Nos. 276-87C and 592-88C

(Filed: February 9, 1998)

CHARLES E. PFUND,	*	Patents; claim interpretation; "Markman hearing"; prosecution history; means-plus-function language; validity; 35 U.S.C. § 102(a) "printed publication"; conception; anticipation under 35 U.S.C. § 102; nonobviousness under 35 U.S.C. § 103.
Plaintiff,	*	
v.	*	
UNITED STATES,	*	
Defendant.	*	

M. Lawrence Oliverio, David Wolf, and Matthew B. Lowrie, Boston, Massachusetts, for plaintiff.

Carl M. DeFranco, Jr., with whom were Frank W. Hunger, Assistant Attorney General, and Vito J. DiPietro, Director, Washington, D.C., for defendant. Paul N. Zolfaghari, of counsel.

OPINION

ANDEWELT, Judge.

BACKGROUND

I.

In these consolidated patent actions filed pursuant to 28 U.S.C. § 1498(a), plaintiff, Charles E. Pfund, seeks compensation from the United States for the alleged unauthorized use of the claimed invention covered by U.S. Patent Nos. 4,279,036 (the '036 patent), 4,664,518 (the '518 patent), and 4,764,982 (the

'982 patent). Plaintiff is the sole inventor and current owner of all three patents. Plaintiff contends that various devices manufactured by or for the United States are covered by claims in one or more of these patents. Defendant responds that the asserted claims are invalid and, in any event, do not cover the accused devices. The court reserved the issue of damages and conducted trial on the issues of whether the patent claims are valid and whether the patent claims cover the accused devices. Trial testimony included that of two accomplished expert witnesses, Dr. William H. Culver for plaintiff and Dr. Robert H. Kingston for defendant. For the reasons set forth below, the court concludes that although certain claims cover certain of the accused devices, those claims are invalid and, hence, plaintiff is not entitled to any compensation under Section 1498(a).

II.

The road that led to the instant suit commenced on or about March 5, 1962, when plaintiff read an article in Electronic News, entitled "Wanted: Better Com For Submerged Subs," in which a rear admiral in the United States Navy explained the Navy's need for an improved communication system between submarines and aircrafts. Plaintiff, a patent attorney in private practice who formerly worked in the field of patents for the Navy and the Air Force, began considering possible ways to improve on existing communication technologies. After plaintiff's initial proposed solutions did not meet favorable response and after reading an April 30, 1962, article in Electronic News discussing developments in laser technology, plaintiff began considering a different approach to the communication problem. While on an airplane flying 20,000 feet above the east coast of the United States, plaintiff noticed the street lights below. Plaintiff thought that if these street lights had receivers and a laser beam were shot from the plane to one of those lights, a communication link could be established. Plaintiff thereafter drafted a handwritten concept document, signed on May 3, 1962, and witnessed after some modification on May 7, 1962. This document described a laser communication system between a satellite and a submarine. Plaintiff explained at trial that the concept document resulted from "the fact that the lasers were coming on fast and available and that you could individually communicate with individual targets on the ground, if you could hit them."

The concept document depicts a two-way communication system in which satellites and submarines communicate by means of laser beams. The satellite and the submarine each have a laser transmitter and receiver. Operators of the submarine know the position of the satellite because the satellite is in stationary orbit. The submarine sends a laser signal to the satellite and the satellite detects the communication through use of "an appropriate detector for receiving laser beam signals." The satellite then uses a tracking system to orient a responsive laser along the line of the beam received from the submarine. Through this communication system, both the satellite and the submarine are able to send and receive information to and from one another. The satellite communicates the information it receives from the submarine to earth via a radio transmission between the satellite and a distant ground station. The concept document explains that "[d]ue to the low dispersion obtained with such laser beams, the transmission of an occasional signal from the submarine to satellite would be relatively secure from enemy detection."

On July 2, 1962, approximately two months after drafting the concept document, plaintiff filed the patent application that ultimately matured into the '036 patent. Years after filing the original application, plaintiff filed two divisional applications that matured into the '518 and '982 patents. The specifications of the three patents in pertinent part are identical. The '036 patent did not issue until July 14, 1981, almost 20 years after plaintiff filed his original application. The delay was the result of secrecy orders, interference proceedings, and other administrative occurrences. The '518 patent, filed on March 27, 1981, issued on May 12, 1987, and the '982 patent, filed on May 7, 1987, issued on August 16, 1988.

III.

The claims of a patent define the metes and bounds of the patentee's rights. 35 U.S.C. § 112; In re Vamco Machine and Tool, Inc., 752 F.2d 1564, 1577 n.5 (Fed. Cir. 1985). Each patent claim is viewed as distinct from the other claims and each is presumed valid. 35 U.S.C. § 282. The proper drafting of patent claims is often difficult and in an effort to assure maximum effective coverage, patent attorneys frequently present a variety of claims that differ in scope by, inter alia, calling for different steps or elements and/or using varying language to describe a particular step or element.

Plaintiff, an experienced patent attorney, took such an approach when he translated the invention described in the concept document into three patents containing a series of different claims which describe various apparatus or methods. For the most part, these claims are variations on a central theme described in the concept document--a communication system in which lasers carry messages between stations and angle tracking systems allow the stations to maintain contact with one another.

Plaintiff alleges that the following patent claims cover devices used by defendant:

The '036 Patent

1. Apparatus for communicating with a mobile vehicle comprising means for transmitting a laser beam toward an orbiting satellite from a vehicle within the portion of the earth's surface beneath said satellite, means for detecting said laser beam received at said satellite to determine the angular orientation of said vehicle from said satellite, means for utilizing the angular orientation data so obtained to establish a narrow beam communication link from said satellite to said vehicle, and means for communicating with said vehicle from a remote point via said satellite and said narrow beam communication link.

4. A communication system comprising spaced stations each having a pulsed laser transmitter and optical receiver, means for reporting the angular location of one station to the other station solely by means of the directivity of a laser beam transmission from said one station to said other station, and means in said other station responsive to the angular location reported for orienting a laser beam transmission to the location of said one station.

5. A communication system comprising a satellite station having a pulsed laser, optical scanning means for scanning the beam from said laser over a field on the earth's surface, a photoresponsive matrix, means for imaging said field on said matrix, means responsive to reception by said matrix of a laser beam transmission from the earth for determining the angular location of the source of the received laser beam and means for controlling said pulsed laser and said scanning means to transmit a laser beam to said location.

17. Apparatus for establishing a communication link via a relay satellite comprising means for illuminating said satellite with a narrow beam laser energy transmission from a ground station and means for utilizing the received energy transmission at the satellite to orient a narrow beam laser energy transmission from the satellite to the ground station to complete the communication link between the satellite and ground station.

The '518 Patent

4. The method of establishing a communication link via a relay satellite comprising the steps of illuminating said satellite with a narrow beam energy transmission from a ground station and utilizing the received energy transmission at the satellite to orient a narrow beam energy transmission from the satellite to the ground station to complete the communication link between the satellite and ground station.

7. The method of communicating with a first station comprising the steps of transmitting a laser beam toward an orbiting satellite from said first station, detecting said laser beam received at said satellite to determine the angular orientation of said first station from said satellite, utilizing the angular orientation data so obtained to establish a narrow beam communication link from said satellite to said first station and communicating with said first station from a remote point via said satellite and said narrow beam communication link.

8. The method of claim 7 wherein said narrow beam communication link is a laser beam.

13. A station for a two-way optical communication system comprising:

means for producing an exiting light-beam;

means for impressing only communication-data on said exiting light-beam;

means for steering said exiting light-beam toward a target station;

means for receiving a single incoming light-beam from said target station, said single incoming light beam adapted to have only communication-data modulated thereon; and

means for causing said single incoming light-beam to produce both tracking-signals and data-signals.

14. A satellite communication relay station comprising:

an orbiting earth satellite;

a radio relay on board said satellite operable to transmit and receive messages between said satellite and a ground station;

laser transmission means on board said satellite including means for modulating a transmitted laser beam with a message received via said radio relay and means for directing said modulated laser beam toward a remote station;

laser receiving means on board said satellite for receiving a laser beam from said remote station and demodulating received laser energy to recover message content thereof; and

means for modulating the message content obtained from a received laser beam onto the transmitter of said radio relay to transmit said message content to said ground station.

15. A satellite communication station comprising:

a satellite vehicle having on board:

a radio receiver for receiving and demodulating a radio signal transmitted to said satellite from a first remote station to obtain the message content of said radio signal;

laser transmitter means operable for transmitting a laser beam from said satellite;

means for modulating the transmitted laser beam with said message content; and

means for directing the modulated laser beam toward a second remote station to transmit said message content to said second remote station.

The '982 Patent

1. The method of communicating with a mobile vehicle comprising the steps of transmitting a laser beam toward a relay station high above the surface of the earth from a vehicle within the portion of the earth's surface beneath said relay station, detecting said laser beam received at said relay station to determine the angular orientation of said vehicle from said relay station, utilizing the angular orientation data so obtained to establish a narrow beam communication link from said relay station to said vehicle, and communicating with said vehicle from a remote point via said relay station and said narrow beam communication link.

2. The method of communicating with a mobile vehicle comprising the steps of scanning a portion of the earth's surface with an optical spot scan from a relay station high above the surface of the earth, transmitting a laser beam toward said relay station from a vehicle within said portion of the earth's surface, detecting said laser beam received at said relay station to determine the angular orientation of said vehicle from said relay station, utilizing the angular orientation data so obtained to transmit a laser beam from said relay station through said optical scan when said scan is oriented toward said vehicle, detecting the laser beam received at said vehicle, and communicating with said vehicle from a remote point by messages exchanged between said remote point and said relay station with said messages being exchanged between said relay station and said vehicle by modulation of the laser beams transmitted and demodulation of the laser beams received.

4. The method of establishing a communication link via a relay station high above the surface of the earth with a narrow beam energy transmission from a ground station and utilizing the received energy transmission at the relay station to orient a narrow laser beam energy transmission from the relay station to the ground station to complete the communication link between the relay station and ground station.

6. The method according to claim 4 in which said narrow beam transmissions are laser beams operating at a wavelength in the blue-green portion of the spectrum selected for transmission through sea water.

7. The method of communicating with a first station comprising the steps of transmitting a laser beam toward a relay station high above the surface of the earth from said first station, detecting said laser beam at said relay station to determine the angular orientation of said first station from said relay station, utilizing the angular orientation data so obtained to establish a narrow beam communication link from said relay station to said first station and communicating with said first station from a remote point via said relay station and said narrow beam communication link.

8. The method of claim 7 wherein said narrow beam communication link is a laser beam.

9. The method of communicating with a submarine comprising the steps of scanning an area beneath a relay station high above the surface of the earth to cover the expected location of the submarine, receiving a message on said relay station from a ground station and transmitting a laser beam communication of said message from said relay station to said submarine.

10. The method of communicating with an earth station comprising the steps of relaying a message from a ground station to a relay station high above the surface of the earth, modulating a laser on board said relay station with said message to produce a modulated laser beam, radiating said modulated laser beam from said relay station to the surface area of the earth where said earth station is located, and detecting

the message at said earth station from said modulated laser beam received at said earth station.

11. The method according to claim 10 wherein said laser beam operates in the blue-green portion of the spectrum selected for transmission through sea water and said earth station is a submarine adapted to detect said message from said laser beam while submerged.

12. The method according to claim 11, wherein said modulated laser beam is scanned over the area of the ocean where said submarine is located.

13. The method according to claim 9 wherein said laser beam operates in the blue-green portion of the spectrum selected for transmission through sea water and said submarine is adapted to detect said message from said laser beam while submerged.

14. A communication station comprising:

a vehicle operable high above the surface of the earth having on board:

a radio receiver for receiving and demodulating a radio signal transmitted to said vehicle from a first remote station to obtain the message content of said radio signal;

laser transmitter means operable for transmitting a laser beam from said vehicle.

CLAIM INTERPRETATION

IV.

Pursuant to 28 U.S.C. § 1498(a), the United States may be liable to plaintiff for the unauthorized use of plaintiff's invention if the patents are valid and the devices manufactured by or for the United States are "described in and covered by" the patent claims. The central issues presented at trial are whether the patent claims are valid and whether the patent claims cover the devices in issue. (1) Claims must be interpreted in the same way when assessing validity and infringement. Connell v. Sears, Roebuck & Co., 722 F.2d 1542 (Fed. Cir. 1983). Hence, the first step in the analysis is for the court to interpret, i.e., determine the scope of, the patent claims. Prior to conducting trial on the issues of infringement and validity, this court held a two-day "Markman hearing" (2) to address two disputed issues of claim interpretation.

A.

The first claim interpretation issue involves the meaning of the term "station" as used in the patent claims. For example, Claim 4 of the '036 patent, Claim 13 of the '518 patent, and Claim 1 of the '982 patent, use the term "station" as follows:

Claim 4 of the '036 patent: "A communication system comprising spaced stations each having a pulsed laser transmitter and optical receiver . . . ."

Claim 13 of the '518 patent: "A station for a two-way optical communication system comprising . . . ."

Claim 1 of the '982 patent: "The method of communicating with a mobile vehicle comprising the steps of transmitting a laser beam toward a relay station high above the surface of the earth from a vehicle within the portion of the earth's surface beneath said relay station . . . ."

(Emphasis added.) Defendant argues that the term "station" in each of these claims should be interpreted as requiring the presence of at least one orbiting satellite. Plaintiff, on the other hand, argues that the term should not be so limited.

1.

When interpreting claim language, a court must first look to the intrinsic evidence in the record which includes the claims, the specification, and any prosecution history submitted into evidence. Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996). A claim term generally will be given its "ordinary and customary" meaning which, if the term is technical in nature, is the interpretation given to it by persons of ordinary skill in the art. Id. (quoting Hoechst Celanese Corp. v. BP Chems. Ltd., 78 F.3d 1575, 1578 (Fed. Cir.), cert. denied, 117 S. Ct. 275 (1996)). If the patentee intends a term to have a meaning other than its ordinary meaning, the patentee must clearly so define the term in the specification. Markman v. Westview Instruments, Inc., 52 F.3d 967, 979-80 (Fed. Cir. 1995) (en banc), aff'd, 517 U.S. 370 (1996); Beachcombers v. WildeWood Creative Prods., Inc., 31 F.3d 1154, 1158 (Fed. Cir. 1994).

Extrinsic evidence, which is "evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises," cannot be used to vary or contradict the terms of the patent claims. Markman, 52 F.3d at 980-81. Rather, extrinsic evidence serves to familiarize the court with the "terminology of the art to which the patent is addressed." Id. at 986. Although dictionaries technically are considered extrinsic evidence, courts can consult such references at any time in order to interpret claim terms in a manner consistent with the specification. Vitronics, 90 F.3d at 1584 n.6.

2.

The term "station" is defined as "the place or position in which something or someone stands," Webster's Third New International Dictionary 2229 (1974), and as "[a]n input or output point along a communications system," Webster's II New Riverside University Dictionary 1133 (1984). Hence, the ordinary meaning of "station" encompasses a variety of different devices. The addition of the adjective "spaced" in Claim 4 of the '036 patent would not limit the term "station" to encompass only a satellite. The verb "space" is defined as "[t]o organize or arrange with spaces between." Webster's II 1113. Hence, the phrase "spaced stations" requires only that two or more stations be arranged so that there is space in between them. Similarly, with respect to Claim 1 of the '982 patent, the adjective "relay" does not support defendant's interpretation. "Relay" is defined as "[a]n act of passing something along from one . . . station to another." Webster's II 992. Hence, the phrase "a relay station high above the surface of the earth" is reasonably interpreted as any device located high above the earth's surface that can relay something to another station. An orbiting satellite is only one such device.

A review of the other claims in the '036 and '518 patents tends to confirm that the term "station" should be given its dictionary meaning, which is significantly broader than the definition proposed by defendant. As to the '036 patent, Claim 4 is the only claim that uses the phrase "spaced stations." The other claims in the '036 patent refer instead to an "orbiting satellite," a "satellite station," or a "relay satellite." Similarly, Claim 13 of the '518 patent is the only claim therein that uses the term "station." All other claims in the '518 patent call for "satellites." In this setting, to treat the terms "station" and "satellite" as synonymous would ignore the patentee's decision to use different terms in different claims. Courts generally should presume that a patentee's use of different terms in different claims of the same patent demonstrates the patentee's intent to employ terms with different meanings, i.e., to produce claims of differing scopes. Tandon Corp. v. United States Int'l Trade Comm'n, 831 F.2d 1017, 1023 (Fed. Cir. 1987).

