

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GODBERSEN-SMITH CONSTRUCTION COMPANY
d/b/a GOMACO CORPORATION,
Petitioner,

v.

GUNTERT & ZIMMERMAN CONST. DIV., INC.,
Patent Owner.

Case IPR2024-00835
U.S. Patent No. 11,535,318

DECLARATION OF KENNETH “MARK” BRYDEN

[REDACTED VERSION]

I. INTRODUCTION

I, Kenneth “Mark” Bryden, declare:

1. I am a Professor in the Department of Mechanical Engineering at Iowa State University, where I have taught courses and performed research in Mechanical Engineering, including engineering design, energy systems, combustion, modeling, simulation, and decision science since 1998. I am a retained technical expert on behalf of Guntert & Zimmerman Const. Div., Inc., (“G&Z”) in the above captioned matter. I have personal knowledge of the facts disclosed herein and, if called as a witness, I could and would testify regarding the opinions disclosed herein.

II. EXPERIENCE AND QUALIFICATIONS

A. Curriculum Vitae

2. Attached hereto as Appendix A is a true and correct copy of my abbreviated Curriculum Vitae (CV). I summarize some of the relevant information regarding my CV as follows.

3. I received a Bachelor of Science degree in General Engineering from Idaho State University in 1977, a Master of Science degree in Mechanical Engineering from the University of Wisconsin–Madison in 1993, and PhD in Mechanical Engineering from the University of Wisconsin–Madison in 1998.

4. I am a Professor in the Department of Mechanical Engineering at Iowa State University, where I have been a faculty member since 1998. In addition, I am

the program director of Decision Science Program in the Ames National Laboratory and have held this position since 2006. The Ames National Laboratory is a U.S. Department of Energy National Laboratory managed by Iowa State University.

5. From 1977 to 1991 I worked at Westinghouse Electric Corporation where I was a technical manager for more than ten years. Specifically, I held a number of engineering and technical management positions, including shift supervisor of a nuclear power plant, engineering manager responsible for planning and managing outages for three nuclear power plants, and the radiological controls engineering manager responsible for three nuclear power plants and one of the few nuclear fuel handling facilities in the world.

6. I have more than 40 years’ experience in engineering, and I have authored or coauthored more than 200 publications, including the textbook *Combustion Engineering*. I have a wide range of engineering experiences that include power plant management and operations, design of energy systems, farm machinery engineering, system integration, and engineering design and decision

making. I have received two U.S. Patents. In addition, I am a co-founder of two software companies AgSolver Inc.¹ and Praxik LLC.²

7. In my capacity as a Professor at Iowa State University, my responsibilities include: teaching undergraduate and graduate students; performing research in mechanical engineering; mentoring masters students, PhD students, and postdoctoral fellows; supervising research scientists; and serving on various university committees. My current research includes the control and design of complex energy systems, dynamic systems modeling, and engineering design and decision making. My research has been funded by grants from the U.S. Department of Energy, Deere & Co., the U.S. Army, and others.

¹ AgSolver is an agronomic decision services company whose products are focused on improving land management decisions, simplifying mandatory compliance and reporting activities, and maximizing returns for agricultural land investments.

AgSolver was founded in 2013 and was acquired in 2017 by EFC Systems.

² Praxik is a software services company focused on delivering visually based decision-making tools for industry. Founded in 2014, Praxik was acquired in 2018 by TCompanies Inc.

8. I am the recipient of the 2013 ASME Melville Medal,³ three R&D 100 Awards⁴ (2006, 2009, 2010), and a 2010 National Excellence in Technology Transfer from the National Federal Laboratory Consortium. In addition, I am a fellow of the ASME and an associate fellow of the AIAA. I have reviewed and evaluated research papers on a wide range of engineering topics, and I am currently an Associate Editor for the International Journal of Energy for a Clean Environment.

B. Compensation

9. My compensation is for my work and is based solely on the amount of time that I devote to activity related to this case (I am paid on an hourly basis) and is in no way affected by any opinions I render. I receive no other compensation from work on this action. My compensation is not dependent on the outcome of this matter. I have no financial interest in the outcome of this matter.

III. MATERIALS CONSIDERED

³ The Melville Medal was first awarded in 1927 and is the highest honor for the best original technical paper published in the *ASME Transactions* in the previous two years period.

⁴ The R&D 100 Awards, sponsored by R&D Magazine, identify the top 100 technological innovations of the past year.

10. In forming my opinions, I have considered Petitioner’s and G&Z’s exhibits and the papers filed in this IPR in preparation for this declaration. My opinions are based on my experience, knowledge of the relevant art, the documents discussed in the declaration.

IV. PERSON OF ORDINARY SKILL IN THE ART

11. I have been informed of the following legal standards that I have used as a framework in forming my opinion:

12. Counsel informed me that a “person of ordinary skill in the art” (“POSITA”) is a hypothetical person who is presumed to be familiar with the relevant scientific field and its literature at the time of the invention for the relevant patents. I understand that this hypothetical person is also a person of ordinary creativity, capable of understanding the scientific principles applicable to the pertinent field.

13. I understand that the factors to be considered in determining the level of ordinary skill in the art to be: (1) the educational level of active workers in the field, including the named inventors of the patent; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; and (5) the sophistication of the technology in the art.

14. I understand that G&Z applied Petitioner’s definition of a POSITA, which is, one who “would have had a four-year degree in mechanical engineering

or a closely related field and at least two years of experience designing, developing, or operating heavy machinery, including their components and control systems.” Pet. at 8. “Additional experience could substitute for a formal degree, and an advanced degree could substitute for experience.” *Id.* at 9. I meet these requirements as Section I shows.

V. LEGAL STANDARDS

A. Claim Construction

15. I understand that a claim of a patent generally shall be construed in accordance with the ordinary and customary meaning of such claim as understood by a person of ordinary skill in the art (“POSITA”) based upon the intrinsic and extrinsic evidence. I have been informed that claim construction is a legal issue for the Court to decide.

B. Obviousness

16. I have been informed that the analysis of obviousness involves several factual inquiries including the scope and content of the prior art, the differences between the prior art and the claim, and the level of ordinary skill in the art at the time of the invention.

17. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. Additionally, I understand that a patent is likely to be

invalid for obviousness if a person of ordinary skill in the art can implement a predictable variation or if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent’s claims. A combination is not obvious, however, where the combination cannot be implemented without undue experimentation or when the motivation to create the combination comes from hindsight.

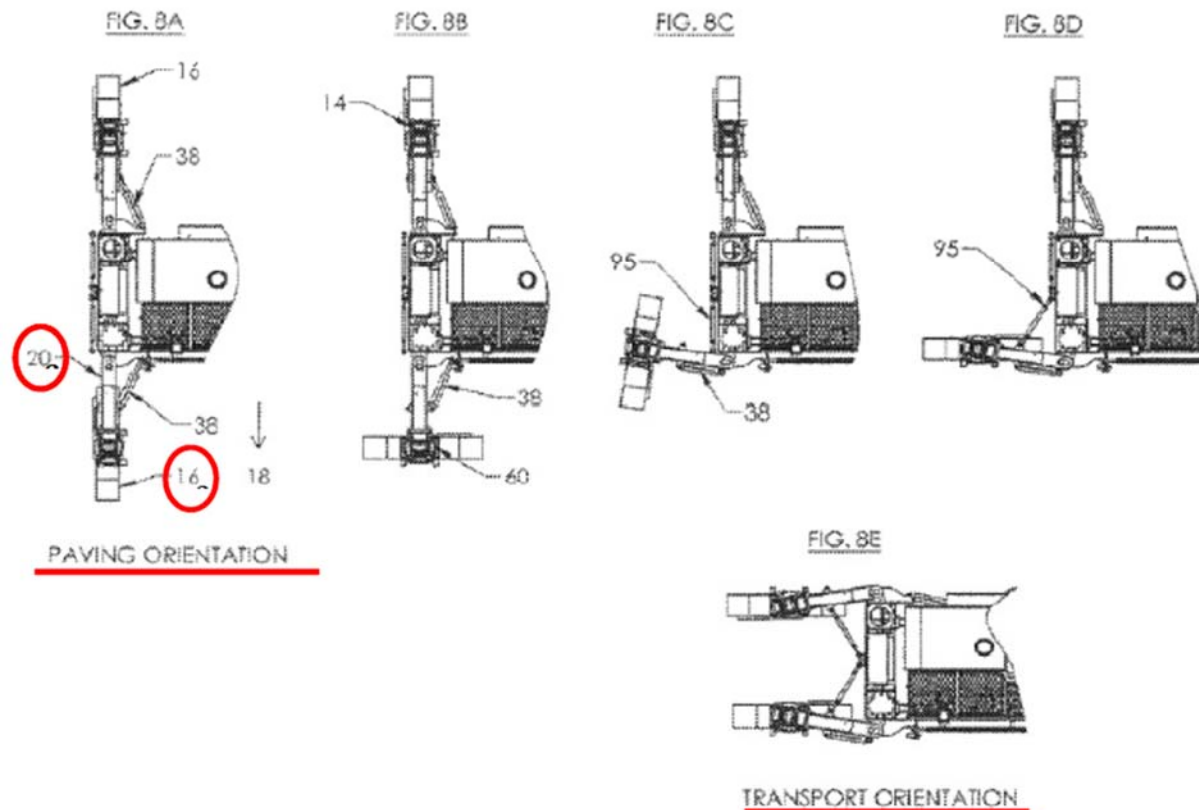
C. Objective Indicia of Nonobviousness

18. I have been informed that in assessing whether a claimed invention is obvious, secondary considerations may weigh towards the non-obviousness of the invention, including the following, which should be considered in determining the obviousness of the claim:

- Whether the claimed invention satisfied a long-felt need;
- Whether the claimed invention was preceded by a history of failures by others to solve a problem or problems solved by such invention;
- Whether the claimed invention achieved a surprising or unexpected result
- Whether the claimed invention has achieved commercial success;
- Whether the claimed invention has been copied; and
- Whether the claimed invention was the subject of skepticism by the Industry.

VI. OVERVIEW OF THE '318 PATENT

19. G&Z's '318 Patent is directed to a specialized swing leg assembly for a slipform paver, which allows an operator to easily and quickly reorientate the angle of the swing legs and crawler tracks. This arrangement enables a broad range of steering angles, a groundbreaking feature that did not exist before 2010. Figures 8A-E of the '318 Patent illustrate partial overhead views of a slipform paver having pivotable swing legs (20) supporting crawler tracks (16). In contrast with the conventional slipform pavers discussed above, these '318 Patent swing leg assemblies move swiftly from the “Paving Orientation” to the “Transport Orientation” without the need to individually lift, adjust, and repin the swing legs and crawler tracks, thereby eradicating costly time delays:



'318 Patent, FIGS. 8A-E (annotated).

20. Each swing leg assembly includes a jacking column (14), which is responsible for raising and lowering its associated crawler track. Id. at 8:53-65, 9:30-32. The crawler tracks are rotatably coupled to the lower ends of the jacking column and are used each time the swing leg is pivoted inwardly or outwardly relative to the machine frame. Id. at 8:65-9:2, 10:52-11:19. Several transducers send the position data for each leg, including the angular position of the swing leg with respect to the frame and the position of the crawler track with respect to the jacking column, to a processor. See id. at 6:23-28, 18:11-19. The processor then determines the necessary

adjustments to ensure the crawler tracks are orientated as intended. *Id.*; see also *id.* at 20:38-42, FIG. 12A (Figure 12A with angular transducers identified as 78).

21. A slew drive is coupled to the “jacking column and crawler track” that “allows for a wide range of steering angles while in 90-degree steering mode to make the machine highly maneuverable on site.” *Id.* at Abstract; *id.* at 7:6-9. Using this novel design, the ’318 Patent solved a longstanding problem with conventional slipform paver machines—namely, the time-consuming and expensive process required to manually maneuver the swing legs during concrete paving and transportation of the paver machines. *Id.* at 7:9-28; see also *id.* at 6:53-65 (specialized swing leg assembly permits the crawler track positions to be relocated without any manual mechanical or electronic adjustments); see also, e.g., *id.* at 5:38-41 (previous approach does not permit moving the paver from one site to another quickly and efficiently).

22. The maneuverability allowed by the ’318 Patent’s swing leg assembly enables large, heavy pavers to avoid obstacles easily while maintaining a consistent paving direction and surface for the concrete. *Id.* at 6:17-35, 15:63-16:19, 16:42-57. The ’318 Patent’s swing leg assembly also ensures that the paver can be narrowed enough for transport over ordinary highways and through crowded construction sites while significantly reducing the time necessary to make these adjustments. *Id.* at 7:6-28. For these reasons and those stated below, the ’318 Patent’s swing leg assembly

marked a significant improvement upon the state of the art, markedly improving the maneuverability of these large and immensely heavy slip form pavers. Thus, Petitioner’s collateral estoppel argument does not apply to these proceedings because the claims of the ’318 Patent present new issues of validity from those of the previous proceeding.

VII. THE ASSERTED REFERENCES

A. CIII

23. *CIII* is the operator’s manual for Gomaco’s CIII (Commander III) machine, which exemplified the conventional slipform paver at the time of the invention. Pet. at 10-20 (citing Ex. 1005, *CIII*); Ex. 2017 at 24-27. To move a swing leg to a new position, it was necessary to “[p]lace adequate blocking or a support under” the leg and “lower the machine frame onto the support system until all weight is removed from the track.” See, e.g., *CIII* at 75, 80. Only with the leg suspended, its locking pins/bolts removed, and its turnbuckles either removed or manually adjusted, could the “hydraulic pivot cylinder” alter the orientation of the swing leg relative to the frame of CIII. Pet. at 14-15, 19-20; *CIII* at 79. Once the new position is achieved, the operators must reinstall the locking pin to the frame end of the cylinder mount. *CIII* at 80.

24. *CIII* further discloses a hydraulic steering cylinder that attaches to the upper guide tube of the jacking column to rotationally control the crawler track.

Pet. at 13. This is the same conventional configuration described and distinguished in the '318 Patent, which was considered undesirable because it does “not allow the crawler tracks to be rotated 90° from their normal operating orientation without the time-consuming repining or repositioning of the steering.” '318 Patent, 4:20-36. *CIII*'s “jacking column includes a lower guide tube that telescopes in and out of the upper guide tube to raise or lower the track or frame.” '749 FWD at 65 (referencing *CIII* at 3-17, 5-15, 5-35). The steering cylinder rotates “the track and guide tubes relative to the outer cylinder of the jacking column.” *Id.* (referencing *CIII* at 5-7, 5-35, 8-71-72); *see also CIII* at 264-266, 377-378.

25. The *CIII* machine's hydraulic steering cylinder is attached to the jacking column and requires manual repositioning and repining of the steering cylinder to the torque arm to approach a 90-degree steering position or maneuver around obstacles. *See CIII* at 80; Ex. 2008 (the deposition transcript of Petitioner's expert Dr. Singhose in IPR2020-01698 (“Singhose 2021 Tr.”) at 18:18-19:7, 15:21-17:7 (describing the “physical limits” of the jacking column steering cylinder configuration); *id.* at 28:21-29:2. In other words, the *CIII* machine cannot quickly and easily reposition its crawler tracks to offset changes in the positioning of the swing leg. Instead, these tasks require that the operator stop the *CIII* machine and manually repin and reposition the swing leg and hydraulic steering cylinder for each track, individually, which can take up to a full shift. *CIII* at 80; Singhose 2021 Tr.

at 12:15-13:21 (testifying that this whole process is “quite extensive” and may take as long as a day to set up).

26. The ’318 Patent eliminates the *CIII* machine’s extensive repositioning process by describing and claiming a slipform paver that can reposition its swing legs and crawler tracks without coming to a stop and individually lifting each crawler track before repining the swing leg. These improvements over the *CIII* and other conventional slipform pavers are made possible using a crawler track rotatably coupled to the jacking column with a slew drive for causing rotation of the crawler track relative to the slew drive. ’318 Patent, 6:66-7:28; *id.* at Claim 1.

B. RIO

27. Ex. 1006 (“*Rio*”) discloses an asphalt road-milling machine with two different actuators for moving a swing leg and crawler track. First actuator 42, is “adapted to move the one ground engaging unit 20 between the projecting position (see FIG. 4) and the retracted position (see FIG. 3) relative to the frame 12.” *Rio*, Abstract; *id.* at 4:38-44; *id.* at 5:11-24. Second actuator 44 is “connected to the lifting column 46 and is adapted to cause at least a portion of the lifting column 46 to rotate about a lifting column axis 48” *Id.* at 4:56-60; *Rio*, FIG. 2.

28. In the preferred embodiment, *Rio* discloses placing a rotary actuator 44 at the upper portion 50 of the lifting column, so that it is spaced apart from other mechanical devices. *Id.* at 5:11-16 (“Such spaced apart positioning avoids problems

caused by an accumulation of mechanical devices at a single location on the lifting column 46.”); *id.* at 5:54-6:6. And while *Rio* contemplates locating the rotary actuator “along the lifting column axis,” it does not contemplate any arrangement that fails to “cause at least a portion of the lifting column 46 to rotate about a lifting column axis.” *Id.* at 4:56-60, 5:8-11. Despite the considerable differences between concrete slipform pavers and asphalt road milling machines, the similarities and shared deficiencies of *CIII* and *Rio* are striking.

