/Samuelson* combination renders claim 6 obvious.

- g. Claim 8: “The self-propelled road milling machine of claim 1, wherein each of the lifting columns includes an integrated position sensor configured to directly detect a lifted condition of its associated lifting column.”**

OMM in view of *Samuelson* teaches this. First, this combination teaches claim 1. *See* Sections VI.A.4.a. Next, the combination teaches the additional limitations in claim 8. Singhose, ¶¶130-36. Specifically, *OMM* discloses four legs (i.e., “lifting columns”)—two in the front and two in the rear. *See* Section VI.A.4.a.iv. Moreover, each leg has an internal hydraulic cylinder that controls the extension and retraction of the leg. *See, e.g., OMM*, 32 (describing the “two front raise and lower solenoids on the front hydraulic manifold” that each control of the front legs’ hydraulic cylinders and the “rear raise and lower solenoid on the rear hydraulic manifold” that controls the hydraulically coupled hydraulic cylinders in the two rear legs); *see also* Section VI.A.3.c; Singhose, ¶130. A POSITA would have been motivated to use sensor-integrated cylinders like *Samuelson*’s inside all four of the PM-465’s legs instead of the existing leg cylinders. *See* Section VI.A.3. This modification would have allowed the PM-465 to measure the extension and retraction of the hydraulic cylinders in each leg, which would have allowed the machine to measure the extension and retraction of the legs themselves (i.e.,

“detect a lifted condition of [the] associated lifting column”), since the legs are fixed to and driven by the internal cylinders. Singhose, ¶131.

A POSITA would have had a reasonable expectation of success with this modification and known it would have improved the functionality of the machine. Singhose, ¶132. First, *OMM* describes a feature where sensors determine if the rear legs are in service height position. *OMM*, 66, 108; *see also id.*, 112. So the PM-465 is already equipped to process leg position signals. But *OMM* recognizes that the operation of the PM-465’s leg-elevation sensors can be compromised by dust and debris and require routine cleaning. *Id.*, 112; *see also id.*, 109. A POSITA would have been motivated to find more robust sensor designs. *See* Section VI.A.3.

Samuelson provides the solution. *See* Section VI.A.2. Because *Samuelson*’s sensor components are inside the hydraulic cylinder, there is “very little chance” of damage. *Samuelson*, 4:48-57, 1:45-49. A POSITA would have been motivated to modify the PM-465’s design by using robust sensor-integrated cylinders in the legs instead of the PM-465 leg elevation sensors described above. This modification would have been simple—the PM-465 already had hydraulic cylinders that raise and lower the legs, and it would have been obvious for a POSITA to replace them with sensor-integrated cylinders like *Samuelson*’s. Doing so would have made the PM-465’s service height feature more accurate and robust. Singhose, ¶133.

A POSITA would have been motivated to implement the sensor-integrated cylinders in *all four legs*. First, it was known before the '390 patent to use leg sensors on the front and rear legs of a road-milling machine—the Roadtec RX-500 did this in 2003. Ex. 1052, ROADTEC000192-211; Ex. 1053, ROADTEC000017-18; [REDACTED]; Singhose, ¶134. These leg sensors allowed an RX-500 operator to calibrate the sensors before milling and position the machine frame parallel to the ground from left to right *and from front to back*. [REDACTED]
[REDACTED]. See Section VI.A.3.c.

Indeed, a POSITA would have been further motivated to use leg sensors in all four legs to keep the machine level/parallel to the ground or a horizontal plane because the state-of-the art encouraged such orientations for road-milling machines. Singhose, ¶135; Section VI.A.3.c; *Sehr*, 3:45-65 (disclosing ground-detecting sensors down the length of the machine frame and a control system that uses information from the sensors to adjust the front and rear legs to keep the machine frame parallel to the ground); Ex. 1060 (JPA-1991-139408), 2 (recognizing benefits of keeping a large piece of mobile machinery horizontal).

