

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VERMEER MANUFACTURING COMPANY
Petitioner,

v.

THE TORO COMPANY
Patent Owner.

Case: To Be Assigned
Patent 10,597,843

DECLARATION OF MARK FLEMING, Ph.D., P.E.



I, Mark Fleming, declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

1. I have been retained by Petitioner Vermeer Manufacturing Company (“Petitioner” or “Vermeer”) to provide technical analysis and opinions relating to U.S. Patent No. 10,597,843 (“the ‘843 patent”) in this proceeding.

2. I am currently a Principal Engineer at Fusion Engineering, LLC in Naperville, Illinois, which is a multidisciplinary engineering consulting and technical services company that offers a wide range of engineering services, including engineering analysis, testing, design and manufacturing review, and consulting services to a variety of clients. This includes the analysis of machinery for construction, agriculture, mining, and material handling, as well as other machinery designed for lifting using linkages and hydraulics.

3. I am also currently an adjunct professor of mechanical engineering at Northwestern University in Evanston, Illinois, where I teach undergraduate and graduate level courses on finite element analysis, failure analysis, and mechanistic data science. I also perform research on multiscale methods for engineering analysis.

4. Prior to joining Fusion Engineering, I was Senior Director of Mechanical Engineering at ITC Experts, Inc. in Sugar Grove, from 2011 to 2014. From 2003 to 2011, I was Senior Director of Mechanical Engineering at Packer

Engineering, Inc. in Naperville, Illinois. Both ITC and Packer Engineering were multidisciplinary engineering consulting companies. As part of my consulting engineering practice, I performed design analysis of construction, agricultural and industrial equipment, including a structural design review of large mining trucks, rollover protection structure and falling object protection structure analysis of mining and industrial equipment, structural and fracture analysis of aerial lift equipment, and fracture analysis of construction equipment loader arms and power train components.

5. Prior to working at Packer Engineering, Inc., I was a design and manufacturing engineer at CNH (formerly Case Corporation) in Burr Ridge, Illinois from 1997 to 2003. CNH designs and manufactures off-highway equipment for agricultural and construction use, including skidsteer loaders and track-type vehicles. During my time at CNH, I participated in the design development of skidsteer loaders, including the structure, loader arms, bucket assemblies, and controls. I was also the manager of a manufacturing simulations group. In that position, I collaborated with manufacturing plants around the world.

6. I am a registered professional engineer in the state of Illinois (license # 062.057502) and have been since 2004.

7. I received a Bachelor of Science degree in mechanical engineering from the University of Nebraska in 1992. As part of my education, I took courses

on machine design and kinematics, and manufacturing processes and techniques. I received a Master of Science degree in Theoretical and Applied Mechanics from Northwestern University in 1994 and a Doctor of Philosophy degree in Theoretical and Applied Mechanics from Northwestern University in 1997. I am a member of the Pi Tau Sigma mechanical engineering honor society and the Tau Beta Pi engineering honor society.

8. I am currently a member of the American Society of Mechanical Engineers (ASME), the Society of Automotive Engineers (SAE), ASM International, and the United States Association for Computational Mechanics (USACM). I am also a member of the Northwestern University Mechanical Engineering industrial advisory board.

9. Through my education, background, and work experience, I have developed a thorough understanding of machine design and manufacturing. Based on my education, training, knowledge, and professional experience, I am fully qualified to testify regarding the subject matter described and claimed in the '843 patent.

10. My *curriculum vitae* is attached as Appendix A to this Declaration.

II. MATERIALS CONSIDERED

11. I have been asked to analyze claims 16-19 of the '843 patent (claims 16-19 are also referred to as the "Challenged Claims").

12. In forming my opinions expressed in this Declaration, I have reviewed and considered the documents and materials identified in Appendix B to this Declaration.

13. I have further relied on my education, skill, training, and experience in the field of agricultural and construction machinery and equipment in forming my opinions. I have also considered the viewpoint of a person of ordinary skill in the art (“POSITA”) at the time of the effective filing date of the ‘843 patent. In Paragraphs 27-29, I provide my opinions as to the proper level of skill for a POSITA.

14. I reserve the right to supplement my opinions in this Declaration to address any new information obtained in the course of this proceeding, or based on any new positions taken by the Patent Owner The Toro Company (“Patent Owner” or “Toro”).

III. COMPENSATION

15. Fusion Engineering is charging \$310/hour for my services in this matter. My compensation is not dependent on the outcome of this proceeding and does not affect the substance of my statements and opinions in this Declaration.

16. As far as I am aware, neither myself nor Fusion Engineering have any financial interest in the Petitioner, Patent Owner, or the ‘843 patent. I also have no

other conflicts of interests relating to the Petitioner, Patent Owner, or the '843 patent.

IV. SUMMARY OF MY OPINIONS

17. I have been asked by counsel for Petitioner to provide my opinions regarding whether the Challenged Claims would have been obvious to a POSITA in light of the prior art. I was also asked to identify what features of the compact utility loader are described as the invention in the specification of the '843 patent.

18. Based on my review of the '843 patent, the file history of the '843 patent, the prior art CTX50 Machine, and the other documents identified in Appendix B, and relying on my education, skill, experience, common sense, and expertise in the field of agricultural and construction machinery and equipment, it is my opinion that the Challenged Claims would have been obvious to a POSITA. The bases for my opinions are detailed throughout this Declaration.

V. LEGAL PRINCIPLES

19. Petitioner's counsel has provided me certain legal principles that I have applied in this proceeding. My analysis and opinions were developed based on the following legal principles.

20. It is my understanding that in this proceeding, prior art to the '843 patent includes compact utility loaders that were on sale before the effective filing date of the '843 patent. I understand that the '843 patent claims priority to

Provisional Application No. 62/118,854, filed on February 20, 2015. For purposes of this Declaration, I have been asked to apply February 20, 2015 as the earliest effective filing date for the '843 patent.

21. I understand that a patent claim is invalid as obvious under 35 U.S.C. § 103 if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art. I further understand that a claim may be found obvious in view of a single prior art reference or from a combination of two or more prior art references. I understand that an invention is obvious if a person of ordinary skill in the art would have had a reason to make the invention and a reasonable expectation of success in so doing.

22. I have been informed that when relying on a combination of prior art references to establish obviousness, it is necessary to show: (1) that the claim elements were known in the prior art; and (2) that a skilled artisan would have been motivated to combine these known elements.

23. To qualify as prior art, a reference must qualify as “analogous art.” A reference is considered analogous if it is from the same field of endeavor or is reasonably pertinent to the particular problem with which the inventor is involved. A reference is reasonably pertinent if it, as a result of its subject matter, logically

would have commended itself to an inventor's attention in considering the problem.

24. It is also my understanding that a patent claim can be obvious in light of a single prior art reference if it would have been obvious to modify that reference. I understand that common sense and common knowledge can be considered in determining whether it would have been obvious to modify a prior art reference if supported by evidence and a reasoned explanation and a POSITA would have been motivated to make such a modification.

25. I further understand that there are certain secondary considerations that may support or rebut the obviousness of a claim. I understand that such secondary considerations include: (i) commercial success of the patented invention, (ii) skepticism of those having ordinary skill in the art at the time of invention, (iii) unexpected results of the invention, (iv) any long-felt but unsolved need in the art that was satisfied by the alleged invention, (v) the failure of others to make the alleged invention, (vi) praise of the alleged invention by those having ordinary skill in the art, and (vii) copying of the alleged invention by others in the field. I have been informed that there must be a nexus between any such secondary consideration and the alleged invention. Contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

26. I am not aware of any secondary considerations that are germane to my consideration of the Challenged Claims. If the Patent Owner has a different view, and asserts that secondary considerations support the validity of the Challenged Claims, I reserve the right to address those assertions.

VI. LEVEL OF ORDINARY SKILL IN THE ART AS OF THE EFFECTIVE FILING DATE OF THE '843 PATENT

27. The '843 patent is directed to a compact utility loader with a scissor lift mechanism mounted to a front support assembly. The Abstract of the '843 patent states as follows:

A compact utility loader is operated by a standing operator at the rear of a frame. A loader arm assembly comprises a scissors linkage on either side of the frame nesting around the prime mover. Each scissors linkage has an upper loader arm that is pivoted at its rear end to rears [sic] ends of a pair of lower loader arms such that the pivot connections to the upper loader arm move upwardly and forwardly relative to the frame during elevation of the loader arm assembly to provide a high lift capability. The frame is self-propelled by a differential drive and steering system that is operated by dual levers. A hand grip extends between and unifies the operation of the levers to permit the operator to more easily move the levers in the ways that are needed to provide either straight motion of the frame or turns of the frame.

Exhibit 1001 at Abstract.

28. The specification of the '843 patent discusses the allegedly unique front-mounted scissor linkage mechanism and support structure employed to raise and lower the loader arm.

29. Based on the subject matter of the patent, it is my opinion that a person of ordinary skill in the art at the time of the alleged invention would have had at least a Bachelor of Science degree in Mechanical or Agricultural Engineering and two years of experience in the design of machines, or have had equivalent knowledge and experience.

VII. THE '843 PATENT

A. The Utility Loader Identified as the Invention in the '843 Patent

30. I have been asked to identify those features of the utility loader held out as the invention of the '843 patent. In making this determination, I was asked to focus on what the '843 patent reasonably conveys to a person of ordinary skill in the art.

31. The '843 patent is titled "Utility Loader With High Lift Loader Arms And Unifying Hand Grip For Dual Traction Control Levers." Exhibit 1001.

32. The '843 patent identifies two inventions: (1) a utility loader with front mounted scissoring loader arms and (2) a unifying hand grip for dual traction control levers. I have only been asked to analyze what is described in the specification as the alleged high lift loader arm invention. I was not asked to analyze the unifying hand grip invention.

33. Before the effective filing date of the '843 patent, the use of "[c]ompact utility loaders [was] well known for performing various types of work

in an outdoor environment.” Exhibit 1001 at 1:14-24. Compact utility loaders are also known as compact tool carriers or mini skidsteers. These machines are specialized small construction equipment that are used to move heavy loads in tight spaces. Generally speaking, compact utility loaders are “self-propelled crawler[s] or wheeled machine[s] having an operating mass of less than 1500 kg with a rigid frame, having either a pedestrian operating positions or standing operator platform at the rear of the machine and either front-mounted interchangeable equipment or lift arms with an attachment bracket capable of coupling to interchangeable, front-mounted attachments.” Exhibit 1004 at 1:26-33 (citing SAE Standard J2752 (dated June 21, 2010)).

34. Unlike full-size skidsteers, compact utility loaders have a smaller frame for maneuvering in smaller spaces in which a full-size skidsteer could not fit. The smaller frame of a compact utility loader is ideal for navigating through spaces such as a fence gate, a residential yard, or other confined work areas.

35. The ‘843 patent notes that although “high lift loader arms” were known on full size skidsteers, this type of loader-arm configuration was not used on compact utility loaders:

Finally, the vertical reach of the loader arms on compact utility loaders is somewhat limited. While high lift loader arms are known on full size skid steer loaders as disclosed in U.S. Patent No. 5,542,814, the use of such high lift loader arms on a compact utility loader has been considered difficult if not impossible due to size and durability constraints. Accordingly, it would be a further advance in

the art to provide a way of safely and durably providing high lift loader arms on compact utility loaders to extend the vertical reach of such loaders. For example, this would allow a compact utility loader to dump debris or materials at higher elevations than previously, thus allowing the use of larger trucks to accept such debris or materials for transport.

Exhibit 1001 at 2:20-32 (emphasis added).

36. The '843 patent holds out the front mounted scissor linkage loader arm and related mounting assembly taught in the specification as the solution to this problem. For example, the Abstract of the '843 patent identifies the invention as “[a] loader arm assembly [that] comprises a scissors linkage on either side of the frame nesting around the prime mover.” Exhibit 1001 at Abstract. In the “Summary of the Invention” section, the specification describes this scissor linkage and related front support assembly configuration in more detail:

SUMMARY OF THE INVENTION

One aspect of this invention relates to a compact utility loader which comprises a frame carrying a prime mover. Ground engaging members are provided on opposite sides of the frame with at least one ground engaging member on each side of the frame being powered to self-propel the frame. A control console is located at a rear end of the frame carrying controls that are manipulated to operate the loader by a standing operator. A loader arm assembly has a pair of scissor linkages on opposite sides of the frame outboard of the prime mover with the linkages nesting around the prime mover when the loader arm assembly is in a lowermost, fully retracted position. Each scissor linkage comprises an upper loader arm having a front end and a rear end and first and second lower loader arms with each lower loader arm also having a front end and a rear end. The front ends of the lower loader arms are pivotally connected to a front support assembly that is fixed to a front portion of the frame. The rear ends of the lower loader arms are pivotally connected by separate pivots to the rear end of the upper loader arm with the rear end of the upper loader arm being free to move upwardly and forwardly relative to the frame as the upper loader arm scissors away from the lower loader arms as the loader arm assembly is elevated between the lowermost, fully retracted position thereof and an uppermost, fully extended position. Finally, an outdoor work operation tool or implement is pivotally carried on the front ends of the upper loader arms ahead of a front end of the frame.

Exhibit 1001 at 2:34-62 (highlighting added).

37. The “high lift loader arm assembly” invention is depicted in Figures 2-5 and described in the “Detailed Description” section of the specification. Exhibit 1001 at 3:19-38. Figure 2 shows the loader arm assembly in the lowermost position:

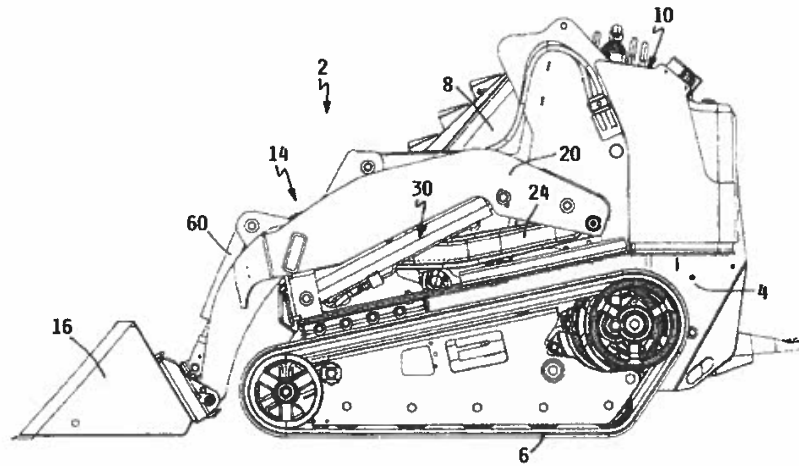
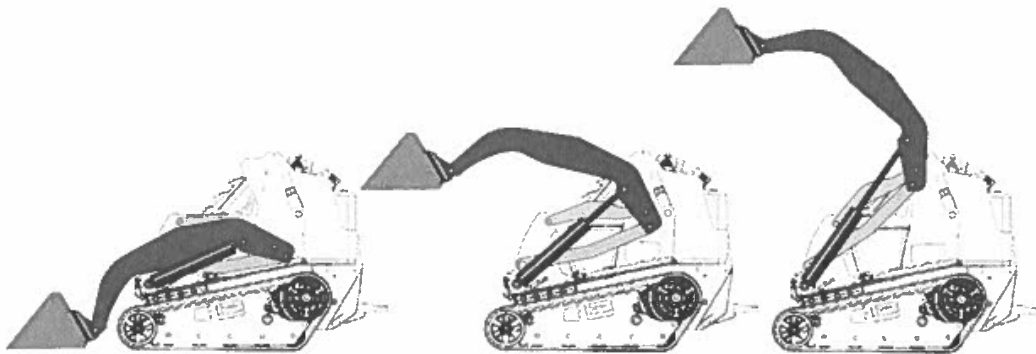


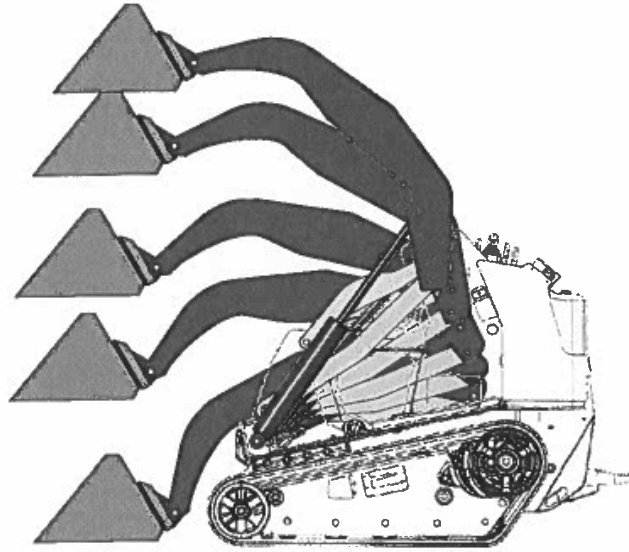
FIG. 2

Exhibit 1001 at Fig. 2, 4:27-29. Figure 3 depicts the loader arm assembly in the raised position, showing the “pair of scissor shaped loader arm linkages 18 positioned on opposite sides of loader frame 4 directly outboard of prime mover 8.” Exhibit 1001 at Fig. 3, 4:42-45. “[E]ach linkage 18 comprises an upper loader arm 20 and two lower loader arms 22 [and] 24 that are pivotally connected by pivots 26, 28 to the rear portion of upper loader arm 20.” Exhibit 1001 at 4:51-54. A hydraulic cylinder actuator (30) with a piston rod (32) lifts and lowers the arm assembly 14 from a lower position (Fig. 2) to a raised position (Fig. 3). Exhibit 1001 at 4:57-59. In the high lift position of Figure 3, “loader arm pivots 26, 28 have significantly risen and moved somewhat more forwardly than the position they occupied in FIG. 2.” Exhibit 1001 at 5:2-7. The patentee specifically identifies the scissor mechanism and front support assembly as the key to solving

the identified problem of achieving high lift on a compact utility loader: “[i]t is this ability of linkages 18 to elevate and move forwardly as upper loader arm 20 scissors away from lower loader arms 22, 24 that provides the high lift function. Loader arm assembly 14 of this invention has sufficient strength to provide high lift even when elevating a fully loaded dump bucket to significantly higher distances above the ground than is typical for a normal loader arm assembly. Referring now to FIG. 4, loader arm assembly 14 includes a squat, robust support assembly 33 that is fixed to loader frame 4 generally at the front of frame 4 and which nests around the front of prime mover 8.” *Id.* at 5:4-15 (emphasis added).