29. Like *CIII*, *Rio* discloses a fixed connection between the inner tube of the jacking column and the crawler track and does not teach or suggest any embodiments with rotary coupling between the jacking column and crawler track, let alone one implemented via a slew drive. *Id.* at 5:25-38. Also, like *CIII*, *Rio* requires the operator to stop the machine and raise the lifting column (46) to lift the ground-engaging unit from the ground before repositioning the swing leg between the retracted or projecting positions. *See, e.g., Rio*, 3:10-22, 6:43-50, 7:62-8:59. And like *CIII*, *Rio*’s design requires the swing leg be locked in place while the machine is in motion in either the retracted or projecting positions. *Id.* at 6:27-37 (disclosing an anti-swing device that engages with a pair of receptacles 88 in the machine frame to lock the swing arm 76).

30. Moreover, *Rio*’s limited retracted and projecting positions prevent its swing leg from changing orientation by up to 180 degrees relative to the module

frame. *Id.* at 6:38-41 (anti-rotate device 90 includes a collar 92 connected with collar keys 94 to the inner tubular member 58, causing the collar to rotate with the inner tubular member in response to the second actuator); *id.* at 6:43-55 (anti-rotate actuator 98 is connected to the machine frame and engageable with the collar receptacles 96 of the collar 92 to permit locking the inner tubular member and ground engaging unit when steering is not desired).

31. Thus, *Rio* is unable to achieve reorientation of its swing arm and ground engaging unit from the two provided retracted and projected positions unless the machine is stopped, the ground engaging unit is supported off the ground, and the keys 74, anti-swing device 84, and anti-rotate device 90 with the anti-rotate actuator 98 are all manually disengaged and then reengaged prior to resuming operation.

32. *Rio* was filed in 2005, published in 2006, issued April 28, 2009, and is assigned to Caterpillar Paving Products, Inc. (“CAT”). *Rio*, Cover. *Rio* describes its invention as relating to an asphalt road planer or milling machine. *Rio*, 1:5-7. From at least 2007, CAT produced a series of road milling machines, including the PM102 Cold Planer (“PM102”). Ex. 2018 at 1-16 (the PM102 Cold Planer information guide, copyrighted 2007).

33. The PM102 includes a machine frame supported by tracks and pivots its right rear track from a projecting position, outside of the machine frame, to a retracted position that is housed within the frame. *Rio*, 3:43-56;



Ex. 2020. PM102’s processor controls the “steering angle of the **right rear track**” based upon “the position of the front tracks.” Ex. 2018 at 11. The PM102 uses a “single-piece swing-arm design” to automatically pivot its lifting column and track, only while the track is lifted off of the ground:

Flush Cutting Feature

Full flush cutting operation with hydraulic control of the right rear leg allows the PM102 to be used up close to a curb, wall or guard rail.



Leg in the full-out position.



Leg in the swing-in position.



Leg in the full-in position.

Flush cutting. The right rear leg can be swung in within the machine's cutting width for full flush cutting applications. With the right rear leg swung in, the machine can cut close to a wall, barrier or other vertical obstruction.

Exclusive Caterpillar single-piece swing-arm design.

The swing-in arm mechanism ensures increased rigidity eliminating excessive wear for increased component life.

Automatic control. The rear leg swing-in system is automatic and controlled from the operator's station. The operator is not required to leave the seat while positioning the right rear leg within the machine's cutting width.

Ex. 2018 at 10. The right rear track steering uses a conventional steering cylinder connected near the lower end of the inner tube of the lifting column, not the rotary actuator:



Ex. 2018 [CAT Cold Planer pdf] at 7; *see also*

<https://www.youtube.com/watch?v=VETLvoi9oYM> (2009 CAT marketing video for the PM102); Ex. 2023 (CAT PM102 from 2011 for sale showing same conventional features as information manual).

34. A POSITA would have also discovered that the implementation of a rotary actuator atop the lifting column for PM102 was used when steering the machine while outfitted with wheels, not tracks. Ex. 2030 (CAT PM102 from 2015 sale showing rotary actuator atop a lifting column connected to wheels); Ex. 2032 (CAT PM 102 from 2011 sale showing rotary actuator atop a lifting column connected to wheels). Thus, a POSITA upon reviewing *Rio* and observing PM102 would conclude that its rotary actuator was not capable of steering crawler tracks. *C.f.* Ex. 2018 at 16 (2007 copyright) *with* Ex. 2033 at 16 (2015 copyright).

C. SMOLDERS

35. *Smolders* discloses a paving machine that utilizes a traditional jacking column and steering cylinder design.

Steering ring 66 comprises two diametrically opposite groove-guided blocks 67 arranged in a groove on the inner periphery of Steering ring 66 while projecting radially inwardly and engaging corresponding longitudinal grooves 65 of the lower portion 9 of lifting column 10. This arrangement makes it possible to Steer the track 16 independently of the height Setting of track 16.

Smolders, 6:35-41; *see also id.*, 6:15-34 (describing the steering gear mechanism 32 and how it attaches to the lifting column). This design attempts to extend the stroke of the steering cylinder to allow slightly steeper steering angles needed for tight radius curb paving, but it has no provision for 90-degree steering, and does not need a transport mode because the machine is narrow enough to fit on a standard trailer. *Smolders* also discloses that its “front truck assemblies 14 are articulated” by “pivoting device 17.” *Smolders*, 5:13-20s, Fig. 1.

VIII. CLAIM CONSTRUCTION

A. **“A swing leg assembly configured to be coupled to a paving machine configured to move in a paving direction . . .”**

36. I agree with G&Z that the term “[a] swing leg assembly configured to be coupled to a paving machine configured to move in a paving direction . . .” should be construed consistent with the plain meaning of its words, which requires a paving machine with a swing leg assembly moving in a paving direction with its crawler tracks on the ground and under load, while laying and finishing concrete in a form.

37. The phrase “configured to move in a paving direction...” clarifies to a person of ordinary skill in the art that the limitations are conducted while the machine is moving in the paving direction. For example, the processor recited in Claim 1 must be read to receive and send the claimed signals to coordinate movements of the swing leg and crawler track when moving and under load. This interpretation of the claims is fully consistent with the corresponding disclosure of this embodiment in the specification:

Onboard computer or processor 82 and the associated transducers 70, 78 form a feedback loop in which the computer receives the angular position signal from swing leg transducer 78. When the angular position of the swing leg changes, the output signal from transducer 78 changes correspondingly. As a result of this orientational change of the swing leg, the angular orientation of the crawler tracks becomes angularly inclined relative to paving direction 18. Computer 82 calculates by how much the angle of the crawler track has to be changed relative to the jacking column (which has also been angularly offset relative to the transport direction by the swivel motion of the swing leg) to reset the crawler track suspended from yoke 62 to the angular orientation of the desired paving direction. The onboard computer then signals by how much worm gear drive 60 must rotationally adjust the orientation of yoke 62 and crawler tracks 16 to again align the crawler tracks with the paving direction. This process is repeated each time the angular position of the swing leg is changed, or when for other reasons

the angular orientation of the crawler tracks becomes misaligned from the desired *paving direction* of the machine.

Thus, the above-described *feedback loop automatically adjusts the angular orientation of the crawler tracks so that the tracks remain oriented in the travel direction without any need to stop operation of the machine* or manually adjust the orientation of the tracks and/or the swing legs.

’318 Patent, 12:43-13:2 (emphasis added); Claim 1; *see also id.* at 11:54-57 (“Providing the slew gear with two oppositely arranged worm drives increases the power available to rotate the crawler track while a portion of the total machine load is carried by it.”).

38. In using the closed feedback loop in conjunction with the slew drive, the paving machine is allowed to remain underload and moving while simultaneously changing the angular orientation of the swing leg and crawler track on-the-fly. ’318 Patent, 15:63-16:14;

An onboard computer or other processor receives the outputs from the transducers and generates a signal to pivot the crawler track relative to the associated jacking column to keep the crawler tracks oriented in the paving direction when the angular orientation of the swing leg changes, and also keeps all the crawler tracks' orientations synchronized. ***Thus, no matter what the swing leg angle is, the crawler track stays straight ahead in the paving direction and position.***

Id. at 6:23-28 (emphasis added);

A closed loop feedback system that connects the hydraulic actuator for the swing leg, the rotary power drive for the crawler, and the onboard computer always maintains the swing leg angle at a fixed, preset angle. If the swing leg migrates away from a preset angle, the swing leg hydraulic cylinder is actuated to maintain the preset angle and at the same time the necessary adjustments to the crawler track orientation are made with the hydraulic rotary power drive or steering cylinder.

Id. at 6:41-49 (emphasis added);

Thus, the *crawler track positions can be relocated when the machine is walked forward or backward while the crawler tracks at all times stay in their straight-ahead normal operating orientation* and position without requiring any manual mechanical or electronic adjustments.

Id. at 6:53-57 (emphasis added); Ex. 1036 at 38-40 (during an IPR challenging a related patent, the Board recognized that the “on-the-fly” embodiment is where the crawler track is rotated when in contact with the ground). In the context of the intrinsic evidence, “on-the-fly” machine operation requires steering of the swing leg and/or crawler track when moving and under load.

39. The term “paving direction” also informs a person of ordinary skill that Claim 4’s “transport position” is different than the paving configuration and which is reached via on-the-fly coordinated steering of the crawler tracks and swing legs under load:

Working in conjunction with the swing leg position transducer, and after unpinning the swing leg hydraulic cylinder from the swing leg, the rotary actuators allow the machine to be preprogrammed to first turn the crawler tracks relative to the jacking columns normal to the paving direction, and then walk the crawler tracks on the ground in an arc around the pivot shaft of the swing legs into their outboard transport position (in which the crawlers are oriented 90°, i.e. substantially transverse to the paving direction) so that the paving machine can be sufficiently narrowed for moving it over ordinary highways to a new paving site with a legal or otherwise approved transport width dimension, or, for maneuvering the paving machine around a paving site which is tightly confined.

’318 Patent, 7:9-22; *id.* at 13:22-14:7 (describing the process for placing the machine into transport position “[w]ith the crawlers resting on the ground” and “walking [them] in an arc around the pivot shaft of the swing leg”); *Id.* at FIGs. 8A-E.

B. “a crawler track rotatably coupled to the jacking column” and “a slew drive coupled to the jacking column and the crawler track, wherein the slew drive is configured to cause rotation of the crawler track relative to the jacking column”

40. I agree with G&Z that the term “a crawler track rotatably coupled to the jacking column, wherein the crawler track is configured to rotate about a second axis to a second angular orientation relative to the jacking column” should be construed to mean that one side of the slew drive is coupled to the jacking column, one side of

the slew drive is coupled to the crawler track, and neither cylinder of the jacking column rotates along with the crawler track.

41. Unlike the '749 Patent, the '318 Patent's express claim language requires a slew drive that rotatably couples the crawler track to the jacking column and rotates the crawler track relative to the entire jacking column:

A swing leg assembly ...comprising:

* * *

a crawler track rotatably coupled to the jacking column, wherein the crawler track is configured to rotate about a second axis to a second angular orientation ***relative to the jacking column***;

a slew drive coupled to the jacking column and the crawler track, wherein the slew drive is configured to cause rotation of the crawler track ***relative to the jacking column***.

'318 Patent at Claim 1 (emphasis added). This language does not recite causing the crawler track to rotate relative to a portion of the jacking column.

42. This plain language reading of the claims is entirely consistent with every embodiment of the invention disclosed in the '318 Patent, which describes coupling a slew drive to the bottom of a rotationally-fixed jacking column, such that the crawler track rotates relative to the entire jacking column. *Id.* at Abstract (“A slew drive coupled to the jacking column and crawler track rotates the crawler track relative to the jacking column between multiple angular orientations.”), 8:65-9:1

(“The crawlers are mounted to the lower ends of the jacking columns, and they are rotatable relative to the jacking columns about vertical axes . . .”), 11:65-67 (“Supports 74 extend across opening 69 and secure the can with transducer 70 at the rotational center between the jacking column and the yoke.”), 12:6-9 (“a signal that indicates the angular position of yoke 62 relative to jacking column 14 and any changes in the angular position due to rotational movements of the yoke”), 12:56-60 (“The onboard computer then signals by how much worm gear drive 60 must rotationally adjust the orientation of yoke 62 and crawler tracks 16 to again align the crawler tracks with the paving direction.”); 13:25-30 (“With the crawlers resting on the ground and initially facing in the paving direction 18, they are rotated 90° about the vertical jacking column axis with worm gear drive 60 into a position in which they are substantially transverse to the paving direction.”).

43. Thus, a person of ordinary skill in the art applying the plain and ordinary meaning for these limitations would construe it to exclude arrangements where a rotary actuator turns either cylinder of the jacking column along with the crawler track.

**IX. GROUND 1: IN MY OPINION, THE CLAIMED INVENTION IS
PATENTABLE OVER THE *CIII* AND *RIO***

**A. *CIII* in View of *Rio* Does Not Disclose a Processor That
Coordinates the Movement of a Swing Leg and Crawler Track
While Moving in a Paving Direction**

44. In my opinion, the Challenged Claims are patentable because the combination of *CIII* and *Rio* does not disclose—and is not alleged to disclose—a processor that performs the claimed operations while the paver is moving in a paving direction. *See* Section VIII.A, *supra*; Pet. at 52-59 (describing operations that occur only when the crawler track is lifted off of the ground).

45. Petitioner’s obviousness arguments expressly depend on the premise that the ’318 Patent’s claims are not limited to the “on-the-fly steering” embodiment. *See* Pet. at 9-10. But rather than construe the claims of this patent, Petitioner suggests that the Board’s ’749 FWD resolves this issue. *See id.* at 10 (“Should Patent Owner again attempt to limit the claims to require on-the-fly steering, the Board should reject this argument for the same reasons as before—the claims lack any such requirement.”). Petitioner is wrong because unlike in the ’749 Patent, the Challenged Claims do recite “such [a] requirement.” *Id.* at 9-10; *see also* Section VII.A, *supra*. Unlike the ’318 Patent, Claim 1 of the ’749 Patent contained no requirement that the processor emit a control signal to move the crawler track in responses to changes in the swing leg orientation while *moving in a paving direction*. The Claims of the ’318 Patent *are* limited to the “embodiment where the crawler

track is rotated when the track is in contact with the ground.” Pet. at 9; Ex. 1036 (’749 FWD) at 35-40.

46. Indeed, the claims are further limited to an embodiment where the crawler track is rotated *responsive to changes in the orientation of the swing leg* while the paver is moving in a paving direction:

a processor configured to...

in response to determining the change of the first angular orientation,⁵
***determine a target second angular orientation⁶ based on the
determined change of the first angular orientation*** and the second
angular orientation based on the second signal; and

send a control signal to the slew drive in order to ***cause the second
angular orientation of the crawler track to rotate to the target second
angular orientation.***

See ’318 Patent, Claim 1 (emphasis added).

47. *CIII* and *Rio* both expressly prohibit moving their swing legs under load or while in motion and include locking mechanisms to ensure that such movement

⁵ The first angular orientation is the orientation of the swing leg “relative to the paving machine.” Ex. 1001 at Claim 1.

⁶ The second angular orientation is the orientation of the crawler track “relative to the jacking column.” Ex. 1001 at Claim 1.

cannot occur. *See CIII* at 80 (“To swing the assembly to the left from any position, remove the locking pin from the frame end of the mount and move the swing control switch to extend the swing cylinder, swinging the leg to the left, until the locking pin can be inserted in the desired position.”); *see also Rio*, 6:27-37 (disclosing an anti-swing device that engages with a pair of receptacles 88 in the machine frame to lock the swing arm 76 when the asphalt milling machine is in motion).

48. For at least the foregoing reasons, the Challenged Claims over *CIII* in view of *Rio*.

B. *CIII* in View of *Rio* Does Not Render Obvious “a crawler track rotatably coupled to the jacking column” or “a slew drive coupled to the jacking column and the crawler track . . . configured to cause rotation of the crawler track relative to the jacking column”

49. In my opinion, the Challenged Claims are also patentable because neither *CIII* nor *Rio* discloses a crawler track rotatably coupled to a jacking column, and Petitioner’s argument for combining *CIII* and *Rio* such that *CIII*’s crawler track would rotate with respect to the entirety of its jacking column is the product of impermissible hindsight.

50. The ’318 Patent requires coupling a slew drive to a jacking column and crawler track to implement the claimed rotatable coupling which is unlike the ’749 Patent that merely required a rotary actuator physically between the jacking column and crawler track, without any requirement that it be coupled to, or provide a rotatable connection between those elements. Ex. 1036 (’749 FWD) at 68-79.

1. Neither *CIII* nor *Rio* Expressly Discloses “a crawler track rotatably coupled to the jacking column”

51. In my opinion, neither *CIII* nor *Rio* discloses a swing leg assembly with a crawler track rotatably coupled to an entire jacking column. Instead, *CIII* and *Rio* both disclose assemblies where the inner tube of the jacking column rotates along with the crawler track. *CIII* at 378 (“On 4-track capable machines, the track yoke is bolted to the base plate of the inner guide tube.”); *Rio* at 5:32-6:6 (discussing the rotation of the inner tubular member 58 using a key and keyway arrangement to permit sliding between it and the outer cylinder 66); *see also* Ex. 1036 (’749 FWD) at 11-12, 77 (determining that *Rio* discloses a complex jacking column with an internal “key and keyway arrangement” controlling the rotation of the “inner tubular member” of its lifting column that “is connected to the bracket 54” which “may be a simple axial wheel support . . . or may support a track section.”).