A POSITA would have known that keeping a road-milling machine's frame parallel to the either the ground surface or a parallel plane in the direction of travel promotes machine stability and operator comfort while milling. Singhose, ¶¶135-

136. Regarding stability, a POSITA would have understood that a road-milling machine can become unstable if the elevation between the front and rear legs differs too much, especially on uneven terrain. *See, e.g.*, Ex. 1057 (EP0940274), ¶¶0022-25; Ex. 1058 (U.S. Pat. No. 7,828,309), 2:4-12, 3:1-9; *see also OMM*, 12 (warning operators about conditions that “could lead to tipping when working on hills, banks or slopes, and when crossing ditches, ridges or other obstructions”). A POSITA would have known that sensor-integrated legs could be used to counteract these instability concerns by continuously extending/retracting the legs to keep the machine frame parallel to the ground (from front to back) or to a horizontal plane (from front to back). Singhose, ¶136. A POSITA would have known that one way to achieve this is to have the controller compare values coming in from the four leg sensors during operation to the calibrated leg sensor values obtained through the pre-milling calibration process. Singhose, ¶100. For these reasons, a POSITA would have been motivated to add sensor-integrated cylinders like *Samuelson*’s to all four legs of the PM-465, and to use them to detect the lifting position of the lifting columns. *Id.* Thus, the *OMM/Samuelson* combination renders claim 8 obvious.

- h. Claim 9: “The self-propelled road milling machine of claim 8, further comprising a controller configured to automatically control the lifted condition of at least one of the lifting columns to establish a predetermined inclination front to rear of the machine frame.”**

OMM in view of *Samuelson* teaches this. First, this combination claim 8. *See* Sections VI.A.4.a, VI.A.4.g. Next, the combination teaches the additional limitations in claim 9. Singhose, ¶137-42. Specifically, the PM-465’s controller automatically controls the elevation of the front two legs based on information it receives from the grade-and-slope sensors. *OMM*, 32, 55; *see* Section VI.A.1. Thus, the controller disclosed in *OMM* “automatically control[s] the lifted condition of at least one of the lifting columns,” as required by claim 9. *See* Singhose, ¶137. *OMM* further describes rear-leg elevation sensors. *OMM*, 112. A POSITA would have known that the signals from these sensors are electronic signals capable of being processed by a controller. Singhose, ¶137; Netka, ¶38. Indeed, the PM-465 as disclosed in *OMM* was a sophisticated machine with controllers capable of both receiving information on leg position and using sensor information to position the legs. Singhose, ¶137.

Accordingly, a POSITA would have known that the controllers on the PM-465 would have worked well with the sensor-integrated cylinders in all four legs of Caterpillar’s modified machine. *See* Section VI.A.4.g. Indeed, a POSITA would

have known that, under Caterpillar's modification, the controller would receive position signals from all four legs and been able to use that information to perform sensed leg-elevation adjustments to both the front and the rear of the machine.

Singhose, ¶¶100, 138. As described in Section VI.A.4.g, *Sehr* is a state-of-the-art reference that provides one example of the claimed "inclination" position running "front to rear of the machine frame"—i.e., parallel-to-ground position. *Sehr*, 3:45-65.

A POSITA would have been motivated to design the control system of the PM-465 as modified by *Samuelson* such that the controller continuously and automatically extends/retracts the legs to keep the machine frame parallel to the ground (from front to back). *See* Sections VI.A.4.g, VI.A.3.c; Singhose, ¶139. Indeed, it was known to use leg sensors on the front and rear legs of a road-milling machine to keep the machine frame parallel to the ground during the pre-milling calibration process from front-to-back. [REDACTED]. A POSITA would have known that, by comparing leg sensor values against the calibrated values during operation, the machine frame could be held at the preset parallel-to-ground inclination position while milling. Singhose, ¶100, 141. A POSITA would have wanted to mill at this orientation when operating on relatively flat ground because doing so keeps the machine stable and maximizes milling efficiency by keeping

the milling drum optimally positioned. *Id.*, ¶¶100, 139; Sections VI.A.4.g, VI.A.3.c.

When traveling up or down a hill, however, a POSITA would have known that the forces acting on the machine change, and the risk of tipping increases. Singhose, ¶139. In these situations, and to maximize stability and operator comfort, a POSITA would have been motivated to move to a preset parallel-to-horizontal-plane position for the machine frame by using the leg sensors to position the legs. *Id.*; Sections VI.A.4.g, VI.A.3.c.

Under these scenarios, the “predetermined inclination front to rear of the machine frame” would either be the parallel-to-ground or parallel-to-horizontal-plane positions. For these reasons, the *OMM/Samuelson* combination renders claim 9 obvious, especially when considered in context with the state-of-the-art.

