United States Court of Appeals for the Federal Circuit

00-1310

LOCKHEED MARTIN CORPORATION,

Plaintiff-Appellant,

v.

SPACE SYSTEMS/LORAL, INC.,

Defendant-Appellee,

Edward V. Filardi, Skadden, Arps, Slate, Meagher & Flom, LLP, of New York, New York, for plaintiff appellant. With him on the brief were Robert B. Smith, of New York; and David W. Hansen, of Palo Alto, California.

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On remand from the Supreme Court of the United States

United States Court of Appeals for the Federal Circuit

00-1310

LOCKHEED MARTIN CORPORATION,

Plaintiff-Appellant,

v.

SPACE SYSTEMS/LORAL, INC.,

Defendant-Appellee.

DECIDED: March 24, 2003

Before SCHALL, Circuit Judge, FRIEDMAN, Senior Circuit Judge, and GAJARSA, Circuit Judge.

GAJARSA, Circuit Judge.

DECISION

This case has been remanded to this court by the United States Supreme Court for further consideration in light of Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki, Co., 535 U.S. 722 (2002). The Supreme Court granted a petition for certiorari following our earlier decision in this case, vacated our decision, and remanded following its decision in Festo. Lockheed Martin Corp v. Space Sys./Loral, Inc., 249 F.3d 1314, 58 USPQ2d 1671 (Fed. Cir. 2001), vacated, 535 U.S. __, 122 S. Ct. 2349 (2002). We have carefully reviewed the Festo decision and have considered its impact on the various issues raised by the parties, especially with regard to the prosecution history estoppel effect as may be amended by Festo. However, other grounds were also briefed and argued by the parties. We now review and consider those other grounds in order to avoid further delay in the resolution of this long, complex, and protracted litigation. Based upon the alternative grounds, we affirm the decision of the United States District Court for the Northern District of California ("district court") in this case on a basis that does not implicate the Supreme Court's decision in Festo.

I. BACKGROUND

In the prior appeal, Lockheed Martin Corporation ("Lockheed") challenged the district court's grant of summary judgment of noninfringement on various grounds. See Lockheed, 249 F.3d at 1322-26, 58 USPQ2d 1676-79. We affirmed on the single ground that under our prior decision in Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 56 USPQ2d 1865 (Fed. Cir. 2000) (en banc), vacated, 535 U.S. 722, "'prosecution history estoppel [bars] the application of the doctrine of equivalents' to limitation [b]," the critical claim limitation at issue in the case. Lockheed, 249 F.3d at 1327, 58 USPQ2d at 1680 (citing Festo, 234 F.3d at 586, 56 USPQ2d at 1886).

The Supreme Court reversed our Festo decision, holding that we had misinterpreted and misapplied the doctrine of equivalents. Festo, 535 U.S. 722. It then entered the following order on Lockheed's petition for a writ of certiorari seeking review of our decision in the prior appeal:

> Petition for writ of certiorari granted. Judgment vacated, and case remanded to the United States Court of Appeals for the Federal Circuit for further consideration in light of Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. __, 122 S. Ct. 1831, 152 L. Ed. 2d 944 (2002).

535 U.S. __, 122 S. Ct. 2349 (2002).

On the same day, the Court entered identical orders in eight other cases coming from this court on petitions for writ of certiorari. See 535 U.S. __, 122 S. Ct. 2322-24 (2002).

The Supreme Court thus followed its routine practice of summarily "vacat[ing] the judgment below, and remand[ing] the case to the lower court for reconsideration in light of an intervening Supreme Court ruling." Robert L. Stern et al., Supreme Court Practice 317 (8th ed. 2002) (footnote omitted).

We do not interpret the Supreme Court's order in this case as requiring us to address the Festo issue or as precluding us from deciding the case on some other ground. Because the Court vacated our prior judgment affirming the district court's order granting summary judgment, the case on remand stands in the same posture as it did in the earlier appeal before our decision there. We think that all the Supreme Court intended was that, if we again considered the prosecution history estoppel point, we should do so in light of the Court's elucidation of that doctrine in its Festo opinion. There is no reason to believe, however, that the Supreme Court intended to require us on remand to limit our analysis to the theory we previously had followed. Indeed, our disposition of this appeal on grounds other than prosecution history estoppel literally complies with the Supreme Court's order in the sense that, "in light of Festo," we have "further consider[ed]" the case and concluded that the judgment of the district court should be affirmed on another ground.

A. Introduction

Lockheed is the assignee of U.S. Patent No. 4,084,772 ("the '772 patent"), which discloses an apparatus and method for steering a satellite. In 1995, Lockheed's predecessor, Martin Marietta Corporation, brought this patent infringement action against Space Systems/Loral, Inc. ("SSL"), alleging that certain SSL satellites infringe the '772 patent. The '772 patent, entitled "Roll/Yaw Body Steering for Momentum Biased Spacecraft," claims a structure and method for reducing the pointing errors of a satellite that has entered into an inclined orbit by varying the speed of the satellite's transverse momentum wheel in a sinusoidal manner.