52. The jacking column of the ’318 Patent similarly includes inner and outer tubes. ’318 Patent at 11:20-39. However, unlike the fixed connections between the inner cylinders and crawler tracks disclosed in *CIII* and *Rio*, the claimed crawler track is rotatably coupled to the jacking column in its entirety. Construing the claims to encompass rotation of the inner tube along with the crawler track would be inconsistent with the claim’s requirement that only the crawler track must rotate relative to the jacking column. *See* Section VIII.B, *supra*. Accordingly, as Dr. Singhose acknowledged on cross-examination, *Rio* does not expressly disclose a

crawler track rotatably coupled to a jacking column. Ex. 2012 (Singhose Tr. Day II) 18:3-18; 30:12-25. It also turns wheels, which are much easier to turn than crawler tracks.

2. Neither *CIII* nor *Rio* Expressly Discloses a Slew Drive Coupled to a Jacking Column and a Crawler Track

53. In my opinion, neither *CIII* and *Rio* disclose coupling a slew drive to ***a jacking column and a crawler track***, such that that crawler track rotates with respect to the entire jacking column. *CIII* admittedly does not disclose a slew drive. Pet. at 13-14. And *Rio* is clear that its second rotary actuator turns the milling machine’s crawler track by rotating the portion of the jacking column that is fixedly coupled to the crawler track:

The second actuator 44 is connected to the lifting column 46 and is ***adapted to cause at least a portion of the lifting column 46 to rotate about a lifting column axis 48*** that is oriented generally vertically relative to the work machine 12.

Rio, 4:56-60 (emphasis added); *id.* at 5:32-61 (The rotary actuator “causes the cylinder 66 to rotate as the cylinder flange 68 slides on the outer tubular member 60” of the lifting column). The cylinder 66 is engaged with the inner tubular member 58 by a pair of keys 74” and the corresponding key and keyway prevents relative rotational movement between the crawler track, inner tubular member 58, and cylinder 66. *Id.* at 5:63-6:6.

54. Rio does not describe *any* embodiments in which its second rotary actuator does not “cause at least a portion of the lifting column 46 to rotate about a lifting column axis 48.” Therefore, Rio fails to reasonably suggest coupling a slew drive to a jacking column and a crawler track such that the crawler track rotates with respect to both cylinders of the jacking column.

3. Petitioner’s Proposed Combination of Rio and CIII Uses the ’318 Patent as a Guide

55. Petitioner’s proposal to “modify each of CIII’s swing-leg assemblies by positioning Rio’s rotary actuator 44 between the jacking column and crawler track, and using that rotary actuator to rotate CIII’s crawler track relative to the entire jacking column, rather than just its outer cylinder,” is the product of looking to the ’318 Patent for guidance. Pet. at 45.

(a) The “State-of-the-Art” References are Not “State-of-the-Art” and Do Not Establish That it Was Well Known to Rotatably Couple a Crawler Track to a Jacking Column

56. I understand that Petitioner cites several “state-of-the-art references” for the proposition that “this design was well known.” *Id.*; *id.* at 27-38. I disagree. None of the many “state-of-the-art” references cited in the Petition—which are many decades old—disclose or even fairly suggest rotatably coupling a crawler track to a jacking column.

57. *Miller* does nothing to cure *CIII* and *Rio*’s deficiencies because its steering housing 122 is not a slew drive and is not coupled to the jacking column and crawler track, as claimed. *Miller*’s steering housing 122 is connected to the walking beam of the machine’s frame, not the jacking column. See *Miller* at 5:21-26 (describing that the “extendable support member” attaches to bogey mount 66, 68 not “steering housing 122”), 6:8-13 (“A steering spindle is provided at the ends of each walking beam. Thus, as previously described, the walking beam 64 has the steering spindles or housings 122 at its ends . . .”).

58. *Littman*’s prime mover is far afield from the concrete slipform paver disclosed in the ’318 Patent and fails to disclose a slew drive between a jacking column and a crawler track. See Ex. 1007 (“*Littman*”), 1:11-27; Ex. 2011 (Singhose Tr. Day I) at 152:1-153:12 (stating that *Littman*’s use in road construction would be similar to a forklift). Rather than being coupled to a jacking column and crawler track, *Littman*’s rotary actuator is located fully within the telescoping second section 70 that Petitioner likens to a jacking column. *Littman*, FIGs. 4, 5. Indeed, rather than disclose the type of upright jacking columns found in the ’318 Patent, *Littman*’s elongated legs articulate at angles during operation and, as such, its wheels are subject to an entirely different set of forces than those seen in the claimed slipform paver in the ’318 Patent. *Littman*, FIG. 2.

59. *Whitaker*’s supporting means 26 (which Petitioner likens to the claimed jacking column) has rectangular upper telescopic sections and a round lower end 28 that is fixedly coupled to the crawler track and ring gear 31. Ex. 1011 (“*Whitaker*”) at FIG. 3. Motor 32 is mounted on the lower end of the support shaft 26 and rotates lower section 28 in conjunction with its crawler track. *Id.* Accordingly, like *CIII* and *Rio*, *Whitaker* discloses rotating the crawler track along with a portion of the jacking column. Thus, *Whitaker* also does not establish that it “was well known” to rotate a crawler track relative to an entire jacking column, let alone doing so with a slew drive coupled to the jacking column and crawler track such that the crawler track rotates relative to the entire jacking column. Pet. at 45.

60. Ex. 1009 (“*Johns*”) also fails to establish that it was “well known” to place a slew drive physically between a jacking column and crawler track because *Johns*’ “mobile work platform” lacks a swing leg assembly and jacking column. It is also not comparable in size or weight to a conventional large concrete slipform paver. *Johns*, FIG. 2; Ex. 2012 (Singhose Tr. Day II) at 25:12-21. It also turns wheels, which are much easier to turn than crawler tracks.

61. Finally, Ex. 1021 (“*Smolders*”) is directed to a paving machine that discloses a steering design that relies upon the fixed connection between its lifting column and crawler track to rotate the lower portion of the lifting column when steering. *Smolders*, 6:35-41 (“two diametrically opposite groove-guided blocks 67

arranged in a groove on the inner periphery of Steering ring 66 while projecting radially inwardly and engaging corresponding longitudinal grooves 65 of the lower portion 9 of lifting column 10”); *see also id.* at 6:15-34 (describing the steering gear mechanism 32 and how it attaches to the lifting column).

62. In my opinion, Petitioner’s primary references do not teach or suggest rotatably coupling a crawler track to a jacking column with a slew drive. And far from confirming that the claimed design was well known, the “state-of-the-art” references disclose several ways to turn a wheel or a crawler track with a rotary actuator that *do not* involve (1) rotating the crawler track with respect to an entire jacking column or (2) coupling a slew drive to a crawler track and jacking column to cause such rotational movement.

**(b) Petitioner’s Proposed Combination Merely Uses the
’318 Patent to Retrace the Inventors Steps**

63. In my opinion, because none of the art disclose the claimed limitations, Petitioner’s proposal to rotatably couple *CIII*’s crawler track to its jacking column with *Rio*’s rotary actuator simply uses the ’318 Patent to retrace the inventor’s path.

**(c) A POSITA Would Not Have Expected a Reasonable
Expectation of Success in Modifying *CIII* with *Rio***

64. It is my opinion, that when considering whether it would have been obvious to apply *Rio*’s teachings to *CIII*, a POSITA would look to evidence of how

well the design operated in the real world as part of the routine engineering process. In doing so, they would have discovered that the machines implementing one or more aspects of *Rio*’s teachings only had one swing leg, and it had to be lifted off the ground when relocating the track. *Supra* at §III.B.1; *see also e.g.*, Ex. 2018 at 1-2; Ex. 2017 at 27; Ex. 2011 (Singhose Tr. Day I) at 81:16-83:3.

65. They would also notice that in asphalt milling machines that included crawler tracks, those machines used conventional steering cylinders, not rotary actuators. *Supra* at §VII.B. Because of the similarities in weight and the forces required to rotate the crawler tracks in *CIII* and *Rio*, a POSITA would not have expected success in a design where the rotation of the crawler track was not performed by rotating at least the lower portion of the jacking column as well. Dr. Singhose acknowledged that due to the weight of the machines and the extra friction, crawler tracks require more torque to rotate than wheels, especially on unprepared, uneven, or loose ground. Ex. 2011 (Singhose Tr. Day I) at 70:8-73:17; 114:10-24; 144:18-145:11.

66. The only physical machine the Petition and Dr. Singhose attempt to extract knowledge from is Gomaco’s own GT-3200, which was a fraction of the size of *CIII* and *Rio*. Ex. 1010 at 8 (weight is 13,000-16,000 lbs.); Ex. 2010 (Klein Tr.) at 36:16-18 [REDACTED]; Ex. 2037 (GT-3200 Brochure) at 4. Thus, a POSITA around the time of filing, would

have been aware of the physical implementation of *Rio* and understood the limitations of its rotary actuator design in smaller paving machines, such that they would not have been motivated to implement the modifications proposed in the Petition on the larger CIII.

X. Ground 2: IN MY OPINION, THE CLAIMED INVENTION IS PATENTABLE OVER THE *CIII-RIO-SMOLDERS* COMBINATION

67. The Petition does not allege that *Smolders* cures any of the deficiencies noted above with respect to Independent Claim 1. Accordingly, it is my opinion that Claims 2-7 are patentable for at least the same reasons as Independent Claim 1.

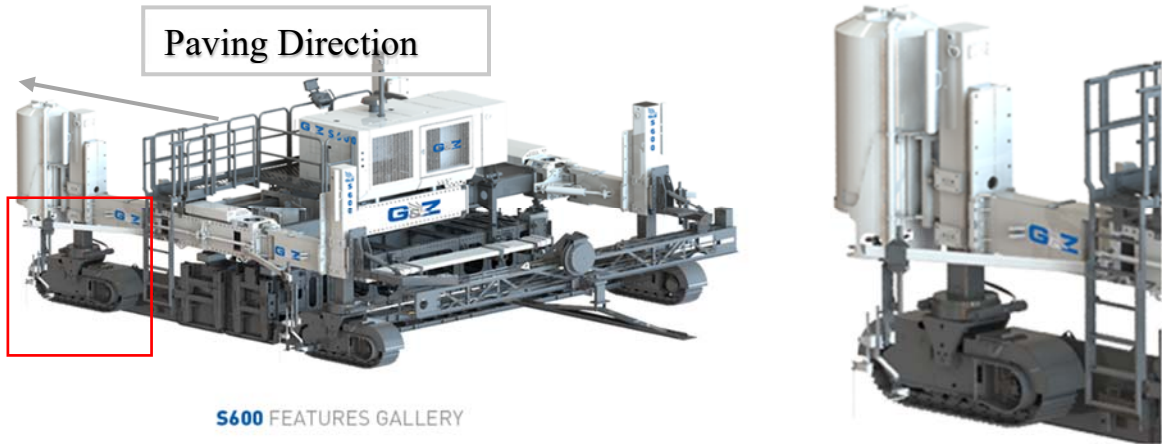
XI. IN MY OPINION, THE OBJECTIVE INDICIA OF NONOBVIOUSNESS CONFIRMS PATENTABILITY OVER THE *CIII-RIO* COMBINATIONS

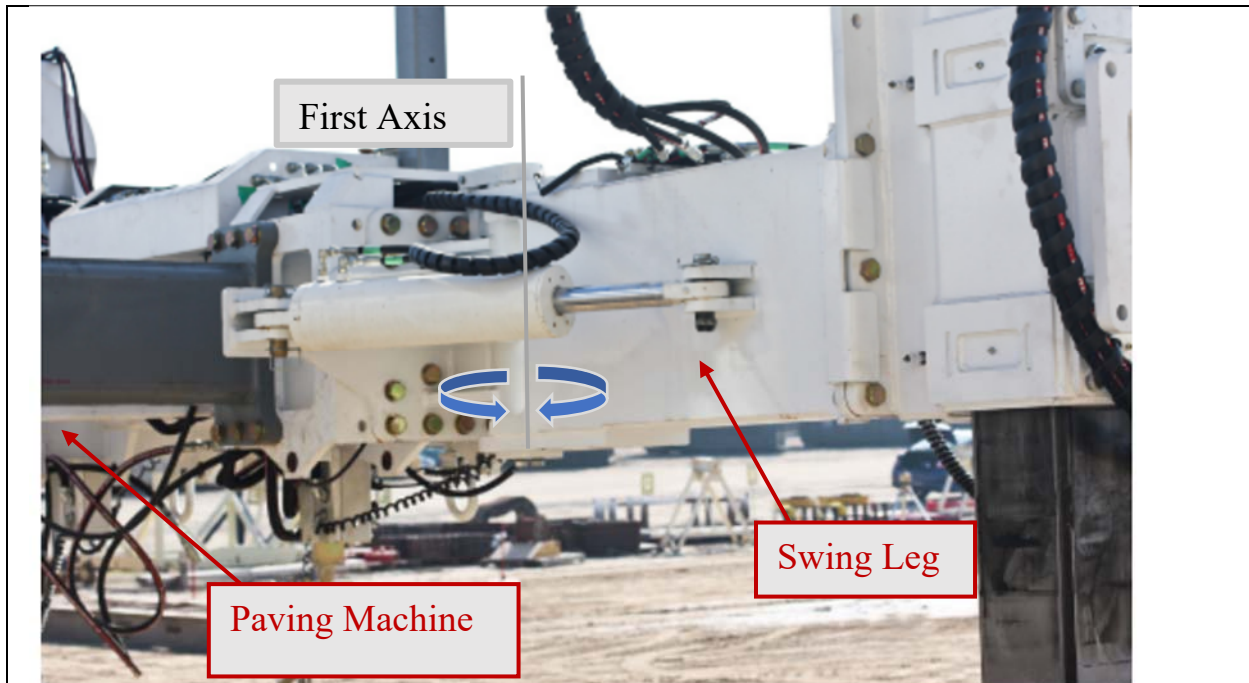
A. The Objective Indicia Evidence is the Direct Result of the Unique Characteristics of the Claimed Invention, Practiced by G&Z’s S600 Paving Machines

68. I have been informed that for objective indicia to carry any weight, there must be a nexus between the merits of the claimed invention and the objective evidence. This can be established by showing that the evidence is a direct result of the unique characteristics of the claimed invention. In my opinion, the evidence discussed herein is directly tied to the claimed invention.

69. In my opinion, a nexus is shown, at the very least, through the S600’s implementation of unique characteristics of the claimed invention’s swing leg, slew

drive, sensors, and processor features enabling its SmartLeg / AccuSteer Technology, as shown below.

'318 Patent, Claim [1Pre]	A swing leg assembly configured to be coupled to a paving machine configured to move in a paving direction for spreading, leveling, and finishing concrete into a form having a generally upwardly exposed, finished concrete surface and terminating in lateral concrete sides, the swing arm assembly comprising:
 Ex. 2038 at 1	
'318 Patent, Claim [1A]	a swing leg configured to be coupled to the paving machine, and configured to pivot about a first axis to a first angular orientation relative to the paving machine;



SmartLeg

The S600 is also available with the new and patented SmartLeg: Swing Leg System. Working in tandem with the AccuSteer steering system, the SmartLeg System allows the operator to adjust the bolster swing leg angle on the fly by means of a hydraulic cylinder and bolster angle transducer which relocates the crawler track while automatically keeping the crawler track straight ahead. This system allows the contractor to maneuver around track line obstacles (e.g. fire hydrants, airport runway lights, light poles, etc.) on the fly without the need of stopping to make a bolster swing leg mechanical adjustment or resetting the steering transducer.

Ex. 2038 at 4;

SMARTLEG SWING LEG SYSTEM



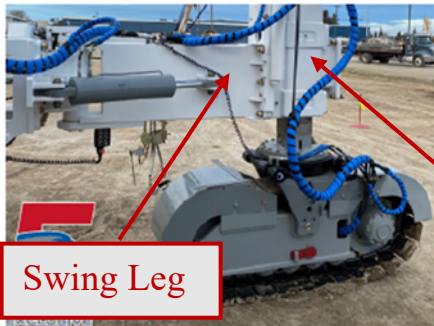
▲
The SmartLeg system in tandem with AccuSteer allows the swing leg angle to be adjusted on-the-fly to maneuver around an obstacle while automatically keeping the crawler track straight ahead.

Ex. 2019 (G&Z S600) at 4; Ex. 2039 (GZ 007789 - S600) at 5.