- i. **Claim 10: “The self-propelled road milling machine of claim 9, wherein the predetermined inclination comprises the machine frame being parallel to the ground surface or a milling track.”**

OMM in view of *Samuelson* teaches this. *See* Section VI.A.4.h. In proving why claim 9 was obvious, Caterpillar relied on a scenario where the “predetermined inclination” was one where the machine frame was “parallel to the ground surface.” *Id.* Thus, claim 10 would have been obvious for the reasons provided for claim 9, especially in view of the “parallel-to-ground” portion of that

analysis. Singhose, ¶143; Ex. 1059 (JPA-1991-276889), 2 (recognizing benefits of keeping a large piece of mobile machinery parallel “relative to the crawlers”); *Sehr*, 3:45-65.

- j. **Claim 11: “The self-propelled road milling machine of claim 9, wherein the predetermined inclination comprises the machine frame being parallel to a horizontal plane.”**

OMM in view of *Samuelson* teaches this. *See* Section VI.A.4.h. In proving why claim 9 was obvious, Caterpillar relied on a scenario where the “predetermined inclination” was one where the machine frame was “parallel to a horizontal plane.” *Id.* Thus, claim 11 would have been obvious for the reasons provided for claim 9, especially in view of the “parallel-to-horizontal-plane” portion of that analysis. *See* Section VI.A.4.h; Singhose, ¶144; Ex. 1060 (JPA-1991-139408), 2 (recognizing benefits of keeping a large piece of mobile machinery horizontal).

- k. **Claim 12: “The self-propelled road milling machine of claim 8, further comprising a controller configured to automatically control the lifted condition of at least one of the lifting columns.”**

OMM in view of *Samuelson* teaches this. The limitation added by claim 12 is included in its entirety in claim 9. Thus, claim 12 is obvious for the same reasons claim 9 is obvious. *See* Section VI.A.4.h. Singhose, ¶145.

I. Independent Claim 13

Claim 13 is obvious because all limitations are either disclosed by *OMM* or taught by the *OMM/Samuelson* combination, as shown below.

i. [13pre]: “A self-propelled road milling machine, comprising:”

OMM discloses this, as shown in the element [1pre] analysis. *See* Section VI.A.4.a.i; Singhose, ¶147.

ii. [13a] “a machine frame;”

OMM discloses this, as shown in the element [1a] analysis. *See* Section VI.A.4.a.ii; Singhose, ¶148.

iii. [13b] “at least two front ground engaging supports, and at least one rear ground engaging support;”

OMM discloses this, as shown in the element [1b] analysis. *See* Section VI.A.4.a.iii; Singhose, ¶149.

iv. [13c1] “front and rear lifting columns supporting the frame from the ground engaging supports,”

OMM discloses this, as shown in the element [1c] analysis. Section VI.A.4.a.iv; Singhose, ¶150.

- v. **[13c2] “wherein each of the front and rear lifting columns comprise a hydraulic piston/cylinder unit having an integrated position sensor configured to generate position signals representing a lifted position of the respective lifting column;”**

The *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 8 analysis. *See* Sections VI.A.4.a and VI.A.4.g; Singhose, ¶151 (explaining that the limitation in element [13c2] and the limitations added by claim 8 are not verbatim the same but that the substance of the limitations is virtually identical, which means that element [13c2] is obvious for the same reasons the additional limitations in claim 8 are obvious).

- vi. **[13d] “a milling roller supported from the frame for treatment of a ground surface;”**

OMM discloses this, as shown in the element [1d] analysis. *See* Section VI.A.4.a.v; Singhose, ¶152.

- vii. **[13e] “a height adjustable stripping plate arranged behind the milling roller and operable to be lowered, during operation, into a milling track generated by the milling roller; and”**

OMM discloses this, as shown in the element [1e] analysis. *See* Section VI.A.4.a.vi; Singhose, ¶153.

- viii. **[13f1] “first and second height adjustable side plates arranged on opposite sides of the milling roller”**

OMM discloses this, as shown in the element [1f] analysis. *See* Section VI.A.4.a.vii; Singhose, ¶154.

- ix. **[13f2] “wherein at least one of the side plates comprises first and second hydraulic piston/cylinder units spaced apart in a traveling direction of the milling machine,”**

OMM discloses this. As shown in the element [1f] analysis, each of the two side plates on the PM-465 has two hydraulic piston/cylinder units attached to them that raise and lower the side plates vertically relative to the machine frame. *See* Section VI.A.4.a.vii; Singhose, ¶155. As the pictures in *OMM* show, the two hydraulic piston/cylinder units on each side plate are spaced apart along the sides of the machine, making the piston/cylinder units “spaced apart in a traveling direction of the milling machine.” *See* Section VI.A.4.a.vii; Singhose, ¶155.