38. I created the images below using the machine depicted in Figure 2 and Figure 3 of the ‘843 patent to illustrate how the scissor linkage mechanism and front mounting assembly allow the loader arm assembly to extend to its full height:





39. The specification of the '843 patent teaches that this scissor linkage mechanism and front support assembly is what allows for the use of a "high lift loader arm assembly that accommodates the small form of loader 2." Exhibit 1001 at 4:40-45. The '843 patent does not teach any other way, other than through use of a scissor linkage and front mounted support assembly like that depicted in Figure 3, to solve the problem of achieving high lift on a compact utility loader.

B. The Challenged Claims

40. The '843 patent has three independent claims (1, 11, and 16) and sixteen dependent claims (2-10, 12-15, and 17-19). Claim 16 is reproduced below:

Claim 16. A compact utility loader, which comprises:

(a) a frame carrying a prime mover;

(b) ground engaging members carried by the frame with at least one ground engaging member being powered to self-propel the frame;

(c) a control console at a rear end of the frame carrying controls that are manipulated to operate the loader, the controls protruding at least upwardly from a control mounting surface to terminate in upper ends that are spaced above the control mounting surface;

(d) a rear foot platform on the rear end of the frame for permitting the controls to be accessible from behind by an operator who stands on the rear foot platform;

(e) a loader arm having a front end that carries an outdoor work operation tool;

(f) an actuator that is extendable and collapsible in length for lifting and lowering the loader arm relative to the frame, the actuator being pivotal relative to the frame and having a pivot connection to the loader arm;

(g) a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, the connecting arms being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof; and

(h) wherein the pivot connection of the actuator to the loader arm is lower than the control mounting surface of the control console in the lowered position of the loader arm and is higher than the control

mounting surface of the control console in the raised position of the loader arm.

Exhibit 1001 at 11:8-12:14.

41. Claims 17-19 each relate to additional features of the loader arm assembly and how the actuator is connected to the loader arm:

17. The loader of claim 16, wherein the pivot connection of the actuator to the loader arm is located ahead of and proximate to a front end of the control mounting surface of the control console in the raised position of the loader arm.

18. The loader of claim 17, wherein the pivot connection of the actuator to the loader arm is higher than the upper ends of the controls in the raised position of the loader arm.

19. The loader of claim 16, wherein the pivot connection of the actuator to the loader arm is higher than the upper ends of the controls in the raised position of the loader arm.

Exhibit 1001 at 12:15-24.

C. Summary of the Prosecution History of the ‘843 Patent

42. I have reviewed the prosecution history (also known as the file history) of the ‘843 patent.

43. In the original patent application, which was filed on March 4, 2019, the patentee filed Application No. 16/291,656. This application was eventually issued as the ‘843 patent. Exhibit 1002.

44. As it was originally filed, the application included eight claims, with original independent claim 1 reproduced below:

Originally Filed Claim 1: A compact utility loader, which comprises:

- (a) a frame carrying a prime mover;
- (b) ground engaging members carried by the frame with at least one ground engaging member being powered to self-propel the frame;
- (c) a control console at a rear end of the frame carrying controls that are manipulated to operate the loader;
- (d) a loader arm having a front end that carries an outdoor work operation tool;
- (e) an actuator for lifting and lowering the loader arm relative to the frame; and
- (f) a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, the connecting arms extending in a fore-and-aft direction relative to the frame and being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof, the first connecting arm being above and substantially vertically adjacent to the second connecting arm in the lowered position of the loader arm.

Exhibit 1002 at 199.

45. On May 14, 2019, the Patent Examiner rejected original claims 1-8 as obvious under 35 U.S.C. § 103 over U.S. Patent No. 9,017,005 (to Martin) in view of U.S. 2008/0197588 (to Azure). Exhibit 1002 at 170-176. The Examiner found

that Martin disclosed each element of claim 1 except for element (c) relating to the claimed control console. Exhibit 1002 at 173-175.

46. The Examiner found that Martin disclosed element (f) of a “first pivotal connecting arm and a second pivotal connecting arm.” Exhibit 1002 at 174. According to the Examiner, Azure disclosed element (c) of claim 1. Exhibit 1002 at 175.

47. On November 13, 2019, Patent Owner amended claim 1 to add the following language to the end of limitation (f): “over substantially all of a fore-and-aft length of the first connecting arm.” Exhibit 1002 at 128. Patent Owner also added new claims 9-22. Exhibit 1002 at 130-133. Claim 19—which ultimately issued as claim 16—stated as follows:

New Claim 19. A compact utility loader, which comprises:

- (a) a frame carrying a prime mover;
- (b) ground engaging members carried by the frame with at least one ground engaging member being powered to self-propel the frame;
- (c) a control console at a rear end of the frame carrying controls that are manipulated to operate the loader, the controls protruding at least upwardly from a control mounting surface to terminate in upper ends that are spaced above the control mounting surface;
- (d) a rear foot platform on the rear end of the frame for permitting the controls to be accessible from behind by an operator who stands on the rear foot platform;

(e) a loader arm having a front end that carries an outdoor work operation tool;

(f) an actuator that is extendable and collapsible in length for lifting and lowering the loader arm relative to the frame, the actuator being pivotal relative to the frame and having a pivot connection to the loader arm;

(g) a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, **the connecting arms extending in a fore-and-aft direction relative to the frame and** being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof; and

(h) wherein the pivot connection of the actuator to the loader arm is lower than the control mounting surface of the control console in the lowered position of the loader arm and is higher than the control mounting surface of the control console in the raised position of the loader arm.

Exhibit 1002 at 132-133 (emphasis added).

48. On December 11, 2019, the Examiner held a telephone interview with Patent Owner. In this interview, the Examiner proposed canceling claims 8 and 9 based on a new matter issue. Exhibit 1002 at 2 and 22-23. The Examiner also indicated that claims 14-18 and 19-22 were “rejectable under obvious-type, non-statutory double patenting, but would be allowable if accompanied with a terminal

disclaimer.” Exhibit 1002 at 23. Patent Owner authorized the Examiner suggested amendments. Exhibit 1002 at 22-23.

49. In a follow-up conversation with the examiner on December 18, 2019, the Patent Owner also requested that the Examiner “delete” the following limitation within each of Claims 14 and 19 (which issued as claims 11 and 16, respectively):

Claim 14, section (e) is amended as followed;

(e) a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, the connecting arms ~~extending in a fore and aft direction relative to the frame and~~ being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof;

Claim 19, section (g) is amended as followed;

(g) a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, the connecting arms ~~extending in a fore and aft direction relative to the frame and~~ being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof; and

Exhibit 1002 at 18, 20, 23 (highlighting added).

50. This amendment removed the last limitation tying the claimed compact utility loader to the specific loader arm configuration identified in the specification as the invention, as I described above in Paragraphs 30 to 39. Claims

11 and 16 were issued with the highlighted limitations above omitted. Exhibit 1001 at 10:4-48, 11:8-12:15.

VIII. CLAIM CONSTRUCTION

51. It is my understanding that claims in a PGR are given the meaning that the term would have to a person of ordinary skill in the art. As previously stated, it is my opinion that a POSITA would have had at least a Bachelor of Science degree in Mechanical or Agricultural Engineering and two years of experience in the design of machines, or equivalent knowledge and experience.

A. “at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions”

52. Limitation (g) of claim 16 requires a “first pivotal connecting arm and a second pivotal connecting arm” to support the loader arm for movement between lowered position and raised position. Exhibit 1001 at 12:1-8. The specification of the ‘843 patent does not recite the language “connecting arm.” Instead, the specification describes the claimed “pivotal connecting arms” as “lower loader arms.” Exhibit 1001 at 2:46-60, 4:51-5:7.

53. According to limitation 16(g) the “connecting arms” are “configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions.” Exhibit 1001 at Claim 16. This functional claim language is unclear

and raises two necessary questions. *First*, what part of the loader arm must move upward and forward? Some specific point along the loader arm or the entire loader arm? If a specific point, which one? *Second*, which positions of the loader arm must be compared to determine whether there has been “at least some upward and forward movement” of the loader arm during its travel?

54. Based on my review of the ‘843 patent, the only answer to the first question—and the one that avoids making this language ambiguous to a POSITA—is to require the two points at which the upper loader arm connects to the lower loader arms to move upwardly and forwardly. This is the only approach taught in the specification of the ‘843 patent for determining whether this condition is satisfied. For example, the Abstract identifies the pivot connections at the rear end of the upper loader arm as the portion moving upwardly and forwardly when the loader lifts:

(57)

ABSTRACT

A compact utility loader is operated by a standing operator at the rear of a frame. A loader arm assembly comprises a scissors linkage on either side of the frame nesting around the prime mover. Each scissors linkage has an upper loader arm that is pivoted at its rear end to rear ends of a pair of lower loader arms such that the pivot connections to the upper loader arm move upwardly and forwardly relative to the frame during elevation of the loader arm assembly to provide a high lift capability. The frame is self-propelled by a differential drive and steering system that is operated by dual levers. A hand grip extends between and unifies the operation of the levers to permit the operator to more easily move the levers in the ways that are needed to provide either straight motion of the frame or turns of the frame.

55. The Summary of the Invention section of the specification also identifies the points of connection with the lower loader arms as the portions of the upper loader arm that must move upwardly and forwardly when lifted:

retracted position. Each scissor linkage comprises an upper loader arm having a front end and a rear end and first and second lower loader arms with each lower loader arm also having a front end and a rear end. The front ends of the lower loader arms are pivotally connected to a front support assembly that is fixed to a front portion of the frame. The rear ends of the lower loader arms are pivotally connected by separate pivots to the rear end of the upper loader arm with the rear end of the upper loader arm being free to move upwardly and forwardly relative to the frame as the upper loader arm scissors away from the lower loader arms as the loader arm assembly is elevated between the lowermost, fully retracted position thereof and an uppermost, fully extended position. Finally, an outdoor work operation tool or implement is pivotally carried on the front ends of the upper loader arms ahead of a front end of the frame.

Exhibit 1001 at 2:48-62. In the Detailed Description section, the '843 patent again makes it clear that the rear end of the loader arm is what must move upwardly and forwardly:

Pivots 26, 28 in each linkage 18 are not attached to loader frame 4, but only serve to pivotally connect the two lower loader arms 22, 24 to upper loader arm 20. This permits the rear end of linkage 18 to elevate and move forwardly as loader arm assembly 14 is elevated by hydraulic cylinder 30. Compare FIG. 2 to FIG. 3. In FIG. 2, loader arm pivots 26, 28 are low and rearwardly located relative to loader frame 4. In the high lift position of FIG. 3, loader arm pivots 26, 28 have significantly risen and moved somewhat more forwardly than the position they occupied in FIG. 2. It is this ability of linkages 18 to elevate and move forwardly as upper loader arm 20 scissors away from lower loader arms 22, 24 that provides the high lift function.

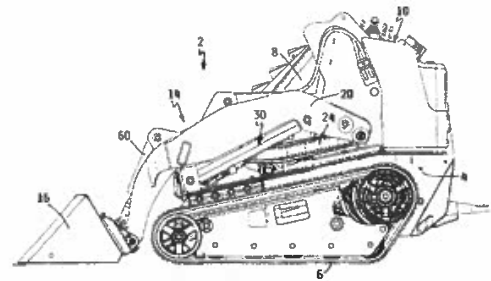


FIG. 2

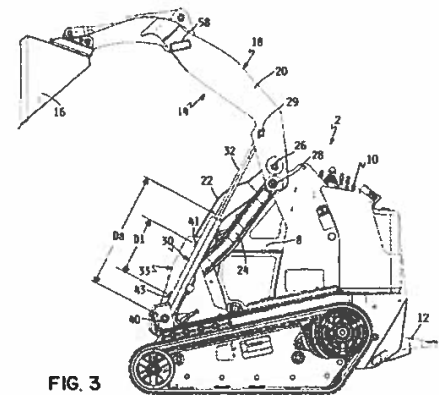


FIG. 3

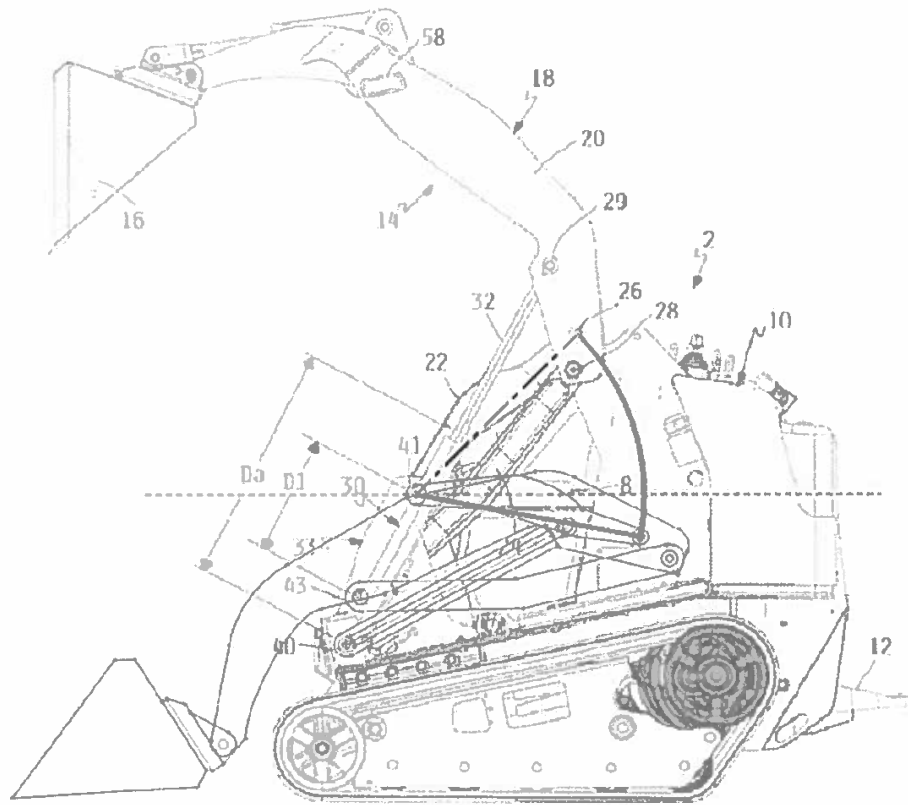
Exhibit 1001 at 4:62-5:7, Figs. 2-3.

56. This portion of the specification also answers the second question: At what point in time during the motion of the loader arm is the “at least some upward and forward movement” determined? Once again, the only interpretation supported by the specification—and that avoids ambiguity—requires the “upward and forward” movement to be compared at the fully raised and fully lowered positions of the upper loader arm. The specification exclusively identifies these two positions as the necessary test points. The specification instructs the reader to “[c]ompare FIG. 2 to FIG. 3.” Exhibit 1001 at 4:62-5:7, Figs. 2-3. Figure 2 presents the machine in its most lowered position and Figure 3 presents the machine in its most raised or “high lift” position. *Id.*

57. Based on the specification's disclosure summarized above, a POSITA would understand the claim language "at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions" to require that the points of attachment between the lower loader arms and the upper loader arm must be positioned "upward and more forward" in the fully raised position than they are in the fully lowered position.

58. I note that this construction is also necessary to read the claim on the sole embodiment taught in the specification of the '843 patent. The relevant points of the disclosed embodiment do not consistently move forward and upward throughout their travel from the fully lowered to fully raised position.