A communications satellite typically orbits the earth in a geosynchronous equatorial orbit, circling the earth once every twenty-four hours in the equatorial plane. A geosynchronous orbit in the equatorial plane allows a satellite to maintain the same position relative to fixed points on the earth's surface, and is often referred to as "geostationary." A satellite in geostationary orbit, when viewed from the ground, appears to remain stationary in the sky. Therefore, a geostationary orbit enables a communications satellite to maintain a constant relationship with transmitters on earth. In addition to preserving a geosynchronous equatorial orbit, a communications satellite must also maintain a proper "attitude," or pointing direction, so that its antennae remain pointed at the desired target on the earth.

While in orbit, however, a satellite is subject to various destabilizing forces such as the gravitational effects of the sun and the moon. Such forces may cause a satellite to drift out of its equatorial orbit, into an "inclined" north-south orbit. A satellite in an inclined orbit may still orbit the earth in a geosynchronous manner (once every twenty-four hours), but may no longer appear stationary in the sky to an earthbound observer.

The following diagram, Figure 2 of the '772 patent specification, depicts an inclined orbit relative to an equatorial orbit:

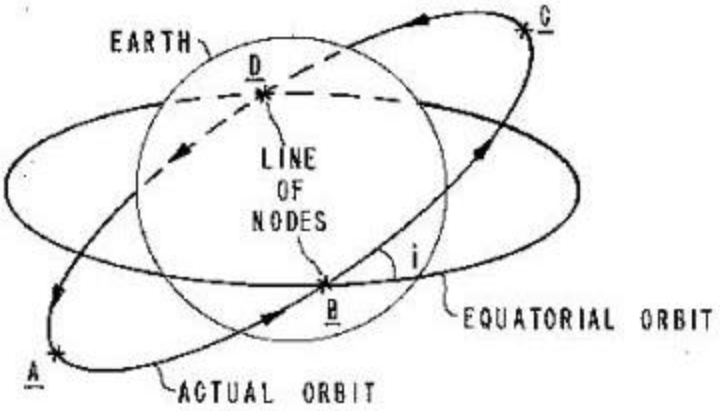

FIG. 2

Therefore, in an inclined orbit, the antennae of a communications satellite point north of the equator for half of the

orbit and south of the equator for half of the orbit. Unless the satellite corrects for solar and lunar gravitational effects, the orbit of a geosynchronous satellite acquires an inclination at the rate of about 0.8 degrees annually.

The '772 patent discloses a system for allowing a communications satellite to continue to operate effectively after entering an inclined orbit. It does so by changing the attitude, or pointing direction, of the satellite when the satellite is north and south of the equator. The method described by the '772 patent rotates the satellite so that its antennae point north or south, and remain pointed at the same earth target over the course of twenty-four hours.

The attitude of satellites is described in terms of movement and rotation about three axes. The "pitch" axis lies in a north-south direction, the "roll" axis points in the direction of satellite orbital movement, and the "yaw" axis points to the center of the earth. In an inclined orbit, roll pointing error occurs when a satellite is north or south of the equator. There is no roll pointing error when a satellite is above the equator twice each orbit (depicted above in Figure 2 at points B and D). Conversely, yaw pointing error is greatest when a satellite crosses the equator. There is no yaw pointing error when a satellite is furthest north or south of the equator (depicted above in Figure 2 at points A and C).

The structure and method described by the '772 patent rotates a satellite around its roll axis such that its antennae point to the south when the satellite is north of the equator, and point to the north when the satellite is south of the equator. In this manner, even though a satellite is moving north and south during its orbit, it remains pointed at the same earth target, and behaves as if it were still in geostationary orbit.

B. The '772 Patent Technology

Many communication satellites employ at least one "momentum" or "reaction" wheel centered on the pitch axis of a satellite ("pitch wheel") powered by an electric motor. A spinning momentum wheel creates angular momentum, or "stiffness," and opposes any satellite rotation about the roll or yaw axis. In other words, the spinning pitch wheel acts like a gyroscope, resists external forces, and keeps the pitch axis pointed in a north-south direction.

In addition to this resistance effect, momentum wheels also cause a satellite to rotate around its axes by taking advantage of the physical law of conservation of angular momentum. When a momentum wheel increases speed in one direction, it causes the entire satellite to spin in the opposite direction along the same axis in order to conserve angular momentum. Thus, through careful control of momentum wheels centered on different axes, a proper satellite attitude can be maintained.

As discussed above, the invention described by the '772 patent is a structure and method for spinning a second momentum wheel centered on a satellite's yaw axis. This wheel is referred to as the "yaw" wheel or "transverse" wheel.