- x. **[13f3] “each piston/cylinder unit having an integrated position sensor configured to generate position signals representing changes in position for the respective at least one side plate.”**

The *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the element [1g] analysis. *See* Section VI.A.4.a.viii; Singhose, ¶156. As Dr. Singhose explains, the limitation in element [13f3] and the

limitation in [1g] are not verbatim the same, but the analysis for element [1g] shows why all limitations in element [13f3] are taught by the *OMM/Samuelson* combination. For example, the modified PM-465 machine described in the element [1g] analysis has two sensor-integrated cylinders like *Samuelson*'s on each side plate that generate "position signals" on the vertical position of the side plate by continuously measuring the extension and retraction of the side plate cylinders as the side plates move up and down while traversing the ground during milling (i.e., each side plate has two sensor-integrated cylinders that "generate position signals representing changes in position" of the side plates). Section VI.A.4.a.viii. Moreover, the sensors on the sensor-integrated cylinders are inside the hydraulic cylinders themselves and are thus "integrated" position sensors, as required by element [13f3]. *Samuelson*, 4:35-45, Figs. 5-6. Accordingly, the *OMM/Samuelson* combination teaches and renders element [13f3] obvious.

- m. Claim 14: "The self-propelled road milling machine of claim 13, further comprising a controller operably associated with the position sensors and configured to determine displacement of the at least one of the first and second side plates with respect to the machine frame, based at least in part on the generated position signals from one or more of the position sensors."**

In addition to claim 13, *see* Section VI.A.4.1, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 2 analysis. *See* Section VI.A.4.b; Singhose, ¶157 (explaining that while claims 14

and 2 are not verbatim the same, the substance of the claims is virtually identical, and that claim 14 is obvious for the same reasons claim 2 is obvious); *see also* Sections VI.A.4.b, VI.A.4.l.x.

- n. **Claim 15: “The self-propelled road milling machine of claim 14, wherein the controller is configured to control the milling depth of the milling roller by generating control signals to vertically adjust one or more of the lifting columns.”**

In addition to claim 14, *see* Section VI.A.4.m, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 4 analysis. *See* Section VI.A.4.d; Singhose, ¶158; *see also* Sections VI.A.4.a-b.

- o. **Claim 16: “The self-propelled road milling machine of claim 13, wherein the stripping plate comprises one or more position sensors configured to generate position signals representing changes in position for the stripping plate.”**

In addition to claim 13, *see* Section VI.A.4.l, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 5 analysis. *See* Section VI.A.4.e; Singhose, ¶159.

- p. **Claim 17: “The self-propelled road milling machine of claim 16, wherein the stripping plate further comprises one or more piston/cylinder units integrating the one or more position sensors.”**

In addition to claim 16, *see* Section VI.A.4.o, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 6

analysis. *See* Section VI.A.4.f; Singhose, ¶160; *see also* Sections VI.A.4.e, and VI.A.4.a.

- q. **Claim 19: “The self-propelled road milling machine of claim 13, further comprising a controller configured to automatically control the lifted condition of at least one of the lifting columns to establish a predetermined inclination front to rear of the machine frame.”**

In addition to claim 13, *see* Section VI.A.4.1, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 9 analysis. *See* Section VI.A.4.h; Singhose, ¶161. Moreover, as explained in the claim 8 analysis, it would have been obvious to achieve the claimed “predetermined inclination front to rear of the machine frame” by implementing sensor-integrated piston cylinders like *Samuelson*’s in each of the PM-465’s four legs and having a controller process the position signals from those leg sensors in a way that keeps the machine frame parallel to either the ground or a horizontal plane. *See* Section VI.A.4.g; Singhose, ¶161; *see also* Section VI.A.3.c.

- r. **Claim 20: “The self-propelled road milling machine of claim 19, wherein the predetermined inclination comprises the machine frame being parallel to the ground surface or a milling track.”**

In addition to claim 19, *see* Section VI.A.4.q, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 10 analysis. *See* Section VI.A.4.i; Singhose, ¶162; *see also* Section VI.A.3.c.

- s. **Claim 21: “The self-propelled road milling machine of claim 19, wherein the predetermined inclination comprises the machine frame being parallel to a horizontal plane.”**

In addition to claim 19, *see* Section VI.A.4.q, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 11 analysis. *See* Section VI.A.4.j; Singhose, ¶163; *see also* Section VI.A.3.c.