An examination of the specification and file history leads to the same conclusion. "Claims must be read in view of the specification, of which they are a part." Markman, 52 F.3d at 979. Defendant relies upon the following statement in the specification to support its proposed narrow interpretation of the term "station":

The present invention provides a communication system which uses an established set of relay stations which preferably will be orbiting earth satellites of either stationary orbit or in a polar orbit with known paths so that present position is always predictable to both the shore base or command station and the mobile vehicle with which it is required to communicate. Preferably the system of relays is provided by a suitable system of orbiting earth satellites, but in a given tactical situation a relay station of a temporary nature may be launched for relaying messages during a limited interval of time while the tactical situation is in existence. The description of the present invention will proceed, however, with reference to a system of earth satellites carrying equipment to be herein described.

Col. 1, lns. 62-68 through Col. 2, lns. 1-8.

The statement that the established set of relay stations "preferably will be orbiting earth satellites" means nothing more than orbiting satellites are the preferred embodiment of the invention. As the Court of Appeals for the Federal Circuit stressed in American Permahedge, Inc. v. Barcana, Inc., 105 F.3d 1441, 1444 (Fed. Cir. 1997) (quoting Laitram Corp. v. Cambridge Wire Cloth Co., 863 F.2d 855, 865 (Fed. Cir. 1988), cert. denied, 490 U.S. 1068 (1989)), "[r]eferences to a preferred embodiment, such as those often present in a specification, are not claim limitations." See also Ekchian v. Home Depot, Inc., 104 F.3d 1299, 1303 (Fed. Cir. 1997). The Federal Circuit reiterated this general point as follows:

It is entirely proper to use the specification to interpret what the patentee meant by a word or phrase in the claim. But this is not to be confused with adding an extraneous limitation appearing in the specification, which is improper. By "extraneous," we mean a limitation read into a claim from the specification wholly apart from any need to interpret what the patentee meant by particular words or phrases in the claim. "Where a

specification does not require a limitation, that limitation should not be read from the specification into the claims."

E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co., 849 F.2d 1430, 1433 (Fed. Cir.), cert. denied, 488 U.S. 986 (1988) (citations omitted) (quoting Specialty Composites v. Cabot Corp., 845 F.2d 981, 987 (Fed. Cir. 1988)). For this same reason, defendant's focus on the statement in the specification that the position of the relay station always be "predictable" does not support its narrow interpretation of the claim term "station." The claims do not include any terms that suggest such a limitation. Moreover, assuming the limitation concerning predictability were a claim requirement, predictability as to position certainly is not unique to satellites.

Defendant also seeks support for its interpretation of "station" in the prosecution history. Defendant cites the following statement made by plaintiff in an interference proceeding in which plaintiff was the "Senior Party":

Junior Party compares the ABSTRACT OF THE DISCLOSURE in each parties' application. It is clear that Junior Party's abstract encompasses a broad scope that includes Senior Party's invention. Both

disclose laser communication systems and both contemplate that one or more of the stations be located in an orbiting earth satellite.

Rockwell Interference No. 100,888 (Senior Party Opposition to Junior Party's Motions to Dissolve Under 37 C.F.R. § 1.231, Nov. 15, 1982). But therein plaintiff does no more than summarize similarities in the abstracts of the two patent applications involved. Plaintiff does not purport to summarize the claims themselves or imply that the claims are limited to the subject matter in the abstracts.

Based upon a review of the claims, the specification, and the prosecution history, the court concludes that the term "station" as it appears in the claims does not require the presence of at least one orbiting satellite.

B.

Understanding the second claim interpretation issue requires some additional explanation of the patents and the claims in issue. The patent specification describes a system whereby one station utilizes an incoming laser beam from a ground station to direct an outgoing laser beam in the same direction as the incoming laser beam. The receiving station detects the incoming laser beam, determines the angle of arrival of the beam, and uses that angle information to send a laser beam back along the same angle to the ground station. The specification describes two alternative structures that can be used to detect and determine the angle of arrival of a laser beam, one involving a detector array and the other a conical scan. With respect to conical scans, the specification states:

In situations where maximum security is not a primary factor, the system can be readily modified to permit a transponding mode between the lasers in the satellite and the ground station. For example, each satellite laser transmission would be triggered by the receipt of a laser transmission from the ground station and vice-versa to maintain data exchange therebetween. For these systems angle tracking of the beams would be simplified by introducing well-known conical scan techniques and transponding off-axis error signals to servo the scan axis.

Col. 11, lns. 9-19. The essence of defendant's second claim interpretation argument is that based on statements made by plaintiff during the course of the prosecution history, all of the patent claims must be interpreted to exclude from their literal scope tracking the laser beam through the use of conical scans or quadrant detectors, which both parties agree are the structural equivalent of conical scans. [(3)]

1.

Prosecution history potentially can be helpful when interpreting the literal scope of claim terms. Markman, 52 F.3d at 980. Statements made during the prosecution history with respect to the patentee's understanding of the scope of a claim term can preclude the patentee from later interpreting that term in an inconsistent manner. Alpex Computer Corp. v. Nintendo Co. Ltd., 102 F.3d 1214, 1221 (Fed. Cir. 1996), cert. denied, 117 S. Ct. 2480 (1997). But using the prosecution history to help interpret a particular claim term is different from using the prosecution history to add a limitation that is not present in the claim. As the Federal Circuit explained in Markman, "[a]lthough the prosecution history can and should be used to understand the language used in the claims, it too cannot 'enlarge, diminish, or vary' the limitations in the claims." Markman, 52 F.3d at 980 (quoting Goodyear Dental Vulcanite Co. v. Davis, 102 U.S. 222, 227 (1880)). In other words, if a statement in the prosecution history is interpretive of a claim term, then that statement is relevant to determining the literal scope of the claim, but if the statement is simply inconsistent with the claim language, then it is not. "When it comes to the question of which should control, an erroneous remark by an attorney in the course of prosecution of an

application or the claims of the patent as finally worded and issued by the Patent and Trademark Office as an official grant, we think the law allows for no choice. The claims themselves control." Intervet America, Inc. v. Kee-Vet Lab., Inc., 887 F.2d 1050, 1054 (Fed. Cir. 1989).

2.

Before discussing the specific portions of the prosecution history upon which defendant relies, it is necessary for the court to address an issue of claim interpretation that arises from the instructions enunciated in 35 U.S.C. § 112. The sixth paragraph of 35 U.S.C. § 112 (hereinafter referred to as Section 112(6)) provides:

An element in a claim . . . may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Hence, in the absence of other claim language that restricts the scope of the claim, Congress has declared that where the wording of the claim brings it within the scope of Section 112(6), the means or steps described exclusively in functional terms are construed to cover the corresponding structures described in the specification for performing that function and equivalents thereof. See In re Donaldson Co., 16 F.3d 1189, 1193 (Fed. Cir. 1994) (en banc).

Various of the claims in issue here fall within the interpretive instructions of Section 112(6). For example, in describing the structures for detecting and determining the angle of the incoming laser beam, Claim 1 uses purely functional language, i.e., "means for detecting said laser beam received at said satellite to determine the angular orientation of said vehicle from said satellite." There is nothing in Claim 1 that arguably limits the structures that would be encompassed within this description aside from the requirement that they perform the stated function.

When interpreting claims that fall within the scope of Section 112(6), prosecution history certainly can be helpful in determining, for example, which embodiments disclosed in the specification perform the corresponding function in the claim and the extent to which other structures not described in the specification would be equivalents of those disclosed structures. Prosecution history also can be helpful when interpreting other claim terms that could limit the scope of the structures encompassed within the claim. In the absence of such other limiting language, however, prosecution history cannot form the basis for eliminating from the scope of the claim those structures that Congress in Section 112(6) unequivocally determined should fall within the scope of that claim, i.e., "the corresponding structure [for performing a specified function] . . . described in the specification." Hence, if the specification unequivocally discloses a structure as performing a certain function and the claim uses means-plus-function language that calls for a means for performing that function, unless there is some other limitation in the claim that can be interpreted to exclude that structure, Section 112(6) mandates that the claim be interpreted to encompass that disclosed structure.

Herein, the specification unambiguously discloses the use of conical scan techniques to perform the function of tracking the angle of the incoming laser beam ("For these systems angle tracking of the beams would be simplified by introducing well-known conical scan techniques."). Hence, for those claims that describe in purely functional terms the detection and angle tracking of laser beams and contain no other limitations that arguably would exclude conical scans, Section 112(6) mandates that these claims be interpreted to encompass conical scans. To the extent attorney arguments made during prosecution of the patent applications suggest that such claims do not encompass conical scan techniques, such arguments are in conflict with the claim language, specification, and congressional

mandate. In the face of such conflict, "[t]he claims themselves control." Intervet, 887 F.2d at 1054.

Alpex, 102 F.3d 1214, upon which defendant relies, does not suggest a contrary application of Section 112(6). Alpex involved the issue of whether a particular structure was the equivalent of a structure disclosed in the specification. The claims therein related to a microprocessor-based home video game system. Id. at 1216. The claims used means-plus-function terminology and the specification disclosed random access memory (RAM) as one structure for carrying out the claimed function. Id. at 1217. During the prosecution of the patent, the patentee distinguished the claims from cited prior art on the ground that the prior art used a shift register-based system as opposed to a RAM-based system. Id. at 1219. Based on this prosecution history, the court concluded that the patentee could not later argue that a shift register-based system is structurally equivalent to the RAM-based system disclosed in the specification. Id. at 1221.

The Federal Circuit's determination in Alpex with respect to whether one structure for performing a particular function is the "equivalent" of another structure is fundamentally different from the determination involved herein with respect to whether a particular structure constitutes "the corresponding structure . . . described in the specification." Equivalents typically is a complex factual issue which is not resolved in Section 112(6), i.e., Section 112(6) does not specify which structures should be considered the "equivalent" of a structure specifically described in the specification. Therefore, prosecution history that provides information as to whether a particular structure is equivalent to a structure described in the specification helps resolve a potential ambiguity as to whether a particular structure falls within the scope of a claim. But when, as here, the specification unambiguously describes a structure as carrying out the function called for in the claim, Section 112(6) mandates that the claim be interpreted to encompass that structure. Hence, for those claims that describe the detection and angle tracking of laser beams in a purely functional manner and fall within the scope of Section 112(6), unless there are other limitations in the claim that would exclude conical scans, there is no ambiguity that conical scans come within the literal scope of the claim because conical scans constitute a "corresponding structure [for performing the detection and angle tracking of laser beams as] described in the specification." For such claims, excluding conical scans from the scope of the claim based on prosecution history would improperly add a limitation to the claim that unambiguously is not present in the claim language. (4)

With respect to any claims for which an ambiguity exists and the prosecution history may be relevant to claim interpretation, the court will next consider defendant's prosecution history arguments. Defendant relies in part on statements made during the prosecution of the '036 patent application. During the course of the prosecution, the patent examiner rejected certain claims based on three pieces of prior art--U.S. Patent Nos. 3,060,425 (the Cutler patent) and 3,095,538 (the Silberstein patent) and an April 21, 1961, article in Electronics entitled "Optical Ranging System Uses Laser Transmitter" (Publication I). In rejecting certain of plaintiff's claims, the patent examiner reasoned that the Cutler and Silberstein patents "show a system of orienting a communication link between a satellite and a station on the earth," Publication I "teaches the advantages of using laser transmissions for directive communication," and the Publication I lasers obviously could be used in the systems disclosed in the Cutler and Silberstein patents.

In the Cutler system, the satellite received a signal from a ground station which instructed the satellite how to orient its transmitter so as to transmit signals back to the ground station. Defendant contends that plaintiff's arguments in response to the patent examiner's rejection of the claims based on the Cutler patent demonstrated plaintiff's understanding that the claim language did not encompass the use of

conical scans for laser detection and angle tracking. Representative of plaintiff's arguments are the following statements:

[I]t is clear that the satellite [disclosed in the Cutler patent] is incapable of resolving the position of the ground station without the reception of actual error information content on the received message from the ground. This is to be contrasted with applicant's laser transmission and reception system which provides by virtue of the narrowness of the laser beams and their optical properties for the resolution of the position on the ground of the transmitting laser relative to a field of view beneath the satellite. As disclosed, this resolution is achieved by means of a matrix and an optical system which images the field of view on the matrix, thereby permitting the matrix to select with as high an angular resolution as desired the exact angular location of a source of laser transmission that is received at the satellite.

Defendant argues that plaintiff's references to a matrix detector and his distinguishing the prior art based on the satellite not receiving an error signal from the ground station indicate that plaintiff interpreted the claims as limited to a matrix detection system and as excluding the use of conical scans. The court, however, cannot agree that the prosecution history of the '036 patent supports such an interpretation.

First, plaintiff's references to matrix technology serve only as an example of a technology for laser detection and angle tracking. The references do not indicate that plaintiff interpreted his claims as not also covering the use of conical scans, which the specification discloses as an alternative to detector array matrices for performing laser detection and angle tracking. Next, as to transmission of an error signal from the ground station, defendant focuses on the specification paragraph quoted above (see supra p. 13) which proposes the use of conical scans for laser detection and angle tracking. Defendant points to the phrase "transponding mode" in the first sentence and correctly notes that this mode refers to transmissions between the satellite and the ground station. Defendant then contends that the subsequent reference to "transponding off-axis error signals to servo the scan axis" necessarily means that for the conical scan techniques disclosed in the specification, error signals are similarly transmitted between the satellite and the ground station. Because plaintiff distinguished the Cutler patent by explaining that plaintiff's claimed invention did not transmit error signals from the ground station to the satellite, defendant argues, plaintiff necessarily interpreted the claims as not including the disclosed conical scan techniques. The deficiency in this argument, however, is that the specification does not anticipate the transmission of error signals from the ground station to the satellite when conical scans are used for laser detection and angle tracking.

Initially, a brief discussion is warranted as to the state of conical scan technology at the time plaintiff filed the '036 patent application. See MIT Radiation Laboratory Series, Radar System Engineering 207-10 (Louis N. Ridenour ed., 1st ed. 1947); U.S. Patent No. 2,473,175 (issued on June 14, 1949). Conical scans contain a receiving element that scans in a circular motion around an axis which can be referred to as the scan axis. See McGraw-Hill Dictionary of Scientific and Technical Terms, 161, 413, 1668 (4th ed. 1989). As it rotates, the receiving element detects any incoming signal. If the scan axis points directly at the source of the signal, the magnitude of the received signal is the same throughout the entire circular scan and the error signal is zero. If, however, the source of the signal is not directly in line with the scan axis, then the magnitude of the transmission will vary during the course of the circular scan. From this variance, an error signal is created and is sent to a servomechanism which in turn changes the scan axis. Through this feedback system based on error signals, the servomechanism continues to readjust the direction of the conical scan device until the device's scan axis points toward the source of the signal. Therefore, when using conical scan techniques, error signals generally are not transmitted between a conical scanning device and a distant point but rather are used internally within the conical scan apparatus to redirect the conical scan receiver.

Plaintiff's specification appears fully consistent with this general description of conical scan technology. The specification provides for the use of an error signal to "servo the scan axis" of the conical scan and thus indicates that error signals are sent to a servomechanism which responds by changing the axis of the conical scan device. In this context, defendant's argument that the specification must be interpreted to require the transmission of conical scan error signals between the satellite and the ground station fails. The most efficient use of such error signals would be to use those signals directly on the satellite to readjust the direction of the conical scan device. The specification does not suggest any benefit that would result from instead transmitting the conical scan error signal from the satellite to the ground station and then back to the satellite. (5) Nor does the description of the ground station in the specification suggest that the ground station is capable of utilizing error signals so as to aid the satellite in determining the position of the ground station.

Viewing the specification as a whole, the term "transponding" in the phrase "transponding off-axis error signals to servo the scan axis" is most appropriately interpreted as synonymous with the term "sending" and would include sending error signals directly to a servomechanism within the satellite, without first transmitting the signals to the ground station. (6) Hence, the prosecution history of the '036 patent does not indicate that plaintiff interpreted the patent claims as excluding from their literal scope the use of conical scans or quadrant detectors for laser detection and angle tracking.

4.

Defendant alternatively relies upon the prosecution history of the '518 patent. Defendant contends that plaintiff's statements therein make clear that plaintiff interpreted all of the claims of the '036, '518, and '982 patents that involve laser detection and angle tracking as excluding the use of conical scans or quadrant detectors. The pertinent prosecution history upon which defendant relies concerns plaintiff's attempt, ultimately unsuccessful, to convince the patent examiner to declare patentable an amended Claim 22. The patent examiner rejected the original Claim 22 as being obvious over U.S. Patent Nos. 2,494,645 (the Collins patent) and 2,982,859 (the Steinbrecher patent). In response, plaintiff amended Claim 22 to read as follows, with the underlined segments representing added text and the bracketed segments representing deleted text:

The method of communication between spaced stations using a laser beam comprising the steps of scanning a laser beam from one station to cover a field including a second [another] station, determining at said second station the relative angular position between said stations solely by resolving the angle of arrival of the [by receiving a] laser beam transmitted from said first station [between stations] and controlling the laser beam transmission [between said stations in accordance with said angular orientation] from said

second station to return along said angle of arrival to communicate via said laser beam.