When the yaw wheel is accelerated, it creates angular momentum about the yaw axis. In response, the pitch wheel and the entire satellite must rotate about the roll axis in order to compensate and cancel the angular momentum created by the yaw wheel, thereby adjusting the north-south pointing direction of the antennae.

As described by the '772 patent, the amount of north-south roll pointing attitude adjustment varies with the speed and spin direction of the yaw wheel. When the yaw wheel is not spinning, the satellite does not rotate about its roll axis. However, increased yaw wheel speed in one direction points the satellite to the north; increased yaw wheel speed in the other direction points the satellite to the south. In short, by varying the speed and direction of the yaw wheel, the satellite can be steered about its roll axis, adjusting and correcting for the north-south roll pointing errors described above.

The following diagram, Figure 3 of the '772 patent specification, depicts the pointing direction resulting from this roll pointing attitude adjustment. As depicted, by rotating the satellite around its roll axis by F degrees, the satellite points at the equator:

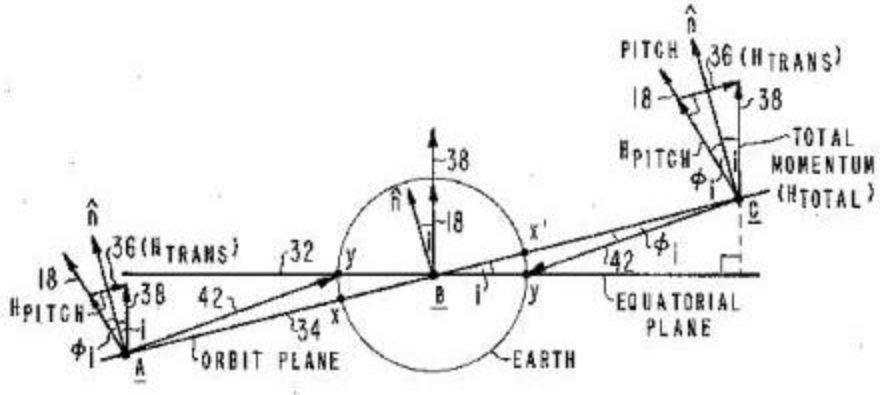

FIG. 3

The speed of the yaw wheel varies in a “sinusoidal” manner based on the orbital angle of inclination and the satellite’s distance from the equator. That is, the yaw wheel spins slowly after the satellite crosses the equator, and spins at a maximum velocity when the satellite is furthest north or south in relation to the equator. As the satellite again approaches the equator, the yaw wheel slows down. As the satellite crosses the equator, the yaw wheel slows, stops, and reverses direction. The rate of change of yaw wheel spinning velocity is based on a sinusoidal variation over twenty-four hours.

The following diagram, Figure 4 of the '772 patent specification, depicts a block diagram of the control system described by the '772 patent:

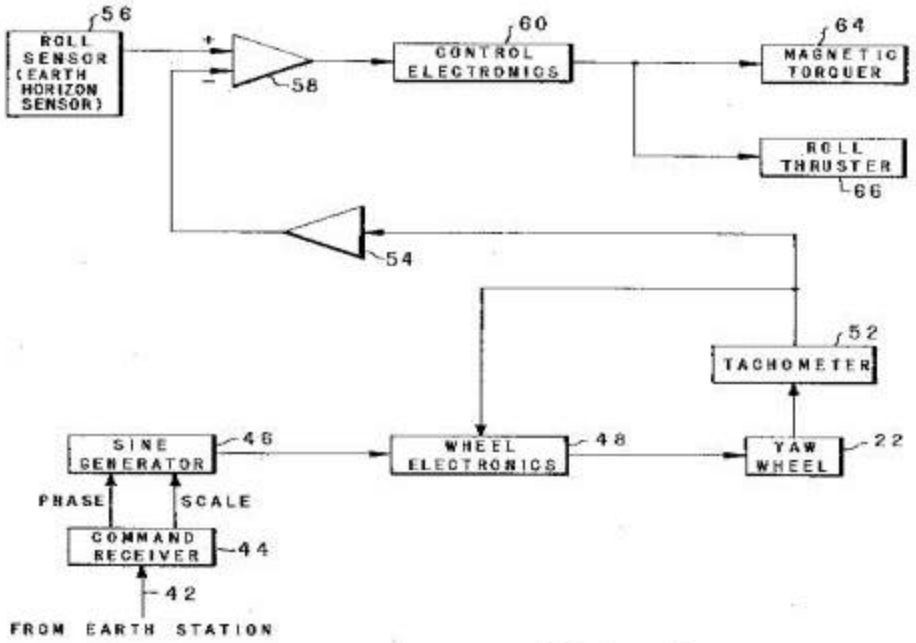

FIG. 4

The intentional north-south attitude adjustment described in the specification of the '772 patent creates an additional control problem which must be resolved. Prior art satellites employed an "earth horizon" or "roll" sensor in order to keep the yaw axis pointed at the center of the earth during equatorial orbit. If the earth sensor described by the '772 patent determines that the yaw axis is not pointed at the center of the earth, it activates the magnetic torquer (64) or roll thruster (66) in an attempt to reorient the satellite. During inclined orbit, however, the satellite is intentionally rotated about its roll axis. Unless the satellite is otherwise "fooled," the earth sensor would activate the magnetic torquer or roll thruster in an attempt to undo the intentional attitude adjustment.