- t. **Claim 22: “The self-propelled road milling machine of claim 13, further comprising a controller configured to automatically control the lifted condition of at least one of the lifting columns.”**

In addition to claim 13, *see* Section VI.A.4.l, the *OMM/Samuelson* combination teaches this limitation and renders it obvious, as shown in the claim 12 analysis. *See* VI.A.4.k; Singhose, ¶164; *see also* Section VI.A.3.c.

B. GROUND 2: Claims 7 and 18 Are Obvious over *OMM*, *Samuelson*, and *Zarniko*

Claim 7 depends from claims 1 and 5, and claim 18 depends from claims 16 and 13. As described, claims 1, 5, 13, and 16 are obvious over the *OMM/Samuelson* combination. *See* Sections VI.A.4.a, VI.A.4.e, VI.A.4.l, VI.A.4.o. The additional feature added by claims 7 and 18 is the same: “a controller configured to determine a relative displacement between one or more of the side plates and the stripping plate based on generated positions signals from their respective position sensors.” *Zarniko* renders this limitation obvious.

1. Summary of U.S. Patent No. 4,943,119 to *Zarniko*

Zarniko is assigned to MOBA, a company that makes sensor-driven control systems for construction machines. Ex. 1022. *Zarniko* describes one such control system for a road-milling machine. The *Zarniko* system uses ultrasonic sensors to measure vertical distances between points on the machine and the ground. *Zarniko*, 2:10-34, 3:56-4:19. Some of the sensors measure down to the unmilled, or “unmachined” portion of the road, while another sensor measures down to the milled, or “machined” portion of the road. *Id.*

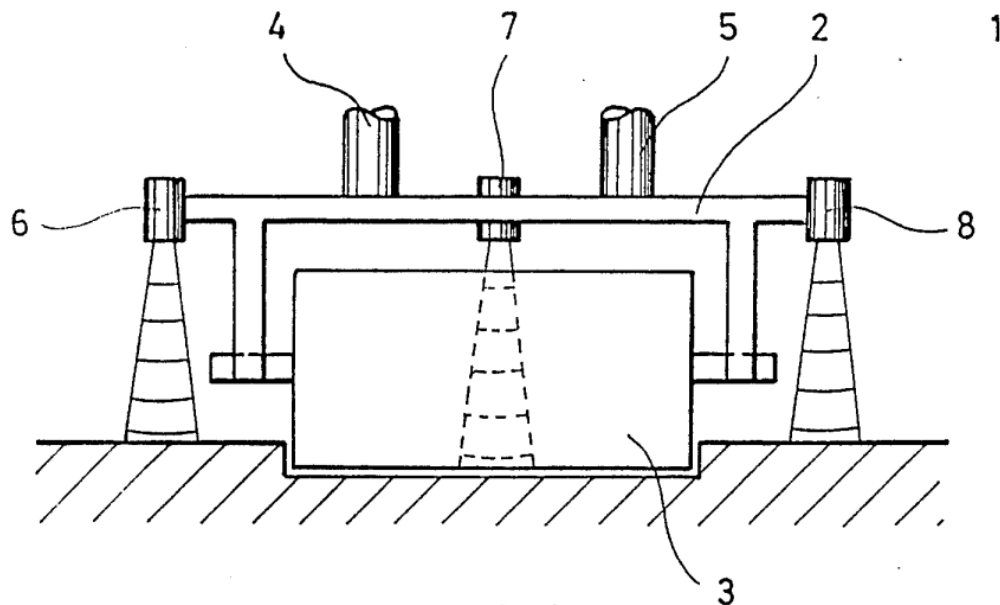


FIG. 1

Id., Fig. 1 (showing ultrasonic sensors 6 and 8 measuring to the unmilled surface and ultrasonic sensor 7 measuring to the milled surface).

The *Zarniko* control system then compares the distances to the unmilled surface with the distance to the milled surface and determines a “difference” that the microprocessor uses to determine the milling depth. *Id.*, 4:66-5:12, 2:22-59.

The system compares the measured values with a “setpoint value,” and if the “milling depth” is “not equivalent to the setpoint value,” the system “produces a reference signal” that the “microcomputer” uses to adjust the hydraulic cylinders so that the rotor drum is milling at the desired depth. *Id.*, 4:66-5:12, 2:32-59.

Zarniko explains that comparing the distances to the milled and unmilled surfaces as described allows its control system to “automatically compensate[] for the “wear of the machining tool.” *Id.*, 2:39-45, 2:3-9.