In presenting amended Claim 22, plaintiff argued that the amended claim was patentable over the Collins and Steinbrecher patents.

The Collins patent discloses a two-way light communication system in which a modulator applies a tone oscillation on a light beam so that an individual, using earphones, can hear a tone whenever a beam is received. The individual adjusts the receiver manually until a maximum signal is heard. This maximum amplitude signal indicates that the receiver and transmitter are aligned. In response to the patent examiner's citation of the Collins patent, plaintiff argued that the amended language of Claim 22, which requires the angular position between the receiving and transmitting stations to be determined "solely" by resolving the angle of arrival of the received laser beam, distinguishes Claim 22 from "any amplitude

responsive system such as Collins." Plaintiff explained that his claimed system "does not rely on the amplitude of the received signal so long as the signal is detectable at all."

The Steinbrecher patent discloses a light communication alignment system which employs four quadrant photocell receivers. When all four receivers are aligned in the direction of the incoming beam, each receives a signal of equal amplitude. When the four receivers are not perfectly aligned, unequal signals result and error signals are produced and sent back to the transmitting station. Using the feedback of these error signals, the four detectors are realigned until the signals in the four receivers are equal. In response to the patent examiner's citation of the Steinbrecher patent, plaintiff described the Steinbrecher system as one that "does not actually orient the directivity of the receiving station but rather transmits the orientation error signal to the transmitting station." Plaintiff then distinguished Claim 22 on the grounds that Claim 22 resolves the angle between stations (1) without communicating back to the transmitting station; and (2) "solely by the angle of arrival of the received laser beam without regard to the amplitude of received signals."

As explained above, prosecution history can be relevant to the interpretation of claim terms to the extent that the prosecution history explains what the patentee meant by those terms. The prosecution history cited above indicates that plaintiff interpreted the language in amended Claim 22 as not encompassing any device that relies on signal amplitude to determine the angle of arrival of the received laser. The prosecution history shows that plaintiff understood that by amending Claim 22 to include the limitation that the relative angle between stations was determined "solely" by resolving the angle of arrival of the received laser beam, the claim distinguished systems such as the Collins and Steinbrecher systems which employ amplitude of the received signals to determine the angle between stations. Because conical scans and quadrant detectors use error signals derived from the amplitude of the incoming laser beam, the prosecution history supports a conclusion that plaintiff interpreted the language in amended Claim 22 as not encompassing the use of conical scans or quadrant detectors.

To the extent other claims employ the identical pertinent wording as Claim 22, it certainly could be argued that plaintiff also interpreted those claims as not encompassing the use of conical scans or quadrant detectors. The problem with defendant's prosecution history argument, however, is that defendant seeks to use the prosecution history of Claim 22 to support an interpretation of other claims that do not employ the claim language upon which plaintiff relied to exclude structures that use amplitude to determine the angle between the receiving and transmitting stations. The claims in issue in this litigation employ different limitations than amended Claim 22 and none includes the limitation that the relative angle between stations is determined solely by resolving the angle of arrival of the received laser beam. To the contrary, most claims simply call for "determin[ing] the angular orientation" of the ground station, with no further pertinent limitation as to how the angle is determined. See, e.g., Claims 1 and 2 of the '036, '518 and '982 patents.

The prosecution history of the '518 patent upon which defendant relies simply does not suggest that plaintiff took a position, one way or the other, as to whether the language of the claims in issue encompasses structures that use the amplitude of the incoming signal to determine the angle between stations. In this regard, the scope of each claim is determined based on its own language. Therefore, an acknowledgment by plaintiff in the prosecution history that he amended Claim 22 so as to overcome certain cited references does not mean that plaintiff necessarily believed that other claims, with different language, also would have to be amended to avoid rejection over those same references. Stated in another way, there is no indication in the cited prosecution history that plaintiff believed that the claims in issue excluded the use of conical scans or quadrant detectors for laser detection and angle tracking or that the language in those claims was insufficient to render the invention patentable over the Collins and Steinbrecher patents. (7)

For all of the above reasons, this court concludes that the prosecution history of the '036 and '518 patents does not limit plaintiff's claims so as to exclude the use of conical scans or quadrant detectors.

V.

Before turning to the issues of patent validity and infringement, the court will address one other issue relating to the scope of the claims which involves application of Section 112(6). Many of the patent claims use functional language to describe laser detection and angle tracking. For example, Claim 4 of the '036 patent calls for the following:

[A] means for reporting the angular location of one station to the other station solely by means of the directivity of a laser beam transmission from said one station to said other station, and means in said other station responsive to the angular location reported for orienting a laser beam transmission to the location of said one station.

As noted above, for claims that use such means-plus-function language, Section 112(6) mandates that the claim be interpreted to encompass "corresponding structure[s] . . . described in the specification and equivalents thereof." As a prelude to the discussion of infringement and validity, a brief discussion would be helpful with respect to the "corresponding structures" disclosed in the specification for laser detection and angle tracking.

The specification discloses two embodiments for laser detection and angle tracking. The first is described in Figure 1 and the related specification text and involves an optical system, a two-dimensional detector array, a matrix, a storage device, and a track computer. The detector array is comprised of photoresponsive elements and each element corresponds to a certain incoming angular orientation. The laser beam passes through the optical system and strikes one of the photoresponsive elements. The photoresponsive element, which is connected to a suitable matrix, transmits to the matrix the angular orientation of the origin of the beam and the matrix in turn translates the information into machine code. The converted information is then stored in a storage device. If this system is placed on a movable station such as a satellite, the storage device works in conjunction with a track computer. The track computer takes into account the motion of the satellite and adjusts the stored information to reflect the present position of the transmitting station.

When sending a responsive laser, the track computer does not affirmatively direct the laser to fire in any one direction. Rather, the laser is pointed through an optical system that is adapted to produce a scan of a given area. A scan generator causes the optics to perform a scan cycle of this given area. While scanning, the scan generator sends positional information to a device called a comparator. The positional information from the track computer is also sent to the comparator, and when the positional information from both the track computer and the scan generator coincide, a signal is sent to a pulse generator, which fires the laser. Hence, for detection and angle tracking of an incoming laser and orienting a responsive laser transmission, this first embodiment disclosed in the specification uses an optical system, a detector array, a matrix, a storage device, a track computer, a comparator, and a scan generator.

The second embodiment disclosed in the specification is described at col. 11, lns. 9-19, and utilizes conical scan techniques. Although the court was able to gain a partial understanding of this disclosure through the use of intrinsic evidence, expert testimony was necessary to understand fully this alternative conical scan structure, i.e., exactly how one of ordinary skill in the art would understand that the previously disclosed structure could have been "readily modified" so as to "introduc[e] well-known conical scan techniques." Col. 11, lns. 9-12. As explained by plaintiff's expert, this second embodiment also utilizes an optical system to receive the incoming laser beam. The detector array, however, is replaced with a conical scan unit. The matrix in the Figure 1 embodiment, in effect, is used as an

integration unit, which utilizes the error information from the conical scan unit in an attempt to reduce the error signal to zero. The integration unit sends an integrated signal to a servomotor and directs the servomotor to adjust the optics of both the transmitter and the receiver in the appropriate direction. The storage device, track computer, comparator, and scan generator in Figure 1 are not employed. When properly oriented, the conical scan optics are continually adjusted so as to point in the direction of the incoming beam. With this system, it is not necessary to have separate optical systems to receive and transmit the laser. The servomotor adjusts both the receiving unit and transmitting unit toward the direction of the incoming beam. Thus, if the incoming and outgoing beams pass through the same optic system, the servomotor need only control one set of optics. Hence, with respect to this alternative conical scan embodiment, the specification teaches one of ordinary skill in the art to accomplish detection and angle tracking of laser beams, including directing a return laser, through the use of transmitting and receiving optics, a conical scan unit, an integration unit, and a servomotor.

VALIDITY

VI.

Pursuant to 35 U.S.C. § 282, patent claims are presumed to be valid. To overcome this presumption, defendant must prove invalidity of the patent claims in issue by clear and convincing evidence. Massey v. Del Labs., Inc., 118 F.3d 1568 (Fed. Cir. 1997). A patent can be rendered invalid for failing to satisfy any of a series of statutory requirements. Pertinent to this case, the claims in issue are invalid if these claims are anticipated by the prior art under 35 U.S.C. § 102 or in view of the prior art are obvious to persons of ordinary skill in the art under 35 U.S.C. § 103.

Defendant cites a series of references as prior art and argues that all of the patent claims in dispute either are anticipated or obvious in view of that art. During or prior to trial, the court resolved disputes as to the prior art status of most references upon which defendant relies. The court now will discuss in some detail the prior art status of two significant documents. The first document is a report that is the third in a series of reports prepared by Philco Scientific Laboratory under a contract with the Air Force (Philco III). The second is a report issued by scientists working at Electro-Optical Systems, Inc. (the Electro-Optical Report).

A.

Philco III, authored by R.F. Anderson and entitled "Study and Investigation of Acquisition and Tracking of Optical Communication Systems," discusses a communication system for use with satellites in which communications are carried on modulated laser beams and the satellites use quadrant detectors to track one another and maintain communication.

1.

Defendant offers Philco III as a Section 102(a) "printed publication." A document is considered a printed publication as of the date on which the document became sufficiently accessible to the public interested in the art. Constant v. Advanced Micro-Devices, Inc., 848 F.2d 1560, 1569 (Fed. Cir. 1988); Carella v. Starlight Archery and Pro Line Co., 804 F.2d 135, 139 (Fed. Cir. 1986). If a document became publicly accessible more than one year prior to the filing date of a patent application, then the document constitutes prior art under Section 102(b) regardless of when the patentee conceived of the invention. Where, however, the document became publicly accessible within one year of the filing date of the patent application, the document constitutes prior art only if the document was published before the date of the invention. Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1576 (Fed. Cir. 1996). Defendant established that Philco III was accessible to the public on June 5, 1962, approximately one month before

plaintiff filed the '036 patent application. [(8)] Hence, Philco III is prior art unless plaintiff conceived of his invention prior to June 5, 1962.

The filing date of a patent is presumptively the date of invention. Id. at 1576. The patentee has the burden of producing evidence to overcome this presumption and if the patentee satisfies this burden, the alleged infringer then has the burden of demonstrating by clear and convincing evidence that the printed publication predates the date of invention. Id. at 1577. The standard for determining the date of invention derives from 35 U.S.C. § 102(g). Where, as here, the patentee did not reduce his invention to practice prior to filing the patent application, the patentee can demonstrate invention prior to the publication date by showing (1) conception of the invention prior to the publication date and (2) the exercise of reasonable diligence toward filing his application from a date prior to the publication date up through the filing of the patent application. Id. at 1578; see also 35 U.S.C. § 102(g). Hence, Philco III is prior art unless plaintiff (1) conceived of the claimed invention prior to June 5, 1962, and (2) proceeded with reasonable diligence from a date prior to June 5, 1962, up through the filing of the '036 patent application on July 2, 1962. Id.

At trial, plaintiff established the exercise of reasonable diligence during the relatively short period from the May 7, 1962, witnessing of the concept document to the July 2, 1962, date on which plaintiff filed the '036 patent application. During this period, plaintiff proceeded with reasonable persistence and speed to draft and file a patent application describing his invention. Thus, in determining whether Philco III constitutes prior art, the only issue remaining is whether plaintiff conceived of the invention prior to June 5, 1962.

2.

"Conception exists when a definite and permanent idea of an operative invention, including every feature of the subject matter sought to be patented, is known." Sewall v. Walters, 21 F.3d 411, 415 (Fed. Cir. 1994). "Conception is complete when one of ordinary skill in the art could construct the apparatus without unduly extensive research or experimentation." Id. In other words, conception has occurred if "[a]ll that remains to be accomplished, in order to perfect the act or instrument, belongs to the department of construction, not invention." Coleman v. Dines 754 F.2d 353, 359 (Fed. Cir. 1985) (quoting Gunter v. Stream, 573 F.2d 77, 80 (CCPA 1978)).

A patentee may not rely exclusively upon his or her own testimony to prove that conception occurred prior to the date on which the invention was reduced to practice. Rather, some form of corroborating evidence is required. Price v. Symsek, 988 F.2d 1187, 1194 (Fed. Cir. 1993). The Federal Circuit explained this rule as follows:

[C]onception by an inventor . . . can not be proved by his mere allegation nor by his unsupported testimony where there has been no disclosure to others or embodiment of the invention in some clearly perceptible form, such as drawings or model, with sufficient proof of identity in point of time. For otherwise[,] such facile means of establishing priority of invention would, in many cases, offer great temptation to perjury, and would have the effect of virtually precluding the adverse party from the possibility of rebutting such evidence. Hence it has been ruled in many cases that mere unsupported evidence of the alleged inventor, on an issue of priority, as to . . . conception and the time thereof, can not be received as sufficient proof of . . . prior conception."

Id. (quoting Mergenthaler v. Scudder, 11 App. D.C. 264, 278-79 (App. D.C. 1897)). In evaluating evidence that seeks to corroborate the oral testimony of an inventor, courts employ a "rule of reason" analysis pursuant to which "[a]n evaluation of all pertinent evidence must be made so that a sound

determination of the credibility of the inventor's story may be reached." Price, 988 F.2d at 1195.

3.

For all claims other than Claim 5 of the '036 patent, plaintiff contends that the concept document described above provides the required corroboration of plaintiff's testimony that he conceived of his invention prior to June 5, 1962. Plaintiff alleges that the concept document as witnessed by a third party on May 7, 1962, shows that by that date plaintiff had conceived of the invention described in these claims. For Claim 5 of the '036 patent, plaintiff relies upon different documents and contends that these documents corroborate plaintiff's testimony that he conceived of the invention described in Claim 5 on some undetermined date prior to June 5, 1962.

The court agrees that the concept document corroborates plaintiff's conception prior to June 5, 1962, of the invention described in all claims other than Claim 5 of the '036 patent. The concept document shows that plaintiff had a "definite and permanent" idea of a communication system involving a satellite, a submarine, and a ground station. Sewall, 21 F.3d at 415. As described therein, the satellite and submarine each have a laser transmitter and receiver through which they are able to communicate with one another. The satellite has the capacity to scan its laser over a particular area of the earth. The satellite detects a transmission from the submarine and, through the use of a tracking system, orients a responsive laser beam along the line of the incoming laser beam received from the submarine. The satellite communicates the information it receives from the submarine to a ground station through a radio transmission system. Upon review, this disclosure specifically depicts or teaches one of ordinary skill in the art to combine all of the elements or steps called for in all claims other than Claim 5 of the '036 patent.

For example, the following table lists each element of Claim 1 of the '036 patent and the corresponding description in the concept document which shows that plaintiff had conceived of the inclusion of such elements in his invention when he drafted the concept document.

Elements of Claim 1 of the '036 Patent	**Corresponding Description in the Concept Document**
"Apparatus for communicating with a mobile vehicle comprising"	"communication [between a satellite] and a submerged submarine"
"means for transmitting a laser beam toward an orbiting satellite from a vehicle within the portion of the earth's surface beneath such	"a laser beam transmitted . . . from the submarine [to the satellite]"
Elements of Claim 1 of the '036 Patent	**Corresponding Description in the Concept Document**
"means for detecting said laser beam received at said satellite to determine the angular orientation of said vehicle from said satellite,"	"The satellite contains an appropriate detector for receiving laser beam signals and a tracking system to orient one of the beams radiated from the satellite along the line of the beam received from the submarine."

"means for utilizing the angular orientation data so obtained to establish a narrow beam communication link from said satellite to said vehicle,"	"the satellite . . . will reorient the laser beams from the satellite to be directed . . . toward the submarine. This beam upon being detected in the submarine completes the
"and means for communicating with said vehicle from a remote point via said satellite and said narrow beam communication link."	"[the satellite] can accurately aim its laser beam and send a coded signal to the satellite which will reorient the laser beams from the satellite to be directed (one beam only) toward the submarine. This beam upon being detected in the submarine completes the communication link via radio transmission between the satellite and a distant ground station."