59. As depicted below, pivot point 26 of the disclosed embodiment moves upward and backward during roughly 20% of its travel from the lowered to raised configuration. This portion of the pivot point's travel is indicated by the red line in the figure below:



60. Finally, it is worth noting that my proposed claim construction is consistent with language in the specification, which indicates that the fully raised position of the upper loader arm is considered to be the “high lift position” of the machine. The ‘843 patent specification explains that the “high lift position” or configuration of the machine is attained because of the scissor linkages moving the specified pivot points 26 and 28 upward and more forward. It is therefore consistent with the specification—and necessary from a functional perspective—to assess whether the pivot points have moved “upward and forward” by placing the machine in its high lift configuration. Put another way, if the patent teaches that

high lift is obtained by upward and forward positioning of the scissoring pivot points, it is necessary to place the machine in its high lift configuration when ascertaining whether a given machine makes use of the “upward and forward” positioning of the pivot points to attain high lift.

61. Numerous portions of the specification address the high lift position of the invention and explain that such higher lift is the direct result of upward and forward positioning of the pivot points which connect the lower scissoring loader arms to the upper scissoring loader arm. *See, e.g., Exhibit 1 at Abstract (“Each scissor linkage has an upper loader arm that is pivoted at its rear end to rear ends of a pair of lower loader arms such that the pivot connections to the upper loader arm move upwardly and forwardly relative to the frame during elevation of the loader arm assembly to provide a high lift capability.”), 5:2-7 (“In the high lift position of FIG. 3, loader arm pivots 26, 28 have significantly risen and moved somewhat more forwardly than the position they occupied in FIG. 2. It is this ability of linkages 18 to elevate and move forwardly as upper loader arm 20 scissors away from lower loader arms 22, 24 that provides the high lift function.”), 2:20-30 (“Accordingly, it would be a further advance in the art to provide a way of safely and durably providing high lift loader arms on compact utility loaders to extend the vertical reach of such loaders.”), 4:47-50 (“FIG. 3 illustrates linkage 18 in the uppermost, fully extended, high lift position of loader arm assembly 14. In*

this position, dump bucket 16 has been elevated a considerable distance above the ground.”).

B. “proximate”

62. Dependent claim 17 requires the pivot connection of the actuator to the loader arm to be located “ahead of and proximate to a front end of the control mounting surface of the control console in the raised position of the loader arm.” In the context of claim 17 and the ‘843 patent, a POSITA would understand the term “proximate” to mean “close” or “near.”

63. “Proximate” is not used in the ‘843 patent except in claim 17. In Figure 3, which depicts the pivot connection of the actuator to the loader arm (29), the pivot connection is ahead of the control console and positioned forward of the front end of the control mounting surface of the control console some unspecified distance:

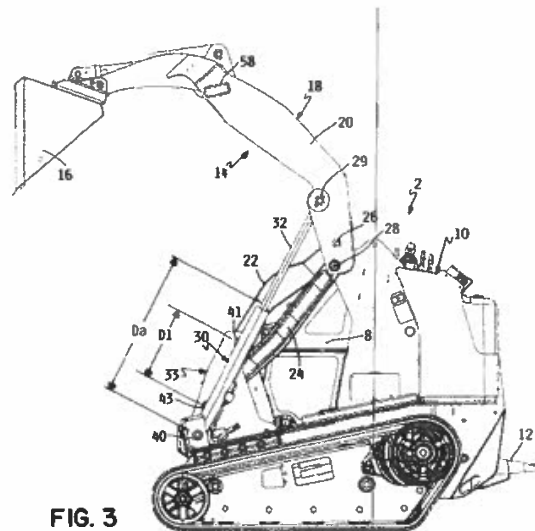


FIG. 3

Exhibit 1001 at Figure 3 (annotations added).

64. During prosecution, Patent Owner argued that the prior-art Bares reference (Exhibit 1013) did not satisfy the limitations of issued claim 17 because, according to Patent Owner, “Bares does not teach a pivot connection which ‘is located ahead of and proximate to a front end of the control mounting surface of the control console in the raised position of the loader arm’” Exhibit 1002 at 3-4. Patent Owner did not provide any insight or guidance during prosecution on how to determine what is “proximate” to the control console.

65. Merriam-Webster defines “proximate” as “very near” or “close.” Exhibit 1005. From an engineering perspective, the term “proximate” means “near” or “close.”

66. The term “proximate” in claim 17 should therefore be construed to mean “close” or “near.”

VIII. THE CHALLENGED CLAIMS WOULD HAVE BEEN OBVIOUS IN LIGHT OF THE PRIOR ART CTX50 COMPACT UTILITY LOADER.

67. For purposes of this Declaration, I have been asked to assume that Vermeer’s CTX50 mini skidsteer machine/compact utility loader (“CTX50 Machine”) is “prior art.” This assumption is based on the fact that the CTX50 Machine was sold before February 20, 2015, the effective filing date of the ‘843 patent. Exhibit 1008 at ¶¶ 13-19.

68. Vermeer's CTX50 Machine is a ride along compact utility loader with a loader arm for attaching various outdoor work operation tools. Exhibit 1006.

69. I inspected two CTX50 compact utility loaders on July 24, 2020, at which time I took photographs and videos of the two machines. Selected photographs, and screenshots from the videos I took, are shown in Exhibit 1007.

70. Using the videos I took of the CTX50 Machines during my inspection, I traced the motion of certain points of the machine to show how the machine raises the loader arm from the lowered position to the raised position. The still images below are taken from one of the videos:



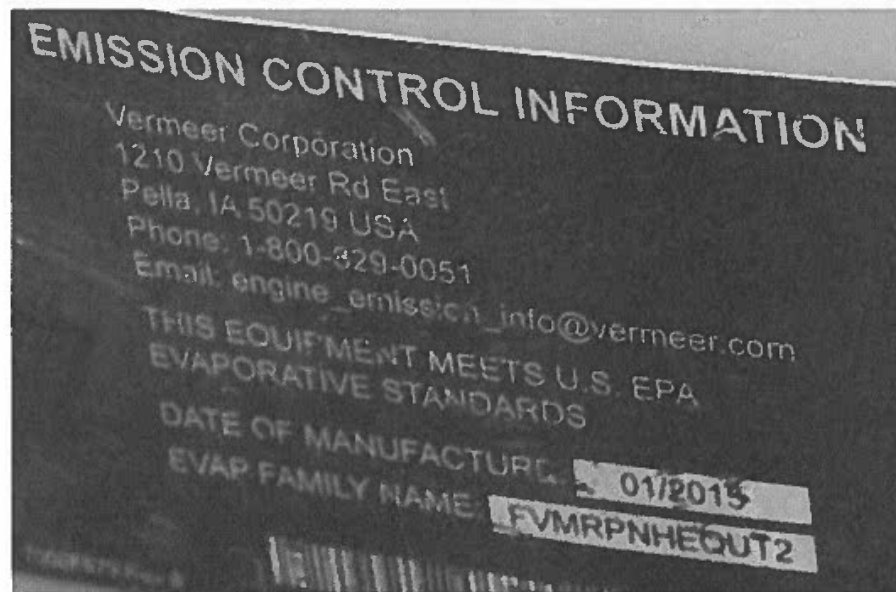


Exhibit 1007.

71. In this video, the motion of the pivot locations and the loader arm was tracked using computer vision. Red target markers were placed on the ends of the seven pin locations shown in the above figures. After placing red target markers on these points of the CTX50 Machine, I recorded a video of the compact utility loader arm being raised from a lowered position and then returned to the lowered position such that the bucket was raised and lowered. The positions of the red target markers were tracked at each frame of the video to track the movement of the pin locations. Additional details of this methodology are described in SAE 2020-01-0924. *See* Fleming, M., R. Krishnaswami, K. Nakamoto, Fuel tank dynamic strain measurement using computer vision analysis, SAE 2020-01-0924.

72. The CTX50 Machines that I inspected, and that are depicted in the photographs in Exhibit 1007, have serial numbers 1VR2070L3F1000105 and 1VR2070L5F1000106, and were built in late 2014 and January 2015, respectively:





Exhibits 1007; Exhibit 1012.

73. The CTX50 Machines I inspected are the same model as the CTX50 Machine sold prior to the effective filing date of the '843 patent. Exhibit 1008 at ¶¶ 20-22. The CTX50 Machines I inspected have the same structure, functionality,

and operation as the CTX50 Machine sold before the effective filing date of the '843 patent. *Id.*

A. Claim 16 Would Have Been Obvious to a POSITA in Light of the CTX50 Machine.

1. Claim 16, Preamble - The CTX50 Machine Was a “Compact Utility Loader”

74. The CTX50 Machine was a “compact utility loader.” The CTX50 Machine is identified as Vermeer’s “Mini Skid Steer,” which is another name for a compact utility loader. Exhibit 1006. The image below, showing the CTX50 Machine, shows that it is a compact utility loader like that claimed in claim 16:

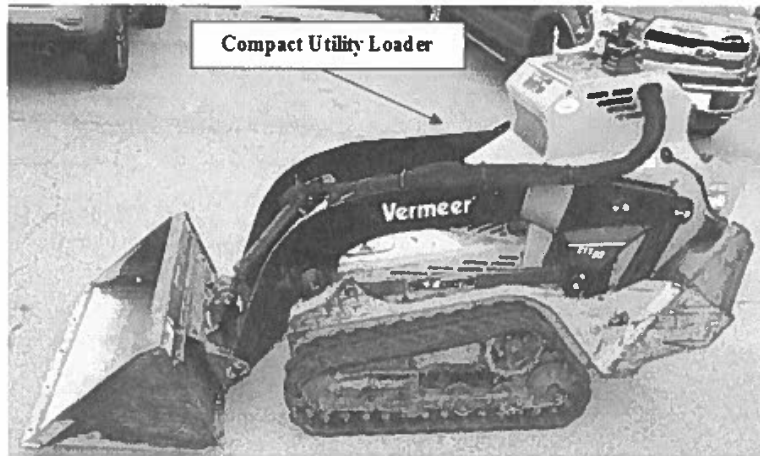


Exhibit 1007.

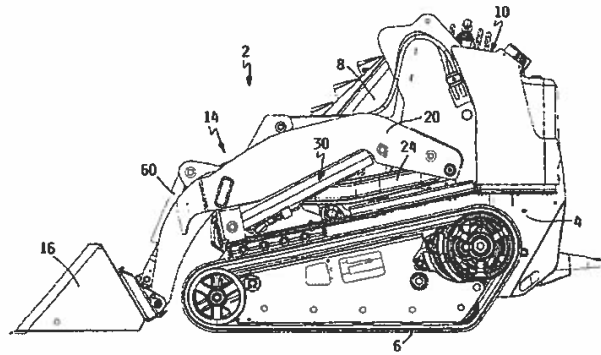


FIG. 2

Exhibit 1001 at Figure 2.

2. Claim 16(a) - The CTX50 Machine Had a Frame Carrying a Prime Mover as Claimed in Claim 16(a)

75. Claim 16(a) requires “a frame carrying a prime mover.” Exhibit 1001 at Claim 16(a). The ‘843 patent states that the “prime mover” used in the claimed compact utility loader is an “internal combustion gasoline or diesel engine,” which is carried on a frame. Exhibit 1001 at 4:6-9. The CTX50 Machine included such a prime mover carried by a frame.

76. As can be seen in the below comparison of the CTX50 Machine and Figure 2 of the ‘843 patent, the CTX50 Machine had a frame carrying a prime mover:

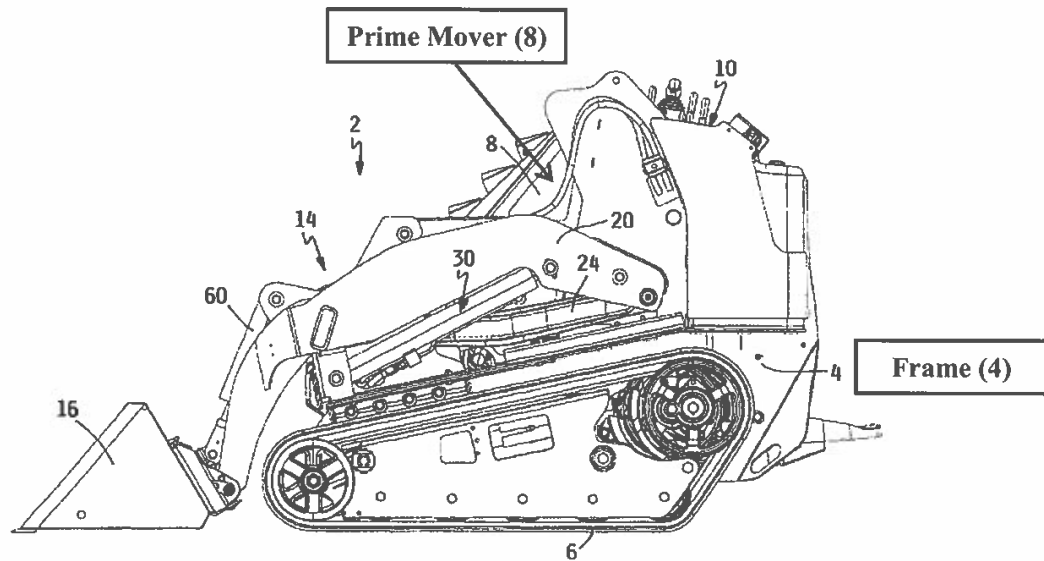


FIG. 2

CTX50 Frame



CTX50 Prime Mover

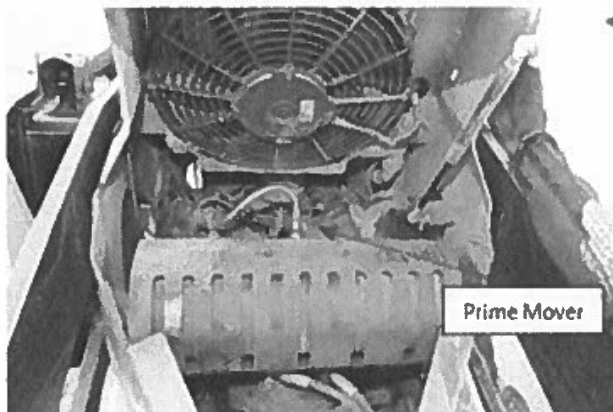


Exhibit 1007 (identifying the engine in the CTX50 Machine).

3. *Claim 16(b) – The CTX50 Machine Had the Claimed Ground Engaging Members Carried by the Frame*

77. Claim 16(b) requires “ground engaging members carried by the frame with at least one ground engaging member being powered to self-propel the frame.” Exhibit 1001 at Claim 16(b). The ‘843 patent describes the claimed “ground engaging members” in Figure 2 as “ground engaging endless tracks 6 on opposite sides” of the utility loader frame. Exhibit 1001 at 4:1-5.

78. The CTX50 Machine had ground engaging members in the form of endless tracks, as can be seen in a comparison of Figure 2 of the ‘843 patent with the CTX50 Machine:

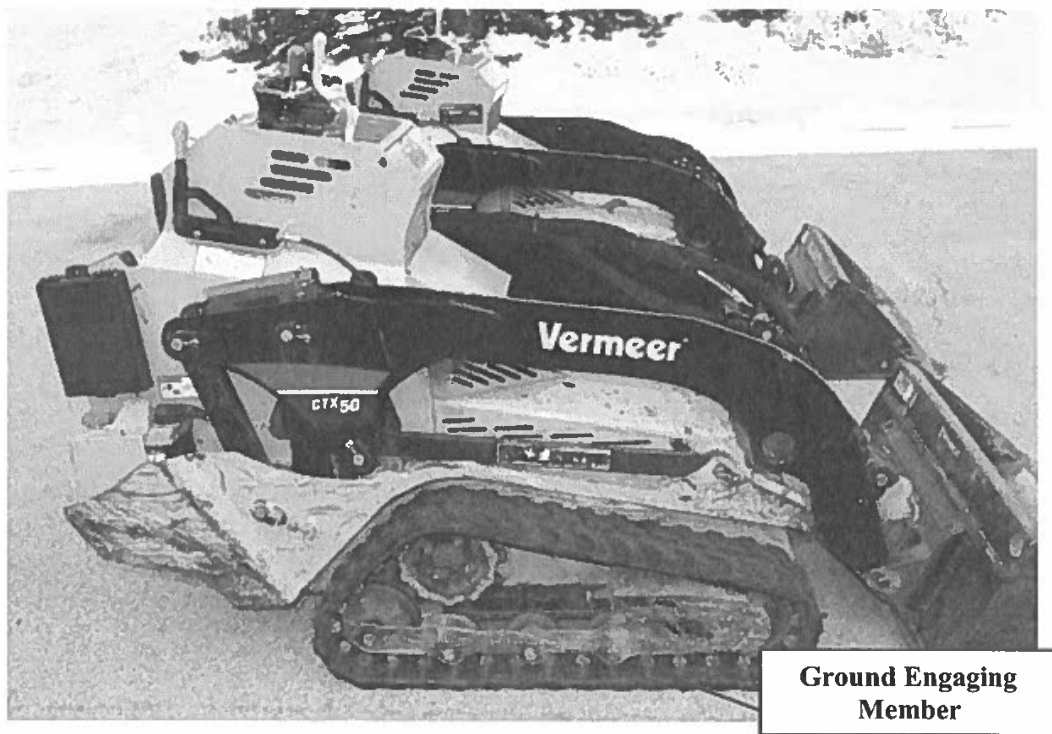
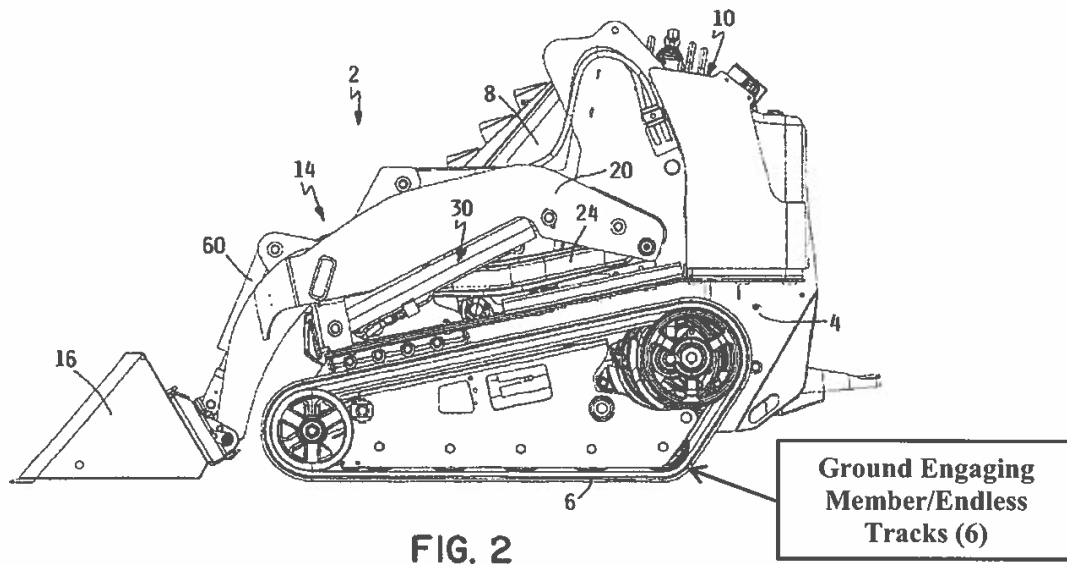


Exhibit 1007.