2. Rationale for Combining *OMM* and *Samuelson* with *Zarniko*

Caterpillar describes the rationale for combining *OMM* and *Samuelson* in Section VI.A.3. A POSITA would have been further motivated to combine *Zarniko* with *OMM* and *Samuelson*. First, like *OMM* and *Samuelson*, *Zarniko* is analogous art to the '390 patent. For example, *Zarniko* and *OMM* both disclose road-milling machines. *Zarniko*, 1:6-10. And like *Samuelson*, *Zarniko* discloses hydraulic cylinders used to move components on construction machines. *Id.*, 3:36-55, 5:4-12. Thus, *OMM*, *Samuelson*, and *Zarniko* all relate the same field of endeavor.

Singhose, ¶168.

Next, the PM-465 machine in *OMM* as modified by *Samuelson* has two sensor-integrated hydraulic cylinders on each side plate and on the moldboard. *See* Section VI.A.3. Thus, the modified machine's control system can measure the elevation of the side plates and the moldboard relative to the ground. *Id.* A POSITA would have been motivated to apply *Zarniko* to this design and would have had a reasonable expectation of success in doing so. Singhose, ¶168. As described, *Zarniko* describes the benefits of calculating vertical distances to the milled and unmilled surfaces and comparing those values to determine a milling depth. *Zarniko*, 2:10-59, 3:56-5:12. A POSITA would have known that the same type of information comparing distances to milled and unmilled surfaces could be obtained using the elevation values obtained from the sensor-integrated cylinders on the side plates and moldboard (with the side plate sensors providing values associated with the unmilled surface, and the moldboard sensors providing values associated with the milled surface). Singhose, ¶169. A POSITA would have wanted to make this modification because it would allow the control system to compensate for the wearing down of the rotor bits. *See Zarniko*, 2:39-45, 2:3-9; Singhose, ¶169.

Zarniko provides additional disclosures that would motivate a POSITA to make the proposed modification (i.e., using the side plates and the moldboard to sense elevation values associated with the milled and unmilled surfaces and then

have the control system compare those values and position the rotor drum at the preset milling depth by extending or retracting the legs). In particular, *Zarniko* describes problems associated with using mechanical ground sensors on road-milling machines. *Zarniko*, 1:12-45 (explaining that mechanical sensors “can easily be damaged under the rough conditions which normally exist in road repair work”). *Zarniko* also identifies problems with using ultrasonic noncontact sensors on road-milling machines. *Id.*, 1:46-68 (explaining that the accuracy of ultrasonic sensors can be compromised by atmospheric elements). Caterpillar’s proposed *OMM/Samuelson* combination solves these problems because it monitors the ground through physical contact (via the side plates and moldboard), but the relevant sensors are away from the ground and protected inside the hydraulic cylinders, making the proposed sensing system very robust. *See* Section VI.A.3; Singhose, ¶170. Thus, a POSITA would have been motivated to use Caterpillar’s proposed *OMM/Samuelson* sensing system instead of one that uses ultrasonic sensors to obtain the distances to the milled and unmilled surfaces (which are then compared by the control system as described in *Zarniko*). Singhose, ¶170.

3. Claim-by-Claim Analysis

- a. **Claim 7: “The self-propelled road milling machine of claim 5, further comprising a controller configured to determine a relative displacement between one or more of the side plates and the stripping plate based on generated position signals from their respective position sensors.”**

Claim 7 depends from claims 1 and 5. Claims 1 and 5 are obvious over the *OMM/Samuelson* combination. See Sections VI.A.4.a and VI.A.4.e. *Zarniko* renders the additional limitation in claim 7 obvious. Singhose, ¶171-73. A POSITA viewing *Zarniko* would have looked for ways to measure a distance to the unmilled surface and a distance to the milled surface and compare those values because, as *Zarniko* explains, doing so would have allowed the control system to compensate for the wearing down of the rotor bits. See *Zarniko*, 2:39-45, 2:3-9; Singhose, ¶171.