Defendant contends that the May 7, 1962, concept document does not show that at the time plaintiff had a "definite and permanent" idea of the invention described in Claim 1 of the '036 patent or any of the other claims in issue because plaintiff did not identify in the concept document the particular structures, later identified in the specification, that plaintiff would use to carry out certain of the functions described in the patent claims. For example, although the concept document calls for an "appropriate" tracking system, it does not identify any particular structure for use in such a system. It is not necessary, however, for plaintiff to provide that level of detail to demonstrate that he had conceived of the invention defined in the patent claims. Based on the trial testimony, including the testimony of both parties' experts, the court concludes that if one of ordinary skill in the art had reviewed the concept document on May 7, 1962, he or she could have proceeded to construct the invention as described in each of the patent claims without undue research or experimentation. At the relevant time, for example, conical scans and quadrant detectors were state of the art angle trackers employed for detecting distant signals. Given plaintiff's direction to use an "appropriate" tracking system, one of ordinary skill in the art reasonably would proceed to choose a conical scan or quadrant detector without undue research or experimentation.

The same reasoning applies to the other claim elements that are not referenced with the same specificity in the concept document as in the specification. For example, certain claims call for either a "pulsed" or "blue-green" laser whereas the concept document simply calls for a laser. But at the time the concept document was authored, there were only two forms of lasers--pulsed and continuous wave--and upon reading the concept document, one of ordinary skill in the art would interpret the concept document as suggesting the use of both types. The choice of a pulsed laser would not involve undue research or experimentation. As to the color of the laser, the concept document calls for the satellite to transmit to the submarine by using a laser "at a wavelength and power to achieve the necessary penetration of sea water." One of ordinary skill in the art would interpret this requirement as suggesting the use of a blue-green laser.

Defendant alternatively faults the concept document for failing to anticipate the difficulties that would be confronted in creating an operable laser communication system. For example, defendant points to plaintiff's failure to address the difficulties of transmitting a laser through the atmosphere and sea water. Cloud cover causes a laser signal to lose its intensity, and at the relevant time, sea water was penetrable only to a very small degree. But a communication system potentially could be useful even if operated

only on clear days, and at trial both experts agreed that if the transmission were done on a clear day, an operable system could be constructed in accordance with the concept document and the claimed invention. (9) Although it is true that an engineer seeking to construct an operable system based on the concept document would have to address certain engineering issues inherent whenever a group of distinct elements is combined in a single system, the crucial issue in evaluating the concept document is whether undue experimentation would be

required to resolve these issues. The court concludes that it would not. Hence, Philco III does not constitute prior art against any claims other than Claim 5 of the '036 patent.

4.

Claim 5 of the '036 patent combines different elements than the other claims and apparently because of these differences plaintiff does not rely upon the concept document to show invention of Claim 5 prior to June 5, 1962. Instead, plaintiff relies upon other documents he drafted which were entered into evidence during trial as plaintiff's exhibits (PX) 26, 27, and 28.

PX-26 is a handwritten document that depicts a point-to-point laser communication system with scanning means using cross prisms. This document identifies two scientific articles which, upon review, discuss lasers and infrared sources. But PX-26 does not disclose the elements described in Claim 5 of the '036 patent and, in addition, plaintiff did not present compelling testimony that upon review of PX-26 or the cited articles, one skilled in the art could have produced without undue experimentation the apparatus described in Claim 5.

PX-27, also a handwritten document, contains two figures which are almost identical to Figures 1 and 2 of the '036 patent. Figure 1 generally depicts the apparatus covered in Claim 5 and therefore, if drafted prior to June 5, 1962, PX-27 would be adequate to show conception of Claim 5 prior to the publication date of Philco III. Because PX-27 is undated, plaintiff relies upon another handwritten document, PX-28, to demonstrate that PX-27 was drafted prior to June 5, 1962. PX-28, dated June 5, 1962, states "add Fig 3" and includes a figure showing communication between two points on earth, points A and B, with laser connections between point A and the satellite and point B and the satellite. Plaintiff argues that because PX-28 proposes to add a third figure and PX-27 contains two figures to which such a third figure could be added, it follows that PX-28 refers to PX-27 and hence, PX-27 must have been drafted prior to PX-28, or prior to June 5, 1962.

Plaintiff's logic as to the relative timing of the drafting of PX-27 and PX-28 is flawed. The '036 patent application contained two figures--Figures 1 and 2--which are essentially identical to the two figures depicted in PX-27. The patent application did not contain a Figure 3. The most likely implication from these facts is that PX-27 represented a final depiction of the desired figures rather than an interim one. Indeed, if plaintiff had previously drafted the two figures in PX-27, which in essence were included in the patent application, and then later instructed the draftsmen to add a Figure 3, it is not apparent why Figure 3 was not also included in the patent. The more likely inference is that the "add Fig 3" proposal in PX-28 refers to an earlier draft of plaintiff's proposed patent application. In other words, by the time plaintiff drafted PX-27, the decision had been made to go with the two figures therein. Plaintiff has failed to demonstrate any connection between PX-27 and PX-28 or that the two documents were drafted in the sequence plaintiff proposes. Hence, plaintiff has failed to show conception of the invention in Claim 5 prior to June 5, 1962, and Philco III constitutes prior art against that claim.

B.

The second significant document in discussing prior art status is the Electro-Optical Report, authored by Duane E. Erway and others at Electro-Optical Systems, Inc., and entitled "Direct Use of Solar-Energy for Communication, Part I--Analysis of Solar-Optical Communication." Plaintiff initially stipulated to the admissibility of the Electro-Optical Report for prior art purposes, but later, at trial, the court allowed plaintiff to withdraw that stipulation. The focus of the dispute involves a Department of Commerce publication in U.S. Government Research Reports, Vol. 37, No. 6 (Mar. 20, 1962), which provides:

The reports listed in this publication, unless otherwise noted, are available from the Office of Technical Services, U.S. Department of Commerce, at the prices indicated.

* * * * *

This publication is issued twice a month to announce new material available through the Office of Technical Services, which sells copies of Government reports at the cost of reproduction and handling. For additional information and ordering instructions, see inside of front cover.

The inside of the front cover states that the reports listed therein have been "released" by various government agencies and "may be ordered through any Department of Commerce Field Office." The Electro-Optical Report is one of the reports listed.

Plaintiff argues that defendant did not demonstrate affirmatively that the Electro-Optical Report actually was available to the public as of March 20, 1962, and that a careful comparison of the Electro-Optical Report and the abstract written in the Department of Commerce publication suggests that the Electro-Optical Report was not available when the publication was issued. As to that comparison, plaintiff notes that the abstract lists "Duane E. Erway, T.A. Hardin, and others" as the authors of the report while the face of the Electro-Optical Report lists only Duane E. Erway. In addition, plaintiff points out that the abstract fails to state the number of pages in the report and lists the number of references cited as 100 instead of 198. But these differences hardly indicate that the publication's explicit statement that the Electro-Optical Report was "released" and "available" is incorrect. Although Erway is listed as the sole author on the face of the Electro-Optical Report, the report's foreword lists Erway, Hardin, and four others as coauthors. As to the number of pages, the abstract simply is silent--it does not give an incorrect number of pages. As to the number of references, the publication does give an incorrect number, but it is not apparent that this inconsistency was anything more than a typographical error or a simple mistake that had nothing to do with the availability of the report to the public.

In In re Epstein, 32 F.3d 1559, 1566 (Fed. Cir. 1994), the Federal Circuit reviewed the abstracts presented therein and concluded that it had "no reason to believe that the abstracts and the statement[] of 'release' . . . appearing in the abstracts are inaccurate or that the authors of the statements are untrustworthy." The court further remarked that "[t]o flatly reject the abstracts as unreliable would require us to assume that the vendors are engaging in false or misleading advertising, which--in the absence of evidence supporting such--we will not assume." Id. These same general conclusions are warranted here. The abstract in the Department of Commerce publication constitutes clear and convincing evidence, at least on a prima facie basis, that the Electro-Optical Report was available on the date the publication was issued. The evidence plaintiff presents is insufficient to support a contrary conclusion that the report was not available on March 20, 1962. [(10)] Hence, the Electro-Optical Report constitutes prior art.

VII.

When assessing the validity of a patent, prior art is interpreted and applied from the perspective of

persons of ordinary skill in the art. Hence, before turning to the issue of whether based on the prior art the claims are obvious to persons of ordinary skill in the art, the court will define the characteristics of such persons.

Plaintiff's patented invention generally involves a communication system in which lasers are used to carry messages between stations. The invention of lasers preceded the May 7, 1962, witnessing of the concept document by only a few years. Hence, at the time of plaintiff's invention, there were relatively few people with extensive laser experience. There was, however, optimism in the scientific community about the potential use of lasers in communications. Those working or interested in the area of laser communications had backgrounds in various other relevant technologies, such as optics and communications. Based on the testimony of the experts at trial, the court concludes that one of ordinary skill in the art would have had a bachelor of science degree with experience in developing systems as well as one or two years of laboratory experience. Such a person would have had an interest in and a general knowledge of new developments with lasers and would have had significant experience in optics and/or communications, such as radar, microwave, or radio communications.

VIII.

"'For a prior art reference to anticipate in terms of 35 U.S.C. § 102, every element of the claimed invention must be identically shown in a single reference.' Diversitech Corp. v. Century Steps, Inc., 850 F.2d 675, 677 (Fed. Cir. 1988). These elements must be arranged as in the claim under review." In re Bond, 910 F.2d 831, 832 (Fed. Cir. 1990). Defendant contends that six separate references anticipate certain claims in each of plaintiff's three patents. The court will describe the technical disclosure in each of the six references, determine for each reference whether the disclosure therein renders any patent claims invalid under 35 U.S.C. § 102, and then consider the disclosures of these and other references as a group to determine whether the prior art renders the claims invalid under 35 U.S.C. § 103. Ultimately, the court concludes that none of the six references renders any claim invalid under Section 102, but taken together with other references, the prior art renders the claims invalid under Section 103. (11)

A.

The Electro-Optical Report, referred to above, describes a proposed optical communication system that uses modulated sunlight to carry information between satellites in space. Defendant contends that the Electro-Optical Report anticipates Claims 1, 4, 5, and 17 of the '036 patent, Claims 4 and 13 of the '518 patent, and Claims 2, 4, 9, and 12 of the '982 patent. Because the system disclosed in the Electro-Optical Report is the closest of all the prior art to plaintiff's claimed invention, the court will discuss the Electro-Optical Report in considerable detail.

1.

The Electro-Optical Report is directed primarily at a communication system that uses sunlight as the source for a modulated communication beam. A satellite in space tracks the sun and utilizes the sun's solar energy to create a focused light beam. The light is then modulated so as to impress information onto the beam and the beam is transmitted toward a receiving station, such as a second space satellite. The receiving station demodulates the beam to secure the information and transmits a return beam so as to complete the communication link. The two stations then continually and simultaneously track and communicate with one another. (12) In addition to satellite-to-satellite communications, the report discusses the use of satellites as relay stations for communications between an earth station and another satellite or a remote station.

The report is in excess of 440 pages and identifies and describes characteristics of the devices that can be used to perform the functions required in the communication system. Section 2 of the report describes the properties of the major components of the system, Section 3 describes the physical characteristics of a complete system, Section 4 describes practical aspects of solar-optical communications systems and addresses some potential problems, and Section 5 contains comparative performance studies.

Section 2 begins by analyzing relevant properties of the sun, including spectral output and variations of properties over the solar surface. Subsection 2 then discusses and lists the functions of the transmitter system, as follows:

The general function of the solar optical communication transmitter is very similar to any communication transmitter with the exception that it must collect the energy it uses as a carrier instead of generating it internally. In general, the transmitter in the system under consideration must do the following:

(a) Collect solar energy efficiently (this implies tracking the sun).

(b) Eliminate the spectrally unuseful (systemwise) portion of the energy as early as possible to avoid overheating in components.

(c) Optically modify the energy beam so that it can be modulated.

(d) Impress information on the beam by a suitable modulation device.

(e) Optically direct the output beam towards the receiver and control its beam characteristics (this implies tracking the receiver).

Subsection 2.2 goes on to describe the general components for the transmission system and divides the required optics into three categories: (1) the collecting optics, which collect the sunlight; (2) the internal optics, which direct the light from the collecting optics to a modulator and then from the modulator to the re-emitting optics; and (3) the re-emitting optics, which direct the light toward the receiving station. The discussion of the collecting optics describes the elements necessary for directing the beam to the re-emitting optics, including a Cassegrain telescope. Subsection 2.2 then describes the combination of the three categories of transmitter optics, including the composition, positioning, and design considerations of the lenses and mirrors. The discussion of the transmission system in Subsection 2.2 concludes with a detailed explanation of the modulators that potentially can be used for impressing data on the transmitted light beam.

Subsection 2.3 describes the receiver used for receiving the transmitted light beam. The receiving unit contains its own system of optics, which is either an arrangement of mirrors or a Cassegrain receiver. The optics work in conjunction with an optical detector to receive the modulated optical transmissions. The report notes that "[c]ertainly there is a large variety of types of devices available for detection of radiant energy," but the report lists only "[t]he more relevant of these devices," including three types of photoelectric detectors--photoemissive, photoconductive, and photovoltaic. The report concludes that the best type of detector to use in the system is a multiplier phototube, which is a photoemissive detector. The report suggests using a demodulator with the multiplier phototube to decipher the information impressed onto the received optical beam. The remainder of Section 2 presents a detailed examination of the characteristics of the earth's atmosphere and other background issues so as to provide a context in which to design a solar optical communication system.

Section 3 covers the communication aspects and certain physical and operational characteristics of the system and discusses signal-to-noise ratio problems encountered in the detection and modulation of optical transmissions. Section 4 discusses "the areas which present practical limitations to the use of solar optical communications systems" and explains the necessary steps to produce an operable system. Subsection 4.2 addresses the satellite's acquisition and tracking of the sun and states:

Clearly, acquisition and accurate tracking of the sun are essential to the efficient operation of a Solar Optical Communication system of the type proposed. Slow acquisition lengthens the effective dark period, or dead time, of an orbiting system and poor tracking reduces the collector efficiency. Because the system must give reliable, maintenance-free performance for an extended period of time, the paramount criteria to be applied to the acquisition/tracking system is that of reliability.

Subsection 4.2 describes a variety of specific mechanisms that can be used to achieve such acquisition and tracking of the sun.

For an operable optical communication system, in addition to the acquisition and tracking of the sun, it also is necessary to have acquisition and tracking capabilities between the satellite and the station with which the satellite is communicating. Subsection 4.3 covers such station acquisition, which it labels as "a problem of major concern," and discusses two acquisition methods. The first method is the a priori method in which the transmitting station has "accurate information as to the past, present and future location and velocity characteristics of the partner station." Based upon that information, which is stored in a "simple computer," the transmitter is directed toward the location at which the other station is known to be. The a priori method is the same method suggested in plaintiff's patent specification for the submarine's acquisition of the satellite. (13)

The second station acquisition method is a search method "in which a systemized search [is] conducted until the other station [is] located and acknowledged an inquiry." Because a satellite's location generally is predictable to only a limited degree, Subsection 4.3 concludes that the most desirable acquisition technique typically is to combine the two methods, where the a priori method is used to direct the transmitter toward the general area in which the satellite is known to be located and then the search method is used to scan that general area to locate the satellite.

Subsection 4.4 covers station tracking. Station acquisition refers to the ability of a station, such as a satellite, to detect the incoming light beam from another station. Once the station detects the incoming beam, the station must be able to orient accurately its receiving and transmitting elements in the direction of the transmitting station, which it accomplishes by tracking the incoming beam. This tracking function allows the transmitters and receivers of both communicating stations to remain directed at one another. In Subsection 4.4, tracking is accomplished by adjusting the direction of the transmitters and receivers in response to any relative changes in the locations of the stations. Subsection 4.4 begins its discussion of tracking as follows:

As with acquisition, tracking and stabilization problems are not major study areas of this program, but are essential subjects for a working system. It must be stated again that these locating and positioning problems are not peculiar to an optical frequency communications system. The requirements, and generally the solutions, are independent of frequency and therefore apply to any system.

Once non-stationary communicating partners have located each other, information must be supplied to the antenna control systems so that contact is maintained. Possible techniques for supplying this information are discussed below. It will be assumed that the transmitting and receiving antennas are mounted on the same axes.

This reference to mounting the transmitting and receiving antennas "on the same axes" implies to one of ordinary skill in the art that a satellite's receiving and transmitting elements will always point in the same direction. If so directed, when the receiver on the first station has successfully tracked, and therefore is pointing in the direction of, the second station, the transmitter on the first station also will be pointing in the direction of the second station and thereby can emit an optical beam directed toward the second station.

Subsection 4.4 refers to two types of tracking--transmitter tracking and receiver tracking. Transmitter tracking, used in the typical situation involving two-way communications, involves the receiver of one station tracking the transmitter of the other station so as to maintain contact between the two stations. In other words, in transmitter tracking the receiving station determines the location of the transmitting station. The report explains:

The following is a general discussion of some of the techniques and requirements of tracking systems. A statement as to the specific requirements imposed on the tracking devices must be related to total system requirements, allowable weights, antenna beamwidths, safety factors, etc. for a particular design.