**'318 Patent, Claim
[1B]**

a jacking column coupled to the swing leg;

SMARTLEG SWING LEG SYSTEM

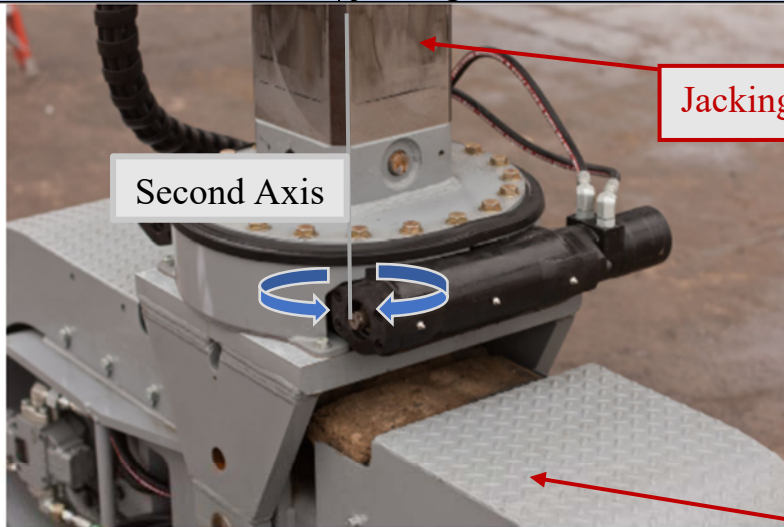


▲
The SmartLeg system in tandem with AccuSteer allows the swing leg angle to be adjusted on-the-fly to maneuver around an obstacle while automatically keeping the crawler track straight ahead.

Ex. 2019 (G&Z S600) at 4.

**'318 Patent, Claim
[1C]**

a crawler track rotatably coupled to the jacking column,
wherein the crawler track is configured to rotate about a
second axis to a second angular orientation relative to the
jacking column;



Jacking Column

Second Axis

Crawler Track

AccuSteer

As an option, the S600 can be equipped with the patented AccuSteer: Slew Drive Track Control System. The AccuSteer system uses slew drives which are mounted on top of the crawler track yokes to steer the tracks in lieu of conventional steering cylinders. They eliminate the need to repin steering cylinders and reset the steering transducer when changing the swing leg/crawler track position. The AccuSteer slew drives are powered with dual hydraulic motor driven hourglass worm gears giving enormous power and gear life to the gearbox. The AccuSteer system allows the operator to independently rotate each crawler track 320 degrees providing unparalleled paver maneuverability on site, rapid swing leg relocation for paving and transport, and speeds width change. This option includes the required heavier duty jacking columns and reinforced track yokes. These jacking columns have 42" (1.1m) of hydraulic lift and 36" (915mm) of mechanical bolting adjustment.

Ex. 2038 at 3;

ACCUSTEER SLEW DRIVE TRACK CONTROL

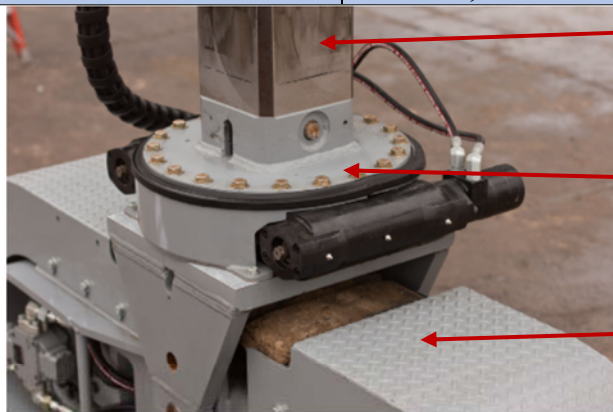


▲
The AccuSteer system offers unparalleled maneuverability and accuracy allowing synchronized steering in 90 degree mode in every swing leg position.

Ex. 2019 (G&Z S600) at 4; Ex. 2039 at 4.

'318 Patent, Claim 1: [1D]

a slew drive coupled to the jacking column and the crawler track, wherein the slew drive is configured to cause rotation of the crawler track relative to the jacking column;



Jacking Column

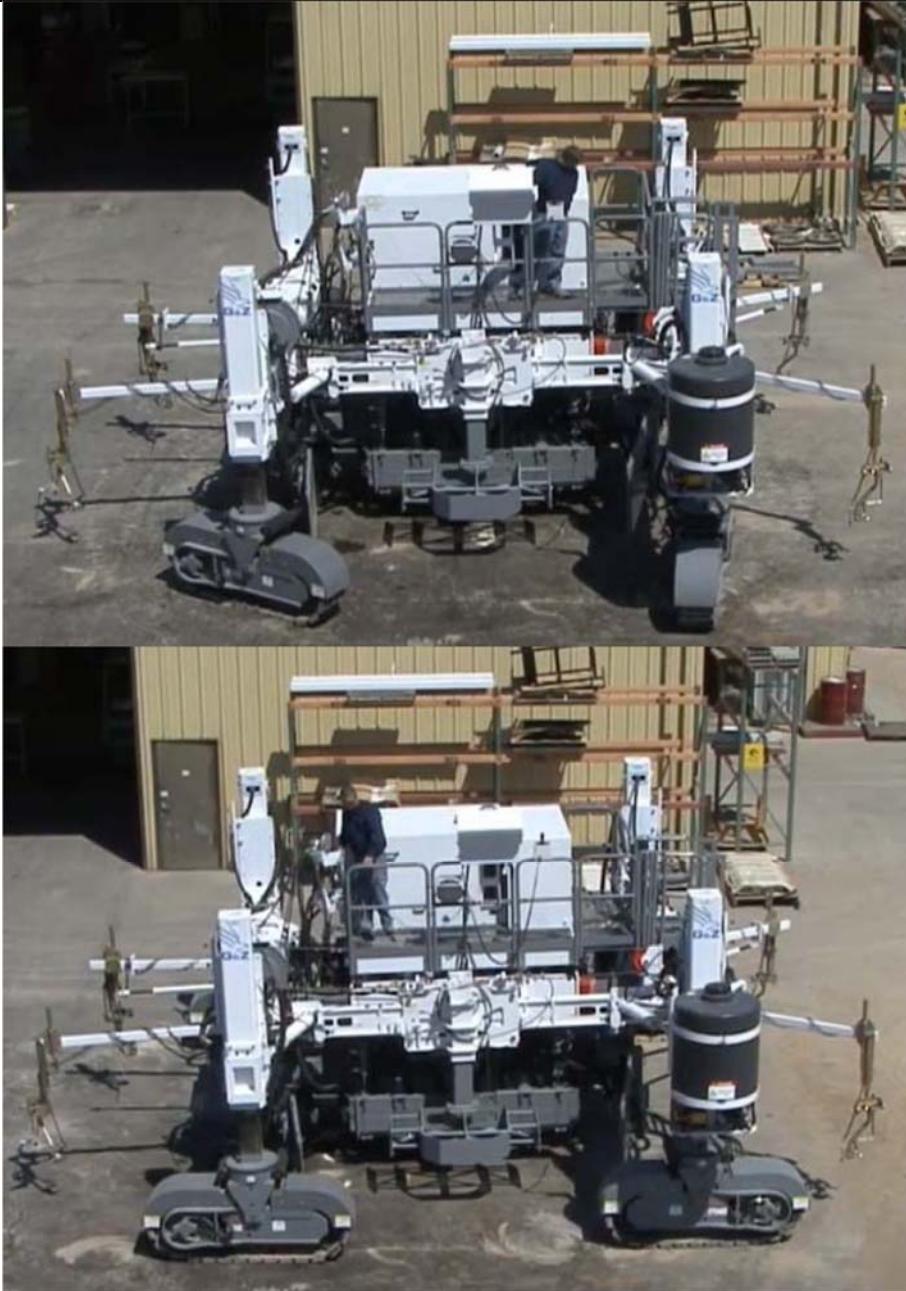
Slew Drive

Crawler Track

AccuSteer

As an option, the S600 can be equipped with the patented AccuSteer: Slew Drive Track Control System. The AccuSteer system uses slew drives which are mounted on top of the crawler track yokes to steer the tracks in lieu of conventional steering cylinders. They eliminate the need to repin steering cylinders and reset the steering transducer when changing the swing leg/crawler track position. The AccuSteer slew drives are powered with dual hydraulic motor driven hourglass worm gears giving enormous power and gear life to the gearbox. The AccuSteer system allows the operator to independently rotate each crawler track 320 degrees providing unparalleled paver maneuverability on site, rapid swing leg relocation for paving and transport, and speeds width change. This option includes the required heavier duty jacking columns and reinforced track yokes. These jacking columns have 42" (1.1m) of hydraulic lift and 36" (915mm) of mechanical bolting adjustment.

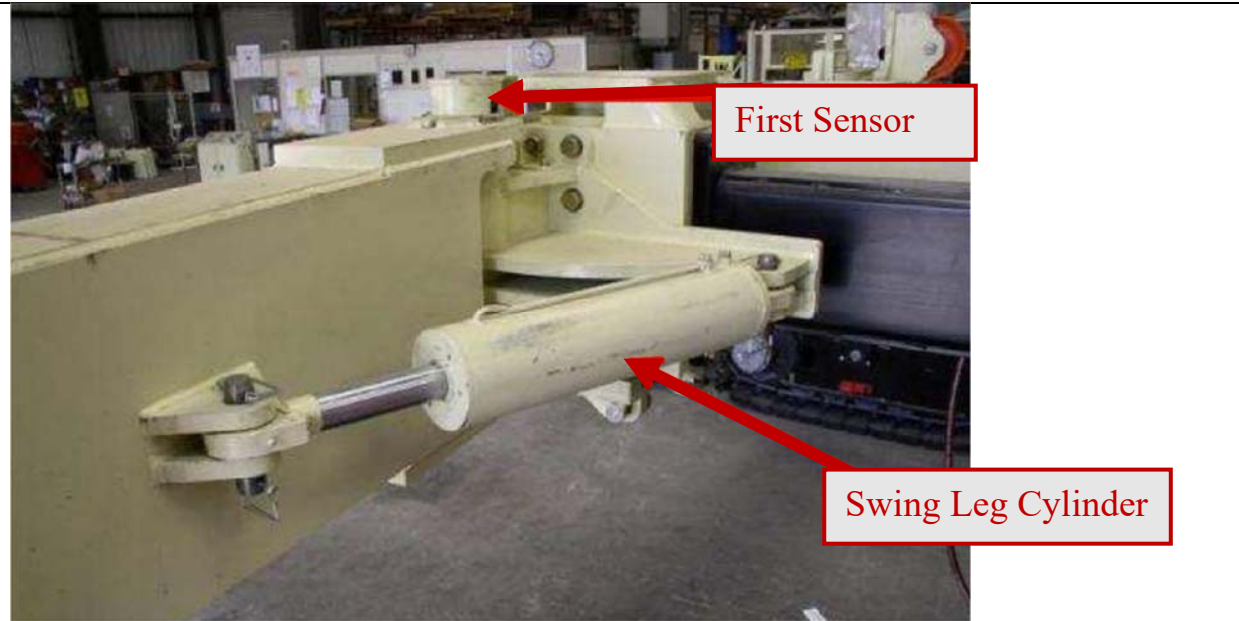
Ex. 2038 at 3; *id.* at 7 (showing 90-degree steering of crawler tracks using the slew drive); Ex. 2019 at 4; Ex. 2039 at 4;



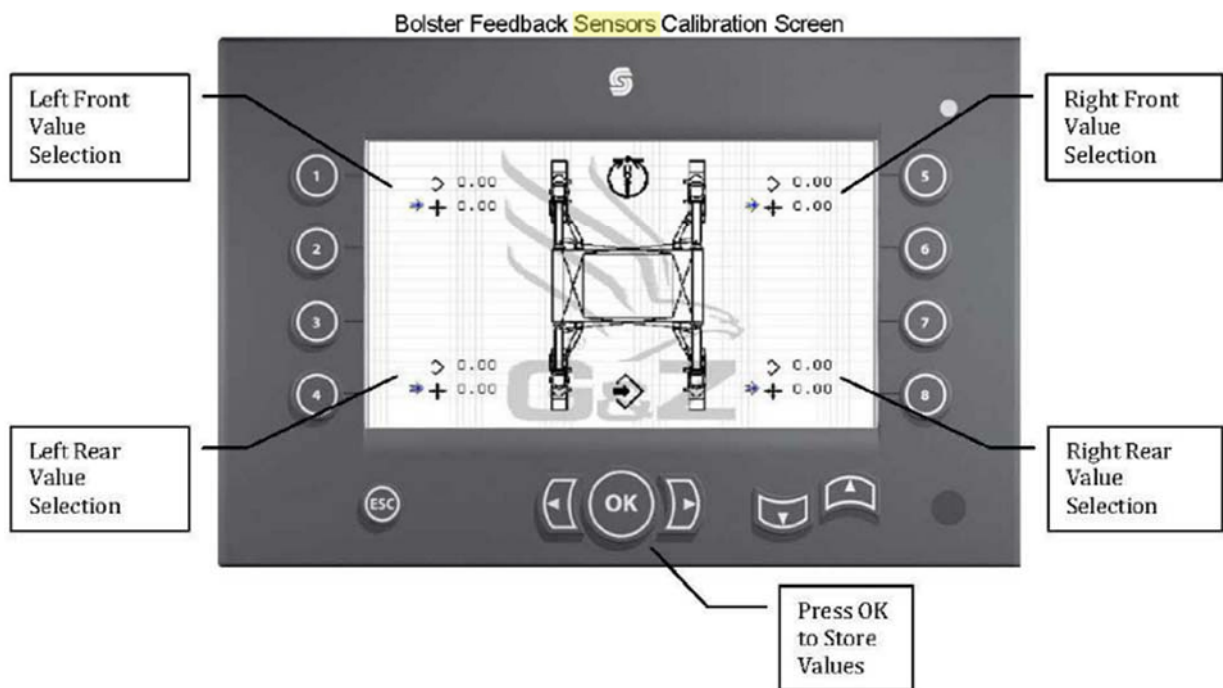
Ex. 2040 (S600 Slipform Paver) (showing the S600's slew drive causing rotation of the crawler tracks relative to the jacking column).

**'318 Patent, Claim
1: [1E]**

a first sensor configured to emit a first signal
corresponding to the first angular orientation;



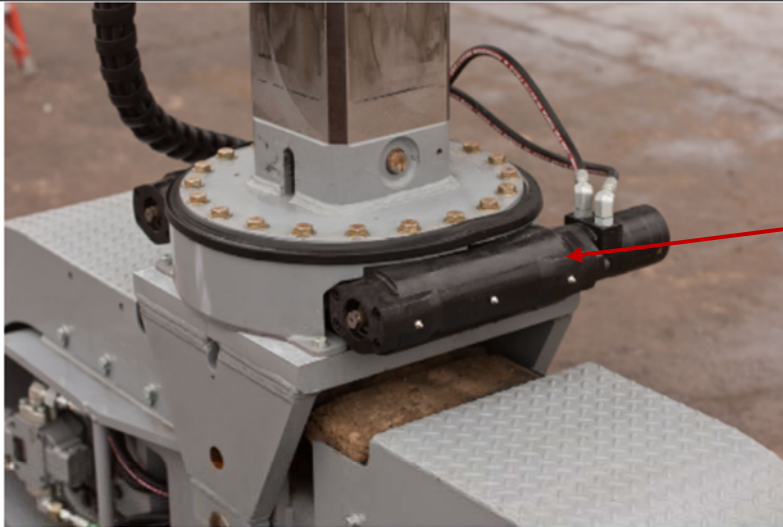
See above image of S600 SmartLeg sensor and cylinder;



Ex. 2041 (S600 operating manual) at 34(showing S600’s processor receiving signals from its SmartLeg sensor);

’318 Patent, Claim 1: [1F]

a second sensor configured to emit a second signal corresponding to the second angular orientation; and



Slew Drive with
Steering Sensor

AccuSteer

As an option, the S600 can be equipped with the patented AccuSteer: Slew Drive Track Control System. The AccuSteer system uses slew drives which are mounted on top of the crawler track yokes to steer the tracks in lieu of conventional steering cylinders. They eliminate the need to repin steering cylinders and reset the steering transducer when changing the swing leg/crawler track position. The AccuSteer slew drives are powered with dual hydraulic motor driven hourglass worm gears giving enormous power and gear life to the gearbox. The AccuSteer system allows the operator to independently rotate each crawler track 320 degrees providing unparalleled paver maneuverability on site, rapid swing leg relocation for paving and transport, and speeds width change. This option includes the required heavier duty jacking columns and reinforced track yokes. These jacking columns have 42" (1.1m) of hydraulic lift and 36" (915mm) of mechanical bolting adjustment.