A POSITA would have known that *OMM*’s PM-465 machine as modified by *Samuelson* would have easily been able to accommodate this modification. The modified *OMM/Samuelson* machine has two sensor-integrated cylinders on each side plate and on the moldboard, and the sensors can be used to track the position of side plates and moldboard relative to the machine frame as the side plates and moldboard ride along and monitor the ground See Sections VI.A.3.a-b, VI.B.1-2. It would have been obvious for a POSITA to use the sensors in the sensor-integrated

cylinders on the side plates to provide signals on side plate elevation that relate to a distance to the unmilled surface (“generated position signals”), to use the sensors in the sensor-integrated cylinders on the moldboard to provide signals on moldboard elevation that relate to a distance to the milled surface (“generated position signals”), and to use the PM-465’s sophisticated control system, including the ECM controller, to compare the relative positions between the distance measurements and ensure that the rotor drum is positioned at the depth set by the operator (“controller configured to determine a relative displacement between one or more of the side plates and the stripping plate”). Singhose, ¶172.

A POSITA would have been further motivated to make this modification knowing that *OMM*’s PM-465 machine as modified by *Samuelson* has a robust sensor system in the side plates and moldboard (because the sensors are protected inside the hydraulic cylinders), and because the PM-465’s control system is already able to receive and process signals from multiple different sensors at the same time. *OMM*, 32; *see also SOTA*, 6-7 (relied on as a state-of-the-art reference in this ground). For these reasons, the *OMM/Samuelson/Zarniko* combination discloses a “a controller configured to determine a relative displacement between one or more of the side plates and the stripping plate based on generated position signals from their respective position sensors” and renders claim 7 obvious.

- b. Claim 18: “The self-propelled road milling machine of claim 16, further comprising a controller configured to determine a relative displacement between one or more of the side plates and the stripping plate based on generated position signals from their respective position sensors.”**

Claim 18 depends from claims 13 and 16. Claims 13 and 16 are obvious over the *OMM* and *Samuelson* combination. See Sections VI.A.4.l and VI.A.4.o, respectively. Moreover, the *OMM/Samuelson/Zarniko* combination teaches the limitation added by claim 18, as shown in the claim 7 analysis. Section VI.B.3.a; Singhose, ¶174. Thus, claim 18 is also obvious.

VII. DISCRETIONARY DENIAL IS NOT WARRANTED

A. Denial of Institution Is Not Warranted Under § 325(d)

The examiner did not have *OMM* during prosecution. See Ex. 1001, (56) (References Cited). While *Samuelson* and *Zarniko* were submitted to the examiner in an IDS (Ex. 1008, 69 and 636), the examiner did not substantively consider these references or apply them in a substantive rejection. Furthermore, the references and grounds in this petition are not cumulative of any addressed during prosecution. The only prior-art reference the examiner substantively discussed—the Wirtgen W1900 machine—lacked a sensor-integrated cylinder. Ex. 1008, 92. *Samuelson* provides this missing feature and it was thus material error for the examiner to fail to apply it. Further, the examiner did not raise any prior art against

the claims that issued as claims 7 and 18—the claims against which *Zarniko* is cited, and this was thus also material error. *Id.*, 96-97. “The Board has consistently declined exercising its discretion under Section 325(d) when the only fact a Patent Owner can point to is that a reference was disclosed to the Examiner during the prosecution.” *Amgen Inc. v. Alexion Pharm., Inc.*, IPR2019-00739, Paper 15 at 62 (PTAB Aug. 30, 2019); *see also Amber.io, Inc. v. 72Lux, Inc.*, IPR2020-00015, Paper 8 at 19-20 (PTAB Apr. 1, 2020) (evaluating reference disclosed in IDS under *Advanced Bionics* and *Becton Dickinson* before concluding that citation of a reference in an IDS alone, without any substantive consideration of that reference during prosecution, did not warrant a discretionary denial under 325(d)). Therefore, the facts here do not support a discretionary denial under 35 U.S.C. § 325(d).

B. Denial of Institution Is Not Warranted Under *Fintiv*

The stage of the parallel district court litigation also does not support a discretionary denial based on the *Fintiv* factors.

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. The district court trial will occur *at the earliest* in February of 2024, and possibly even later given that the case was just reassigned to

a new judge. Ex. 1011; Ex. 1018. Thus, the Final Written Decision is expected to issue at least the month before the district court trial, and possibly even farther before the district court trial, assuming a Final Written Decision deadline in January 2023. This factor, therefore, weighs in favor of institution. *See, e.g., Intel Corp. v. PACT XPP Schweiz AG*, IPR2020-00542, Paper 11 at 14 (P.T.A.B. Sept. 9, 2020).