79. The ground engaging member (track) on the CTX50 Machine is powered to self-propel the frame of the compact utility loader. This is how the CTX50 Machine is able to move the frame.

4. *Claim 16(c) – The CTX50 Machine Had the Claimed Control Console at the Rear End of the Frame*

80. Claim 16(c) requires “a control console at a rear end of the frame carrying controls that are manipulated to operate the loader, the controls protruding at least upwardly from a control mounting surface to terminate in upper ends that are spaced above the control mounting surface.” Exhibit 1001 at Claim 16(c). As was common of compact utility loaders at the time of alleged invention, the CTX50 Machine had a control console at the rear end of the compact utility loader frame. The control console had controls that the operator manipulated to operate the loader.

81. The controls on the control console of the CTX50 Machine protruded upwardly from a mounting surface and terminated in upper ends that were spaced above the mounting surface. This control console with controls protruding upwardly spaced above the control mounting surface can be seen in the below images of the CTX50 Machine:

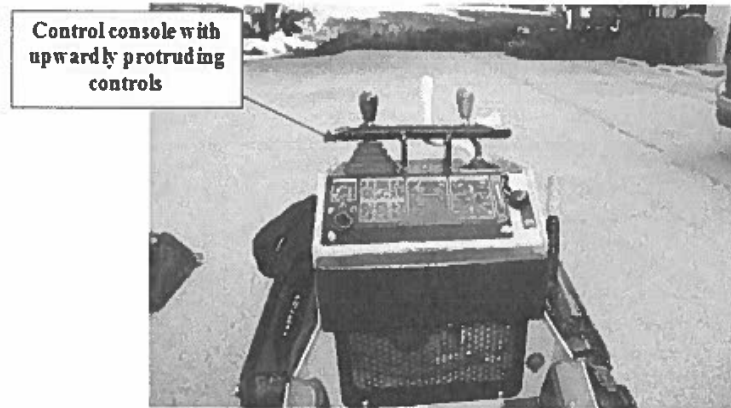
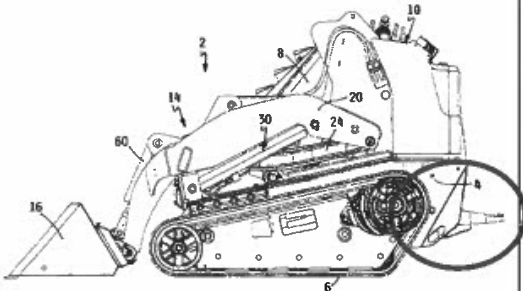
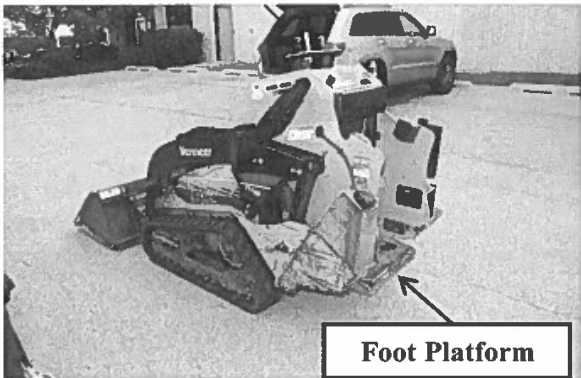


Exhibit 1007 (emphasis added).

5. *Claim 16(d) – The CTX50 Machine Had the Claimed Rear Foot Platform on the Rear End of the Frame*

82. Claim 16(d) requires “a rear foot platform on the rear end of the frame for permitting the controls to be accessible from behind by an operator who stands on the rear foot platform.” Exhibit 1001 at Claim 16(d). To permit the operator of the CTX50 Machine to access the control console, the CTX50 Machine had a foot platform on the rear end of the frame of the compact utility loader. The rear foot

platform, as can be seen in the images of the CTX50 Machine below, permits the controls to be accessible from behind the compact utility loader by an operator who stands on the rear foot platform to operate the control console:

Rear Foot Platform in Fig. 2	Rear Foot Platform on CTX50 Machine
 FIG. 2 Exhibit 1001 at Figure 2 (emphasis added).	  Exhibit 1007.

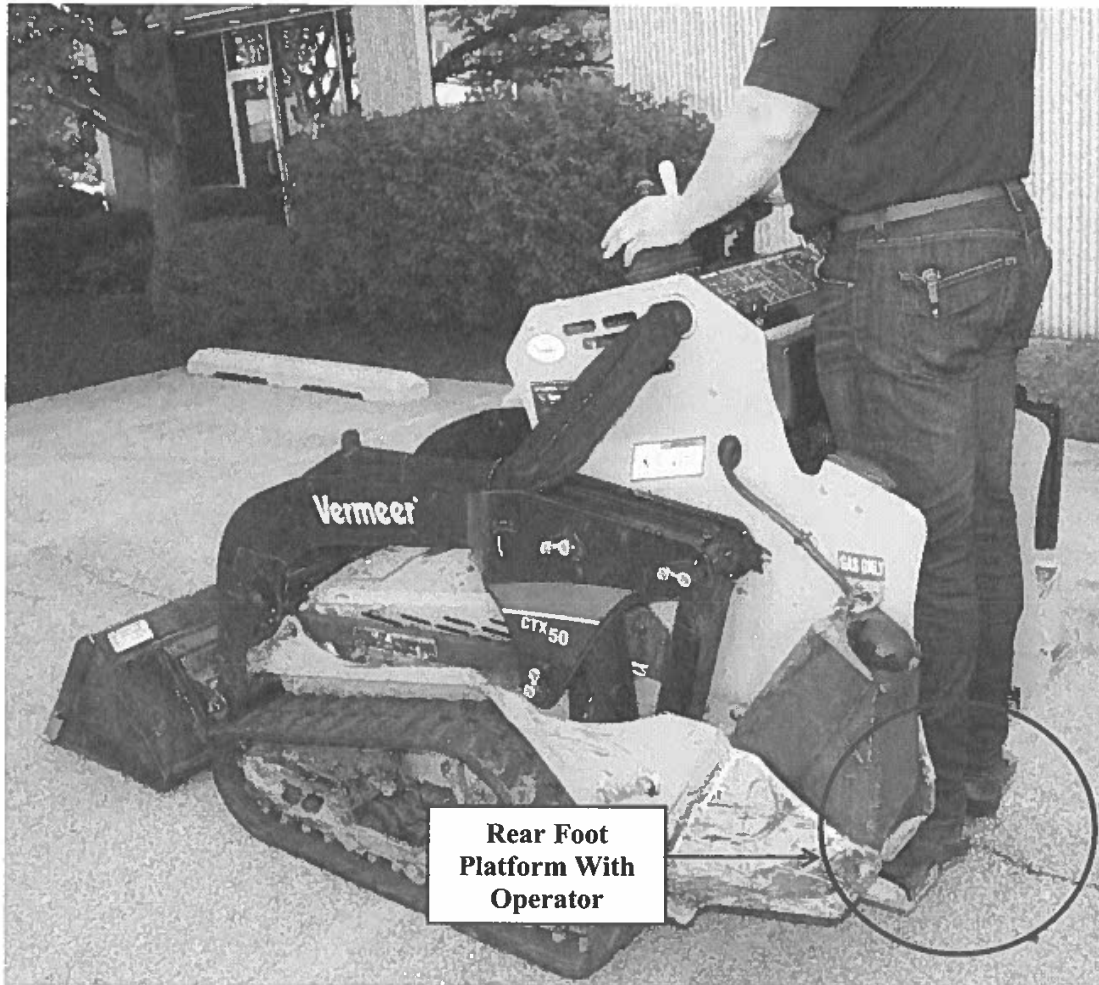


Exhibit 1007 (emphasis added).

6. *Claim 16(e) – The CTX50 Machine Had the Claimed Loader Arm Having a Front End that Carried an Outdoor Work Operation Tool*

83. Claim 16, limitation (e) requires a compact utility loader with a “loader arm having a front end that carries an outdoor work operation tool.” Exhibit 1001 at Claim 16(e). The outdoor work operation tool, as described in the ‘843 patent, includes pivotal dump buckets (as shown in Figures 2 and 3),

trenchers, augers, chippers, fork lifts, etc. Exhibit 1001 at 4:32-39. Each of these outdoor tools was well-known at the time of invention to be used at the end of a loader arm in a compact utility loader.

84. The CTX50 Machine includes a loader arm having a front end that carries an outdoor work operation tool. The CTX50 Machine could utilize numerous different types of outdoor work operation tools, such as a bucket, grapple, or auger. The below photo of the CTX50 Machine demonstrates an outdoor work operation tool (bucket) on the front end of a loader arm:

CTX50 Machine with Bucket on Loader Arm

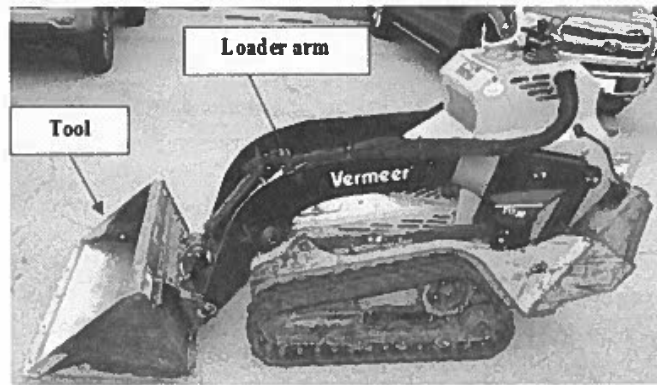


Exhibit 1007.

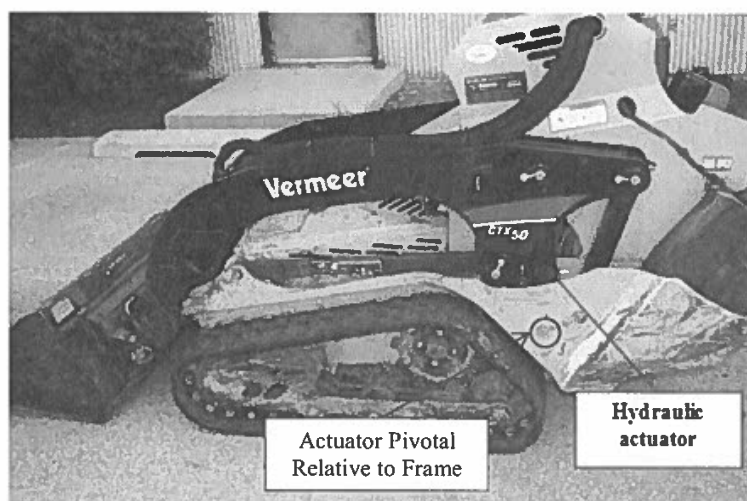
85. The CTX50 Machine expressly discloses a “loader arm having a front end that carries an outdoor work operation tool.”

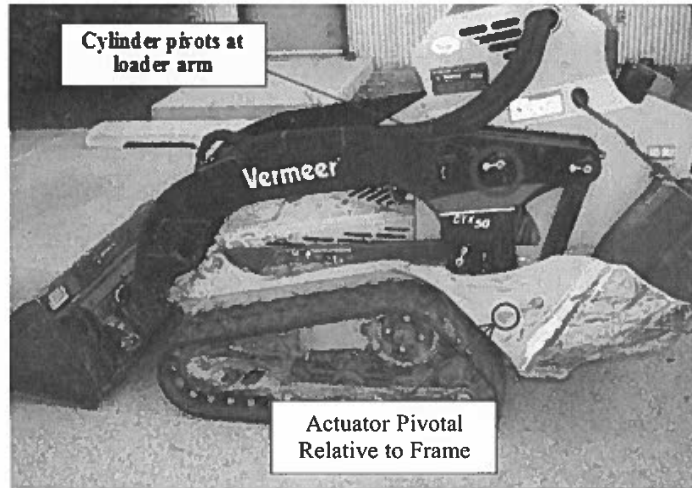
7. ***Claim 16(f) – The CTX50 Machine Had the Claimed Actuator That is Extendable and Collapsible in Length for Lifting and Lowering the Loader Arm, with the Actuator Pivotal Relative to the Frame and Pivotaly Connected to the Loader Arm***

86. Claim limitation 16(f) requires an “actuator that is extendable and collapsible in length for lifting and lowering the loader arm relative to the frame, the actuator being pivotal relative to the frame and having a pivot connection to the loader arm.” Exhibit 1001 at Claim 16(f). The ‘843 patent states that the actuator of the claimed invention can be a hydraulic cylinder. Exhibit 1001 at 4:57-61 (“Hydraulic cylinder 30 is the actuator that lifts and lowers loader arm assembly 14 between its FIG. 2 and FIG. 3 positions and any desired position in between. Other actuators, such as electrical actuators, could be used in placed of hydraulic cylinders 30 used in linkages 18.”). The CTX50 Machine had an actuator as described in the claim.

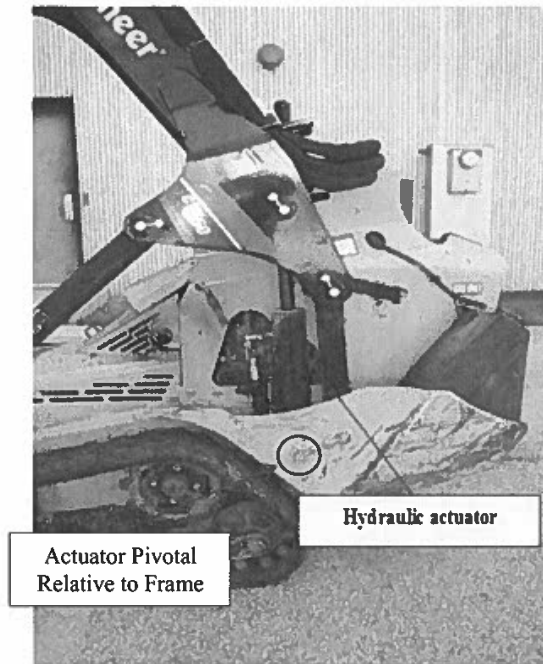
87. The images below show that the CTX50 Machine utilized a hydraulic cylinder as an actuator to raise and lower the loader arm:

Actuator in Down Position





Actuator in Extended Position



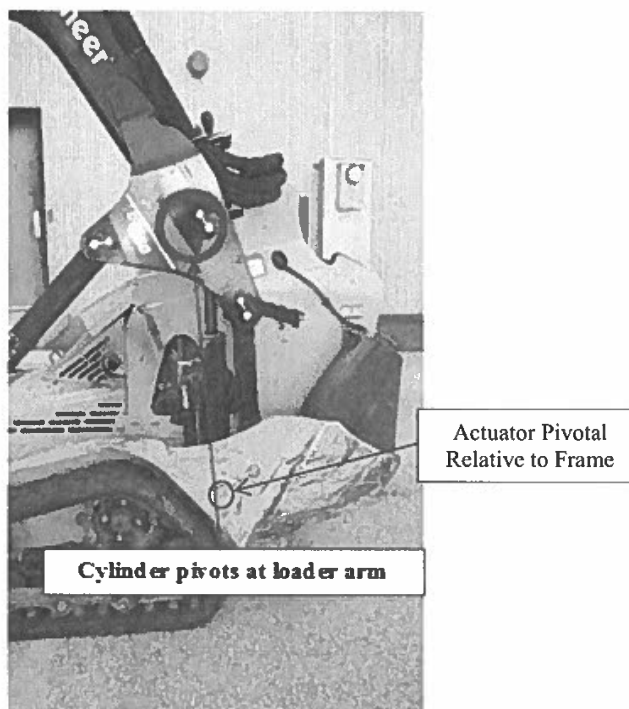


Exhibit 1007.