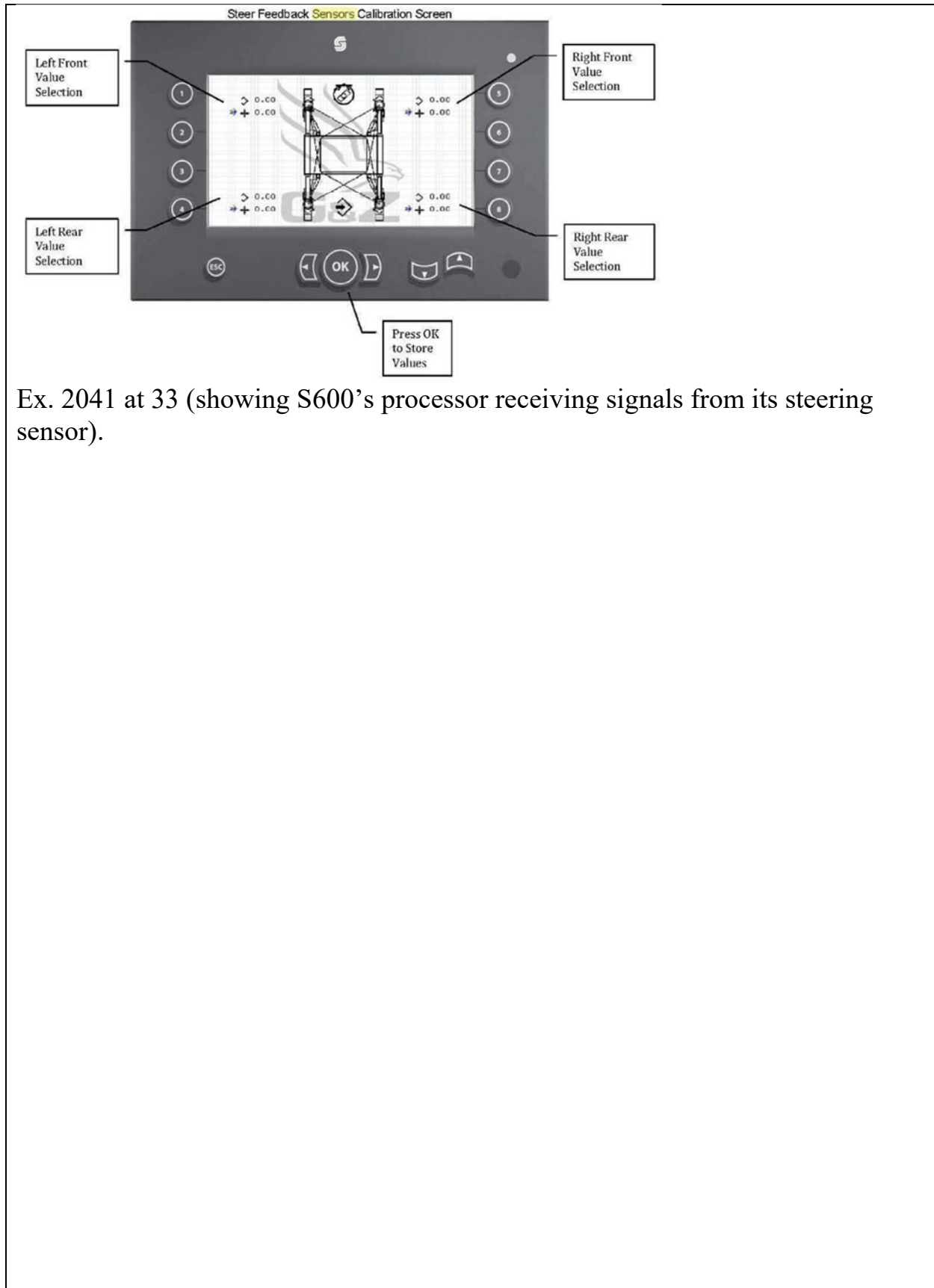
Ex. 2038 at 3;

ACCUSTEER SLEW DRIVE TRACK CONTROL



The AccuSteer system offers unparalleled maneuverability and accuracy allowing synchronized steering in 90 degree mode in every swing leg position.

Ex. 2019 at 4; Ex. 2039 at 4;



Ex. 2041 at 33 (showing S600’s processor receiving signals from its steering sensor).

**’318 Patent, Claim
[1G]**

a processor configured to:
receive the first signal from the first sensor, and the
second signal from the second sensor;

determine a change of the first angular orientation based
on the first signal;

in response to determining the change of the first angular
orientation, determine a target second angular
orientation based on the determined change of the
first angular orientation and the second angular
orientation based on the second signal; and

send a control signal to the slew drive in order to cause
the second angular orientation of the crawler track to
rotate to the target second angular orientation.



Operator Controls

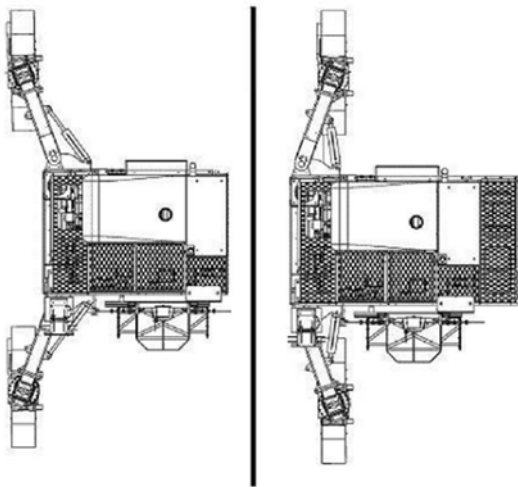
G&Z Next Generation Plus 1 Operator Control System incorporates user friendly operator features and state of the art networked controllers allowing extensive monitoring and diagnostic capability including remote diagnostics. The Operator Console features intuitively organized switches which are labeled with standard ISO symbols making this a durable, easy to use, multi-lingual user interface.

Ex. 2038 at 5; Ex. 2019 at 4 (showing reconfiguration of the crawler track based upon changes in the angular orientation of the swing leg while moving underload); Ex. 2021 at 7 (describing how the S600 uses its AccuSteer and

SmartLeg systems in tandem to “adjust the swing leg angle on the fly while automatically keeping the track straight ahead.”);

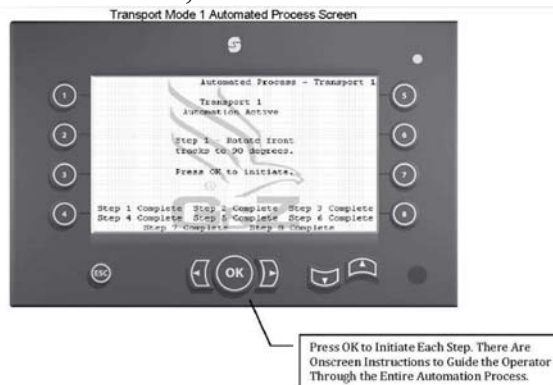
HYDRAULIC SWINGLEG SYSTEM

As an option, the Hydraulic SwingLeg system is used in lieu of the standard adjustable turnbuckles. Working in tandem with the crawler track slew drives, the SmartLeg system allows the operator to adjust the bolster swing leg angle on the fly by means of a hydraulic cylinder and a bolster angle transducer, which relocates the crawler track while keeping the crawler track pointing straight ahead. This allows contractors to maneuver around track line obstacles on the fly without need of stopping to make a mechanical adjustment and re-calibrating the **sensor** transducer.

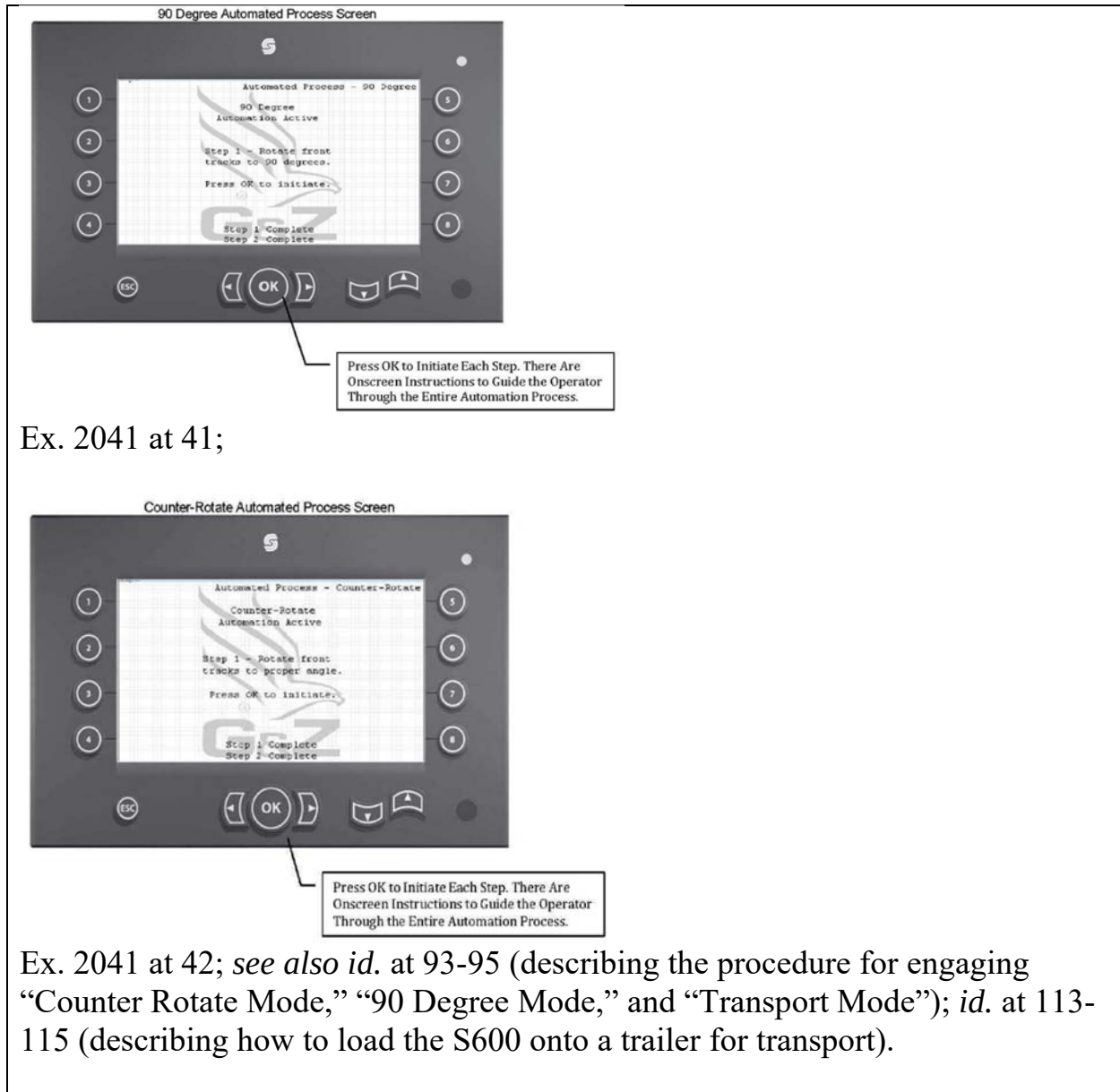


Inboard/Outboard Positions

Ex. 2041 at 77;



Ex. 2041 at 41;



B. G&Z’s SmartLeg/AccuSteer Technology Resolved a Decade Long Need For Repositioning the Swing Leg/Crawler Track When Moving and Under Load

70. After reviewing the evidence, it is my opinion that G&Z’s claimed swing leg assembly solution, as embodied on the S600, solved the long-felt industry need for a slipform paver with greater maneuverability as the limited

mobility of conventional slipform pavers was also manually intensive, costly, and prohibitive.

71. I understand that by the early 2000s, contractors began requesting a slipform paver that could maneuver in the tight confines of urban and airport worksites, as the industry began moving towards more jobs centered on repairing roads rather than originally laying them down on undeveloped ground where space was not limited and maintaining traffic was not an issue. Ex. 2022 (“Greenwood Decl.”) at ¶¶ 3, 5.

72. As discussed above, conventional slipform pavers did not have the maneuverability to accomplish the jobs on these sites demanded in either a cost or time efficient manner. I understand that this was because an operator had to stop the slipform paver and raise the crawler track off the ground, manually unpin the turnbuckles on each swing leg, reposition each leg, then repin and attach the turnbuckles to the swing leg, unpin and detach the jacking column hydraulic steering cylinder, then reattach the hydraulic steering cylinder, reposition each crawler track, and recalibrate the steering sensors, before finally lowering the crawler track to the ground so the machine can begin working again in the paving direction. ’318 Patent at 1:28-5:61. These manual adjustments were due to the conventional design, as each swing leg had a turnbuckle(s) or locking pins, and an

upright jacking column with a steering cylinder located on it. ’318 Patent at 2:12-3:5, 4:20-36.

73. The swing leg’s turnbuckle(s) or locking pins locked the jacking column and crawler track into position and any necessary change in configuration that was needed to move around the job site, avoid obstacles, or pave in a narrow profile required a time-consuming manual process that I understand, could take up to half a day. Guntert Decl. at ¶¶4-5; Greenwood Decl. at ¶¶ 3-4. Further, the hydraulic steering cylinder had to be manually repined to relocate the crawler track, and it offered only limited crawler track steering angles making quick adjustments nearly impossible. ’318 Patent at 4:20-36.

74. Given these drawbacks for the conventional slipform paver design at the time, there existed a need for a slipform paver that was able to: (1) reposition each swing leg and crawler track simultaneously while under load and continuing to move in a paving direction; (2) quickly transform the machine from a paving mode to 90 degree steering position for maneuvering on site, width change or configuring the machine into the transport mode; and (3) enable a wide range of steering angles regardless of the angular orientation of the swing leg. Guntert Decl. at ¶13; Greenwood Decl. at ¶ 4.

75. Upon its release in 2010, G&Z’s S600 solved these issues using its SmartLeg / AccuSteer technology. Ex. 2021 at 5-8 (G&Z Fall 2010 Newsletter

announcing the “New S600 Multi-Purpose Slipform Paver”); Ex. 2014 at 1-2 (describing the S600 with SmartLeg / AccuSteer as “providing exceptional maneuverability on site” and offering “a high level of flexibility for the contractor to maneuver around track line obstacles (e.g. fire hydrants, airport runway lights, etc.) on the fly and without stopping”).

76. I understand Mr. Greenwood is a seasoned veteran within the paving industry, articulated that “a slipform company that could respond to the industry demands by introducing a slipform paver that can on-the-fly reposition its swing legs and crawler tracks and relocate the crawler tracks to a 90 degree steering position for maneuvering and to walk the slipform paver out from a paving mode and into the transport mode **would have a license [to] print money.**” Greenwood Decl., ¶ 4.

77. AccuSteer also works to enable the benefit of “quick telescopic tractor width changes” with VariWidth by “walk[ing] the machine in or out using 90-degree steering mode.” 2014 at 2 (describing VariWidth working together with AccuSteer as a “huge time saver”); *see also e.g.* 2042 at 21 (describing AccuSteer and SmartLeg systems).

78. The S600 with SmartLeg / AccuSteer technology would have dramatically improved productivity because it made possible to maneuver the swing leg with jacking column and crawler track position simultaneously, on-the-

fly, under load, to avoid obstacles in the paving path. Greenwood Decl. at ¶¶ 6-7. It also quickly and easily changed the slipform paver from the paving mode to the transport mode, vice versa, using 90-degree steering. Guntert Decl., ¶¶ 16-19; Greenwood Decl. at ¶¶ 4, 6-7.

79. With these improvements over conventional pavers, it is my opinion that the S600 with SmartLeg / AccuSteer technology became the gold standard in the paving community. The S600’s maneuverability and versatile paving applications, provide contractors with a machine capable of center-line paving, side-mounted paving and barrier paving, easy transport, and easy to set-up, change width and breakdown. These functionalities are among the primary considerations of contractors, even today, purchase a paving machine. Ex. 2043 at 1-2 (2022 article discussing purchasing considerations with representatives from Gomaco, Wirtgen, and Power Curbers Companies).

C. The S600’s Use of a Slew Drive for Driving And Steering Under Load Overcame Industry Skepticism

80. The record evidence also shows that due to the weight of the paving machines at issue and the forces required to reposition and maintain the crawler track when under load, those skilled in the art were skeptical of the use of a slew drive for repositioning the track when moving and under load.

81. I note that Kinematics, a motion control company that manufactures slew drives was skeptical of the use of a slew drive in a paving machine because

[REDACTED]

[REDACTED] Ex. 2013 at 1 (July 14, 2009 message email from the President of Kinematics Manufacturing Inc.). Even G&Z’s VP of Engineering expressed doubt in a slew drive design stating that he did not [REDACTED]

[REDACTED] Ex. 2024 at 4 (June 19, 2009 e-mail).

D. GOMACO and Other Competitors Copied G&Z’s S600 With SmartLeg/AccuSteer Technology

82. In my opinion, given the access to G&Z’s paving machines and the substantial similarity in pavers, GOMACO copied G&Z’s S600’s technology.

83. I understand that following the release of the S600 with SmartLeg/AccuSteer technology, G&Z displayed the S600 at a trade show event (ConExpo 2011) that GOMACO attended. Ex. 2025 at 5 (describing that ConExpo 2011 G&Z displayed its S600 machine and a demonstrated the machine’s ability to navigate around obstacles and transform from paving mode to transport mode):



Guntert Decl., ¶ 18 (depicting G&Z S600 at ConExpo 2011).

84. ConExpo bills itself as “the largest construction show in North America” and in 2011 it lived up to its hype. Ex. 2027 at 1. The 2011 ConExpo attracted nearly 120,000 attendees from all over the globe, 2,400 exhibitors, and held hundreds of industry meeting and educational seminars. Ex. 2026 at 1-2; Ex. 2027 at 1-2.

1. GOMACO

85. The evidence shows that Gomaco had access to the S600 starting at least as early as ConExpo 2011, and the S600 is marked with the '318 Patent and every other patent in its family. Ex. 2044 at 1 (showing the S600 marked by US Patent Nos. 8,459,898; 9,359,727; 10,589,807; 11,535,318; 11,772,723).

86. Gomaco was at ConExpo 2011, in Booth 5111, where it displayed its new line of products. Ex. 2028 at 2. There Gomaco would have up-close access to

the design and functionality of G&Z’s S600 with SmartLeg / AccuSteer technology.