Tracking of a transmitter (transmitter tracking) by a receiving station is not especially difficult. A wide variety of sensors have been developed for star trackers for astronomical and navigational applications. Most are of a "conical scanning" type and some were described in Section 4.2. Further detail is not necessary at this time and new devices are being developed. One such new device is a star tracking multiplier phototube. This item combines a phototube with a special aperture and deflection circuits to provide error signals for the servo motors. The device has not yet been evaluated.

An example of the abilities of current technology is the Hale telescope at Mt. Palomar, where tracking accuracies of less than one second of arc are obtained. The error detector in this case consists of a phototube placed behind a rotating eccentric aperture. Since receiver beamwidths are likely to be one or two minutes wide it is apparent that error detectors of sufficient accuracy are available.

Subsection 4.2, which is referenced in the above quotation, lists several types of trackers, including a conical scan, a quadrant detector, and a radiation tracking transducer. It also contains a schematic diagram of a servo system that utilizes a quadrant detector type of sensor. The schematic diagram shows error signals sent from the sensor, through an amplifier, to a two-phase servomotor. This is the type of basic servo system that one of ordinary skill in the art would understand could be used with conical scans and quadrant detectors.

The second type of tracking discussed in Subsection 4.4 is receiver tracking, which is used in one-way communication links, i.e., when one station transmits a signal to a second station but the second station does not transmit any return signal. Receiver tracking is necessary, for example, when one station's transmitter fails in a two-way communication link. In such a case, transmitter tracking is not possible because there would be no transmission from the one station for the receiver of the other station to track. Hence, for the two stations to maintain contact, it is necessary for the transmitter of the one station to track the receiver of the second station. The report proposes two methods for receiver tracking--to provide the transmitting station with information as to the predicted motion of the receiving station, (14) and to place reflectors on the receiving station so that the transmitted beams bounce back for tracking by the transmitting station.

As described above, most of the discussion in the Electro-Optical Report concerns a communications system in which the communication beam is captured sunlight that is processed in the optical portion of the spectrum. Subsection 5.2 discusses the use of lasers as a source in an optical communication system

as follows:

Lasers can conceivably be applied to optical communication in two ways: as sources and/or as detectors.

* * * * *

Laser sources, because of their narrow optical bandwidths, are potentially attractive for use in optical communication links which are limited by background current. In such links the [signal-to-noise] power ratio varies inversely with optical bandwidth. (Until, of course, the bandwidth becomes so narrow the link is no longer background limited.)

One of the more attractive aspects of laser sources is the possibility of direct modulation over wide information bandwidths without an excessive expenditure of modulation power. It is presently too early to determine if this hope will be realized.

2.

As described above, to anticipate a claim, a prior art reference must show every element called for in the claim and "[t]hese elements must be arranged as in the claim under review." In re Bond, 910 F.2d at 832. All of the claims that defendant contends are anticipated by the Electro-Optical Report, except Claim 4 of the '518 patent, are properly interpreted as limited to the use of lasers rather than any other light source. (15) The Electro-Optical Report, however, does not show a laser and the other claim elements arranged in the manner set forth in these claims. The Electro-Optical Report provides a detailed description of a communication system using sunlight and instructs the reader as to the various components and steps that should be combined to produce an operable optical communication system. With respect to lasers, the report indicates that "[l]asers can conceivably be applied to optical communication . . . as sources." The report, however, does not specify which components would be used in conjunction with a laser when a laser is chosen as an optical source. Nor does the report state that lasers simply could replace sunlight in the combination of elements described for the sunlight-based system. Because the Electro-Optical Report does not show a laser and the other claim elements in the manner set forth in these claims, the report does not anticipate the claims and render them invalid under 35 U.S.C. § 102.

Claim 4 of the '518 patent requires a somewhat different analysis. Claim 4 is a method claim and calls in pertinent part for "illuminating said satellite with a narrow beam energy transmission from a ground station." This reference to a narrow beam transmission is not in means-plus-function or step-plus-function language and hence the claim interpretation rules in Section 112(6) do not apply. The Electro-Optical Report, however, does not anywhere specifically identify the beam transmitted from the ground station, i.e., it does not specifically state that the ground station also uses collected focused sunlight or any other narrow energy transmission. Because defendant must prove that every element of the claimed invention is "identically shown in a single reference," the court concludes that defendant also has failed to demonstrate that the Electro-Optical Report shows all of the claim elements in the arrangement called for in Claim 4 of the '518 patent. Diversitech Corp., 850 F.2d at 677.

B.

Next, defendant relies upon a December 5, 1960, Jet Propulsion Laboratory Report, California Institute of Technology, authored by Sidney Frankel and entitled "Preliminary Investigation of Optical Communications with Lasers" (the JPL Report). Defendant contends that the JPL Report anticipates Claim 17 of the '036 patent, Claim 4 of the '518 patent, and Claim 4 of the '982 patent.

The JPL Report "presents the results of a preliminary investigation of the use of Lasers as sources and receiving amplifiers in a space-to-Earth communications link." The report begins with the statement that "it has been suggested that [lasers] might be applied to space communications" and then proceeds to undertake highly technical calculations concerning the use of lasers and, alternatively, microwaves for space communications. The JPL Report describes a system in which a modulated laser is fed to a transmitter, radiated to a receiving antenna, and then demodulated in "some sort of detection system." The report's description of the system components deals primarily with the characteristics of a laser transmission and the types of receivers that could be used in its detection.

The JPL Report, however, fails to address with specificity the particular means for tracking the laser. Although the report states that one of the purposes of the system is to furnish a signal for "angle and doppler tracking," it never discusses how tracking could be accomplished, not to mention the particular structures used for angle tracking. The conclusion in the JPL Report discusses the possibility of using an "extended detector system (with a multiplicity of outputs, either parallel or sequential)." But this discussion is in the context of a possible solution to acquisition problems, not tracking. The report suggests that the use of such an extended detector system could increase the field of view of the reception system on board a spacecraft. It does not, however, indicate that such a system could be used to detect the position of a ground station, nor does it suggest any of the particular structures disclosed in the patent for performing the tracking function.

Claim 17 of the '036 patent uses means-plus-function language to define the tracking function and hence must be interpreted, for Section 102 purposes, to cover only those structures described in the specification and equivalents thereof. 35 U.S.C. § 112. Because the JPL Report does not disclose the structures to be employed in tracking the laser, it cannot anticipate Claim 17 of the '036 patent. Claim 4 of the '518 patent and Claim 4 of the '982 patent are method claims which call for "utilizing" an incoming laser to orient a return laser. Because the JPL Report does not specify utilizing the laser in such a way, the report does not anticipate these claims.

C.

Next, defendant relies upon a November 3, 1961, article entitled "Lasers: Devices and Systems---Part II," published in Electronics and authored by Leon Dulberger and Sy Vogel (the Dulberger Article). Defendant contends that the Dulberger Article anticipates Claims 4 and 17 of the '036 patent, Claim 4 of the '518 patent, and Claims 4 and 6 of the '982 patent. The Dulberger Article discusses possible applications for lasers in communications and states in its opening paragraph that "SPACE COMMUNICATIONS are expected by many researchers to be an area of early practical applications of lasers." The article discusses the possibility of utilizing lasers in a number of different communication systems, including communications in space, on earth, and undersea. The article also recognizes security benefits that would result from using lasers in communications and explains: "High-security communications links, such as ship-to-ship signaling, could benefit from the high directionailty of the laser beam to achieve an interception-proof network."

With respect to the structures that make up a laser communication system, the Dulberger Article discloses both a transmitting and receiving station. The transmitting station contains its own optics, laser amplifiers, laser oscillators, and a telescope for transmitting the laser. The receiving station includes a telescope and a superheterodyne detection system. In discussing the modulation of the laser beams to produce communication messages, the article makes specific reference to the research performed by Electro-Optical Systems and states:

Experiments using light for communication have proved that light beams can be effectively modulated. Last year, Electro-Optical Systems, Inc., Pasadena, Calif., conducted experiments using collected light

from the sun and moon, focused to obtain a narrow light beam. The firm has said that it would be possible to use many of their system's principles when substituting a laser as the primary light source.

With respect to communications with spaceships, the article recognizes the initial problem of establishing contact with the spaceship. The article, however, is not specific as to how acquisition and tracking is accomplished. The article states:

Optical beacons would greatly assist space ships wishing to establish contact or a rendezvous. A beacon signal could consist of reflected sunlight or thermal radiation or laser pulses. The narrow spectral output of a laser beacon would provide a signal to noise advantage over an incoherent beacon. An optical setup external to the laser beacon might be used to vary the beacon's beamwidth. The target space ship could have an omnidirectional arrangement of light detectors spaced about the surface of the ship; after receiving a call from a transmitter beacon, the detector would command a laser on the target ship to answer in the direction of the call.

Although acquisition uses omnidirectional light detectors, it is not clear whether this is a two-dimensional array of detectors or merely a number of detectors spaced at various positions along the spaceship. Moreover, although the article discloses the use of the detectors for "receiving a call from a transmitter beacon," and that "the detector would command a laser on the target ship to answer in the direction of the call," it does not teach that the omnidirectional detectors are the structures used to determine the position of the transmitting stations or disclose the accompanying structures or equivalents described in plaintiff's patent specification for use with a detector array for tracking. Because the Dulberger Article does not disclose the specific structures described in the specification for achieving the tracking function, the article cannot anticipate Claims 4 and 17 of the '036 patent which use means-plus-function language to describe the structures that accomplish tracking.

With respect to Claim 4 of both the '518 and '982 patents, the article does not disclose a ground-to-satellite link. With respect to Claim 6 of the '982 patent, the article does not disclose transmission from a ground station to "a relay station high above the surface of the earth" using a laser "in the blue-green portion of the spectrum." Therefore, the Dulberger Article does not anticipate any of these claims.

D.

Next, defendant relies upon an article entitled "Some Factors Affecting Applicability of Optical-Band Radio (Coherent Light) to Communication," published in the September 1961 issue of RCA Review and authored by David Luck (the Luck Article). Defendant contends the Luck Article anticipates Claim 4 of the '036 patent, Claims 13, 14, and 15 of the '518 patent, and Claims 6, 10, and 14 of the '982 patent. The article begins with an explanation that the invention of lasers provided the basis for "a whole new technology" for

communication and that "[w]ork on the tremendous task of bringing this new technology to a useful stage is already commencing, and is likely to grow rapidly in scope and pace." (16)

After discussing in detail the properties of coherent transmissions, i.e., lasers, signal-to-noise ratio problems, power capabilities, and the like, the article contains a detailed discussion of the equipment needed in a laser communication system. The discussion begins with an observation that the general organization of equipment needed for laser communication ("optical-band radio") is "of course, . . . entirely similar to the organization of more familiar radio systems." The article then offers a general description of a one-way communication system in a block diagram that depicts a communication from a transmitter to a receiver. The diagram shows a power source and power supply converter to initiate the

"optical band generator." Information is placed on the laser beam using an "information source" which is connected to a modulator which modulates the laser beam. An "aiming" device is attached to the "radiator," which, as described later in the article, is the transmitting optics. With respect to receipt of this radiated laser, the receiver has a "radiation collector," or optical receiver, which uses an "aiming" device to receive the beam. The radiation collector is connected to a "rejection filter" which rejects all wavelengths except for the laser, and the rejection filter is connected to a detector. The received signal passes to an "information band amplifier" and then to a block which indicates "information use." As an alternative, a superheterodyne operation is suggested for incorporation into the system, but strictly as an optional choice, although the author suggests that it "will probably become essential in time."

The article offers an analysis of certain of the blocks of the diagram. With respect to the optical generators, the article mentions different types of lasers, including pulsed lasers, which are described as the only mode of operation permitted when "the more powerful and compact crystalline devices" are used. The Luck Article explains different modulation techniques, commenting that the modulation of "optical-band coherent generators [is] in a rather primitive state," but that current modulation techniques are nevertheless feasible. With respect to aiming the transmitter, the Luck Article notes the progress astronomers have made in this area and the importance of considering their contribution when designing a laser communication system. The Luck Article explains:

Operation with extremely directive beams calls for extremely accurate beam aiming. It is just as well that aiming to a fraction of a second of arc has been a routine practical operation in astronomy for many decades. If it were not for this accumulated evidence, the radio engineer surely would never believe that what the astronomer does habitually could be made technically feasible at all.

The Luck Article analyzes both the optics needed to direct the emitted beam and the detection system. For the detection system, the article concludes that until better techniques are developed, "all detection must be done by known types of photoelectric devices, whether photoemissive or photoconductive, and that these are in fact well suited to the task by virtue of being basically square-law devices."

The Luck Article recognizes that one function that must be addressed is the aiming of the receiver so as to receive the incoming beam. As noted above, there is an "aiming" device attached to the "radiation collector," i.e., the receiver. But neither the diagram nor the text of the article discloses how aiming is accomplished. There is no discussion of the use of conical scans, quadrant detectors, or detector arrays to perform the aiming function. The article does suggest the use of mosaic detectors but does not state that the purpose of these detectors is to track the incoming beam. Instead, the article suggests the use of mosaic detectors to increase the field of view of the receiving element without degrading the signal-to-noise ratio. Given the absence of any description of the "means for reporting the angular location of one station to the other" and the "means for causing said single incoming light-beam to produce . . . tracking-signals" described in the patent specification, the Luck Article does not anticipate Claim 4 of the '036 patent or Claim 13 of the '518 patent.

As to Claims 14 and 15 of the '518 patent and Claims 6, 10, and 14 of the '982 patent, the Luck Article does not disclose a satellite or relay station "high above the surface of the earth." References to the possibility and feasibility of using an "optical-frequency radio" without anything more does not disclose a satellite or the structures needed for space communications, or the act of transmitting a laser to a relay station high above the surface of the earth. Hence, the Luck Article does not anticipate any of these claims.

E.

Next, defendant relies upon an article entitled "Coherent Light as Data Carrier," published in the April

1962 edition of Space/Aeronautics and authored by James Holahan (the Holahan Article). Defendant contends that the Holahan Article anticipates Claims 4 and 17 of the '036 patent, Claims 4, 13, 14, and 15 of the '518 patent, and Claims 4, 10, and 14 of the '982 patent. This general survey article describes the possible use of lasers as communications carriers and discusses the basic components that would be necessary for such a communication system.

The article begins by detailing some of the basic characteristics of a laser and describing some of its advantages and limitations. It lists certain of the then-existing lasers, which operate either in a pulsed or continuous wave mode. After reviewing some of the characteristics of these lasers, the article discloses that the "essentials" of any laser communication system include "a generator, a modulator, a detector and the focusing, collecting and filtering optics," and that "[a]n advanced system in addition might use an optical pre-amplifier and possibly superheterodyne components such as a local oscillator, a mixer, and a wide-band . . . amplifier." The article discusses optical detectors including a photomultiplier coupled with an optical filter and a wide-band amplifier, and a superheterodyne detector, which the author recognizes is unlikely to be developed in the near future.

The article contains a diagram showing a coherent-light communications system proposed by General Electric for "closed-circuit TV and earth-satellite links." The diagram shows a transmission and receiver unit that is involved in a two-way communication. The incoming laser beam strikes a beam steering mirror and then passes through a superheterodyne detector and a Cassegrain telescope. A steering control motor directs the beam steering mirror so that the incoming and outgoing lasers enter and exit in the appropriate direction. A modulator is located just beyond the laser for placing communications on the beam.

Defendant contends that this diagram necessarily discloses an angle tracker because the steering control is depicted as being connected to a photomultiplier mixer, which is part of the superheterodyne detector. The steering control directs the outgoing beam by rotating the beam steering mirror. But although the diagram certainly discloses a means for steering the beam, it does not disclose a specific type of angle tracker, much less mention the specific angle trackers disclosed in plaintiff's patent specification. Defendant's expert testified that one of ordinary skill in the art would understand that the photomultiplier mixer was sending a signal to the steering mirror, but he could only speculate as to the type of "message" involved. Because the Holahan Article does not disclose the specific angle tracking structures set forth in the patent specification, it cannot anticipate Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent because these claims use means-plus-function language and hence cover only those angle trackers described in the specification and equivalents thereof. With respect to Claims 4, 14, and 15 of the '518 patent and Claims 4, 10, and 14 of the '982 patent, which are method and apparatus claims, the Holahan Article does not disclose either a radio receiver or radio relay and fails to disclose any act whereby an incoming beam is "utilized" in any way to send a return beam.

F.