The '772 patent discloses a structure and method for "fooling" the earth sensor. A tachometer (52) generates a signal representing the speed and direction of the yaw wheel. This signal, representing the angle of intentional roll, is subtracted from the signal generated by the earth sensor (56) by a summer (58), and effectively "fools" the earth sensor from undoing the intentional attitude adjustment.

C. The '772 Patent Claims

Claim 1, the only independent claim in the '772 patent at issue, reads as follows:

> A control system for an orbiting pitch momentum biased satellite, said satellite having a pitch, roll, and yaw axis, and wherein the momentum of said satellite is defined by a momentum vector,
> said satellite being adapted to be placed in an orbit defining a plane that is inclined relative to a plane containing a geo-synchronous orbit,
> said inclination inherently causing roll and yaw pointing errors with respect to said geo-synchronous orbit, comprising:

a. a transverse wheel mounted parallel to said yaw axis and adapted for bi-directional rotation and varying speed,
b. means for rotating said wheel in accordance with a predetermined rate schedule which varies sinusoidally over the orbit at the orbital frequency of the satellite whereby the attitude of said satellite is offset in response to the effect of said rotating wheel by the direction of the pitch axis being changed with respect to said momentum vector, the direction of said pitch axis with respect to the inclined orbit normal varying sinusoidally at the orbital frequency to null said roll pointing error due to said orbit inclination, the momentum vector being maintained perpendicular to the plane of the geo-synchronous orbit to null said yaw pointing error due to said orbit inclination,
c. means responsive to said transverse wheel when rotating for generating a signal indicative of the speed and direction of said wheel,
d. attitude sensing means for generating an attitude error signal indicative of an error in desired role attitude relative to said inclined orbit,
e. means responsive to said roll attitude error signal to orient said satellite by altering the inertial direction of said momentum vector,
f. said orientation means including means responsive to said wheel speed and direction signal for modifying said attitude error signal to be non-responsive to said offset in attitude generative by said transverse wheel, said attitude offset being in addition to said roll attitude errors,
said attitude offset due to said rotating transverse wheel having a predetermined relation to said inclination,
whereby the yaw pointing errors due to said inclination are substantially reduced to zero by said momentum vector being repositioned to be perpendicular to the plane of said geo-synchronous orbit, and
whereby the roll pointing errors due to said inclination are reduced substantially to zero by the rotation action of said transverse wheel.

'772 patent, col. 10, ll. 1-52 (emphases added).

The transverse wheel of limitation [a] is the yaw wheel discussed above.[1] The structure corresponding to the means recited in limitation [b] is the sine generator (46) and wheel electronics (48) noted in Figure 4 above. When the satellite enters inclined orbit, the sine generator commands the wheel electronics to rotate the yaw wheel (22) in a sinusoidal manner as described above. The structure corresponding to the means recited in limitation [c] is the tachometer (52) and difference amplifier (54). The "signal" referred to in limitation [c] represents the angle of intentional roll adjustment. The structure corresponding to the means recited in limitation [d] is the "earth horizon" or "roll" sensor (56) discussed above. The structure corresponding to the means recited in limitation [e] is the magnetic torquer (64) and/or the roll thruster (66) discussed above. Finally, the structure corresponding to limitation [f] is the summer (58) discussed above, which subtracts the angle of intentional roll from the roll pointing error signal generated by the earth sensor.

D. The Accused SSL Satellites

Lockheed asserts that SSL's Intelsat VII satellites infringe claim 1 of the '772 patent. As discussed above, the '772 patent describes a yaw wheel used in conjunction with a pitch wheel. The SSL satellites do not use a single pitch wheel centered on the pitch axis of the satellite. Instead, the SSL satellites use a pair of "V-Wheels" that straddle the pitch axis in a V-shape; each V-Wheel operates in a single direction. The attitude of the SSL satellites is controlled by altering the relative

speed of the two V-Wheels ("V-Mode").