88. As can be seen above, the CTX50 Machine's hydraulic cylinder contains a cylinder rod that extends to raise the loader arm relative to the frame. To lower the loader arm, the cylinder rod retracts. As can also be seen in the images above, the hydraulic cylinder is pivotal relative to the frame of the CTX50 Machine and has a pivot connection to the loader arm. The actuator is pivotally connected to the loader arm and is pivotal to the frame because it rotates as the loader arm is raised and lowered. The actuator is mounted to the loader arm and the frame with pins to allow this pivot connection.

8. *Claim 16(g) – The CTX50 Machine Had the Claimed First Pivotal Connecting Arm and Second Pivotal Connecting Arm*

89. Claim 16(g) requires “a first pivotal connecting arm and a second pivotal connecting arm for supporting the loader arm for movement between a lowered position and a raised position, the connecting arms being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof.” Exhibit 1001 at Claim 16(g). The CTX50 Machine contained a “first pivotal connecting arm” and a “second pivotal connecting arm” that were used to support “the loader arm for movement between a lowered position and a raised position.”

90. As discussed above, the limitation “the connecting arms being configured to produce at least some upward and forward motion of the loader arm in the fore-and-aft direction as the loader arm moves between the lowered and raised positions thereof” requires that the points of attachment between the connecting arms and the loader arm be positioned more upwardly and forwardly when the machine is in its fully raised condition than when it is in its fully lowered condition. The CTX50 Machine discloses connecting arms and a loader arm that satisfy this condition.

91. The images of the CTX50 Machine below show the “first pivotal connecting arm” and “second pivotal connecting arm” when the loader arm is in a lowered position and when the loader arm is in a raised position:

First and Second Pivotal Connecting Arm in the Lowered Position

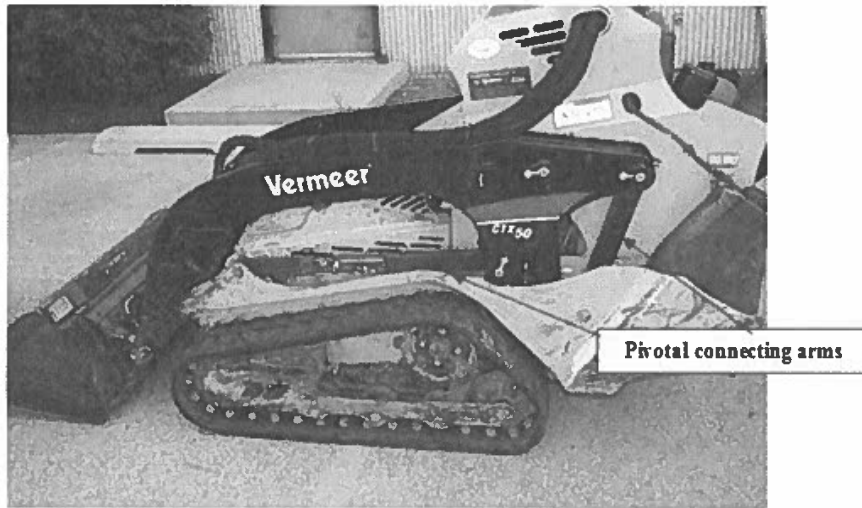


Exhibit 1007.

First and Second Pivotal Connecting Arm in the Raised Position

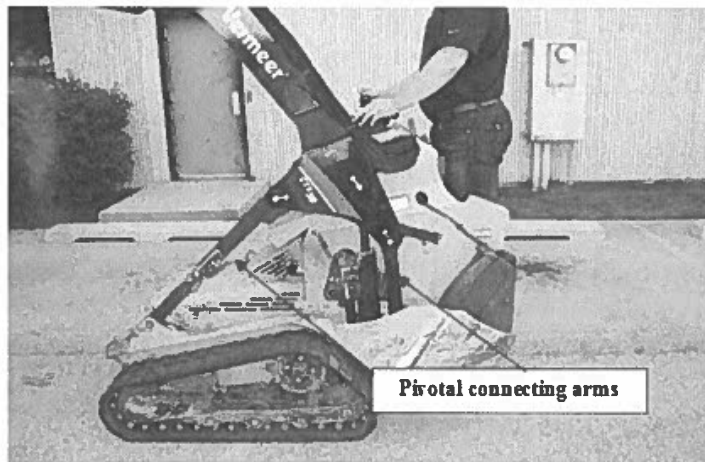


Exhibit 1007.

92. The points of connection between the first and second connecting arms and the upper loader arm are positioned more upwardly and forwardly when

the loader arm is fully raised (i.e., when it is placed in its high lift position or configuration) as compared to when the loader arm is in its lowered position. This can be seen in the image below showing the starting and ending positions of these pivot points on the CTX50:



Exhibit 1007.

9. *Claim 16(h) – It Would Have Been Obvious for a POSITA to Modify the CTX50 Machine to Increase the Pin Height, which Would Necessarily Satisfy this Limitation*

93. Claim 16(h) states that the pivot connection of the actuator to the loader arm is “lower than the control mounting surface of the control console in the

lowered position of the loader arm and is higher than the control mounting surface of the control console in the raised position of the loader arm.” Exhibit 1001 at Claim 16(h).

94. The pivot connection of the actuator to the loader arm in the CTX50 Machine is lower than the control mounting surface of the control console in the lowered position of the loader arm. This can be seen in the following image:

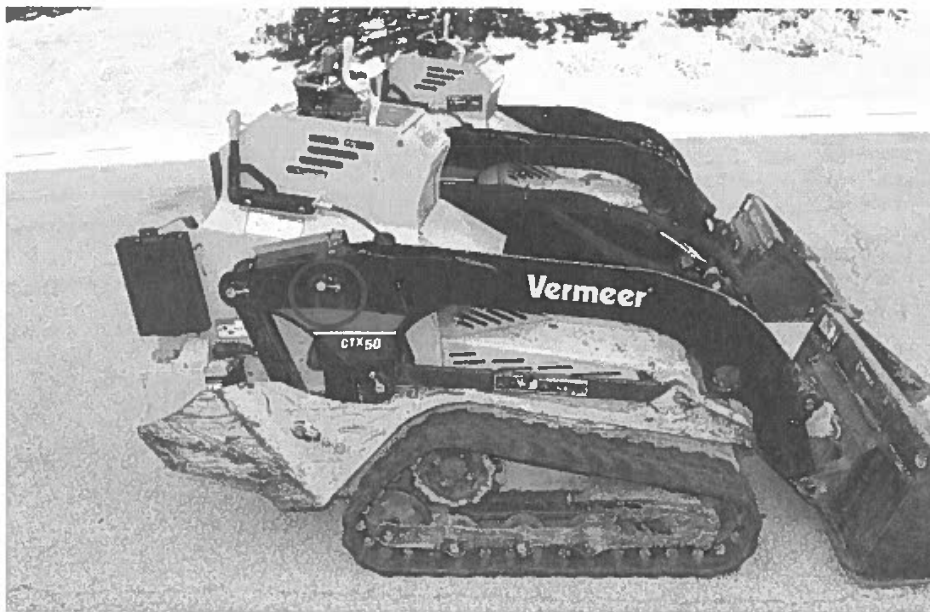


Exhibit 1007.

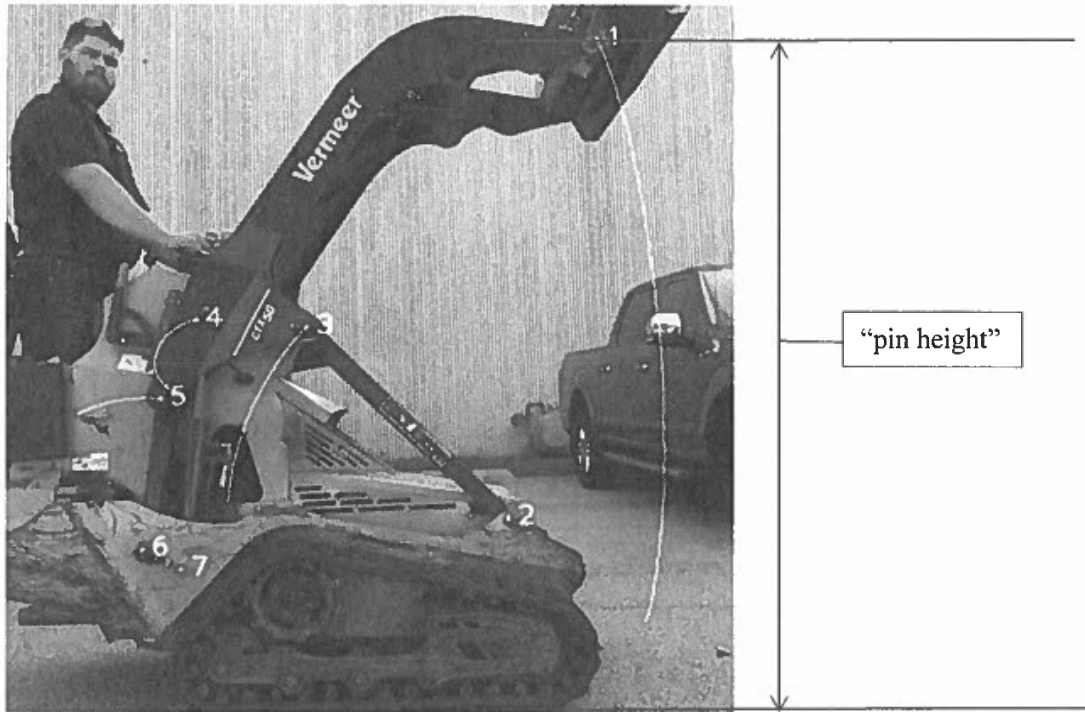
95. The actuator pivot connection to the loader arm in the CTX50 Machine is also slightly lower than the control console when the loader arm is in the raised position. This can be seen in the following image:



Exhibit 1007.

96. While the actuator pivot connection in the raised position is lower than the control console in the CTX50 Machine, it would have been obvious to a POSITA to modify the CTX50 Machine to increase the pin height of the machine.

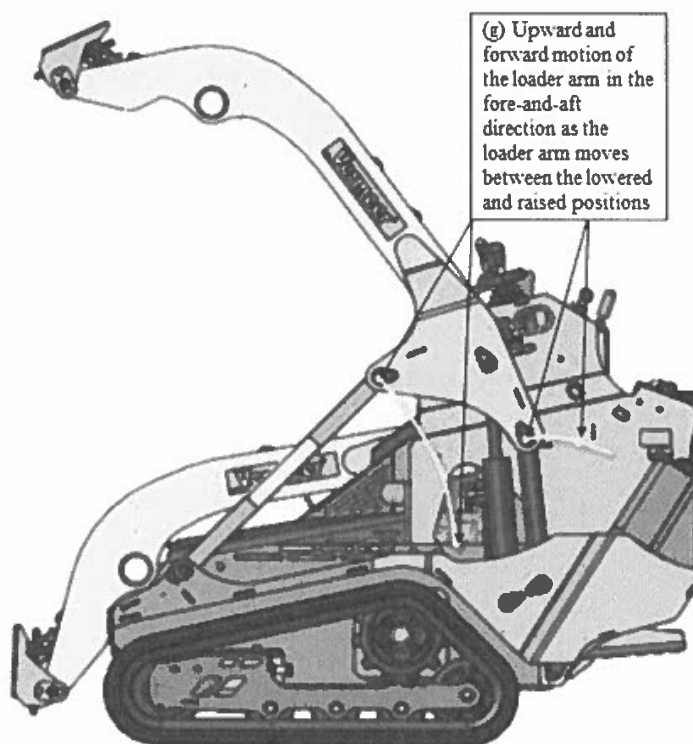
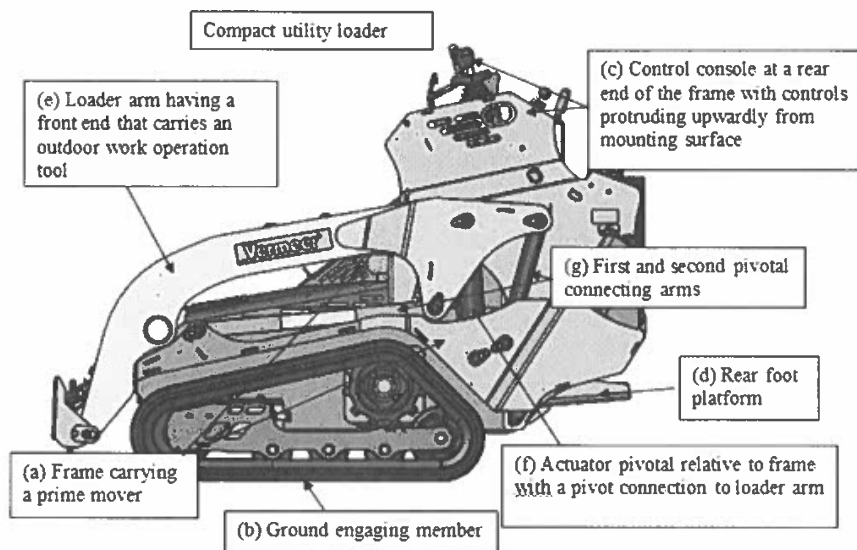
The “pin height” of a compact utility loader is the height from the ground to the pin attaching the tool to the end of the loader arm. This is shown in the image below:



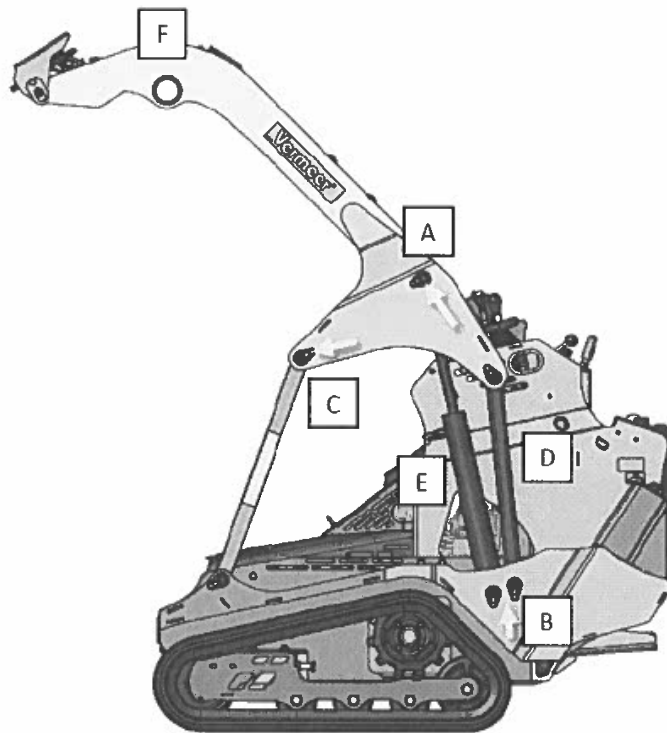
Pin height is an important feature directly related to the versatility of the machine. The minor modifications needed to achieve increased pin height in the CTX50 Machine would raise the location of the pivot connection that joins the actuator to the loader arm, such that this claim limitation would be satisfied by the modified machine. As I discuss in further detail in below, a POSITA would have been motivated to make these modifications to increase the machine’s pin height and would have had a reasonable expectation of success in doing so.

97. To demonstrate how the CTX50 Machine could be easily modified to achieve a higher pin height, I have prepared images showing the modified design that has a pin height of 80 inches—a pin height that many compact utility loaders met or exceeded by 2014. I started with a three-dimensional computer aided design (CAD) model of the CTX50 Machine that represents the same design as the machines sold in 2014. A POSITA as of the effective filing date of the '843 patent would have been able to create and/or modify a CAD model of the CTX50 Machine. Using the CAD model of the CTX50 Machine, I was able to evaluate the motion of the connecting arms and pivot pins as the loader arm moved through the range of motion.