Factor 3 favors institution. Wirtgen did not file its amended complaint adding the '390 patent to the parallel litigation until September 2, 2021. Ex. 1013 (Amended Complaint), and it did not file its initial infringement contentions until December 2, 2021. Ex. 1011 at 12. Wirtgen's final infringement contentions are not due until after the Court's claim construction order, *id.*, which will address at most one term from the '390 patent, Ex. 1062, and the Court will not hold its claim construction hearing until January 24, 2023, Ex. 1063. The fact discovery cutoff is not until March 31, 2023, *see* Ex. 1017, and expert reports are not due until after that, Ex. 1011 at 12. Because the litigation is thus still in its early stages with the Court having issued no substantive orders related to the '390 patent, this factor favors institution. *See, e.g., Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 10 (P.T.A.B. Mar. 20, 2020).

Factor 4 favors institution because the Final Written Decision here will trigger estoppel before the district court trial. *See, e.g., Hanwha Solutions Corp. v.*

REC Solar PTE. Ltd., IPR2021-00988, Paper 12 at 15-16 (P.T.A.B. Dec. 13, 2021).

Factor 5 favors institution because the Final Written Decision here will be before the district court trial. *See, e.g., Huawei Tech.*, Paper 11 at 13-14.

Factor 6 also favors institution and is dispositive under the June 21 Interim Procedure for Discretionary Denials because the unpatentability challenges herein are “compelling.” *OMM* was not before the office. And there is no evidence that the examiner substantively considered *Samuelson* or *Zarniko* in the manner proposed herein. Additionally, Caterpillar’s IPR is the only challenge to the ’390 patent that has ever been before the Board, which favors institution. Moreover, there is a strong public interest against “leaving bad patents enforceable,” which also favors institution. *Thryv, Inc. v. Click-To-Call Techs., LP*, 140 S. Ct. 1367, 1374 (2020).

Because five of the six *Fintiv* factors favor institution, and the remaining factor is neutral, Caterpillar respectfully requests that the Board institute IPR.

VIII. MANDATORY NOTICES

A. Real Party-in-Interest

The Petitioner, Caterpillar Inc., is a real party-in-interest. In addition, Caterpillar subsidiaries Caterpillar Paving Products, Inc. and Caterpillar Prodotti Stradali S.r.L. are real parties-in-interest.

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

Wirtgen America Inc. has asserted the '390 patent in litigation captioned *Wirtgen Am., Inc. v. Caterpillar, Inc.*, Case No. 17-770-RGA (D. Del.).

Caterpillar is concurrently petitioning for *inter partes* review of U.S. Patent No. 9,879,391, which is related to the '390 patent.

C. Lead and Back-Up Counsel, and Service Information

Petitioner designates lead and back-up counsel as noted below. A power of attorney pursuant to 37 C.F.R. § 42.10(b) accompanies this petition.

Lead Counsel	Backup Counsel
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Please address all correspondence to counsel at the address above. Petitioner consents to electronic service by email at the above email addresses.

IX. GROUNDS FOR STANDING

Petitioner certifies that the '390 patent is available for IPR and the Petitioner is not barred or estopped from requesting an IPR challenging the patent claims on the grounds identified herein.

X. CONCLUSION

The challenged claims should be canceled for the reasons discussed above.

Dated: July 20, 2022

By: /Joshua L. Goldberg/
Joshua L. Goldberg, Lead Counsel
Reg. No. 59,369

CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, Petitioner certifies that the word count of Petitioner's Petition for *Inter Partes* Review (exclusive of any table of contents, table of authorities, mandatory notices under § 42.8, certificates of service and word count, and list of exhibits or claim listing) as measured by Microsoft Word is 13,882.

Dated: July 20, 2022

By: /Joshua L. Goldberg/
Joshua L. Goldberg, Lead Counsel
Reg. No. 59,369

CERTIFICATE OF SERVICE

The undersigned certifies that the foregoing Petition for *Inter Partes* Review, the associated Power of Attorney, and Exhibits 1001 through 1008, 1011 through 1013, 1017 through 1018, 1020 through 1030, 1032 through 1034, 1036 through 1060 and 1062 through 1063, were served on July 20, 2022, by FedEx Priority Overnight at the following address of record for the subject patent. The Confidential versions of the Petition and Exhibits 1006, 1020, 1025-1030, 1032-1034, 1036, 1038-1049, and 1054-1056 will be served when Protective Order acknowledgments are received, pursuant to 37 C.F.R. § 42.55.

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A courtesy copy has also been mailed to litigation counsel for Patent Owner
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Date: July 20, 2022

By: / Daniel E. Doku /
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