In addition to the V-Wheels, the SSL Intelsat VII satellites include a yaw wheel centered on the yaw axis of the satellite, referred to as an "L-Wheel." According to SSL, the L-Wheel is activated only when one of the two V-Wheels fails. The L-Wheel rotates in one direction if one V-Wheel fails ("L1-Mode"), and the other direction if the other V-Wheel fails ("L2-Mode"). However, the L-Wheel does not operate in both directions during an orbit. That is, the L-Wheel does not slow down to zero speed and reverse direction during an orbital period. Furthermore, while in operation, the L-Wheel never spins more slowly than a certain "bias" speed in order to offset the partial yaw momentum of the functioning V-Wheel.

The SSL satellites continuously monitor and correct roll and pitch pointing errors detected by the earth sensor. While operational, therefore, the speed of the L-Wheel changes continuously during orbit because it responds to actual errors detected while in orbit. The attitude control system of the SSL satellites is also designed to operate effectively during inclined orbit by compensating for the roll pointing error created by inclined orbit. During inclined orbit, the "roll bias generator" and "yaw momentum bias generator" of the SSL satellites vary the speed of the V-Wheels or the L-Wheel, intentionally causing the satellite to point north or south.

The SSL satellites also include a mechanism to "fool" the satellite from attempting to correct the intentional roll pointing error detected by the earth sensor. As discussed above, if the SSL satellite earth sensor detects a roll pointing error while the L-Wheel is operational, the speed of the L-Wheel changes in order to correct the detected error. However, when the satellite is intentionally rolled during an inclined orbit, the angle of intentional roll is summed with the roll error output signal of the earth sensor, and the satellite is effectively "fooled" from correcting for the intentional attitude adjustment.

E. Procedural Background

On March 10, 1999, the district court held a Markman hearing in order to construe the phrases "adapted for bi-directional rotation" and "varies sinusoidally" contained in limitations [a] and [b] of claim 1 of the '772 patent. The district court subsequently issued its claim construction order regarding these phrases. See Lockheed Martin Corp. v. Space Sys./Loral, Inc., No. C-95-3530-SI (N.D. Cal. Mar. 12, 1999). Of particular importance, the district court concluded that the phrase "varies sinusoidally" used in limitation [b] means "a sine-shaped variation that passes through zero." Id. at 8-9. Relying on intrinsic evidence alone, it ruled that the phrase means "variation that passes through zero and changes direction, or sign." Id. at 9. Furthermore, the district court "decline[d] to construe 'varies sinusoidally' to include variations that do not pass through zero," and determined that additional inputs are "more appropriately addressed under the doctrine of equivalents." Id. at 11-12.

On March 7, 2000, the district court granted summary judgment of noninfringement for SSL. Lockheed Martin

Corp. v. Space Sys./Loral, Inc., 88 F. Supp. 2d 1095, 1102 (N.D. Cal. 2000). First, the district court ruled that the SSL satellites do not literally infringe claim 1 of the '772 patent. Consistent with its construction of the phrase "varies sinusoidally," the district court reasoned that, "[i]t is undisputed that the speed of the accused reaction wheel does not slow to zero and reverse direction." Id. at 1099. Furthermore, the district court stated that, "[i]t is also undisputed that the speed of the Intelsat VII reaction wheel varies according to a rate schedule that is not purely sinusoidal, providing an additional basis for finding that this limitation is not literally met." Id.

The district court also ruled that the SSL satellites did not infringe under the doctrine of equivalents. The district court applied the "function-way-result" analysis to determine the appropriate scope of limitation [b] under the doctrine of equivalents. Id. (referencing Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 40 (1997)). Under the doctrine of equivalents, a finding of infringement is appropriate if each element of the accused device performs substantially the same function, in substantially the same way, to achieve substantially the same result. Warner-Jenkinson, 520 U.S. at 40. The district court determined that the function of limitation [b] is a means for "rotating said wheel," by way of using a "predetermined rate schedule which varies sinusoidally," with the result that "the attitude of said satellite is offset . . . to null said roll pointing error due to said orbit inclination." Lockheed, 88 F. Supp. 2d at 1100.

The district court then ruled that there was a factual dispute as to whether the function and result of the accused SSL L-Wheel are substantially the same as that claimed by limitation [b] of claim 1 of the '772 patent. However, based on its prior claim construction, the district court noted that "it is undisputed that the transverse wheel of the Intelsat VII does not pass through zero twice per orbit." Id. at 1101. Therefore, the district court granted summary judgment of noninfringement for SSL because it determined that the "way" the SSL L-Wheel operated was not substantially similar to that claimed in the '772 patent. Id. The district court held that any other theory of equivalence would vitiate the claim limitation "varies sinusoidally" recited in limitation [b]. Id. (citing Tronzo v. Biomet, Inc., 156 F.3d 1154, 1160, 47 USPQ2d 1829, 1834 (Fed. Cir. 1998)).

As an additional basis for granting summary judgment, the district court ruled the SSL satellites do not infringe limitation [f] of claim 1 of the '772 patent, either literally or through the doctrine of equivalents. Id. at 1102. The district court stated that, "[t]he limitation requiring element [f] to be responsive to a wheel direction signal is simply not met." Id.