98. As shown in the following figures taken from the CAD model for the CTX50 Machine, the as-designed machine satisfies the limitations of claim 16(a)-(g) of the '843 patent:



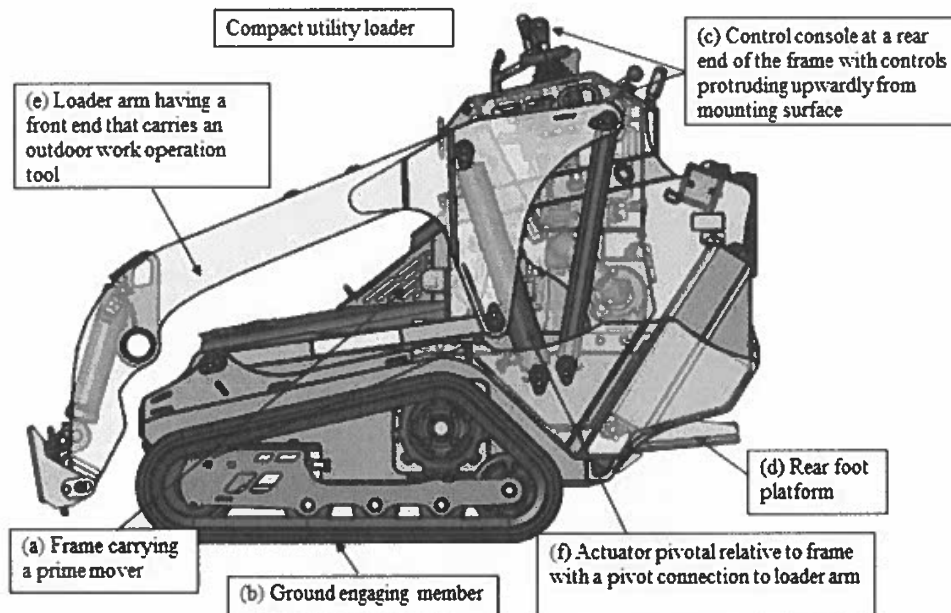
99. The changes needed to increase the pin height of the CTX50 were routine design changes well within the capabilities of those of ordinary skill in the art applying known techniques based on design and market incentives as of the effective filing date of the '843 patent. A POSITA would have had an expectation of success in modifying the CTX50 Machine as discussed below to create a compact utility loader with increased pin height. A POSITA would have had a finite number of obvious design choices when wanting to increase the pin height of a compact utility loader such as the CTX50 Machine, including increasing the length of the rear pivotal connecting arm, lengthening the hydraulic cylinder (actuator), and adjusting some pivot locations. Some additional adjustments to guarding and hydraulic hose routing may also have been useful for the final production version of this configuration. In addition, counterbalance weights could be added, as necessary, to maintain the tipping load. These changes are summarized in the following image:



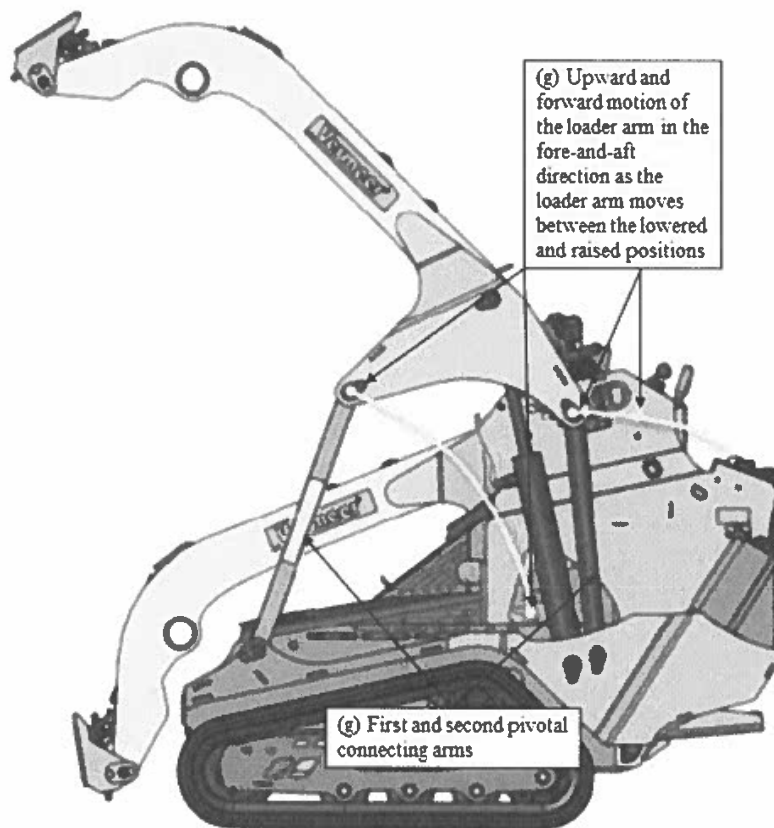
- | | |
|---|---|
| A | Actuator pivot pin position changed 6" |
| B | Actuator bottom pivot and rear link pivot pin positions moved ~2.4" |
| C | Link pivot pin position moved 7.6" and shortened link by 0.5" |
| D | Link length increased from 16" to 26" |
| E | Cylinder length increased (cylinder body 15.75" to 23"; rod length 16" to 22.75") |
| F | Loader arm shape modified slightly to conform to the vehicle |

100. These obvious adjustments to the CTX50 Machine result in a compact utility loader that satisfies all the limitations of claim 16. As shown in the

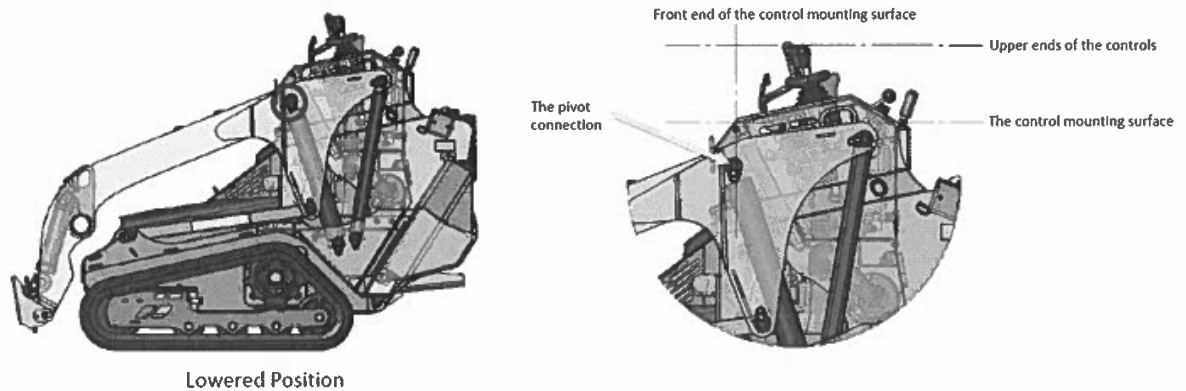
following image, the modified CTX50 Machine would have all the features required by limitations 16(a) through 16(f):



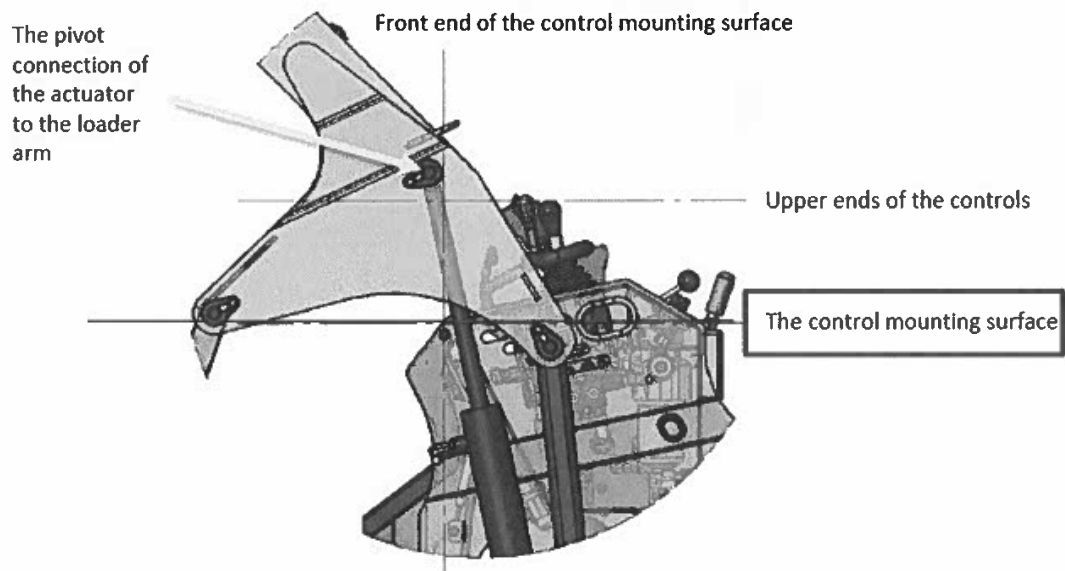
101. Like the original CTX50, the modified version with the increased pin height has loader arms that satisfy limitation 16(g). As seen below, the points of connection between the loader arm and the connecting arms move in an upward and forward motion as seen by comparing their relative positions in the fully lowered and fully raised positions of the loader arms:



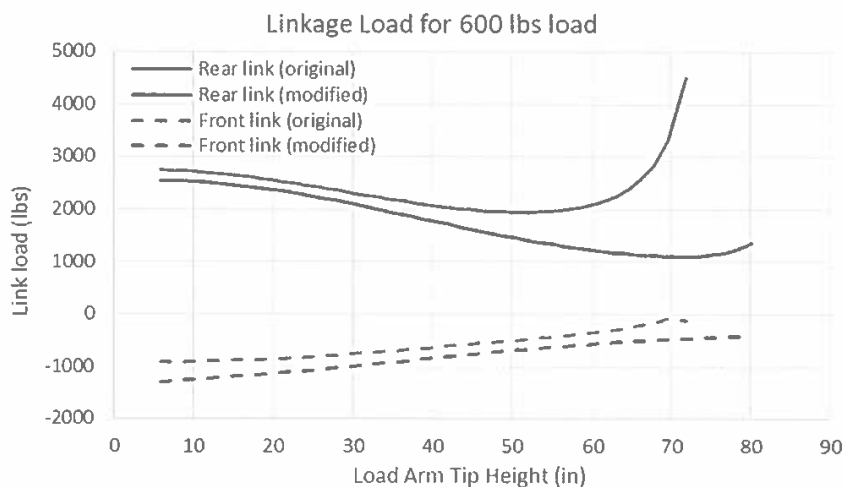
102. With regard to limitation 16(h), the pivot connection of the actuator to the loader arm is lower than the control mounting surface in the lowered position of the loader arm:

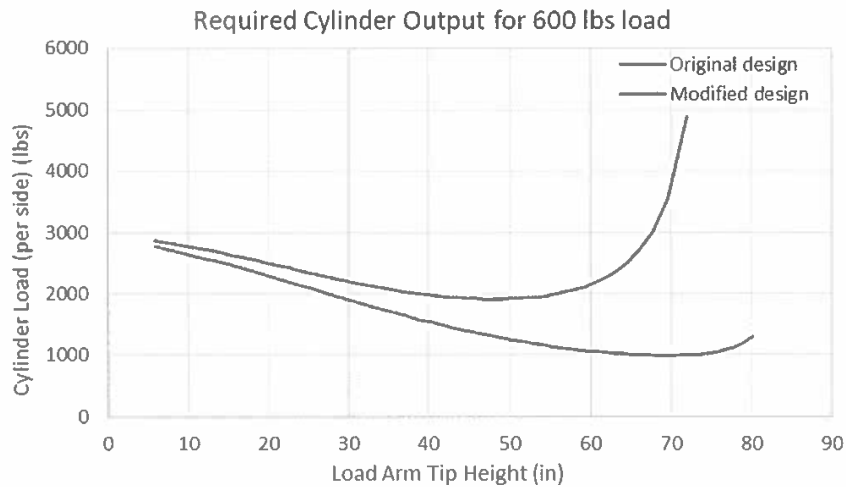


103. In the raised position, the pivot connection of the actuator to the loader arm is higher than the control mounting surface:



104. When designing a compact utility loader, a POSITA would evaluate the cylinder and connecting arm forces for the modified design configuration to compare with the forces on the original geometry. I have performed a connecting arm and cylinder force analysis using the original and modified loader arm geometry, along with the original and updated connecting arm and cylinder pin locations from the CAD models shown above. A finite element model was created using the Abaqus finite element software. Finite element analysis is a common method for performing structural calculations and a POSITA would be familiar with its use for this calculation. A vertical load of 600 lbs was applied at the bucket pin location and the cylinder was actuated to raise the loader arm. The reaction forces at the pivot pin locations were computed throughout the motion. As shown below, the force on the hydraulic cylinder and the forces on the front and rear connecting arms are all similar or reduced with the modified design.





B. A POSITA Would Have Been Motivated to Modify the Vertical Lift CTX50 Machine to Increase Pin Height.

105. It is my understanding that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I further understand that when work is available in one field of endeavor, design incentives and other market forces can prompt variations of it in the same field. I have been informed that if a POSITA can implement a predictable variation, § 103 likely bars its patentability as obvious. Similarly, if a technique has been used to improve one device, and a POSITA would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

106. As shown above in this Declaration, the Challenged Claims are nothing more than a combination of standard, conventional elements already existing and well-known at the time of the purported invention, combined according to known methods to achieve predictable results.

107. A POSITA would have been motivated to modify the already-existing vertical lift mechanism of the CTX50 Machine to increase its pin height based on customer demands, the nature of the problem to be solved, benchmarking against other compact utility loaders in the field, common sense, the teachings of the prior art, and the knowledge and experience of a POSITA. A POSITA would have been motivated to modify the CTX50 Machine to increase the lift height to create a compact utility loader with enhanced functionality such as being able to reach over the edge of standard dumpsters used at landscaping and construction sites. This would result in raising the pivot connection of the actuator on the loader arms.

108. After the introduction of the Vermeer CTX50 Machine's vertical lift compact utility loader in 2014, there would have been clear motivation for a POSITA to use the vertical lift configuration of the CTX50 Machine in a machine with an increased pin height. This straightforward modification of the CTX50 machine would improve versatility and achieve increased utility of the vertical lift technology on compact utility loaders. Based on my experience with designing similar equipment, a new design concept is typically introduced on one model of

machine. The natural progression is then to expand that technology across the product line. Increasing the lift height on a vertical lift compact utility loader is accomplished, in part, by adjusting the arm lengths and pivot locations of the four-bar linkage and actuator of the loader arm assembly.

109. Vertical lift machines allow larger loads to be lifted higher, because the lift height is not constrained by a lift arm pivoting about a single point, and because the center of gravity of the load is maintained closer to the base of the machine, thereby decreasing its propensity to tip. The closer load proximity to the base of the machine also allows vertical lift machines to be used in more confined spaces. Vertical lift machines further offer the advantage of better maintaining the load orientation as it is lifted or lowered, decreasing the need for the user to rotate the attachment throughout the lifting process.

110. Higher lift height, or “pin height,” allows loads to be maneuvered with more versatility. Around 2011, compact utility loaders were capable of lifting to 84.5”, as shown below. *See, e.g., Exhibit 1026.*¹ Manufacturers often use

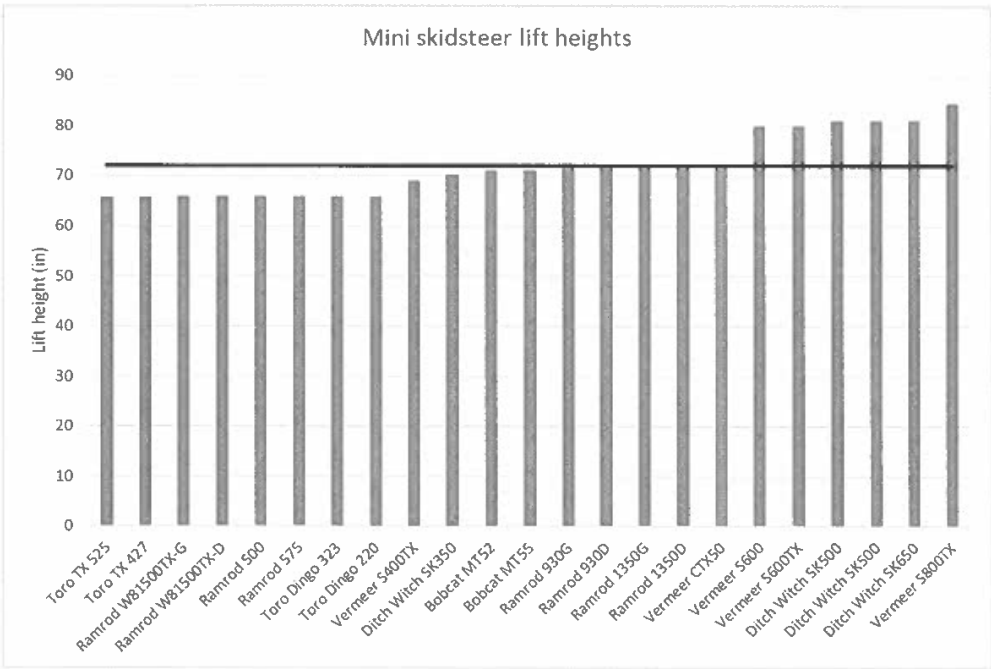
¹ I have independently researched the pin height data contained in Exhibit 1026.

The pin height data is accurate with the exception of the Toro Dingo machines, which are incorrectly identified as 90.1 and 91.2 inches. In Figure 1 below I have corrected the Toro Dingo pin heights by relying on data from Toro’s website.

“benchmarking” to measure their products against competitive products, with a goal of meeting or exceeding critical design and marketing features, such as the lift height.

111. The pin height (lift height) of the CTX50 Machine was 72”. At 72”, the Vermeer CTX50 Machine was below pin heights of other machines in the marketplace. There would have been clear motivation for a POSITA to modify the CTX50 Machine to increase the lift height of the machine as described above to have a compact utility loader to compete with other compact utility loaders of the time.