As set forth above, Philco III constitutes prior art only with respect to Claim 5 of the '036 patent. Philco III reports on Philco Scientific Laboratory's progress under an Air Force contract "to study and evaluate acquisition and tracking for two hypothetical optical space-communications links." Among the different systems presented, at least one involves a satellite with a laser, a system of transmitting and receiving optics, and a quadrant detector with a servomechanism and a servomotor to direct the receiver and transmitter. Plaintiff apparently does not dispute that the detailed description of an optical communication system in Philco III contains all of the elements expressed in Claim 5 in means-plus-function language. As to the elements in Claim 5 not expressed in means-plus-function language, defendant's contention that the Philco III quadrant detector constitutes a "photoresponsive matrix" is consistent with the position plaintiff consistently took during trial that a quadrant detector is literally a

photoresponsive matrix. The deficiency in defendant's contention that Philco III anticipates Claim 5 is the requirement in Claim 5 for a pulsed laser. Philco III discloses a laser but not specifically a pulsed laser. As described in Section VI above in the discussion concerning plaintiff's concept document, the general disclosure of a laser in a laser communication system would at least suggest to one of ordinary skill in the art that a pulsed laser might be used. But the absence in Philco III of a specific reference to a pulsed laser would seem to preclude a determination of anticipation of Claim 5 under Section 102.

Plaintiff alternatively argues that Philco III does not anticipate Claim 5 because the disclosure in Philco III is not enabling in that Philco III teaches the use of a heterodyne detection system and such a system was not available for use in 1962 and could not have been developed without extensive experimentation. But Philco III does not state that a heterodyne detection system is necessarily required and one of ordinary skill in the art at the pertinent time would have known the current status of heterodyne detection systems and that a direct detection system without heterodyne could be used. (17)

For the reasons set forth above, although the six references upon which defendant relies disclose considerable information about laser communication systems, none anticipates any of the claims in any of the three patents and hence, none renders the claims invalid under 35 U.S.C. § 102.

IX.

A.

Next, the court will evaluate whether the claims in issue are valid under Section 103's requirement that the claimed invention be nonobvious. A claim is obvious "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." With respect to prior art, "[w]hile a reference must enable someone to practice the invention in order to anticipate under § 102(b), a nonenabling reference may qualify as prior art for the purpose of determining obviousness under § 103." Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 1569, 1578 (Fed. Cir. 1991). In other words, a reference that does not anticipate because it is not enabling is prior art for Section 103 purposes for all that it teaches one of ordinary skill in the art. Beckman Instruments, Inc. v. LKB Produkter AB, 892 F.2d 1547, 1551 (Fed. Cir. 1989). In making a determination of obviousness, "the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved." Graham v. John Deere Co., 383 U.S. 1, 17 (1966). As part of the obviousness analysis, the court must also consider factors that have been labeled "secondary considerations" but in fact are a primary and necessary part of the obviousness analysis. Secondary considerations include commercial success of the patented invention, whether the claimed invention involved new and unexpected results or filled a long-felt and unsatisfied need in the art, whether others in the field had tried without success to address the technological issue addressed by the invention, and whether the alleged infringer copied the patented invention. Id. at 17-18; Para-Ordnance Mfg., Inc. v. SGS Importers Int'l, Inc., 73 F.3d 1085, 1087-88 (Fed. Cir. 1995).

B.

In contesting the validity of the patent claims under 35 U.S.C. § 103, defendant relies upon the six references described above plus other references, two of which the court will briefly describe. First, defendant relies upon an article entitled "Light as Information Carrier in Space Communication Systems," published in the October 3-5, 1960, issue of IRE Proceedings and authored by K.W. Otten (the Otten Article) The Otten Article explains some of the differences inherent in using radio signals and

alternatively coherent or incoherent light as the source for carrying a message in a communication system. The article explains that under certain stated conditions, one being the size of the antenna, it could be more efficient to use carrier frequencies in the light spectrum rather than radio frequencies. The article discusses tracking between two stations to maintain constant communication where the two stations are in motion relative to one another. As to such tracking, the Otten Article explains:

For a communication link between two stations which are in motion relative to one another and which are separated by large distances . . ., as encountered in space operations, the finite traveling time of the signal sets an absolute minimum for the angular coverage . . . which must be exceeded to permit mutual tracking and an uninterrupted flow of information.

Next, defendant relies upon an article entitled "Optical Communications," published in the October 9-11, 1961, issue of IRE Proceedings and authored by Gordon Jacobs (the Jacobs Article). The Jacobs Article discusses General Electric's design and manufacture of an optical communications system that could use either coherent or incoherent light. The article explains that the transmitter must have sufficient total power for both acquisition and tracking and discusses the possible use of either a continuous wave or pulsed laser. The article expresses the opinion that at that time the pulsed laser represented the more reliable source for coherent light. The article concludes as follows:

The state of the art of optical communication is advancing very rapidly. Although the present new light sources are not much better than the old from a practical system standpoint, the potential is enormous. To keep pace with the advancing light source development corresponding effort is required in the areas of atmospheric propagation, wide band modulation, and wide band detection.

C.

Because the Electro-Optical Report in many ways is the most significant prior art reference, the court will start its Section 103 analysis with a summary of the disclosure in that report and a consideration of the disputes concerning its subject matter.

As explained in detail above, the Electro-Optical Report describes to one of ordinary skill in the art a two-way communication system that involves the collection of sunlight to create a focused light beam. The light is modulated so as to impress information on the beam and the beam is transmitted toward a receiving station through the use of a transmitter. The receiving station demodulates the beam to secure the information and transmits a return beam with information modulated thereon to complete the communication. The communicating stations can "acquire" one another by scanning the general area in which the other station is known to be located, or by using the a priori method of storing and utilizing information as to the precise location of the partner station, or a combination of the two. After acquisition, the two stations maintain contact with one another through a tracking system which includes the use of conical scans or quadrant detectors. The conical scan or quadrant detector tracks the transmitting station by means of the directivity of the received beam, i.e., through the angle of the incoming beam. The incoming beam therefore provides both data information (the information impressed on the beam) and tracking information (information as to the location of the transmitting station based on the angle of the incoming beam).

The Electro-Optical Report teaches mounting the station's receiving and transmitting antennas along the same axis so that when one station acquires and tracks a second station, not only is the first station's receiver directed toward the second station, but also the transmitter is directed at the second station so as to enable the transmission of a return beam. Because the Electro-Optical Report teaches a two-way communication system, both stations necessarily have transmitters and receivers. In addition to satellite-to-satellite and earth-to-satellite communication systems, the Electro-Optical Report also teaches a

communication system in which a satellite serves as a relay station for communication between an earth station and either another satellite or some remote station.

Plaintiff disputes certain aspects of the above description of the teachings of the Electro-Optical Report. First, plaintiff faults the report for not depicting a complete system for any particular use. But the Electro-Optical Report describes in extensive detail a communication system using collected sunlight and this description would enable one of ordinary skill in the art to proceed efficiently to build such a system. Although plaintiff is correct that the report does not contain a system-level diagram that depicts a complete system for any particular use, the report explains the functions that a complete system must achieve and the particular components that can be used to achieve those functions. The detail provided in the report for constructing a system in many ways is far more detailed and sophisticated than the instructions in plaintiff's patent specification, (18) and is sufficient to instruct one of ordinary skill in the art to use the suggested components in combination to produce an operable communication system using sunlight.

Next, plaintiff disputes that the Electro-Optical Report teaches tracking based on the angle or directivity of the incoming beam. The report, however, explains that tracking is employed in two-way communications and proceeds to describe tracking as employing techniques developed in star tracking, including specifically conical scan techniques. Light beams from stars obviously do not contain any impressed information as to the stars' positions and one of ordinary skill in the art would recognize that conical scans track stars, as they track other signals, through angle tracking, i.e., by aligning their axis with the angle of the incoming beam. (19) As in plaintiff's patent, where a transmission is detected by the receiver, the conical scan unit in the Electro-Optical Report detects and is able to track (through transmitter tracking) based upon the inherent properties of the incoming beam. See, e.g., infra p. 73 (Case 30 of infringement analysis and plaintiff's arguments therein).

Further on this point, as explained generally in the claim interpretation discussion above, conical scans are corresponding structures for performing certain functions described in the claims in means-plus-function language, e.g., "means for reporting the angular location . . . solely by means of the directivity of a laser beam transmission" or "means for utilizing the received energy transmission at the satellite to orient a narrow beam laser energy transmission from the satellite to the ground station." Thus, it follows that one of ordinary skill in the art would have interpreted the brief reference in plaintiff's patent specification to "well-known conical scan techniques" as indicating the carrying out of the functions set forth in the claims in this means-plus-function language. But if one of ordinary skill in the art would have so interpreted this brief reference in the patent specification to conical scan techniques, such individuals necessarily also would have understood that the conical scans described in far more detail in the Electro-Optical Report also would operate in the same way to carry out these claimed functions.

Next, in a related argument, plaintiff contends that assuming the Electro-Optical Report teaches tracking through the use of conical scans, which rely on the angle of the

incoming beam, the report nevertheless proposes such tracking only for the purpose of orienting the receiver of a station and not for orienting the transmitter on that station so as to enable the transmission of a responsive beam. But the Electro-Optical Report specifies the assumption that the transmitting and receiving antennas are mounted on the same axis. As explained above, if the two antennas are so mounted, then during acquisition and tracking, not only is the receiver directed at the partner station, but also the transmitter is so directed. (20)

D.

1.

Given the above summary and the detailed discussion of the disclosure in the Electro-Optical Report, for Claim 17 of the '036 patent, Claims 4, 7, 8, and 13 of the '518 patent, and Claims 1, 2, 4, 7, and 8 of the '982 patent, the only element or step not taught directly or impliedly as part of the combination of elements or steps disclosed in the Electro-Optical Report is the use of lasers as the signal source in a two-way communication. As described above, although the Electro-Optical Report discloses the use of a laser as a light source, it does not specify that a laser can be substituted for the optical beam in the component system described therein. Therefore, the first issue to address is whether it was obvious to one of ordinary skill in the art at the pertinent time to substitute a laser for the signal's source in the arrangement of components suggested in the Electro-Optical system.

In analyzing the nonobviousness of any patent claim, it is crucial for the court to resist the temptation to employ hindsight when conducting its analysis. The key to an invention that significantly advances the field of science or technology often is the ability of the inventor to bring a clarity and perceptivity of thought to a complex technical problem so as to enable the inventor to produce what appears to be a simple solution to the problem. With the taint of hindsight, the apparent simplicity of the solution can be misinterpreted to suggest that the solution must have been obvious when in fact at the time of development the solution was far closer to ingenious. Hence, in evaluating obviousness, it is crucial for the court to avoid hindsight and view the invention and the prior art from the perspective of one of ordinary skill in the art at the time of the invention.

In an attempt to exclude hindsight from the obviousness determination, in cases where the claimed invention involves a combination of steps or elements courts have generally looked for some suggestion at the time of the invention that it would be desirable to combine the claimed elements or steps. As the Court of Appeals for the Federal Circuit exclaimed in Micro Chem., Inc. v. Great Plains Chem. Co., 103 F.3d 1538, 1547 (Fed. Cir.), cert. denied, 117 S. Ct. 2516 (1997) (quoting In re Dow Chem. Co., 837 F.2d 469, 473 (Fed. Cir. 1988)), "[t]he consistent criterion for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in light of the prior art." The suggestion to combine the elements or carry out all of the steps of a process need not be expressly presented in the prior art but rather "may come from the prior art, as filtered through the knowledge of one skilled in the art." Motorola, Inc. v. Interdigital Tech. Corp., 121 F.3d 1461, 1472 (Fed. Cir. 1997). For example, the suggestion could come from the "knowledge of those skilled in the art that certain references, or disclosures in the references, are known to be of special interest or importance in the particular field," or "from the nature of a problem to be solved, leading inventors to look to references relating to possible solutions to that problem." Micro Chem., 103 F.3d at 1546 (quoting Pro-Mold and Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996)).

Applying this general approach, although the Electro-Optical Report does not itself specifically disclose replacing sunlight with lasers in the combination of elements disclosed therein, the report does explain that "[l]asers can conceivably be applied to optical communication . . . as sources." This statement by itself would at least suggest to one of ordinary skill in the art at the time that lasers reasonably could be substituted as the optical source in the configuration of elements disclosed in the report. In this regard, one of ordinary skill in the art at the time would have known that a laser could be modulated and that most, if not all, of the modulators, optical receivers, and transmission devices disclosed in the Electro-Optical Report would operate with lasers. In addition, one of ordinary skill in the art would know that conical scans are not only useful for tracking incoherent light but also are useful for tracking coherent light sources such as lasers. Although at the time lasers were in their infancy, those of ordinary skill in the art had sufficient understanding of their optical properties to know that a laser is light in coherent form, which can be detected and tracked using most existing components designed for detecting

incoherent light. The Electro-Optical Report further suggests the use of conical scans to track laser communications in the preface to its discussion of tracking systems, which states as follows:

As with acquisition, tracking and stabilization problems are not major study areas of this program, but are essential subjects for a working system. It must be stated again that these locating and positioning problems are not peculiar to an optical frequency communications system. The requirements, and generally the solutions, are independent of frequency and therefore apply to any system.

(Emphasis added.) Moreover, even if one of ordinary skill in the art would not interpret the disclosure in the Electro-Optical Report to suggest the use of lasers in place of sunlight in the Electro-Optical system, such a suggestion is contained in the Dulberger Article. The Dulberger Article discusses Electro-Optical Systems' experiments using collected light from the sun and states that "[Electro-Optical Systems] has said that it would be possible to use many of their system's principles when substituting a laser as the primary light source."

In any event, even without the reference to lasers in the Electro-Optical Report or the comment in the Dulberger Article with respect to Electro-Optical Systems' research, the prior art still would suggest combining a laser with the other optical communication components called for in the Electro-Optical Report. The Electro-Optical and JPL Reports and the Dulberger, Luck, Holahan, Otten, and Jacobs Articles generally exhibit the excitement in the scientific community as to the potential use of lasers in optical communications. (21) Among others, the JPL Report and the Dulberger and Luck Articles, extend beyond broad theory and each describe specific components necessary in a laser communications system. They each disclose, at least in general terms, a basic laser communication transmission and reception system whereby a modulated laser is transmitted through an optical system. At the receiving unit, a system of optics receives the beam and the beam moves along to a detection system. The Holahan Article lists as "essential" to any coherent light information system "a generator, a modulator, a detector and the focusing, collecting and filtering optics." Both the Luck and Holahan Articles disclose optics that are controlled by an aiming device or steering control motor. The Luck article describes many of the current modulation techniques available for use with lasers, and with respect to the

optical detector, suggests the use of known types of "photoelectric devices, whether photoemissive or photoconductive."

If one of ordinary skill in the art at that time proceeded to construct a laser communication system based on the JPL Report and the Dulberger, Luck, and Holahan Articles, in situations where one or both of the communicating stations is in motion, tracking and stabilization would be just as "essential" as it is in the sunlight-based system described in the Electro-Optical Report. Because at the time there were relatively few optical devices specifically designed for a laser, when determining how to accomplish tracking of a laser, one of ordinary skill in the art would have consulted references in closely related fields discussing tracking systems used in other optical communications systems. The Electro-Optical Report would be viewed as highly pertinent to a laser communication system and that report teaches tracking through the use of conical scan techniques. One of ordinary skill in the art would understand that these techniques likely would work with lasers. In this setting, the prior art references viewed together suggest construction of a laser communication system that accomplishes tracking through the use of conical scans or quadrant detectors and includes all of the other elements or steps called for in Claim 17 of the '036 patent, Claims 4, 7, 8, and 13 of the '518 patent, and Claims 1, 2, 4, 7, and 8 of the '982 patent.

Plaintiff argues that rather than suggesting combining a laser with the other elements in plaintiff's claimed invention, the prior art teaches away from the invention. Prior art "teaches away" when one of ordinary skill in the art "would be discouraged from following the path set out in the reference, or would

be led in a direction divergent from the path that was taken by the applicant." Para-Ordnance Mfg., 73 F.3d at 1090 (quoting In re Gurley, 27 F.3d 551, 553 (Fed. Cir. 1994)). Although the prior art explains that specified significant hurdles must be overcome in developing a laser-based optical communication system, (22) these statements hardly teach away from plaintiff's claimed invention because plaintiff's invention does not resolve, much less address, these hurdles. Perhaps more importantly, the prior art references stress the potential benefits that would result from the successful development of a laser-based system. Viewed as a group, the prior art references exhibit reasonable optimism that the use of lasers could produce important developments in optical communications and encourage rather than discourage efforts to construct a system using the elements called for in plaintiff's claimed invention.