F. Arguments on Appeal

Lockheed does not challenge the district court's claim construction that "varies sinusoidally" means "a variation in a sine-shaped curve that passes through zero." Accordingly, Lockheed concedes that there can be no literal infringement of limitation [b]. However, Lockheed posits that the grant of summary judgment was improper because a factual dispute exists as to whether the SSL satellites contain an equivalent to limitation [b]. Lockheed relies on the testimony of its expert

witness, Dr. Alfriend, for the proposition that the SSL Intelsat VII satellites have a means to rotate their L-Wheel purely sinusoidally. Moreover, Lockheed disagrees with the construction of the phrase "varies sinusoidally" insomuch as it precludes additional, insubstantial inputs.

Finally, Lockheed maintains that the district court failed to conduct a complete infringement analysis as to limitation [f]. Although the district court examined the SSL tachometers and ground-based computer processors, Lockheed argues that the district court failed to consider whether the SSL "roll bias generator" satisfies the requirements of limitation [f].

II. STANDARD OF REVIEW

We review the grant of a motion for summary judgment de novo, drawing all reasonable factual inferences in favor of the non-moving party. Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 255 (1986). Summary judgment "shall be rendered forthwith if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to a judgment as a matter of law." Fed. R. Civ. P. 56(c).

The determination of infringement is a two-step process. First, the court construes the claims to determine the scope of the claims. Second, it compares the properly construed claims to the accused device. Cybor Corp. v. FAS Techs., Inc., 138 F.3d 1448, 1454, 46 USPQ2d 1169, 1172 (Fed. Cir. 1998) (en banc). Claim construction is a matter of law that we review de novo, without deference to the district court. Id. at 1456, 46 USPQ2d at 1172-73. Hence, claim construction of a means-plus-function limitation, as provided by 35 U.S.C. § 112, ¶ 6 (2000), is also a question of law to be reviewed de novo. Chiuminatta Concrete Concepts, Inc. v. Cardinal Indus., Inc., 145 F.3d 1303, 1308, 46 USPQ2d 1752, 1755-56 (Fed. Cir. 1998).

However, a determination of infringement, both literal and under the doctrine of equivalents, is a question of fact. Insituform Techs., Inc. v. Cat Contracting, Inc., 161 F.3d 688, 692, 48 USPQ2d 1610, 1614 (Fed. Cir. 1998). Thus, viewing the facts and inferences in the light most favorable to Lockheed, summary judgment is proper only if "no reasonable jury could return a verdict for the nonmoving party." Anderson, 477 U.S. at 255. Finally, the determination of infringement under the doctrine of equivalents is limited by two primary legal doctrines: (1) prosecution history estoppel and (2) the "all elements" rule. Bell Atl. Network Servs., Inc. v. Covad Communications Group, Inc., 262 F.3d 1258, 1267, 59 USPQ2d 1865, 1869-70 (Fed. Cir. 2001) (citing Festo, 234 F.3d at 586, 56 USPQ2d at 1886). The application of these legal limitations is reviewed by this court de novo. Id.

III. DISCUSSION

1. Claim Construction: Limitation [b]

Both parties agree that limitation [b] of claim 1 of the '772 patent is written as a means-plus-function claim limitation. A means-plus-function limitation recites a function to be performed rather than definite structure or materials for performing that function. Chiuminatta, 145 F.3d at 1307, 46 USPQ2d at 1755. Such a limitation must be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. 35 U.S.C. § 112, ¶ 6.

The first step in analyzing a claim written in means-plus-function form is to identify the claimed function. Chiuminatta, 145 F.3d at 1308, 46 USPQ2d at 1756. The district court determined that limitation [b] recites a means having the function of "rotating said wheel." Lockheed, 88 F. Supp. 2d at 1100. SSL maintains that the district court improperly broadened the function of limitation [b] by "reading out" the remaining claim limitations. We agree with SSL.

Once a court establishes that a means-plus-function limitation is at issue, it must identify and construe that limitation, thereby determining what the claimed function is, and what structures disclosed in the written description correspond to the "means" for performing that function. The phrase "means for" generally invokes 35 U.S.C. § 112, ¶ 6, and is typically followed by the recited function and claim limitations. Greenberg v. Ethicon Endo-Surgery, Inc., 91 F.3d 1580, 1584, 39 USPQ2d 1783, 1786-87 (Fed. Cir. 1996). In identifying the function of a means-plus-function claim, a claimed function may not be improperly narrowed or limited beyond the scope of the claim language. Micro Chem. Inc. v. Great Plains Chem. Co., 194 F.3d 1250, 1258, 52 USPQ2d 1258, 1263 (Fed. Cir. 1999). Conversely, neither may the function be improperly broadened by ignoring the clear limitations contained in the claim language. The function of a means-plus-function claim must be construed to include the limitations contained in the claim language.