Figure 1: Lift heights of compact utility loaders circa 2011 compared to the Vermeer CTX50 Machine



112. Furthermore, increasing the pin height increases the utility of the compact utility loader. For example, increasing the lift height makes the machine compatible with taller and larger dumpsters. Using compact utility loaders to dump materials into a dumpster is a common usage for these machines. Table 1 lists common dumpster sizes. *See Exhibit 1025.*

Table 1: Standard Roll-off Waste Container Heights

<u>Dumpster Size</u>	<u>Most Common Side Height</u>
10 cubic yard	42" or 48"
15 cubic yard	54"
20 cubic yard	48"
30 cubic yard	72"
40 cubic yard	96"

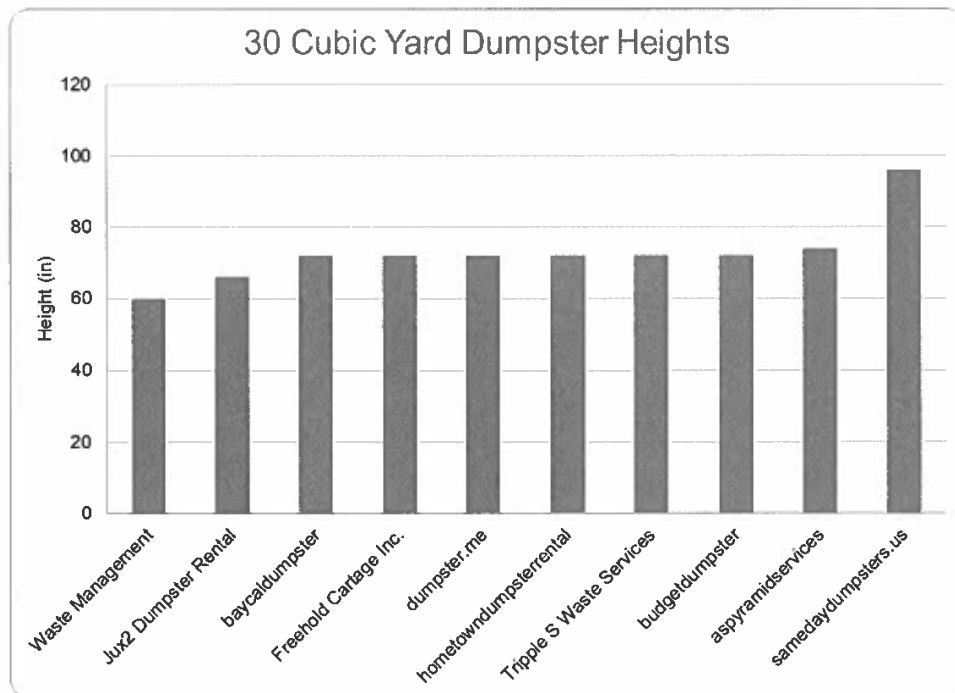


Exhibit 1025.²

113. As indicated in Table 1, the 72” pin height of the CTX50 Machine would make it incompatible with the sidewall height of many of the dumpsters, including the very commonly used 30 cubic yard roll-off type dumpsters (72”). I have performed research on 30 cubic yard dumpsters which shows that the most common height is 72”, as shown in Exhibit 1025. This was true in 2015 prior to the effective filing date of the ‘843 patent. A POSITA would have been aware that clearing the side of a 30 yard dumpster would require a pin height several inches in excess of 72” due to the structure around the pin and to provide clearance.

114. Therefore, there would have been strong motivation to increase the pin height of the CTX50 Machine to reach greater heights. As stated in an article from 2011, “the entire idea behind the compact tool carrier is offering versatility in a small package.” Exhibit 1026. A POSITA would have been aware that maximizing lift height was one of the most important features on a compact utility loader. Toro’s own documents corroborate the fact that maximizing lift height was important to manufacturers. During the “NextGen” design process, Toro designers

² Exhibit 1025 includes research I performed on common dumpster heights. The average heights in the table above is representative of average dumpster sizes as of 2015, and is also true of average heights today.

repeatedly cited lift height as one of the most important features to customers and Toro emphasized the importance of increasing the lift height on their Dingo machine to increase market share and stay competitive. Exhibit 1014 at VMR079915, VMR079916, VMR079921-VMR079922, VMR079987; Exhibit 1015 at VMR083071.

115. Additionally, based on Toro's "Voice of the Customer" research, lift height was the third most valued feature on the machine, and lift height was found to be a feature critical to customers' product selection decisions. Exhibit 1014 at VMR079921-VMR079922. Toro concluded that they were losing market share to DitchWitch and Vermeer due to the Tracked Dingo being insufficient in three major specifications: hinge pin height, dump height, and tipping capacity. Exhibit 1014 at VMR079975. Toro also concluded that their machines were limited in utility due to their limited lift height: "Not being able to match or exceed these key specifications [hinge pin height, dump height, and tipping capacity] translates into some specific and very common jobsite activities that the Toro Dingo cannot currently accomplish," including dumping material into a common 72" dumpster. Exhibit 1014 at VMR079976. As I have indicated, common dumpster heights provide a target design lift height for compact utility loaders, which is consistent with Toro's documentation showing a strong market desire for a pin height that

enabled compact utility loaders to dump over the edge of a standard dumpster with a 72” wall height. Exhibit 1016 atVMR086890.

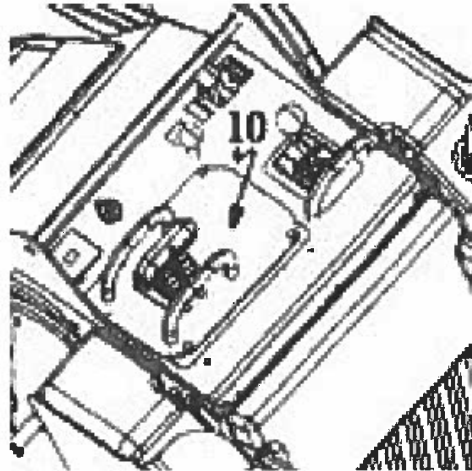
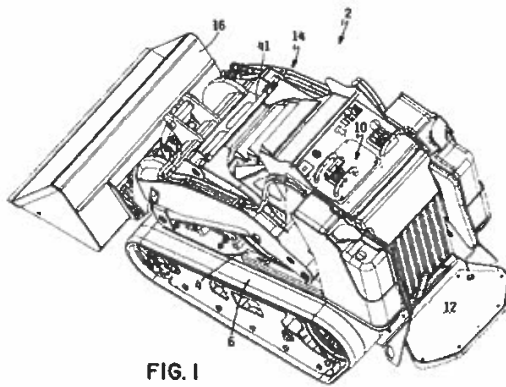
116. Customer demands for higher lift heights provided a strong motivation for a POSITA to increase lift height on compact utility loaders.

117. To increase the lift height of the CTX50 compact utility loader, a POSITA would have—based on a POSITA’s common sense, experience, and knowledge in the field—necessarily raised the pivot connection point of the actuator. This common-sense adjustment results in the pivot connection being located above the control mounting surface for the control console when the loader arm is in the raised position. This would have been an obvious modification to increase the utility and versatility of the CTX50.

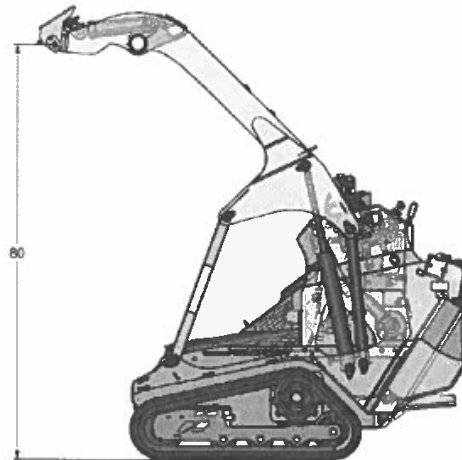
C. A POSITA Would Have Been Motivated to Modify the Vertical Lift CTX50 Machine to Increase Pin Height, Rendering Claim 17 Obvious

118. Claim 17 of the ‘843 patent depends from claim 16 and requires that the “pivot connection of the actuator to the loader arm is located ahead of and proximate to a front end of the control mounting surface of the control console in the raised position of the loader arm.” Exhibit 1001 at Claim 17.

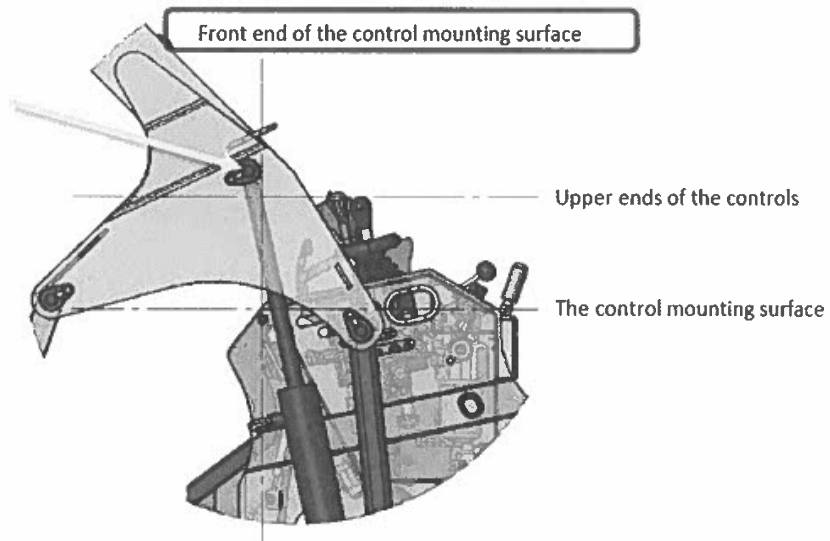
119. The “control mounting surface” is depicted below in the annotated Figure 1 of the ‘843 patent:

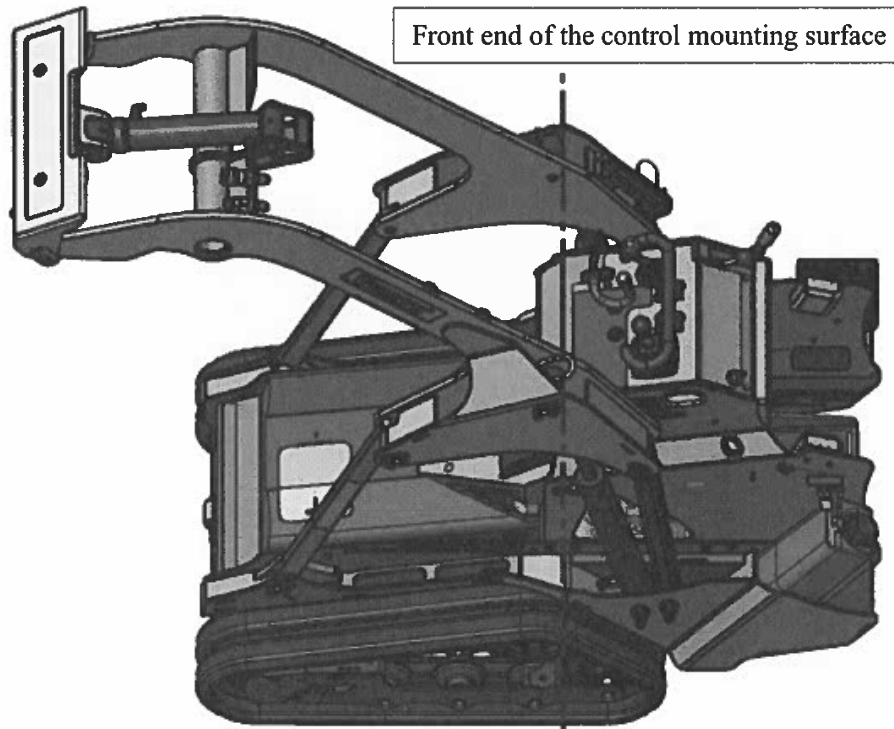


120. Driven by market demands and competitor benchmarking as described in at least Paragraphs 99, 105-117, modifications to the pin height of the CTX50 Machine would be achieved by the obvious changes listed in Paragraph 99. These changes would make the CTX50 Machine compatible with common 30 cubic yard dumpsters. With these modifications, the pivot connection of the actuator to the loader arm is located ahead of and proximate to the control mounting surface in the raised position of the loader arm.



The pivot
connection of
the actuator
to the loader
arm





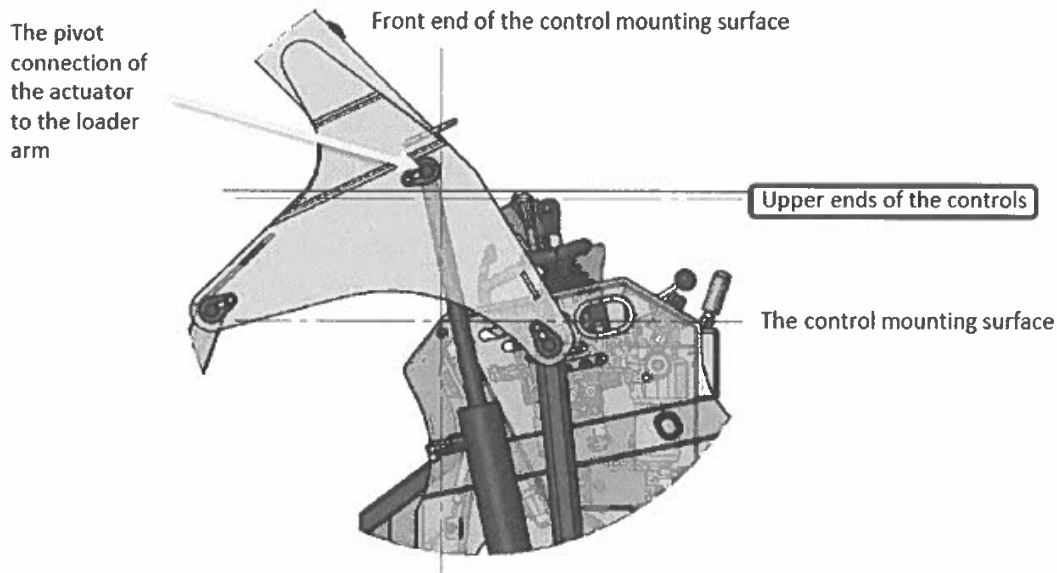
121. The CTX50 Machine shown above satisfies the limitations of claim 17.

D. A POSITA Would Have Been Motivated to Modify the Vertical Lift CTX50 Machine to Increase Pin Height, Rendering Claim 18 Obvious.

122. Claim 18 of the '843 patent depends from claim 17 and further requires the "pivot connection of the actuator to the loader arm is higher than the upper ends of the controls in the raised position of the loader arm." Exhibit 1001 at Claim 18.

123. The pin height of the CTX50 can be increased using the obvious changes listed in Paragraph 99. With these modifications that satisfy the

limitations of claim 17, the pivot connection of the actuator to the loader arm is also higher than the upper ends of the controls in the raised position of the loader arm, as shown below.

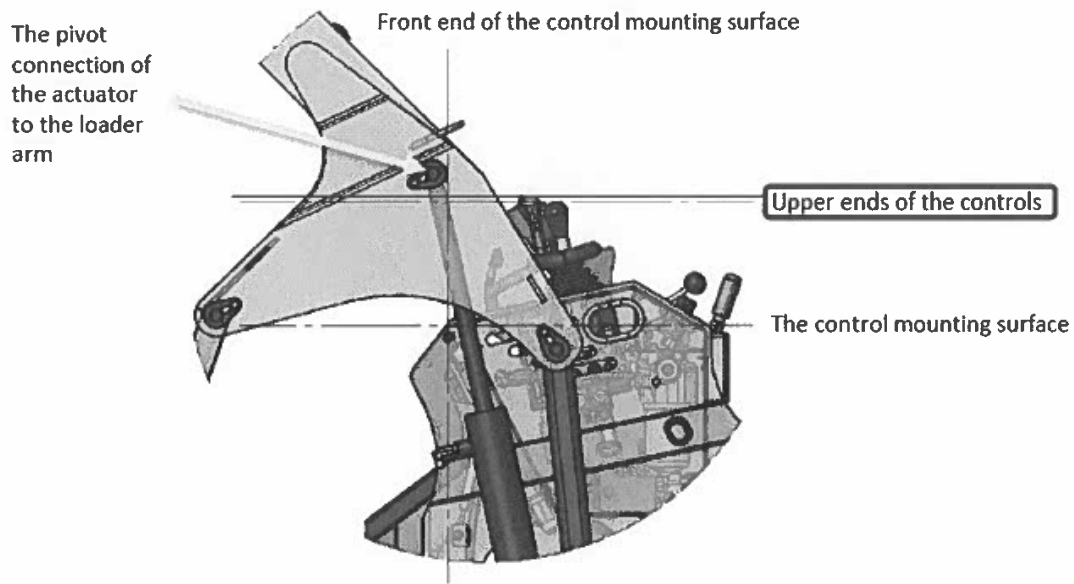


124. The CTX50 Machine shown above satisfies the limitations of claim 18.

E. A POSITA Would Have Been Motivated to Modify the Vertical Lift CTX50 Machine to Increase Pin Height Rendering Claim 19 Obvious.