Plaintiff also suggests that the prior art teaches away from his claimed invention because the references teach the use of either laser amplifiers or superheterodyne detectors for detecting the lasers at the receiving station while plaintiff employs a direct detection system without heterodyne. But one of the two types of optical receivers plaintiff discloses in his patent specification is "an optical superheterodyne receiver employing a laser local oscillator." (Col. 7, lns. 1-8.) In any event, although the references indicate that laser amplifiers or superheterodyne detectors, if developed successfully, could be more efficient than direct detection systems, they do not suggest that direct detection would not work. As plaintiff's expert concedes, one of ordinary skill in the art at the time would have understood that direct detection was a viable option. For example, the Holahan Article discloses an optical receiver for direct detection (a photomultiplier) and lists superheterodyne components as a possible advancement. (23) The Holahan Article notes that "[s]uperheterodynes, on which very little work has been done, are unlikely to be developed in the near future." Hence, the Holahan Article teaches that at least as of 1962, one would have to rely upon direct detection techniques.

2.

Turning to Claim 4 of the '036 patent, the Electro-Optical Report, as described above, discloses all of the elements in Claim 4 except the use of a pulsed laser as the optical source. Similarly, for Claim 5 of the '036 patent, Philco III, as described above, discloses all of the elements in Claim 5, including a laser, but does not specify the use of a pulsed laser. As described above in the discussion concerning plaintiff's concept document, in 1962 there were only two types of lasers--pulsed and continuous wave. The Holahan, Luck, and Jacobs Articles teach the potential advantages of using a pulsed laser. These disclosures would suggest to one of ordinary skill in the art at the relevant time the use of a pulsed laser as the laser in the combination of elements taught in Philco III. These references also would suggest the use of a pulsed laser in the Electro Optical system as modified to employ a laser instead of sunlight as the optical source.

Next, Claims 6, 9, 11, 12, and 13 of the '982 patent add the requirements that the earth station is a submarine and/or that the laser employed is a green-blue laser so as to facilitate transmission through sea water. The Dulberger Article teaches the use of a blue-green laser for communication between underwater craft, and that disclosure, combined with the other references discussed above, is sufficient to suggest to one of ordinary skill in the art communication involving a submarine as the earth station and the use of a blue-green laser to accomplish that communication.

Next, Claim 1 of the '036 patent specifies communicating with a mobile vehicle on earth. Although the Electro-Optical Report does not specify whether the earth station is mobile or stationary, the report

teaches that the components disclosed therein can be used for communication between two moving satellites. This would suggest to one of ordinary skill in the art that the same general arrangement of components could operate when communicating between a satellite and a mobile earth station. In this regard, one of ordinary skill in the art certainly would have understood that it is often necessary to communicate with a mobile vehicle within the earth's surface. Indeed, the Electronics News article that sparked plaintiff's invention teaches communications between satellites and submarines and the Dulberger Article generally teaches communications between ships as well as between underwater mobile vessels. Using means-plus-function language, Claim 1 also calls for a radio relay. (24) The nonobviousness of employing a radio relay in the combination of elements described in Claim 1 is discussed below.

In addition to the elements contained in the previously mentioned claims, Claims 14 and 15 of the '518 patent and Claim 14 of the '982 patent call for a satellite or a "vehicle operable high above the surface of the earth" to function as a relay station which contains on board, in addition to the laser-related communication equipment described above, a radio relay or radio receiver to transmit and receive messages between the satellite and a ground station. With such radio equipment on board, the satellite has the capacity to transmit and receive information to and from a remote station through the use of radio signals and to transmit and receive information to and from a remote station using modulated laser beams. This relay station can receive a message through a radio transmission, impress that message onto a laser beam, and send the impressed laser to a ground station. With respect to the use of radio relays, plaintiff conceded during the two-day hearing on conception that preceded the trial on validity that at the time of plaintiff's invention, satellites were engaging in radio relay transmissions. Plaintiff explained that "a surface station [was] in radio contact with the satellite and radio relays were, at that point, very well known." As to combining radio and lasers in one communication system, the Otten Article in effect teaches that both radio and optical beams can be used to carry communications and that each type of beam has advantages in certain circumstances. This teaching would suggest to one of ordinary skill in the art that it would be appropriate to choose between radio and laser beams as a carrier based upon which would operate best in a particular environment for a particular communication. In this regard, it reasonably would be expected that in certain circumstances, as called for in Claims 14 and 15 of the '518 patent and Claim 14 of the '982 patent, the exercise of such a choice could result in a radio signal transmission to a relay satellite and then a laser communication from the relay station to a remote station. (25) In this regard, as explained in the following section covering secondary considerations, plaintiff has not demonstrated that the use of radio frequencies for part of a communication and laser beams for the remainder would produce any new or unexpected results.

Plaintiff argues alternatively that it is nonobvious to place a radio receiver on board a satellite because scientists were concerned about weight limitations for equipment on satellites. But plaintiff fails to point to any trial evidence that indicates that the combination of a radio relay and laser transmitting and receiving equipment raises any weight concerns. More significantly, one of ordinary skill in the art would recognize the benefits that would result from including a radio receiver on board a satellite and that a determination as to which components to include consistent with weight limitations would involve a straightforward consideration of the trade-offs involved and a prioritization of the functions that the scientists would like the satellite to perform. To the extent that for a particular mission the advantages of including a radio receiver outweigh alternative uses of the weight capacity, one of ordinary skill in the art would choose to include such a receiver. In this regard, the patent specification does not suggest that plaintiff even went through any such analysis. Plaintiff simply included a radio receiver based on the desirability of having on board the functions it would perform. One of ordinary skill in the art would expect such a benefit from the inclusion of a radio receiver and the structure called for in the claim

would therefore be obvious. In this regard, neither the patent specification nor the trial evidence suggests that the decision to include a radio receiver on the satellite would produce any results that would not be expected by one of ordinary skill in the art.

3.

Next, as alluded to above, factors that have been labeled as "secondary considerations" sometimes can be the most probative objective evidence in determining whether the patented invention was obvious at the time to one of ordinary skill in the art. See Heidelberger Druckmaschinen AG v. Hantscho Commercial Prods., Inc., 21 F.3d 1068, 1072 (Fed. Cir. 1994). Commercial success of the patented invention is such a secondary consideration and plaintiff seeks to demonstrate commercial success of his invention based on numerous devices manufactured by or for the United States that plaintiff contends are covered by his patents. But the history of these devices, set forth in detail below in the infringement analysis, tends to show that over three decades after plaintiff conceived of the claimed invention, the laser communication system described in plaintiff's patent claims was not yet commercially available. Generally, the devices plaintiff claims are covered by his patents either involve research in an experimental phase, are embodied only in test-bed form, or were part of a project that ultimately was terminated. Plaintiff has not demonstrated that his claimed invention has overtaken other more traditional communications systems, either in the military or commercial markets. In addition, plaintiff failed in his attempt to convince others to license his patent.

As to whether plaintiff's invention filled a long-felt need in the art, although military and commercial markets are always in need of more efficient communication systems, lasers had been invented only two years before plaintiff filed his patent application and hence were available for a comparatively short period of time for use in a communication system. Because prior to plaintiff's invention there was no long-term unsuccessful efforts to create a laser-based communication system, it is not reasonable to view plaintiff's invention as responding to a long-felt but unsatisfied need in the art or as achieving success where others have tried for a period of time and failed.

Plaintiff also has not demonstrated that the particular combination of elements or steps set forth in his patent claims produced any new and unexpected results. Plaintiff's patent proposes the combination of well-known components for use in a laser communication system. These combinations were suggested by the prior art and many problems that had to be addressed in combining these components were recognized as of the May 1962 date of the concept document. The actual combination of these elements produced no results that were unexpected in 1962 and in fact many of the predicted problems remained after plaintiff's disclosure became available to the public. As explained above, the prior art recognized that certain hurdles must be overcome to create an operable laser communication system, including acquisition of the narrow laser beam, stabilization, development of an appropriate laser, and efficient beam steering. But plaintiff's invention did not address, much less resolve, these hurdles. Indeed, the prior art in many ways went into far greater detail than plaintiff's specification in defining the necessary components for an operable laser communication system. Plaintiff simply has not demonstrated that the elements or steps called for in his patent claims produced results that would be unexpected in May 1962.

Plaintiff contends that a secondary consideration that supports a finding of nonobviousness is the Patent and Trademark Office's issuance of a secrecy order which had the effect of preventing the issuance of any patent to plaintiff from October 4, 1963, through November 19, 1979. Pursuant to 35 U.S.C. § 181, the Commissioner of the Patent and Trademark Office can issue an order requiring an invention covered in a pending patent application to be kept secret if the national interest so requires. But the Commissioner apparently made his determination that a disclosure of plaintiff's claimed invention would have an adverse impact on the national interest without first considering the prior art discussed above which this court concluded was publicly available and was sufficient to establish by clear and

convincing evidence that plaintiff's claimed invention was obvious. Because the secrecy order rested at least to this degree on a faulty premise, the court cannot give significant weight to that order in evaluating obviousness.

Finally, plaintiff contends that the Patent and Trademark Office's declaration of an interference between Claim 13 of the '518 patent and a patent application filed by a third party demonstrates nonobviousness. An interference, however, is declared simply to determine which out of two or more inventive entities was the first to make a patentable invention. 35 U.S.C. § 135. Hence, beyond indicating that the Patent and Trademark Office previously determined that the invention is nonobvious, the declaration of an interference says nothing at all about how the relevant public viewed the patent. As a result of the Patent and Trademark Office issuing the patents herein, plaintiff has gained the

benefit of a presumption of nonobviousness. The declaration of an interference should add nothing to that presumption. (26)

In summary, the purported secondary considerations upon which plaintiff relies do not suggest nonobviousness and for all of the reasons set forth above, defendant has presented clear and convincing evidence that the claims in issue are obvious. (27) Hence, defendant has overcome the statutory presumption of validity and the court concludes that these claims are invalid under 35 U.S.C. § 103.

INFRINGEMENT

X.

Next, consistent with the Court of Appeals for the Federal Circuit's request that trial courts, where reasonably possible, decide both the issues of validity and infringement, see Simmons Fastener Corp. v. Illinois Tool Works, Inc., 739 F.2d 1573, 1576 (Fed. Cir. 1984), the court will now assess infringement. Plaintiff alleges infringement by a variety of different devices manufactured by or for the United States. The parties refer to these devices respectively as Cases 9, 21, 25, 30, 32, 33, 34, 36A-D, 37 and 41.

The first step in the infringement analysis is the step the court performed above--to construe the scope of the claims. Markman, 52 F.3d at 976. The second step is to compare the properly construed claims to the accused devices. Id. Literal infringement exists where the accused device or method contains every element called for in the claim. Lantech, Inc. v. Keip Mach. Co., 32 F.3d 542 (Fed. Cir. 1994). As explained above, pursuant to 35 U.S.C. § 112, where the claims describe an element in a combination "as a means or step for performing a specified function without the recital of structure, material, or acts thereof," the element is literally interpreted to encompass "the corresponding structure, material, or acts described in the specification and equivalents thereof."

The court adopted pretrial procedures intended to narrow the infringement issues on which the parties would need to present evidence at trial. Pursuant to these procedures, plaintiff filed an infringement chart in which plaintiff identified (1) each alleged infringing device, (2) each patent claim that the device allegedly infringed, and (3) for each alleged infringement of a claim the structure in the alleged infringing device that plaintiff contends corresponds to each claim element. Defendant responded to plaintiff's infringement chart with a noninfringement chart in which defendant identified for each alleged infringing device listed by plaintiff and each claim that plaintiff alleged was infringed by that device, each claim element that defendant alleges was not present in the alleged infringing device and explained the reason that defendant concluded that the element was not present. The parties were given

opportunities prior to trial to amend their respective charts and the court went so far as to allow some limited oral amendments to those charts during trial.

Through these procedures, the court was able to narrow the disputed factual issues for trial on infringement to the correctness of the allegations in defendant's noninfringement chart that, for the reasons stated therein, the alleged infringing devices did not contain one or more elements called for in the claims. Hence, the court will now presume that the alleged infringing devices contain those structures that correspond to the claim elements that defendant's final infringement chart does not contest, and for those claim elements that defendant does contest, the court will limit its consideration to the reasons defendant provided in that chart as to why the elements were not present in the alleged infringing devices. If defendant is correct in its reasoning that a particular claim element is not present in the alleged infringing device, then the court will conclude that the alleged infringing device does not literally infringe the claim. On the other hand, if the court rejects the reasons provided by defendant for contending that a particular claim element was absent from the alleged infringing device, the court will conclude that the claim covers the alleged infringing device.

Before turning to the individual cases of alleged infringement, the court will address two contentions by defendant that are common to numerous of the cases. First, defendant contends that Claim 4 of the '036 patent, Claim 13 of the '518 patent, and Claim 1 of the '982 patent are not infringed because each claim requires the presence of at least one orbiting satellite which the alleged infringing devices did not employ. But as explained above in this court's discussion of claim interpretation, the claims refer only to stations, spaced stations, and relay stations and those terms do not require the presence of an orbiting satellite. Second, defendant contends that infringement did not exist because certain alleged infringing devices involved only testing on a test bed or breadboards rather than a complete operable communication system. But in assessing literal infringement, the proper focus is whether the accused device contains every element called for in the claim. If each element is present, then infringement exists and it is not crucial that the elements were contained on either a test bed or breadboards as long as the combination is operable. See Roche Prods., Inc. v. Bolar Pharm. Co., 733 F.2d 858, 863 (Fed. Cir.), cert. denied, 469 U.S. 856 (1984) ("[The alleged infringer] may intend to perform 'experiments,' but unlicensed experiments conducted with a view to the adaption of the patented invention to the experimenter's business is a violation of the rights of the patentee to exclude others from using his patented invention."). In its discussion of infringement in the following cases, the court will not make further reference to these two contentions unless some additional comment is appropriate.

XI.

A. CASE 9

1.

Case 9 involves the NASA 650 mbps Lasercomm Terminals project (the LCT project) which covered the construction and development of two laboratory breadboards for the testing of a communication system for potential use on a government satellite system. Each breadboard had a laser transceiver. The first breadboard had equipment for modulating communications on a laser and then transmitting that laser to the second breadboard, referred to as a "flight-like terminal," located approximately 20 feet away. The second breadboard had a receiver for demodulating the laser communication from the first breadboard and equipment for tracking and determining the angle of the incoming beam.

The contract for the LCT project was canceled prior to completion. Before cancellation, there had been limited development and testing of the breadboard system in which the laser on the first breadboard was manually directed at the receiver on the second breadboard and a modulated laser was transmitted from

the first breadboard and received at the second. As to acquisition and tracking, the second breadboard detected the laser beam and adjusted its receiver so as to point in the direction of the incoming beam, but the testing never reached the point where the second breadboard tracked the angle of the incoming beam and transmitted a responsive laser along the angle of that beam. In addition, the LCT project never performed the communication and tracking functions together or simultaneously transmitted information between the two breadboards.

Plaintiff contends that the work performed under the LCT project infringes Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent. In its noninfringement chart, defendant admits the presence of most of the claim elements and leaves only a few issues for court resolution.

2.

Claim 17 of the '036 patent provides:

Apparatus for establishing a communication link via a relay satellite comprising means for illuminating said satellite with a narrow beam laser energy transmission from a ground station and means for utilizing the received energy transmission at the satellite to orient a narrow beam laser energy transmission from the satellite to the ground station to complete the communication link between the satellite and ground station.

Defendant argues that the apparatus called for in Claim 17 includes a satellite and because the breadboards used in the LCT project were never attached to a satellite, they were not covered by Claim 17. Claim 17, however, does not call for a satellite per se but rather only an apparatus that can be used "for establishing a communication link via a relay satellite" (emphasis added). The claimed apparatus in effect requires only two structures--a "means for illuminating said satellite" and a "means for utilizing the received energy transmission at the satellite to orient a . . . laser." The claim does not require either of these structures to be attached to a satellite. Thus, to show the second claim element in an alleged infringing device, for example, it would be sufficient, in effect, to show that the means for utilizing received energy transmissions, if attached "at the satellite," could perform the claimed communication function.

Therefore, if plaintiff established at trial that the structures on the breadboards contained either the means for accomplishing the functions set forth in the two means-plus-function provisions of Claim 17 or their equivalents, then plaintiff could establish infringement notwithstanding the fact that the breadboards were never attached to a satellite. The problem for plaintiff, however, is that although the LCT project plans generally called for using the type of structures disclosed in the specification or the equivalents thereof, plaintiff never demonstrated that the structures on the breadboards had the capacity to operate in such a manner as to perform the specific functions required in Claim 17.