[REDACTED]

[REDACTED]

[REDACTED] Ex. 2010 at 18:17-20:24; *id.* at 16:20-18:3 [REDACTED]

[REDACTED]

87. The evidence also shows that Gomaco did not release its GP3 with its smart leg and smart steering until at least 2015, and in the previous action for the ’749 Patent, the earliest Petitioner has evidenced as having started developing the design [REDACTED] Ex. 1036 at 55, 60, 84, 88-91 (citing to Exs. 1165, 2002, 2003, 2011, 2054, and 2055 which are all from [REDACTED]); Ex. 2010 at 11:10-14:2 [REDACTED]

[REDACTED]

[REDACTED] Ex. 2045 at 3-4 (Gomaco introduced its “new GP3 slipform paver” at World of Concrete in Las Vegas).

88. This evidence also shows that when developing the GP3, Gomaco investigated different kinds of rotary actuators to solve the maneuverability problem before deciding to copy G&Z’s design. Ex. 1036 at 60, 90 (finding Petitioner changed its design as part of the “typical engineering processes”). Any claim that Gomaco was unaware of G&Z’s S600 and its SmartLeg / AccuSteer slew drive

technology when developing the GP3 in [REDACTED], does not hold water. Ex. 1036 at 90; Ex. 2010 at 16:3-11. The facts clearly show that Gomaco would have been aware of G&Z’s use of a slew drive to allow for 90-degree steering and its ability to coordinate the movements of its swing legs and crawler tracks while under load.

89. G&Z and Gomaco compete in a niche market and for the same customers. Ex. 2010 at 42:4-13, 43:14-45:12. Thus, given the narrow competition between the limited players in the concrete slipform paver field, it is my opinion that each company would naturally keep close tabs on its competitors’ technological developments. *Id.* at 17:17-18:3. In this case, Gomaco would have had at least 3 years of observational information and feedback on the performance and utility of the S600.

90. The GP3 was the first machine to debut for Gomaco using its slew drive smart leg and steering design in 2015 and is copied its design from G&Z’s S600:

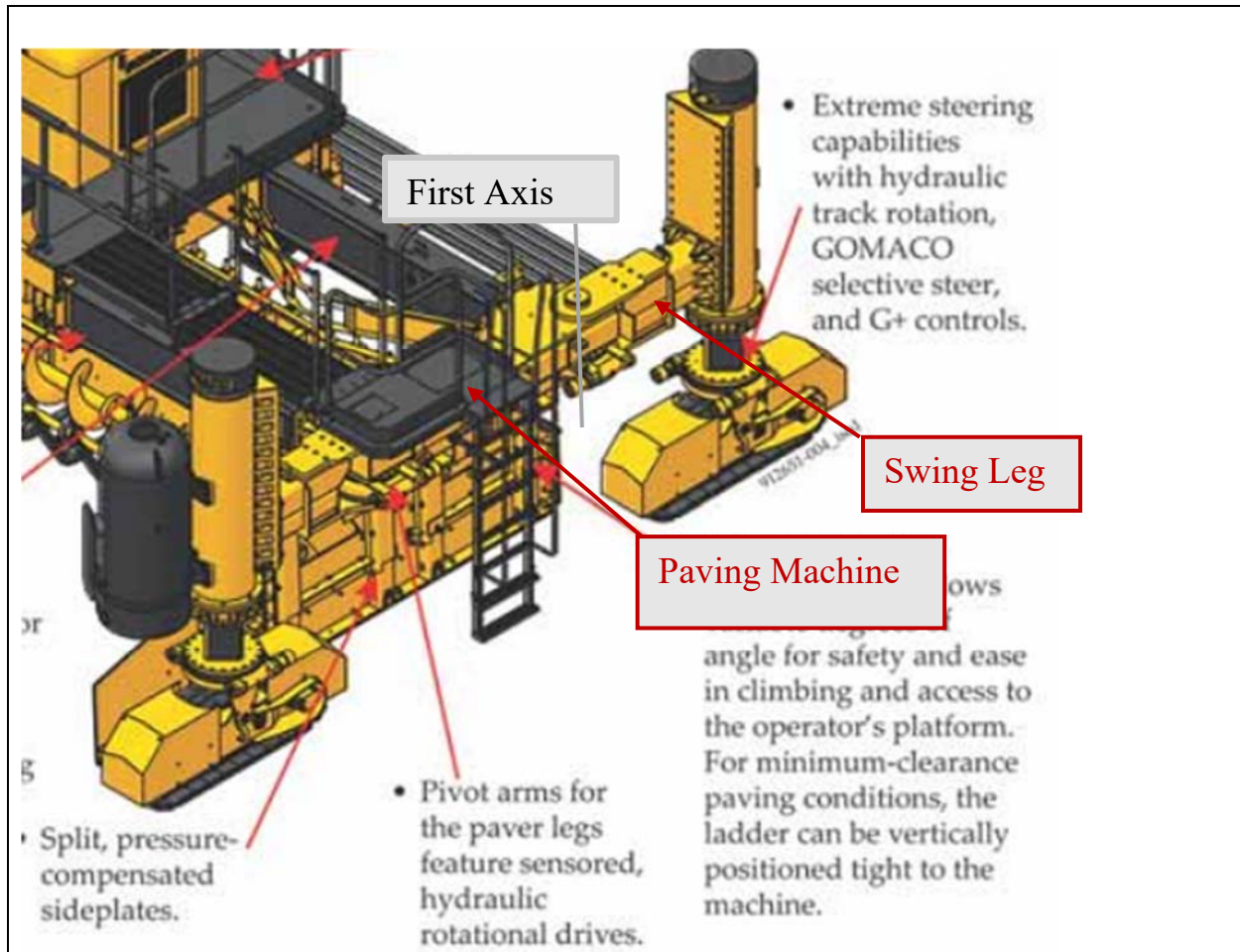
'318 Patent, Claim [1Pre]	A swing leg assembly configured to be coupled to a paving machine configured to move in a paving direction for spreading, leveling, and finishing concrete into a form having a generally upwardly exposed, finished concrete surface and terminating in lateral concrete sides, the swing arm assembly comprising:
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Ex. 2029 at 1

**'318 Patent, Claim
[1A]**

a swing leg configured to be coupled to the paving machine, and configured to pivot about a first axis to a first angular orientation relative to the paving machine;



Ex. 2029 at 5

'318 Patent, Claim
[1B]

a jacking column coupled to the swing leg;

Smart Leg Positioning

Pivot arms for the paver legs feature sensed, hydraulic rotational drives. These Smart Pivots provide the G+ controls with information on the angle of rotation, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering.

Smart Track Steering

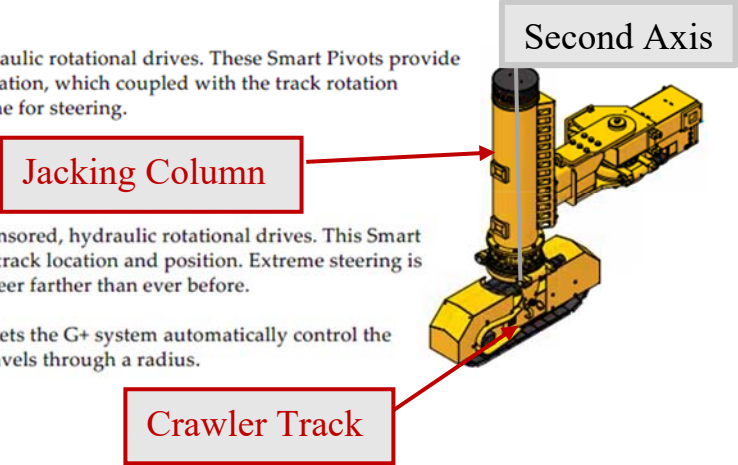
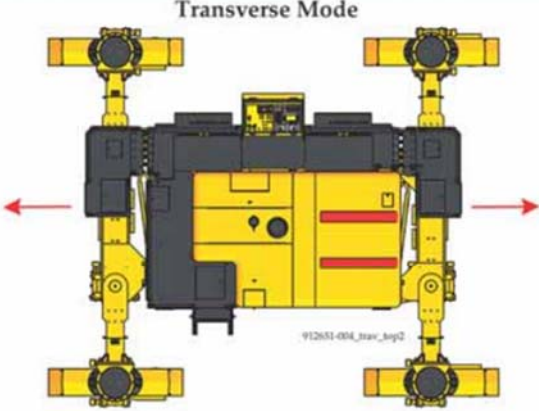
Track steering and rotation is accomplished with sensed, hydraulic rotational drives. This Smart Track Rotation provides the G+ controls with exact track location and position. Extreme steering is now possible with the tracks having the ability to steer farther than ever before.

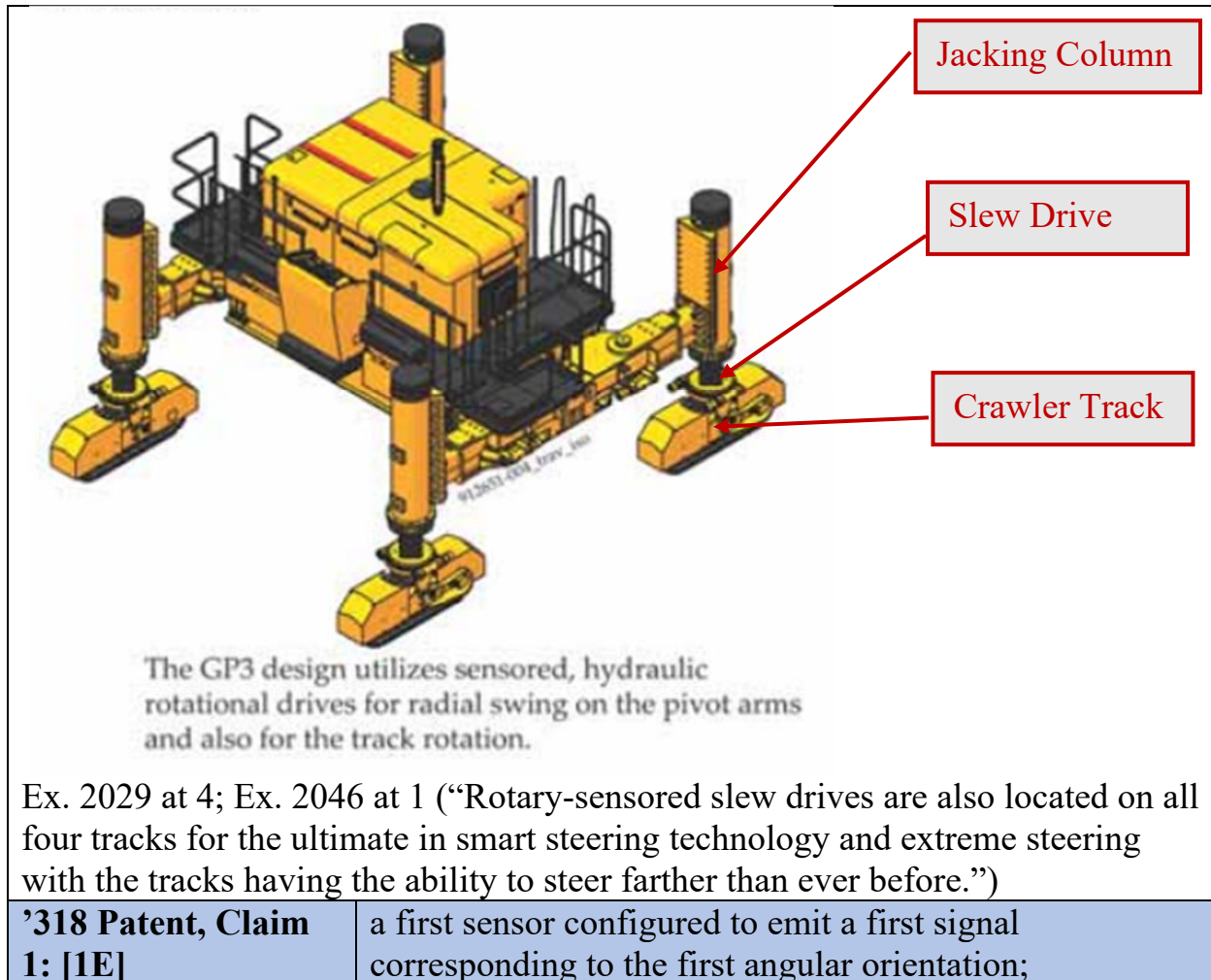
Smart Leg Pivoting and Smart Track Rotation now lets the G+ system automatically control the direction and speed of each individual track as it travels through a radius.

Jacking Column

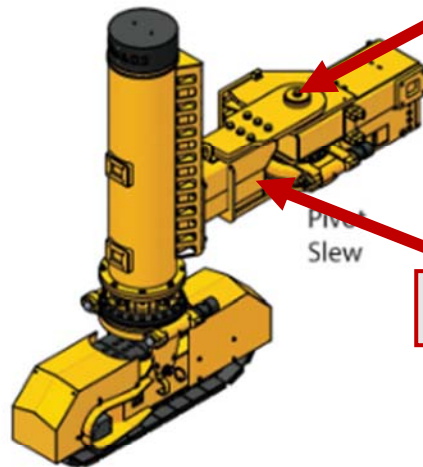
Swing Leg

Ex. 2029 at 3

’318 Patent, Claim [1C]	a crawler track rotatably coupled to the jacking column, wherein the crawler track is configured to rotate about a second axis to a second angular orientation relative to the jacking column;
Smart Leg Positioning Pivot arms for the paver legs feature sensed, hydraulic rotational drives. These Smart Pivots provide the G+ controls with information on the angle of rotation, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering. Smart Track Steering Track steering and rotation is accomplished with sensed, hydraulic rotational drives. This Smart Track Rotation provides the G+ controls with exact track location and position. Extreme steering is now possible with the tracks having the ability to steer farther than ever before. Smart Leg Pivoting and Smart Track Rotation now lets the G+ system automatically control the direction and speed of each individual track as it travels through a radius. Ex. 2029 at 3;	 Transverse Mode  Sensed steer feedback with sensed leg pivots provide continuous reference for the straight-ahead track positioning. Full-steer tracks are turned perpendicular to the straight-ahead line. The G+ control system recognizes the track positioning and provides automatic steering control in the transverse mode. Ex. 2029 at 4
’318 Patent, Claim 1: [1D]	a slew drive coupled to the jacking column and the crawler track, wherein the slew drive is configured to cause rotation of the crawler track relative to the jacking column;



Smart Leg Positioning on Four-Track Pavers



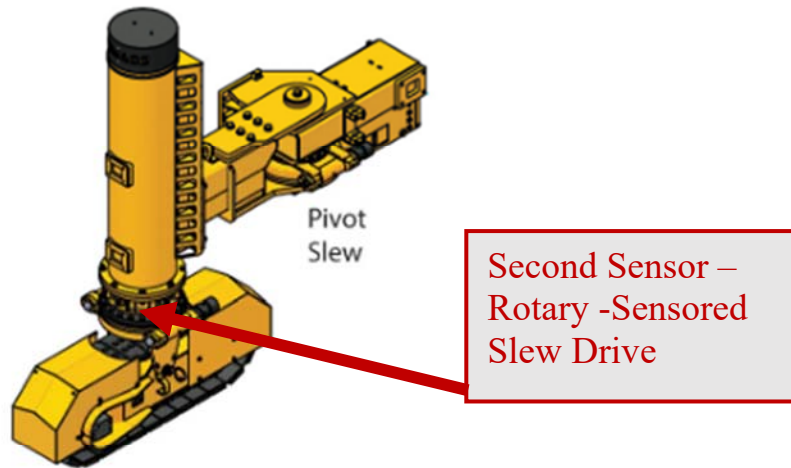
Pivot arms for the paver legs feature rotary-sensored slew drives. These smart pivots provide the G+ controls with information on the pivot arm angle, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering, even when the leg pivot is at an angle.

Ex. 2046 at 24.

**'318 Patent, Claim
1: [1F]**

a second sensor configured to emit a second signal corresponding to the second angular orientation; and

Smart Leg Positioning on Four-Track Pavers



Pivot arms for the paver legs feature rotary-sensored slew drives. These smart pivots provide the G+ controls with information on the pivot arm angle, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering, even when the leg pivot is at an angle.

Ex. 2046 at 24.

**'318 Patent, Claim
[1G]**

a processor configured to:

receive the first signal from the first sensor, and the second signal from the second sensor;

determine a change of the first angular orientation based on the first signal;

in response to determining the change of the first angular orientation, determine a target second angular orientation based on the determined change of the first angular orientation and the second angular orientation based on the second signal; and

send a control signal to the slew drive in order to cause the second angular orientation of the crawler track to rotate to the target second angular orientation.



Ex. 2046 at 12-13 (G+ control system “includes leg position, paving speed and percentage of drive, steering, travel information, grade information, deviation meters, and more.”); *id.* at 1 (“The smart pivots on the legs provide the exclusive G+ control system with information on the pivot arm angle and works together with the track rotation sensors to maintain the tracks in the straight-ahead steering line.”);

Transport Mode

The GP3 slipform paver is designed for easy transport. A retractable, sliding console reduces the shipping width of the machine. The paver can be switched to the transport mode by simply driving the legs around to the transport position. After the legs are in the transport position, G+ travel is switched to “transport” for complete control. The operator can take this paver to the transport mode in minutes without assistance.