125. Claim 19 of the '843 patent depends from claim 16 and further requires "the pivot connection of the actuator to the loader arm is higher than the upper ends of the controls in the raised position of the loader arm." Exhibit 1001 at Claim 19.

126. The pin height of the CTX50 can be increased using the obvious changes listed in Paragraph 99. With these modifications that satisfy the limitations of claim 16, the pivot connection of the actuator to the loader arm is higher than the upper ends of the controls in the raised position of the loader arm, as shown below.



127. The modified CTX50 Machine shown above satisfies the limitations of claim 19.

IX. CONCLUSION

128. As explained above, it is my opinion that the Challenged Claims describe a compact utility loader with features that would have been obvious to one of ordinary skill in the art at the time of the effective filing date in 2015.

129. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner raises and to take into account new information as it becomes available to me.

130. I hereby declare that all statements made herein of my own 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.

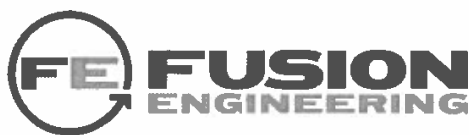
131. In signing this Declaration, I understand that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 26, 2020.


Mark Fleming, Ph.D., P.E.

APPENDIX A



Mark Fleming, Ph.D., P.E.

Principal Engineer

Direct: (331) 229-3328; Cell: (630) 947-2238

MFleming@fusioneng.com

Dr. Mark Fleming, Principal Engineer for Fusion Engineering, LLC, is an experienced mechanical engineer specializing in engineering analysis and accident investigation for vehicles and other machines. He is a consultant for accident investigation and reconstruction, failure analysis, design review and evaluation of products, and machinery and product testing. Dr. Fleming has a Ph.D. in theoretical and applied mechanics studying fracture mechanics and computer simulation methods, a M.S. degree in theoretical and applied mechanics studying reliability and fracture mechanics, and a B.S. degree in mechanical engineering. Dr. Fleming is also an Adjunct Professor of Mechanical Engineering at Northwestern University, where he teaches finite element analysis. He is a licensed professional engineer in the state of Illinois and a member of the American Society of Mechanical Engineers (ASME) and Society of Automotive Engineers (SAE).

Profile

- **Stress Analysis:** Applies finite element analysis to compute stress, strain and deformation of mechanical structures.
- **Fracture Mechanics and Fatigue Analysis:** Analyzes effects of pre-existing flaws and cracks in a structure.
- **Vehicle Engineering and Fuel System Crashworthiness:** Conducts analysis of vehicles under service loads and crash loads. Analyzes the effects of vehicle structure, material selection, and crash energy effects on fuel system integrity.
- **Bolted and Welded Joint Design and Analysis:** Provides understanding of how bolts and welds perform in service and analyzes fracture of these components.

Education

Academic Degrees

- **Ph.D. in Theoretical and Applied Mechanics**, Northwestern University, Evanston, IL, 1997
- **M.S. in Theoretical and Applied Mechanics**, Northwestern University, Evanston, IL, 1994
- **B.S. in Mechanical Engineering**, University of Nebraska, Lincoln, Nebraska, 1992

Expertise Computer Specialization

- Finite element software: ABAQUS/Standard and Explicit, Optistruct, Hypermesh, LS-Dyna
- CAD software: Pro/Engineer, AutoCAD, Solidworks
- Programming Language: Matlab, Python
- Accident reconstruction software: EDCrash, EDSMAC, Simon

Expertise Equipment and Applications

Accident Investigation and Reconstruction	Fuel System Integrity
Agricultural Equipment	Off-highway equipment
Automotive Engineering	Machinery and Product Testing
Bolt Analysis	Product Design Review and Evaluation
Construction Equipment	Stress Analysis
Crashworthiness	Theoretical and Applied Mechanics
Fatigue and Fracture Mechanics	Vehicle Engineering
Finite Element Analysis	Weld Analysis

Experience

Engineering Analysis, Simulation and Testing/Machinery and Vehicles

- Performed accident investigation and reconstruction.
- Inspected and analyzed more than 100 vehicles involved in crashes.
- Conducted design analysis and reviews of products.
- Specialized in the analysis of rollover protective structures (ROPS) and topology optimization.
- Coordinated analysis activities for three product lines, including planning, budgeting, and holding analysis reviews.
- Developed and deployed advanced simulation technologies for the optimization of agricultural and construction machinery.
- Performed testing and finite element simulations in the analysis of design performance.
- Conducted machinery and product testing.
- Was responsible for a corporate-wide analysis team for manufacturing simulations ranging from manufacturing process simulations to factory layout and factory flow simulations.
- Worked with 20 factories worldwide providing analysis and solutions related to the manufacture of agricultural and construction equipment products.

Studies Professional Development

Technical:

- Reliability assessment for welded structures, 1999
- Probabilistic Analysis and Design: Computational Methods and Applications, 1999
- Operations research, 2000
- Logistics, 2000
- Fatigue design analysis with MSC.Fatigue, 2000
- Fatigue data analysis using nCode, 2003
- Vehicle Accident Reconstruction Methods, 2005
- HVE Introductory Training, 2005
- Fundamentals and Automotive Fuel Delivery Systems, 2007
- Vehicle Dynamics for Passenger Cars and Light Trucks, 2009
- Advanced Vehicle Dynamics for Passenger Cars and Light Trucks, 2011

Licenses Professional Registration

- Licensed Professional Engineer in Illinois (License No. 62057502)

Employment Roles and Responsibilities

Fusion Engineering, Naperville, IL 2014 to Present

Principal Engineer

Consult on a broad range of products, equipment and structures in the areas of failure analysis, accident investigation and reconstruction, design review and evaluation, and machinery and product testing.

Northwestern University, Evanston, IL 2013 to Present

Adjunct Professor of Mechanical Engineering

Teach Finite Element Analysis to graduate students.

Core faculty member in the Simulation Driven Engineering (SDE) program.

Research in manufacturing methods and multiscale methods for fatigue, fracture, and damage

ITC Experts, Inc., Sugar Grove, IL 2011 to 2014

Senior Director of Mechanical Engineering

Manage projects in a broad range of products, equipment and structures for ITC Experts, Inc., a for-profit subsidiary of the Institute of Tribology and Coatings, Inc., which is an advanced Research and Development organization providing technical solutions to the military and industry.

Mark Fleming, Ph.D., P.E.
Principal Engineer

Responsible for consultation in the areas of failure analysis, accident investigation and reconstruction, design review and evaluation, and machinery and product testing.

Packer Engineering, Naperville, IL

2003-2011

Senior Director, Mechanical Engineering

Performed accident investigation and reconstruction, product design review and evaluation, and machinery and product testing. Utilized finite element analysis for mechanical design evaluation and vehicle crashworthiness analysis.

CNH Global/Case Corporation, Burr Ridge, IL

1997-2003

Principal Engineer

Advanced Engineering Analysis - 2001-2003

Developed and deployed advanced simulation technologies for the optimization of agricultural and construction machinery. Specialized in vehicle dynamic shake simulations, particle flow methods, and optimization methods. Wrote methodology and "best practices" documents, taught analysis seminars, and coordinated software acquisition and usage.

Manager, Manufacturing Simulations - 2000-2001

Responsible for a corporate-wide analysis team for manufacturing simulations ranging from manufacturing process simulations to factory layout and factory flow simulations. Worked with 20 factories worldwide providing analysis and solutions related to the manufacture of agricultural and construction equipment products.

Engineering Analysis - 1997-2000

Specialized in analysis of rollover protective structures (ROPS) and topology optimization. Introduced a new technology to the design teams such as topology optimization, manufacturing process simulation, and reliability-based design analysis. Coordinated analysis activity for three product lines, including planning, budgeting, and holding analysis reviews.

Affiliations

Memberships

American Society of Mechanical Engineers (ASME)

Society of Automotive Engineers (SAE)

SAE Fire Safety Committee member

ASM International

United States Association for Computational Mechanics

Pi Tau Sigma, Tau Beta Pi (engineering honor societies)

Northwestern University Mechanical Engineering Advisory Board member

Fusion Engineering

1804 Centre Point Circle, Naperville, IL

(630) 466-4065

www.fusioneng.com

Publications:

1. "Fatigue Reliability Method with In-Service Inspections, M.S. Thesis (1994).
2. Belytschko T., Krongauz, Y., Fleming, J., Organ, D.J., and Liu, W.K., "Smoothing and Accelerated Computations in the Element-Free Galerkin Method," Journal of Computational and Applied Mathematics, 74:111-126 (1996).
3. Belytschko, T., Krongauz, Y., Organ, D., Fleming, M., and Krysl, P., "Meshless Methods: An Overview and Recent Developments," Computer Methods in Applied Mechanics and Engineering, 139:3-47 (1996).
4. Organ, D., Fleming, M., Terry, T., and Belytschko, T., "Continuous Meshless Approximations for Nonconvex Bodies by Diffraction and Transparency," Computational Mechanics, Volume 18, Number 3, 225-235 (1996).
5. "Meshless Methods of Fatigue Crack Propagation," PhD Thesis (1997)
6. Fleming, M., Chu, Y., Moran, B., and Belytschko, T., "Enriched Element-Free Galerkin Methods for Crack Tip Fields," International Journal for Numerical Methods in Engineering, 40:1483-1504 (1997).
7. Belytschko, T. and Fleming, M., "Smoothing, Enrichment and Contact in the Element-Free Galerkin Method," Computers and Structures, 71(2):173-195 (1999).
8. Roy, S. and Fleming, M., "Non-Linear Subgrid Embedded Element-Free Galerkin Method for Monotone CFD Solutions," Proceedings of the 3rd ASME/JSME FED Conference (1999).
9. Yi, T. and Fleming, M., "Dynamic Simulations for Self-Propelled Sprayer With a Large Flexible Boom," LMS Conference for Physical and Virtual Prototyping (2002).
10. Olson, J., Fleming, M., Krishnaswami, R. and Pellillo, R., "Fuel Filler System Check Valves – Dynamic Evaluation," SAE Technical Paper 2017-01-1350.
11. Liu, Z., Fleming, M., and Liu, W.K., "Microstructural Material Database for Self-consistent Clustering Analysis of Elastoplastic Strain Softening Materials," Computer Methods in Applied Mechanics and Engineering, 330:547-577 (2018).
12. Zhang, G., Guo, T., Guo, X., Tang, S., Fleming, M., and Liu, W.K., "Fracture in Tension-Compression-Asymmetry Solids via Phase Field Modeling," Computer Methods in Applied Mechanics and Engineering, 357 (2019).
13. Han, X., Gao, J., Fleming, M., Xu, C., Xie, W., Meng, S., Liu, W.K., "Efficient multiscale modeling for woven composites based on self-consistent clustering analysis," accepted in Computer Methods in Applied Mechanics and Engineering.
14. Fleming, M., Krishnaswami, R., and Nakamoto, K., "Fuel Tank Strain Measurement using Computer Vision Analysis," SAE Technical Paper 2020-01-0924.

Presentations:

1. "Design and Analysis for Optimizing Manufacturing Processes," Design Engineering Conference at National Manufacturing Week (March 18-21, 2002).
2. "Manufacturing Simulations," Northwestern University (October 2000).
3. "Elemento Finitos Sin Malla," Universidad Politecnica de Madrid, Madrid, Spain (December 1996).
4. "The Element-Free Galerkin Method for Fatigue Crack Propagation," University of Nebraska, Lincoln, Nebraska (April 1996).
5. "There is a Substitute – Engineering Perspective on the Use of Computer Simulations," ACMIE SLG Workshop, DRI, Las Vegas, NV (February 2006).
6. "The Good, the Bad, and the Ugly – Computer Simulations for Product Development, Failure Analysis, and Mischief," ASM Material Science and Technology 2006 Conference and Exhibition, Cincinnati, OH (October 2006).
7. "Finite Element Analysis in Products Litigation: What you See is Nice, What's Covered is Vital," E.M. Caulfield, M. Fleming, and K. Schiferl, ABA 2008 Emerging Issues in Motor Vehicle Product Liability Litigation, Phoenix, AZ (April 2008).
8. "A New Approach to an Old Topic – Using Finite Element Analysis to Analyze Spot Weld Claims in Crashworthiness Cases," M. Fleming and A. Jones, ABA 2009 Emerging Issues in Vehicle Product Liability Litigation, Phoenix, AZ (April 2009).
9. "Science and Engineering: from Theory to Application", Arantzazu Alarcon-Fleming and Mark Fleming, North Central College Science Seminar, Naperville, IL (May 2011).
10. "Investigating Fires Involving Plastic Fuel Tanks: The Problem with Self-Consuming Evidence", P.W. Miles IV and M. Fleming, ABA 2013 Emerging Issues in Motor Vehicle Liability Litigation, Phoenix, AZ (April 2013).
11. "Fatigue Fracture Analysis using XFEM Combined with Fracture Surface Analysis", M. Fleming and K. Jones, *Advances in Computational Mechanics with Emphasis on Fracture and Multiscale Phenomena workshop honoring Professor Ted Belytschko's 70th Birthday*, Evanston, IL (April 2013).
12. "Computational Methods for Evaluating Variability in Optimization and Product Performance Evaluation", Key Note Presentation, M. Fleming, Symposium: Multidisciplinary Computer-Aided Design and Simulation-Based Optimization – Recent Applications and Future, Evanston, IL (December 2014).
13. "Investigation of an Automotive Spring Fatigue Fracture with Abaqus XFEM", ASM Material Science & Technology 2015 Conference, Columbus, OH (October 7, 2015).
14. "Elastic Cloud Based Make – A New Frontier for Manufacturing Optimization", M. Fleming, Symposium: Multidisciplinary Computer –Aided Design and Simulation-Based Optimization –

Mark Fleming, Ph.D., P.E.
Principal Engineer

Recent Applications and Future, Sponsored by Northwestern University and Altair Engineering, Evanston, IL (December 2016).

15. "Multiscale Analysis Methods for Failure Analysis: Industry and Research Perspective", M. Fleming, WCCM 2018 Short Course: Mechanistic Data-Driven Multiscale Analysis and Applications, New York City, NY (July 2018).

End of CV

APPENDIX B

Materials Considered

Document/Material Description
U.S. Patent No. 10,597,843 (Exhibit 1001)
File History for U.S. Patent No. 10,597,843 (Exhibit 1002)
U.S. Patent No. 10,202,266 (Exhibit 1004)
Merriam-Webster Dictionary (“proximate”) (Exhibit 1005)
CTX50 Mini Skid Steer Spec Sheet (2015) (Exhibit 1006)
CTX50 Machines with VIN Numbers 1VR2070L3F1000105 and 1VR2070L5F1000106 (Inspection Photographs and Videos of CTX50 Machines shown in Exhibit 1007)
Hartke Declaration (Exhibit 1008)
CTX50 Machine Serial Number 1VR2070LXF1000103 Purchase Order, Sales Order, and Invoice (Exhibit 1009)
CTX50 Machine Serial Number 1VR2070L3F1000105 Purchase Order, Sales Order, and Invoice (Exhibit 1010)
CTX50 Machine Serial Number 1VR2070L5F1000106 Purchase Order, Sales Order, and Invoice (Exhibit 1011)
CTX50 Machine Build Date Table (Exhibit 1012)
U.S. Patent No. 6,695,568 (Bares) (Exhibit 1013)
The Toro Company Next Gen TX Project Objective (VMR079914-VMR079989) (Exhibit 1014)
The Toro Company Next Gen Dingo Project Review (January 10, 2014) (VMR083068-VMR083097) (Exhibit 1015)
The Toro Company Solution Alternatives Presentation (VMR086890) (Exhibit 1016)
U.S. Patent No. 5,542,814 (Exhibit 1017)

The Toro Company's Responses to Requests for Admission (Exhibit 1020)
The Toro Company's February 28, 2017 Reexamination Request Against U.S. Patent No. 9,321,386 (Exhibit 1021)
Rental Dumpster Size Charts (including websites referenced in size chart) (Exhibit 1025)
June 17, 2011 Article Implements of Construction at https://compactequip.com/skid-steers/implements-of-construction/ (Exhibit 1026)
SolidWorks File for CTX50 Machine
U.S. Patent No. 6,709,223
U.S. Patent No. 7,980,569
Bobcat Company MT52 Mini Track Loader Specification
Dingo Brochure
Ditch Witch SK350 Operator's Manual
Ditch Witch SK500 Operator's Manual
Ditch Witch SK850 Mini Skid Steer Brochure 10/9/2014
Vermeer S600TX Brochure
Skidsteer geometry demystified, Equipment Today, July 17, 2012 (https://www.forconstructionpros.com/equipment/earthmoving-compact/article/10733059/skid-steer-lift-arm-geometry-and-its-impact-on-loader-performance)
Sizing up compact track loaders for optimal performance (https://mcsmag.com/sizing-up-compact-track-loaders-for-optimal-performance/)
Video: https://www.youtube.com/watch?v=JYZckHbLF8k , February 9, 2015