In this case, the district court erred by improperly broadening the scope of the claimed function by "reading out" the limitations contained in the claim language. The function of limitation [b] is properly identified as "rotating said wheel in accordance with a predetermined rate schedule which varies sinusoidally over the orbit at the orbital frequency of the satellite." The function is properly identified as the language after the "means for" clause and before the "whereby" clause, because a whereby clause that merely states the result of the limitations in the claim adds nothing to the substance of the claim. Tex. Instruments Inc. v. United States Int'l Trade Comm'n, 988 F.2d 1165, 1172, 26 USPQ2d 1018, 1023-24 (Fed. Cir. 1993).

Having identified the function of limitation [b], we next construe the meaning of the words used to describe the claimed function, using ordinary principles of claim construction. The district court construed the phrase "varies sinusoidally" to mean "a variation in a sine-shaped curve that passes through zero." Lockheed, 88 F. Supp. 2d at 1099. In its claim construction order, the district court explained that the "rate" or "speed" of the wheel itself must pass through zero. See Lockheed, No. C-95-3530-SI, slip. op. at 8-10. The district court determined that this construction "is consistent with the

other limitations in the claims themselves regarding the capacity of the transverse momentum wheel to accelerate in one direction, slow to zero, and rotate in the opposite direction." Id.

Neither party disputes the district court's construction of this phrase, and we find no fault in the district court's careful analysis. The meaning of the remaining language of limitation [b] is clear from the plain language of the claim and is consistent with the intrinsic evidence. See Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582-83, 39 USPQ2d 1573, 1576-77 (Fed. Cir. 1996). The wheel must rotate in accordance with a "predetermined rate schedule." According to the written description, the rate schedule is produced by the sine generator and is dependent on the orbital period as well as the angle of orbital inclination. '772 patent, col. 7, ll. 28-64. It is undisputed that the "orbital frequency of the satellite" is twenty-four hours; the written description specifically states that the pointing errors change "at the orbital frequency, which for a spacecraft in a synchronous altitude orbit, is one day." Id., col. 4, l. 29. Furthermore, it is clear from the written description that the rate schedule is "predetermined" insomuch as the sine generator produces a sine wave with an amplitude that changes "on a continuous basis" and that is "related to the inclination deviation" angle. Id., col. 7, l. 28 – col. 8, l. 33.

After identifying the function of the means-plus-function limitation and construing the meaning of the claim language, we look next to the written description to identify the structure corresponding to the function. Micro Chem., 194 F.3d at 1258, 52 USPQ2d at 1263. It is undisputed that the structures disclosed in the '772 patent which correspond to the function of limitation [b] are the sine generator and wheel electronics noted in Figure 4 above. As discussed, the sine generator operates by producing a sine wave signal whose amplitude varies based on the orbital angle of inclination. The wheel electronics are responsive to signals from the sine generator and the tachometer, and generate a signal to the yaw wheel such that the wheel generates a sinusoidal variation of momentum. '772 patent, col. 8, ll. 15-25.

2. Infringement: Limitation [b]

Literal infringement of a § 112 ¶ 6 claim requires that the relevant structure in the accused device perform the identical function recited in the claim and be identical or equivalent to the corresponding structure in the specification. Odetics, Inc. v. Storage Tech. Corp., 185 F.3d 1259, 1267, 51 USPQ2d 1225, 1229 (Fed. Cir. 1999); WMS Gaming, Inc. v. Int'l Game Tech., 184 F.3d 1339, 1347, 1350, 51 USPQ2d 1385, 1390, 1392-93 (Fed. Cir. 1999). Lockheed concedes that there can be no literal infringement of limitation [b] because the SSL satellite L-Wheel rotates about a non-zero bias speed. That is, the SSL L-Wheel does not perform the identical function of limitation [b] as properly construed. However, Lockheed contends that a factual dispute exists as to whether the SSL Intelsat VII satellites meet the requirements of limitation [b] under the doctrine of equivalents. An accused structure that does not literally infringe a means-plus-function claim may nevertheless infringe under the doctrine of equivalents. See Kemco Sales, Inc. v. Control Papers Co., 208 F.3d 1352, 1364, 54 USPQ2d 1308, 1315-16 (Fed. Cir. 2000). Specifically, Lockheed asserts that the testimony of its expert, Dr.

Alfriend, raises a genuine issue of material fact as to whether the SSL satellites contain an equivalent to the claimed means for rotating the transverse wheel about zero speed.