Ex. 2029 at 3;

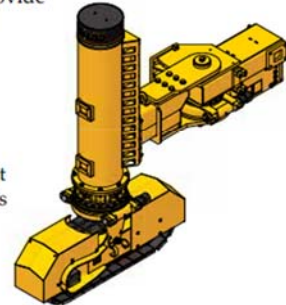
Smart Leg Positioning

Pivot arms for the paver legs feature sensed, hydraulic rotational drives. These Smart Pivots provide the G+ controls with information on the angle of rotation, which coupled with the track rotation sensors, maintain the tracks in the straight-ahead line for steering.

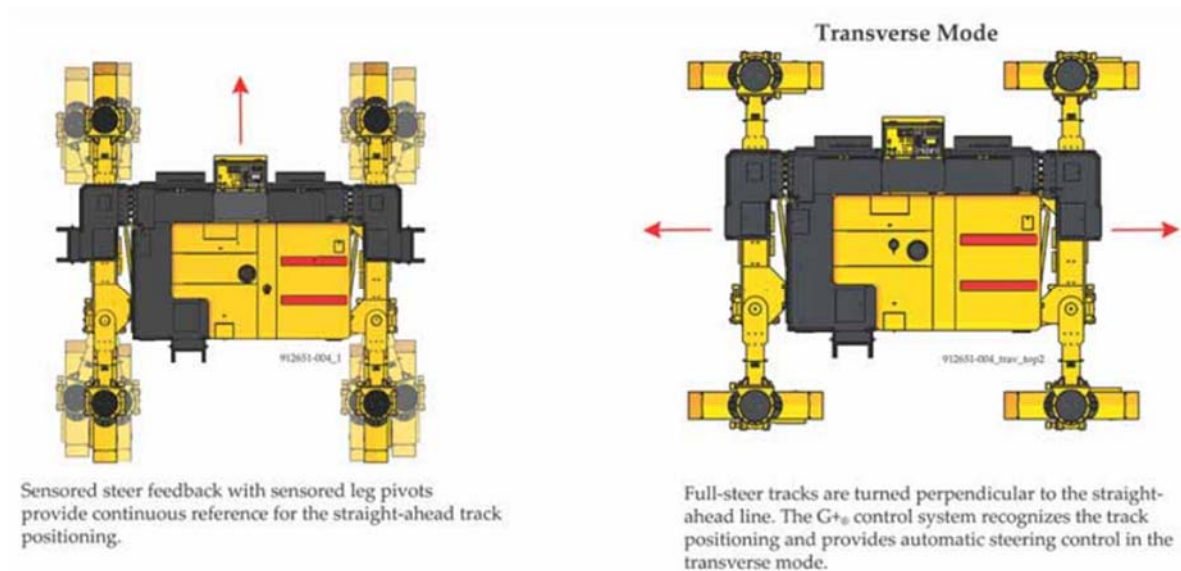
Smart Track Steering

Track steering and rotation is accomplished with sensed, hydraulic rotational drives. This Smart Track Rotation provides the G+ controls with exact track location and position. Extreme steering is now possible with the tracks having the ability to steer farther than ever before.

Smart Leg Pivoting and Smart Track Rotation now lets the G+ system automatically control the direction and speed of each individual track as it travels through a radius.



Ex. 2029 at 3;



Ex. 2029 at 4;

91. In addition to these features, it is also my opinion that the GP3 has the same frame widening features as S600 and paving kit Telescoping / Telescopic End Sections. *C.f.* Ex. 2029 at 3 (Smart Width provides easy, accurate width change setup and also a reference for G+ to control proper steering and track speeds) *with* changes Ex. 2019 at 5-6 (paving kit Telescopic / Telescoping End Sections “TeleEnd” and VariWidth systems provide fast and easy width changes to the machine frame). GP3 also has a paver mounted front tie bar inserter and dowel bar inserter attachment and the ability utilize multiple paving kit configurations for both inset and offset paving, same as the S600. Ex. 2029 at 5-7; Ex.2019 at 5-7, 10-11.

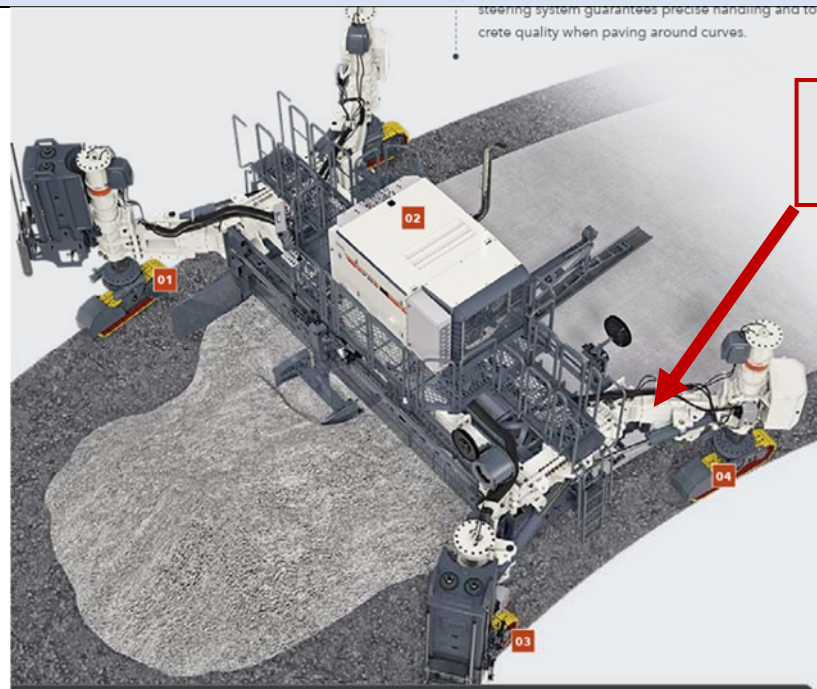
92. Thus, it is my opinion that Gomaco’s access to the S600, delay in altering their GP3 design to be the same as the S600 shows copying.

2. Wirtgen

93. The evidence shows that Wirtgen Gmbh / Wirtgen America, Inc. (“Wirtgen”), is another company in the concrete slipform paver industry and released a slipform paver which, in my opinion, copied G&Z’s S600 design with its SmartLeg / AccuSteer features. Wirtgen was at ConExpo Las Vegas 2011 and would have had access to the G&Z S600 on display and its demonstrations. Ex. 2051. Below, I illustrate the similarities between G&Z’s SmartLeg/AccuSteer features in its S600 Slipform Paver Machine and Wirtgen’s SP64i slipform paver

machine. The SP64i was debuted by Wirtgen in 2017. Ex. 2052 (Wirtgen to premier new paving range in Las Vegas) at 2.

Wirtgen SP64i



‘318 Patent –
Claim [1pre]

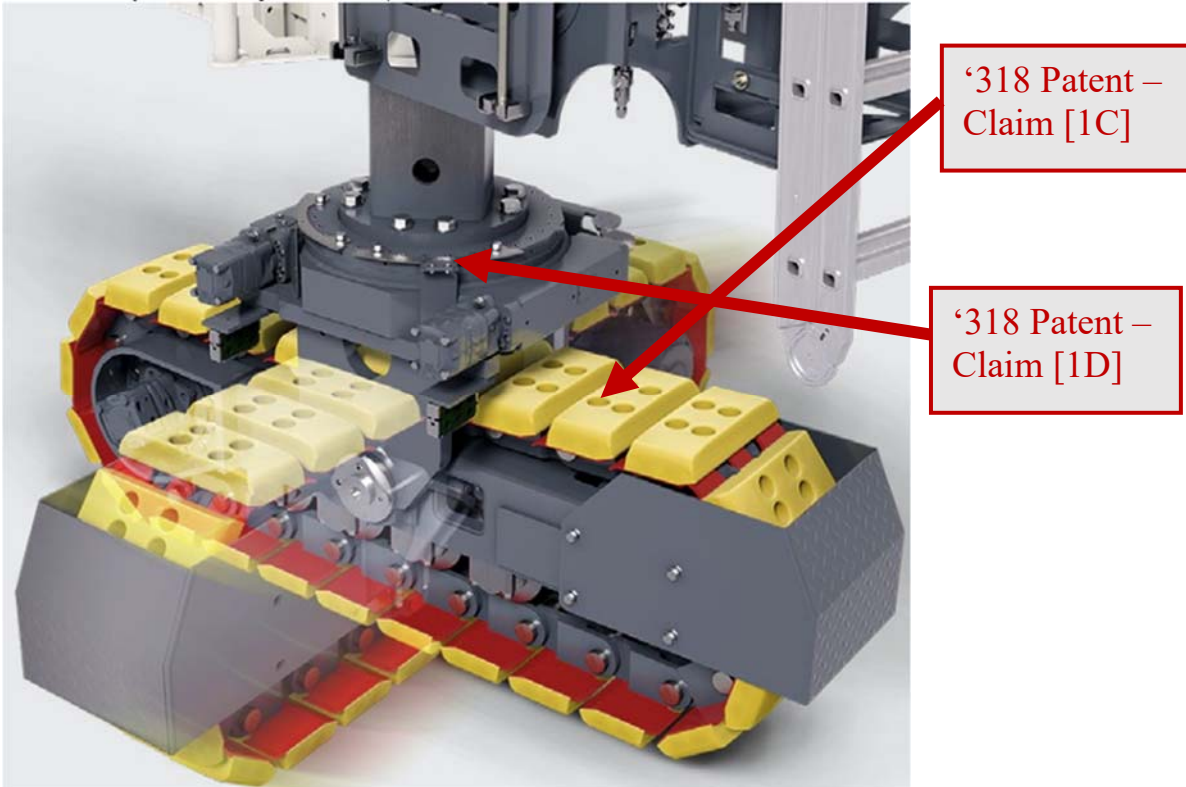
Ex. 2053 at 21;



‘318 Patent –
Claim [1A]

‘318 Patent –
Claim [1B]

Ex. 2053 at 13 (“Crawler units with a wide slewing angle guarantee maximum flexibility on the job site”);



id. at 20-25 (showing the use of the slew drive to rotate the crawler track in unison with the swivel arm for steering and altering the machine configuration, i.e. paving mode or transport mode);

Innovative Worm Gear Steering

The crawler units' steering angles of up to 100° to the left and 160° to the right increase flexibility, such as the ability to easily approach obstacles, particularly on tight job sites.

Crab mode with track units at a steering angle of 90° to the side

Transmission steering allows the machine move sideways with the crawler units rotated by 90°. At the same time, this reduces time-consuming manual paving at the end of the lane, which is often necessary on cramped sites, to a minimum.

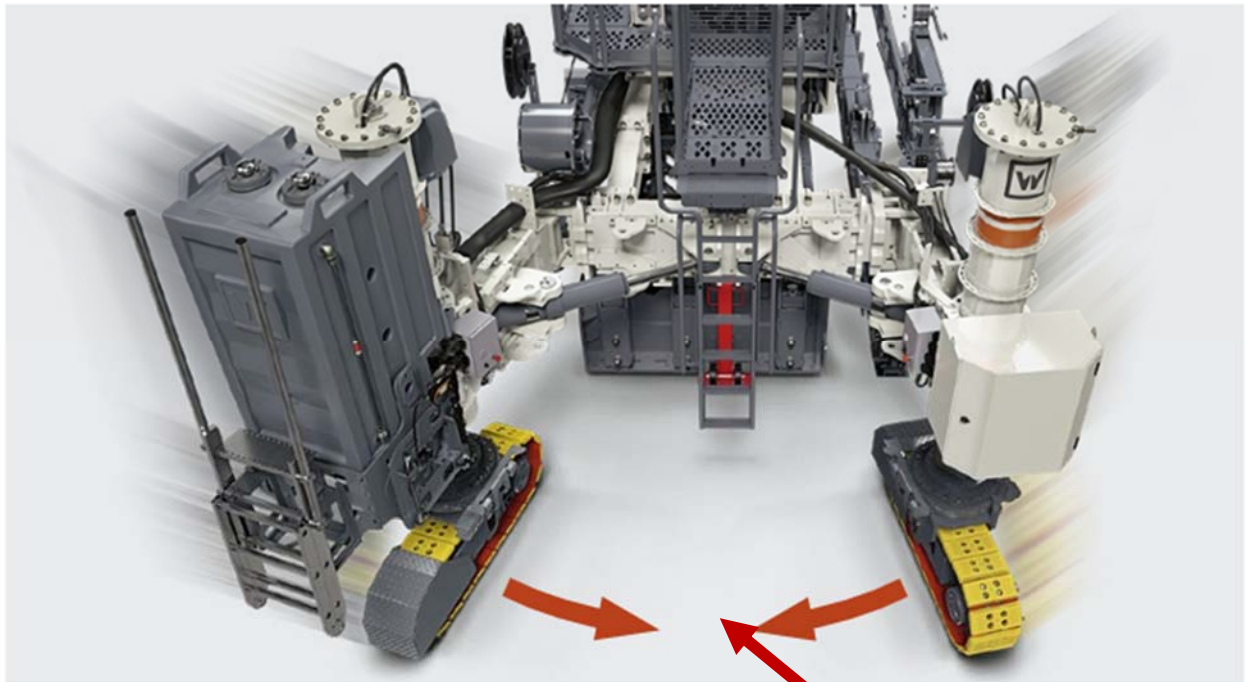
Rotating around Its Own Axis

Rotating the machine around its own axis by means of widely slewable crawler units eliminates the need for time-consuming turning maneuvers in confined construction site conditions.

Paving Plus Package

The additional sensors that can be integrated into the swivel arms optimize machine control.

Id. at 23;



id. at 25;

**04 Steering Angle Sensor Adjustment /
Field-Proven Track Steering**

On the SP 64i, the fully automatic adjustment of the steering angle of all of the crawler units optimizes the machine's driving performance, making high-precision concrete paving possible. Alternatively, the SP 62i's sensitive track steering system guarantees precise handling and top concrete quality when paving around curves.

‘318 Patent –
Claim [1E-G]

id. at 20; *id.* at 23 (Innovative Worm Gear Steering – The crawler units’ steering angles of up to 100 degrees to the left and 160 degrees to the right increase flexibility, such as the ability to easily approach obstacles, particularly on tight job sites)

E. The Competitor’s Praised G&Z’s SmartLeg/AccuSteer Technology Through Copying While the Paving Industry in General Praised the Technology Through Recognition of its Significance

94. The evidence also shows that G&Z’s competitors and the paving industry praised G&Z’s SmartLeg/AccuSteer technology. As established above, GOMACO and other competitors copied the SmartLeg/AccuSteer technology, which those skilled in the art recognize is a form of praise and flattery.

95. In my opinion, the S600 with its SmartLeg / AccuSteer technology responded to industry need for improved maneuverability and was praised by the industry for redefining what mobility means. Today, the S600 design with its SmartLeg / AccuSteer technology represents the industry standard performance that contractors require in a paving machine. For example, Heavy Equipment Guide stated that:

Guntert & Zimmerman (G&Z) has announced the release of the S600 Multi-Purpose Slipform Paver. The G&Z S600 Slipform Paver is designed around a multi-purpose tractor frame that makes it ideal for city street, secondary roads, highway and airport paving as well as a wide range of other applications such as barrier walls, off-set paving and zero or minimum clearance paving. The S600’s design has redefined what mobility means for a small paver without sacrificing the same performance advantages contractors have come to expect from G&Z’s large and mid-size paver. Utilizing G&Z’s time tested and rugged paving kit design, the S600 is capable of achieving excellent ride numbers on the toughest IRI and zero blanking band projects.

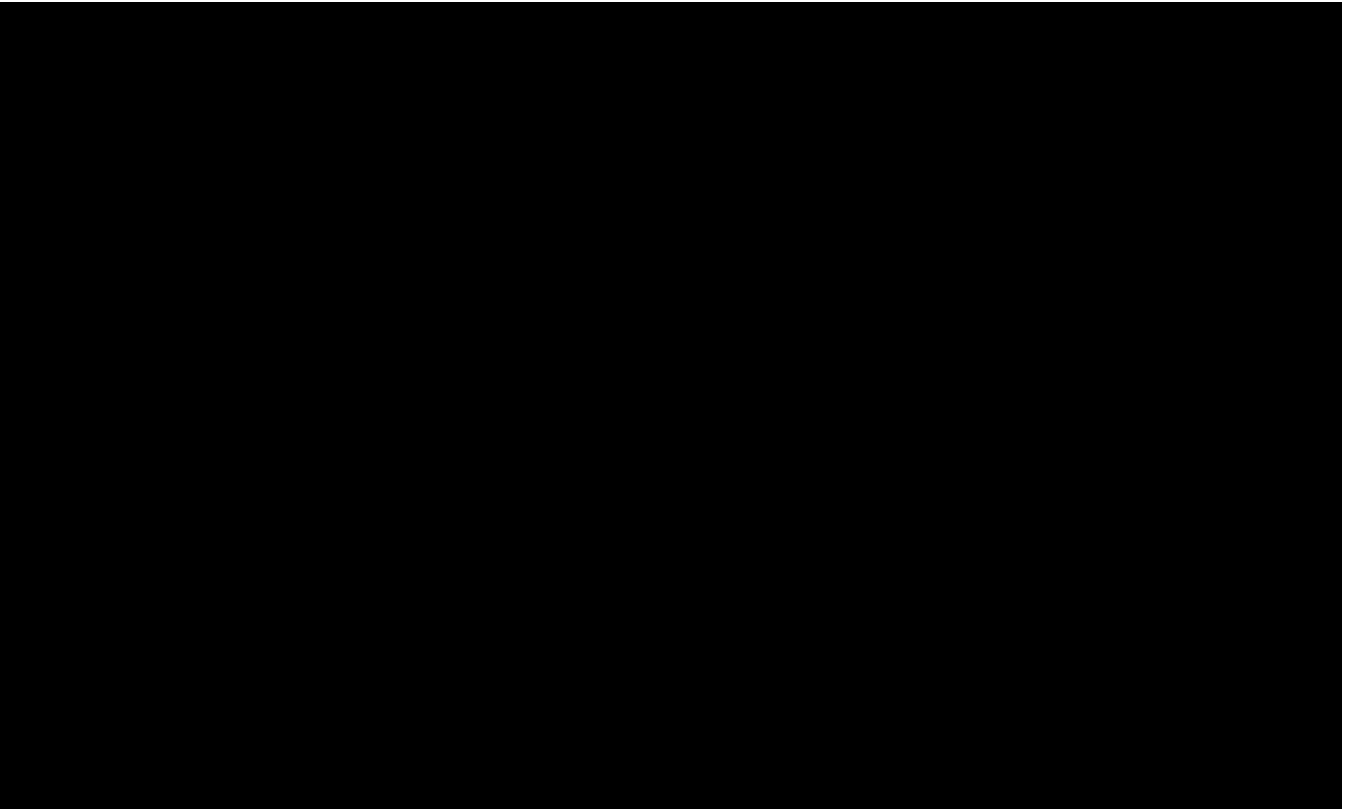
2014 at 1; *id.* (“The versatility of the S600 tractor allows the contractor to quickly switch between applications and paving widths.”).