Lockheed relies on the testimony of its expert, Dr. Alfriend, for the proposition that the SSL satellite L-Wheel "varies according to a sine-shaped curve that passes through zero and changes direction twice per day." According to Dr. Alfriend, "[t]he only difference is that, in the Intelsat VII satellite, when the sinusoidal input is added, the yaw wheel is already spinning at a bias speed, whereas in the '772 exemplary embodiment the wheel is initially stationary." Furthermore, Dr. Alfriend posits that the SSL satellite "has the capability to be operated in inclined orbit with a purely sinusoidal roll bias if desired." Even when other inputs are used, Dr. Alfriend states that, "the bias signal would be predominantly sinusoidal."

It is true that an accused device may infringe under the doctrine of equivalents if each element performs substantially the same function, in substantially the same way, to achieve substantially the same result. Warner-Jenkinson, 520 U.S. at 40. However, this court must first determine whether the scope of the doctrine of equivalents, as applied to the claim limitations of limitation [b], has been narrowed by the legal doctrine of prosecution history estoppel or proscribed by the "all elements" rule. Bell Atl., 262 F.3d at 1267, 59 USPQ2d at 1869-70. These determinations are made de novo. Id.

Under the all elements rule, there can be no infringement under the doctrine of equivalents if even one limitation of a claim or its equivalent is not present in the accused device. Pennwalt Corp. v. Durand-Wayland, Inc., 833 F.2d 931, 935-36, 4 USPQ2d 1737, 1739-40 (Fed. Cir. 1987) (en banc). Such a determination must be premised upon a proper claim construction. Insituform, 99 F.3d at 1109, 40 USPQ2d at 1610. Thus, if a court determines that a finding of infringement under the doctrine of equivalents "would entirely vitiate a particular claim[ed] element," then the court should rule that there is no infringement under the doctrine of equivalents. Bell Atl., 262 F.3d at 1280, 59 USPQ2d at 1879 (citing Festo, 234 F.3d at 587, 56 USPQ2d at 1887 (quoting Warner-Jenkinson, 520 U.S. at 39 n.8)).

Lockheed argues that the speed of the SSL L-Wheel varies sinusoidally even though it always spins faster than a set bias speed. However, it is undisputed that the speed of the SSL satellite L-Wheel does not slow to zero, stop, and reverse direction twice during each orbit of its operation. As discussed above, this is required by the proper construction of the phrase "varies sinusoidally over the orbit at the orbital frequency." Lockheed, 88 F. Supp. 2d at 1099. As recognized by the district court and clarified by the intrinsic evidence of the '772 patent, the sinusoidal variation claimed in limitation [b] is consistent with "the capacity of the transverse momentum wheel to accelerate in one direction, slow to zero, and rotate in the opposite direction." See Lockheed, No. C-95-3530-SI, slip. op. at 10.

Furthermore, limitation [b] requires the transverse wheel to vary in accordance with a "predetermined rate schedule." It is undisputed that the predetermined rate schedule described in limitation [b] of the '772 patent is generated by the sine generator noted in Figure 4 above. It is also undisputed that the rotation of the transverse wheel described in the '772 patent

does not vary based on any input from the earth sensor. As discussed above, it is clear from the written description that the rate schedule is "predetermined" insomuch as the sine generator produces a sine wave with an amplitude that changes "on a continuous basis" and which is "related to the inclination deviation" angle. '772 patent, col. 7, l. 28 – col. 8, l. 33. Therefore, the rate schedule described in limitation [b] is "predetermined" insomuch as it does not include any unfixed real-time inputs, such as those from an earth sensor. The SSL satellite, however, does not utilize a predetermined rate schedule, because the L-Wheel responds to actual real-time error sensed by the earth sensor.

Thus, the SSL satellite L-Wheel does not vary sinusoidally because it does not slow to zero, stop, and reverse direction. Additionally, any rate schedule used by the SSL satellite is not predetermined. These limitations are required by the proper construction of limitation [b]. In the absence of an element that performs the properly construed functions, a finding of infringement under the doctrine of equivalents would entirely vitiate the limitations of limitation [b]. Consequently, limitation [b] or its equivalent is simply not present in the accused device. Accordingly, there can be no infringement under the doctrine of equivalents. We agree with the district court that "element [b] of claim 1 of the '772 Patent is not present in the Intelsat VII through the doctrine of equivalents." Lockheed, 88 F. Supp. 2d at 1101. Moreover, because Lockheed's claim of infringement must fail, we need not discuss the legal doctrine of prosecution history estoppel, nor examine whether the SSL satellites meet the limitations of limitation [f].

IV. CONCLUSION

For the reasons discussed, the district court's grant of summary judgment of noninfringement in favor of SSL is

AFFIRMED.

COSTS

No costs.

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[1] The district court and the parties use the term "element" to refer to subcategories of claim language. However, "[i]t is preferable to use the term 'limitation' when referring to claim language and the term 'element' when referring to the accused device." Festo, 234 F.3d at 564 n.1, 56 USPQ2d at 1868 n.1. We, therefore, use the term "limitation" in this opinion.