96. In my opinion the fact that G&Z sold four prior S600s before ever formally introducing it to the market is significant industry praise. Ex. 2025 at 5.

The evidence also shows that contractors were purchasing G&Z’s slipform pavers with the SmartLeg / AccuSteer technology for urban paving and rehabbing highway road construction projects with much success. Ex. 2054 at 1-4 (describing the use of a S850SL with swing legs on a key section of interstate, close to Columbia, S.C.); Ex. 2055 at 1-4 (describing the use of an S600 for use in a rehabilitation project for road where two interstates meet and receive high traffic).

F. G&Z’s S600’s SmartLeg/AccuSteer Technology Drove the Commercial Success

97. I have reviewed several reports and an internal sales spreadsheet, all of which demonstrate that upon hitting the market, G&Z’s innovative S600’s SmartLeg/AccuSteer technology immediately began paying dividends, with the introduction of these features translating directly into commercial success in the form of significantly increased paving machine sales, driven by those designs equipped with the SmartLeg/AccuSteer technology:



Ex. 2031 (produced based on sales data from the spreadsheet).

98. Once GOMACO entered the market with its copycat version of G&Z’s SmartLeg / AccuSteer equipped paving machines, the GP3, G&Z’s market share quickly eroded, with G&Z [REDACTED] of its market share between 2014 and 2019 while GOMACO’s market share [REDACTED] Ex. 2035 at 13; Ex. 2036 at 10. GOMACO introduced its GP3 paver in 2015. *See supra* § XI(D)(1).

99. In view of the foregoing, it is my opinion that the objective indicia of nonobviousness confirms the patentability of the Challenged Claims over the CIII-Rio combination.

XII. CONCLUSION

100. In conclusion, based on my experience and expertise, it is my opinion that the '318 Patent is patentable over the CIII-Rio combination.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code. Executed on February 26, 2025, in Ames, Iowa.



Dr. Kenneth “Mark” Bryden

APPENDIX A

Kenneth “Mark” Bryden

Education

University of Wisconsin–Madison; PhD, Mechanical Engineering, 1998

University of Wisconsin–Madison; MS, Mechanical Engineering, 1993

Idaho State University; BS, General Engineering with high honors, 1977

Academic Positions Held

2015–present Professor (with tenure), Iowa State University

2004–2015 Associate Professor (with tenure), Iowa State University

2006–2007 Interim Chair, Department of Mechanical Engineering, Iowa State University

2005–2006 Associate Chair, Department of Mechanical Engineering, Iowa State University

2004–2012 Program Chair, Complex Adaptive Systems, Iowa State University

1998–2004 Assistant Professor, Iowa State University

1995–1997 Teaching Assistant, University of Wisconsin–Madison

1991–1998 Graduate Fellow, University of Wisconsin–Madison

Other Professional Employment

2006–present Program Director; Decision Science; US Dept of Energy, Ames National Laboratory
Founding director of the Ames National Laboratory Decision Science program. The Ames National Laboratory is a US Dept of Energy National Laboratory (FFRDC) managed under contract by Iowa State University. Decision Science is one of five programs/ divisions/centers within the Ames National Laboratory.

1989–1991 Manager, Radiological Controls Engineering, Westinghouse Electric Corp.
I managed all radiological controls engineering for three nuclear power plants and one hot fuel cutting and management facility.

1987–1989 Shift Test Manager, A1W Plant, Westinghouse Electric Corp.
Responsible for all on-shift testing during a multiyear refueling and maintenance period for a dual reactor power plant.

1986–1987 Assistant Manager, Operations, A1W Plant, Westinghouse Electric Corp.
Managed day-to-day operations for a dual reactor power plant.

1984–1986 Manager, Long Range Planning and Engineering, Westinghouse Electric Corp.
Planned, proposed, and performed the engineering required for refueling and extended maintenance periods for three nuclear power plants.

1982–1984 Manager, Prototype Programs, Westinghouse Electric Corp.
Programmatic responsibility for three nuclear power plants.

1981–1982 Shift Supervisor, A1W Plant, Westinghouse Electric Corp.

1977–1981 Nuclear Plant Engineer, A1W Plant, Westinghouse Electric Corp.

Honors and Awards

- 2020 Faculty-Staff Inspiration Award, Iowa State University Alumni Association, 2020
- 2013 Melville Medal, American Society of Mechanical Engineers, 2013.
“The Melville Medal was first awarded in 1927 and is the highest honor for the best original technical paper published in the *ASME Transactions* in the past two years.”
- Best Scientific Paper, 2013 International Symposium on Environmental Software Systems, 2013.
- 2012 Regional Excellence in Technology Transfer, for “Virtual Paint,” National Federal Laboratory Consortium, 2012.
- Terrestrial Energy Systems Best Paper Award, AIAA 50th Aerospace Sciences Meeting, 2012.
- AIAA Associate Fellow, 2011.
- R&D 100 Award, for “osgBullet,” Top 100 Research Developments of 2010, R&D Magazine, 2010.
“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention,’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”
- 2010 National Excellence in Technology Transfer, for “Virtual Engineering – Process Simulator Interface,” National Federal Laboratory Consortium, 2010.
The Federal Laboratory Consortium’s Excellence in Technology Transfer Award honors work that brings technologies from labs to the marketplace through collaboration with industry, academia, or other labs.
- Best Paper, 19th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2009), 2009.
- R&D 100 Award, for “Virtual Engineering – Process Simulator Interface,” Top 100 Research Developments of 2009, R&D Magazine, 2009.
“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”
- 2009 Regional Excellence in Technology Transfer, for “Virtual Engineering – Process Simulator Interface,” National Federal Laboratory Consortium, 2009.
- VEISHA Professor, VEISHA student committee, 2009.
- Best Paper, 18th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2008), 2008.
- Center for Excellence in the Arts and Humanities Fellow, ISU Center for Excellence in the Arts, 2007.
- Best Paper, 17th Annual Artificial Neural Networks in Engineering Conference (ANNIE 2007), 2007.

- R&D 100 Award, for “Texture-based Engineering Tools,” Research and Development Magazine, 2006.

“Established in 1963, the R&D 100 Awards is the only S&T (science and technology) awards competition that recognizes new commercial products, technologies and materials for their technological significance that are available for sale or license. Considered by some to be the ‘Oscars of Invention’ the R&D 100 Awards program identifies and celebrates the top 100 revolutionary technologies of the past year.”

- Margaret Ellen White Graduate Faculty Award, ISU, 2006.
Recognizes a member of the graduate faculty who has demonstrated exceptional mentorship to graduate students both during their time at Iowa State and beyond graduation
- Miller Faculty Fellow, Center for Teaching Excellence, ISU, 2004–2006.
- 2004 Information and Electrical Technologies Select Paper Award, 2004 American Society of Agricultural Engineers International Meeting, 2004.
- Superior Engineering Teacher, College of Engineering, ISU, 2004.
- First Place Award, Evolutionary Art, “Computer Generated Evolutionary Music,” 2004 Congress on Evolutionary Computation (CEC2004), 2004.
- E-Week Outstanding Mechanical Engineering Professor, 2003.
- Most Effective Instructor Award, ISU Academic Success Center, 2003.
- Sigma Xi, 2003.
- Leadership through Engineering Academic Diversity Faculty Involvement Award, ISU LEAD program, 1999-2001.
- Outstanding Mechanical Engineering Faculty Member Award, ISU ASME Student Chapter, 2000.
- Pi Tau Sigma Mechanical Engineering Department Outstanding Teaching Assistant Award, University of Wisconsin–Madison, 1997.
- Power Engineering Education Foundation Fellowship, Edison Electric Institute, 1993–1997.
- E. B. Fred Fellowship, University of Wisconsin–Madison, 1992–1993.
- Arthur West Mechanical Engineering Department Award, University of Wisconsin–Madison, 1991–1992.
- Wisconsin Alumni Research Foundation Fellowship, University of Wisconsin–Madison, 1991-1992.
- Graduation with High Honors, Idaho State University, 1977.
- Alpha Mu Gamma, 1976.
- Phi Kappa Phi, 1976.
- President’s Outstanding Achievement Award, Idaho State University, 1975.

Patents

1. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, Canadian Patent No. 2,771,839, February 9, 2016.
2. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, Chinese Patent No. 200980113857, November 2015.
3. “Hybrid Power Plant,” R. Furguson, K. M. Bryden, and S. C. Corns, US Patent No. 8,839,621, September 23, 2014.
4. “Creating Realtime Data-Driven Music Using Context Sensitive Grammars and Fractal Algorithms,” K. M. Bryden, K. A. Bryden, and D. A. Ashlock, US Patent No. 7,304,228, December 4, 2007.

Startups founded

1. AgSolver Inc.— Co-Founder and Board Chair, AgSolver Inc., 2013–2017

AgSolver is an agronomic decision services company whose products are focused on improving land management decisions, simplifying mandatory compliance and reporting activities, and maximizing returns for agricultural land investments. AgSolver was founded in 2013 based on technology developed in my research group. Agsolver was acquired in 2017 by EFC Systems.

2. Praxik LLC — Co-Founder and Board Chair, Praxik LLC, 2014–2018

Praxik is a software services company focused on visually based decision-making tools for industry. Founded in 2014 based on technology developed in my research group, Praxik was acquired in 2018 by TCompanies Inc.

Nonprofits founded

- Engineers in Technical and Humanitarian Opportunities for Service (ETHOS)

Founder, President, and Board Chair, 2002–2015; Board Member, 2015–2020

ETHOS is a non-profit focused on addressing the energy needs of the poor in the developing world. The annual ETHOS conference unites the cookstoves and clean cooking community by bringing together lab and field based scientific knowledge that fosters collaborations, elevates scientific rigor, and disseminates knowledge to manufacturers and designers, leading to development and greater adoption of cleaner stoves.

Professional Service

Editorial Service

- *International Journal of Energy for a Clean Environment*, Editorial Board Member, 2019–present
- *Development Engineering*, Associate Editor, 2015–2023
- *Journal of Engineering for Gas Turbines and Power*, Associate Editor, 2004–2007
- *Energy for Sustainable Development, Special Issue: Cookstoves in Developing Nations*, Guest Editor, March 2005

Service to Professional Societies

- AIAA, AIAA Committee on Standards for CFD, Committee Member, 2003–present
- ASME, Percy Nichols Award Committee, Member at Large, 2019–2023
- ASME, Percy Nicholls Award Committee, Chair, 2010–2020
- AIAA, AIAA Technical Committee on Terrestrial Energy Systems, Committee Member, 2008–2022
- AIAA, AIAA Technical Committee on Meshing, Visualization, and Computational Environments, Committee Member, 2009–2018
- ASME, James Harry Potter Gold Medal Committee, Committee Member, 2010–2016
- AIAA, AIAA Green Engineering Program Committee, Committee Member 2013–2019
- AIAA Technical Committee on Terrestrial Energy Systems, Chair, 2012–2015
- ASME, Power Division, Honors and Awards Committee, Vice Chair, 2013–2014
- AIAA, AIAA Technical Committee on Terrestrial Energy Systems, Deputy Chair, 2010–2012
- ASME, Committee on Academic & Industrial Research, Chair, 2008–2009
- ASME, Fuels and Combustion Technology Division, Executive Committee, Vice Chair, 2004–2005
- ASME, ASME Energy Institute Formation ad hoc Committee, Committee Member, 2003–2005
- ASME, Fuels and Combustion Technology Division, Executive Committee, Program Chair, 2003–2004
- ASME, Power Division Executive Committee, Chair, 2002–2003
- ASME, Fuels and Combustion Technology Division, Committee on Academic & Industrial Research, Chair, 2002–2003
- ASME, Fuels and Combustion Technology Division, Executive Committee, Chair of Administrative Committees, 2002–2003

Government and Educational Committees

- Member, DOE “5G for Science Working Group” and member of the organizing committee for the 5G Enabled Energy Innovation Workshop, 2019 – 2021.
This resulted in the “5G-Enabled Energy Innovation: Advanced Wireless Networks for Science Workshop Report” available at <https://www.osti.gov/servlets/purl/1606539>, 2019–2021
- Member, Advisory Board, Center for Advanced Modeling and Simulation, Idaho National Laboratory, US Department of Energy, 2004-2010
- Member, Advisory Board, Institute for People Centered Computation, Bristol, UK, 2006–2009

Other Professional Service

- Official Nominator, VinFuture Prize, 2023–present
- Member, ANSI sponsored US Technical Advisory Group to ISO/TC 285: Clean cookstoves and their clean cooking solutions, 2012–present
- Member, Global Alliance for Clean Cookstoves, Fuels and Technology Committee, 2011–present

- Board Member, Engineers in Technical and Humanitarian Opportunities for Service (ETHOS), 2015–2020
- Founder, President, and Board Chair, Engineers in Technical and Humanitarian Opportunities for Service (ETHOS), 2002–2015
- Lead author, the World Health Organization development of the *WHO Indoor Air Quality Guidelines: Household Fuel Combustion – Review 10: Burns and Poisoning*, 2012–2014
- Board Member, Board of Directors, Medicine for Mali, 2007–2010

Books authored

1. *Combustion Engineering*, 3rd Ed., K. M. Bryden, K. W. Ragland, S.-C. Kong, Francis Taylor, 2022.
2. *Combustion Engineering*, 2nd Ed., K. W. Ragland, K. M. Bryden, Francis Taylor, 2011.

Selected Peer-Reviewed Articles

Professor Bryden has published more than 250 peer-reviewed articles on wide range of technical topics including power systems, computational and systems modeling, heat transfer and fluid mechanics, engineering design, humanitarian engineering, and applied mathematics. The 34 articles/chapters presented here represent his current work and/or most cited papers.

1. W. Kim, T. I-P. Shih, R. Dalton, K. M. Bryden, S. Y. Chang, G. S. Park, “Flow and Heat Transfer in a Ribbed Converging-Diverging U-Duct Under Rotating and Non-Rotating Conditions,” *J. of Turbomachinery* 147(3): 031005 (2025).
2. S. Ferguson, L. Retzlaff, K. A. Bryden, K. M. Bryden, “Narrative Drives Design Decision Making,” *Proceedings of the Design Society: 18th International Design Conference*, pp 965-974 (2024).
3. K. M. Bryden, “Designing a Sustainable Peace: Narrative Building and the Need for Transparency in Public Modeling,” Chapter 11 in *Building Positive Peace* eds C. Campbell and S. Cordery, Cambridge Scholars Publishing, (2023).
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5. C.-S. Lee, T. I.-P. Shih, K. M. Bryden, R. P. Dalton, R. A. Dennis, “Strongly Heated Turbulent Flow in a Channel with Pin Fins,” *Energies*, 16(3):1215 (2023).
6. P. Pezzini, K. M. Bryden, P. Finzell, D. Tucker, “A Novel Multi-Agent Resource Sharing Algorithm for Control of Advanced Energy Systems,” *Industrial & Engineering Chemistry Research*, 60(30):11171-11186 (2021).
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12. P. Pezzini, K. M. Bryden, and D. Tucker, “Multi-coordination Control Strategy Performance in Hybrid Power Systems,” *J. of Electrochemical Energy and Storage*, 15:031007-1–15 (2018).
13. P. Stevenson, C. A. Mattson, K. Bryden, N. A. MacCarty, “Towards a Universal Social Impact Metric for Engineered Products that Alleviate Poverty,” *J. of Mechanical Design*, 140(4)041401-1–10 (2018).
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15. P. Finzell and K. M. Bryden, “A Novel Resource Sharing Algorithm Based on Distributed Construction for Radiant Enclosure Problems,” *Advances in Engineering Software*, 108:57–67 (2017).
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