Specifically, plaintiff did not demonstrate that the components on the second breadboard had the capacity, if attached to a satellite, "to utiliz[e] the received energy transmission . . . to orient a narrow beam laser energy transmission from the satellite to the ground station to complete the communication link." Plaintiff presented the testimony of Dr. Michael W. Fitzmaurice who held a supervisory position at NASA with respect to the LCT project. According to Dr. Fitzmaurice, NASA's long-term plan for the project was to develop a technology and implement it on satellite systems. NASA, however, met with only limited success before canceling the project. NASA accomplished only a small percentage of its

extensive test plan and did not put in place the entire system called for in the design specification. Dr. Fitzmaurice testified that the laboratory test system was capable of tracking, but only "marginally so." The necessary components for tracking and transmitting a responsive laser to a ground station were never put together and verified in the laboratory. Based on Dr. Fitzmaurice's testimony, along with the other evidence, the court concludes that the breadboards used in the LCT project were capable of rudimentary communication when separated by only 20 feet but that plaintiff failed to show that the structures on these breadboards had the capacity to fulfill the specific functions requires in Claim 17 by operating as a communication system from a satellite to a ground station. Hence, plaintiff has failed to prove that Claim 17 of the '036 patent covers the devices used in the LCT project.

3.

Claim 4 of the '036 patent provides:

A communication system comprising spaced stations each having a pulsed laser transmitter and optical receiver, means for reporting the angular location of one station to the other station solely by means of the directivity of a laser beam transmission from said one station to said other station, and means in said other station responsive to the angular location reported for orienting a laser beam transmission to the location of said one station.

Claim 13 of the '518 patent provides:

A station for a two-way optical communication system comprising:

means for producing an exiting light-beam;

means for impressing only communication-data on said exiting light-beam;

means for steering said exiting light-beam toward a target station;

means for receiving a single incoming light-beam from said target station, said single incoming light beam adapted to have only communication-data modulated thereon; and

means for causing said single incoming light-beam to produce both tracking-signals and data-signals.

The infringement analysis for these claims is different from the analysis above for Claim 17 because Claims 4 and 13 do not require a system that functions over the distances required for communications between a satellite and a ground station. These claims simply call for structures that can communicate when separate from one another.

For both claims, defendant contends that because the breadboards used in the LCT project never engaged in simultaneous two-way communications, these devices cannot be classified as involving an operable two-way communications system. But assuming some form of two-way communication is required by these claims, the totality of the evidence indicates that at a rudimentary level, the two

breadboards, separated by only 20 feet, were capable of basic communication with one another. The second breadboard was capable of simple angle tracking, demodulating the signal received, and then transmitting a return laser. Claims 4 and 13 do not require communication at more than this rudimentary level.

Next, defendant disputes that the breadboards involved in the LCT project included the structures set forth in plaintiff's patent specification or the equivalents thereof, which correspond to the following claim elements: (1) the "means in said other station responsive to the angular location reported for orienting a laser beam transmission to the location of said one station" (Claim 4 of the '036 patent); and (2) the "means for steering said exiting light-beam toward a target station" (Claim 13 of the '518 patent). In response to plaintiff's infringement chart alleging the presence of each of these elements, defendant takes the position in its noninfringement chart that the elements were not present because the alleged infringing device did not contain the "means for acquisition and tracking as described in [the] patent specification."

Defendant makes an analogous argument in its noninfringement chart for many of the other alleged cases of infringement which are discussed below. In addressing the instant case, and most others, the same issue is presented--whether the alleged infringing device employs the conical scan embodiment disclosed in the patent specification for acquisition and angle tracking. As described above, that conical scan embodiment requires a conical scan unit or an equivalent, such as a quadrant detector, combined with optics, an integration unit, and a servomotor which adjusts the optics of both the transmitter and receiver in the appropriate direction. The trial evidence, including the testimony of plaintiff's expert, Dr. Culver, demonstrates that each of these required structures was present in the breadboards involved in the LCT project. The second breadboard employed a quadrant detector in conjunction with a system of optics and a servo system which used an integrator. The servo system responded to the laser signal detected in the quadrant detector and directed the transmission and reception optics (which in the alleged infringing device were the same), to point in the direction of the incoming laser beam. Because the breadboards included the structures set forth in the specification or the equivalents thereof and, as arranged, performed the required claimed functions, the court concludes that the work performed

under the LCT project was covered by Claim 4 of the '036 patent and Claim 13 of the '518 patent. (28)

B. CASE 21

Case 21 involves the Navy Tactical Airborne Laser Communication program (the TALC program) which covered the actual demonstration of two-way laser transmissions between a submarine and an aircraft. The TALC field tests were conducted in May 1991 and the program was terminated the following October. Plaintiff contends that the system constructed and used in the TALC program was covered by Claim 4 of the '036 patent, Claims 13 and 15 of the '518 patent, and Claims 1, 2, 4, and 6-14 of the '982 patent.

1.

With respect to Claim 4 of the '036 patent, defendant again focuses on the means employed in the alleged infringing device for acquisition and angle tracking. Defendant contends that the aircraft used in the TALC program does not employ the claimed "means . . . responsive to the angular location reported for orienting a laser beam transmission" because it lacked the means for acquisition and tracking described in plaintiff's patent specification.

Although the record is not without ambiguity, the court ultimately concludes that plaintiff has

established by a preponderance of the evidence that the communication system used in the TALC aircraft includes the necessary structures for acquisition and angle tracking. The TALC system includes optics, a quadrant detector, an integration unit, and a servomotor for adjusting the optics of both the transmitter and receiver in the appropriate direction. In the TALC device, the receiving and transmitting elements are attached, or "slaved" together, so that when the servomotor directs the receiving optics toward the partner station, the transmitting optics necessarily also move in that direction.

Ambiguity as to this conclusion arises in part from the final report prepared on the TALC project which lists only five modes of operation for pointing the receiver in the direction of the partner station. Operating under any of these five modes, all of which involve either fixed pointing or scanning patterns, does not require the use of the quadrant detector for tracking. An earlier report, however, lists a sixth mode, an automatic tracking mode, in which the receiver automatically determines the angle of the incoming beam and the receiving and transmitting elements are automatically aligned with the incoming beam. Robert E. Munn, manager of the TALC project, testified that the aircraft used for the TALC testing contained the necessary equipment and had the capability to operate under this sixth mode. For an apparatus claim such as Claim 4 of the '036 patent, which uses language that brings the claim within the scope of 35 U.S.C. § 112(6), it is sufficient that all of the elements called for in the claim are present and the apparatus, if operated, could perform the function called for in the claim. It is not necessary that the operation actually be performed. See Lemelson v. United States, 752 F.2d 1538, 1549 (Fed. Cir. 1985).

Viewing the trial record as a whole, plaintiff has demonstrated the presence of the required components for acquisition and angle tracking, and that these components were arranged in such a way so as to achieve the function called for in Claim 4 of the '036 patent. (29)

2.

With respect to Claim 13 of the '518 patent, defendant bases its noninfringement allegation in part on the same arguments discussed above with respect to Claim 4 of the '036 patent. For essentially the same reasons explained with respect to Claim 4, these arguments are not convincing with respect to Claim 13. For example, Claim 13 calls for a "means for steering said exiting light-beam toward a target station" and a "means for causing said incoming light-beam to produce . . . tracking-signals." Defendant disputes the presence of the structures set forth in the specification or the equivalents thereof to perform these functions. But, as discussed above, the accused device contains a quadrant detector and related devices plus an optical receiver which are sufficient to perform the disclosed steering and tracking function and correspond or are equivalent to the devices described in the specification.

3.

Claim 15 of the '518 patent provides:

A satellite communication station comprising:

a satellite vehicle having on board:

a radio receiver for receiving and demodulating a radio signal transmitted to said satellite from a first remote station to obtain the message content of said radio signal;

laser transmitter means operable for transmitting a laser beam from said satellite;

means for modulating the transmitted laser beam with said message content; and

means for directing the modulated laser beam toward a second remote station to transmit said message content to said second remote station.

Hence, Claim 15 contains an explicit requirement of a "satellite vehicle." Plaintiff contends that an aircraft containing the appropriate tracking equipment qualifies as a "satellite vehicle." But the term "satellite" is defined as "[a] manmade object designed to orbit a celestial body." Webster's II New Riverside University Dictionary at 1038 (1984). The type of aircraft used in the TALC project, i.e., a turboprop airplane, is not so designed. Plaintiff has not pointed to any evidence in the claims, specification, or prosecution history that supports a definition of "satellite" different from its dictionary definition.

In its post-trial brief, plaintiff resorts to the doctrine of equivalents and argues that an airplane is the equivalent of a satellite. A determination under the doctrine of equivalents is different from a determination under Section 112(6) as to whether a structure is the "equivalent" of a structure disclosed in the specification. If a structure is a Section 112(6) "equivalent," then it comes within the literal scope of the claim. The doctrine of equivalents, on the other hand, allows a patentee, in certain narrowly defined circumstances, to expand the coverage of a claim beyond its literal scope so as to include a device that contains insubstantial differences from the invention defined in the claim. Hilton Davis Chem. Co. v. Warner-Jenkinson Co., 62 F.3d 1512, 1517-18 (Fed. Cir. 1995) (en banc), rev'd on other grounds, 117 S. Ct. 1040 (1997). (30) An analysis of equivalence is performed on an element-by-element basis. Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 117 S. Ct. 1040, 1044 (1997). Some factors considered in such an analysis include whether the claimed element and the alleged infringing element are interchangeable and whether the two structures perform substantially the same function in substantially the same way to achieve the same result. Hilton Davis, 62 F.3d at 1518.

Applying these standards, the equivalency of an airplane and satellite is far from apparent. Airplanes and satellites function in very different ways. For example, a satellite orbits the earth at altitudes far above that at which an airplane is capable of flying, a satellite's flight path is not compromised by weather, and a satellite does not require frequent refueling. Given these differences, a device that produces adequate communication between an airplane and a ground station may not be capable of providing communication between a satellite and a ground station. Plaintiff has not presented any significant evidence to support a determination that an airplane is the equivalent of a satellite in the context of the instant claim and, hence, has failed to establish equivalency.

4.

The text of the pertinent claims of the '982 patent is set forth above. See supra pp. 6-8. All of these claims except Claim 14 are method claims. For method claims, literal infringement exists only if all of the acts recited in the claims are actually performed. Joy Techs, Inc. v. Flakt, Inc., 6 F.3d 770, 775 (Fed. Cir. 1993). The court interprets Claims 1, 2, and 7-13 as calling for a communication between two points on earth using as a conduit a relay station high above the earth. Plaintiff has not demonstrated that the TALC program included any transmission from a remote point, via the airplane, to the submarine. Rather, the trial record suggests only that a pre-programmed message was sent from the aircraft to the submarine. Hence, Claims 1, 2, and 7-13 do not cover the system used in the TALC project. (31)

The methods called for in Claims 4 and 6 of the '982 patent require the relay station to "utilize" the

received laser transmission to orient a return beam. As explained above, the automatic tracking mode in place during the TALC program contained a means for acquisition and tracking as set forth in the specification. But although there is evidence that the TALC device's automatic tracking mode was tested on one occasion, plaintiff has not demonstrated that the test accomplished the utilization of the laser transmission as required in Claims 4 and 6. On at least one occasion, problems arose involving the pointing mechanisms on the aircraft, and the court is left to speculate whether these troubles occurred during the testing of the automatic tracking mode or one of the other modes, none of which "utilizes" the received laser beam. (32) Plaintiff points to Munn's testimony to the effect that in one instance a signal was acquired for tracking purposes. But plaintiff takes this testimony out of context. (33) Read in context, Munn never testified that automatic tracking ever occurred. In fact, Munn specifically stated that the use of the receiver to acquire a signal does not necessarily result in tracking but rather allows only for the possibility that if the incoming beam is acquired then it also can be tracked. The evidence therefore does not establish that the received laser was ever "utilized" as required in Claims 4 and 6 of the '982 patent. (34)

Claim 14 of the '982 patent is an apparatus claim which in pertinent part calls for "a radio receiver for receiving and demodulating a radio signal transmitted to said vehicle from a first remote station to obtain the message content of said radio signal," and a "means for modulating [a] transmitted laser beam with said message content" (emphasis added). The accused system contains devices that correspond to each of these requirements. The aircraft had a radio receiver that could receive and demodulate messages and also a keyboard and computer with which an operator could type the received message onto a laser beam by means of a modulator. (35)

In summary, out of all of the claims asserted by plaintiff, the court concludes that the system used in the TALC project was covered only by Claim 4 of the '036 patent, Claim 13 of the '518 patent, and Claim 14 of the '982 patent. (36)

C. CASE 25

Case 25 involves the Massachusetts Institute of Technology Lincoln Laboratory program referred to as the Lasercom Intersatellite Transmission Experiment (LITE) which covered the construction of an engineering model to demonstrate the feasibility of a satellite laser communication system. The LITE engineering model was spaced apart from an engineering model test set that contained a laser and an optical receiver. Plaintiff contends that Claim 4 of the '036 patent and Claim 13 of the '518 patent cover the LITE model.

As to Claim 4, the dispute again involves acquisition and tracking. Defendant contends that the accused device lacks the claim requirement for a "means in said other station responsive to the angular location reported for orienting a laser beam transmission to the location of said one station." But the LITE model used a quadrant detector, which is equivalent to the disclosed conical scan detector, which produced error signals that were sent to processing equipment for providing feedback to a control mechanism that adjusted the mirrors through which both the received and transmitted lasers pass. To one of ordinary skill in the art, these structures constitute the optics, integration unit, and servomechanism disclosed in the specification for performing the function of orienting the return laser transmission. The evidence demonstrates that the LITE engineering model was operable. Hence, this model is covered by Claim 4 of the '036 patent.

With respect to Claim 13, defendant raises essentially the same argument as with Claim 4. Defendant

disputes the presence of a "means for steering said exiting light-beam toward a target station" and a "means for causing said single incoming light-beam to produce both tracking-signals and data-signals" on the grounds, rejected above, that the alleged infringing device lacks the means for acquisition and tracking described in the specification. Hence, the LITE engineering model is also covered by Claim 13 of the '518 patent.

D. CASE 30

Case 30 involves the Air Force Systems Command's Laser Airborne Communication Experiment (HAVE LACE) at the Wright Patterson Air Force Base in Ohio. The HAVE LACE project, which terminated in 1986, involved the development and testing of two laser transceivers for air-to-air and air-to-ground stations. The system was operable and the testing of all equipment was successful. Plaintiff contends that Claims 4 and 17 of the '036 patent covered the work performed under the HAVE LACE project.

Defendant disputes the presence of the necessary tracking equipment called for in Claims 4 and 17, much like it has done in the prior cases. But again, the HAVE LACE device contained the structures or their equivalents as described in the conical scan alternative in the patent specification. The HAVE LACE device used quadrant detectors to generate error signals to a microprocessor-based scan controller. A controller integrated the received signal and, working in conjunction with gimbals, adjusted the receiver and transmitter optics, thereby functioning as a servomechanism.

As to Claim 4, defendant argues that the HAVE LACE device involved passing positional information between the two stations which is inconsistent with the Claim 4 requirement that the angular location of one station be reported to the other station "solely by means of the directivity of a laser beam transmission." But to the extent positional information was passed between stations, that information was provided to enable an operator manually to direct the transmitter within the general field of view of the receiving station. Once within the general field of view, the equipment was capable of determining, and in fact did determine, the angular position of the incoming beam solely by means of the directivity of the laser transmission. Thus, the HAVE LACE device operated in a manner similar to the patent specification embodiment in which the submarine tracks the satellite "with the aid of angular position information transmitted from the satellite and received by the submarine." Col. 9, lns. 57-59. Claim 4 requires only that the station receiving the initial laser transmission be able to determine the angular orientation of the received beam solely from the inherent properties of the beam. The accused device has the required structures to perform this function and actually did perform this function. As a result, Claims 4 and 17 of the '036 patent cover the HAVE LACE device.

E. CASE 32

Case 32 involves the Air Force's Laser Crosslink Subsystem (LCS) which was designed to provide an optical communication link to satellites that were part of an ongoing satellite program called the Defense Support Program (DSP). McDonnell Douglas Corporation designed and produced four stand-alone LCS units. LCS # 1 was fit onto a satellite but only as a "Trail-blazer" unit, a name coined to describe the not-yet-complete unit that was used to test whether the satellite and a production-level LCS could interface electrically. LCS # 2 and LCS # 3 were each integrated with a DSP satellite but were never launched into space and were ultimately removed from the satellites because of technical problems. LCS # 4 was completed, or close to being completed, but was never integrated with a satellite. The LCS program terminated in November 1993 without any LCS satellite ever being launched into space. Plaintiff contends that Claim 4 of the '036 patent, Claims 13 and 15 of the '518 patent, and Claim 14 of the '982 patent covered the work performed under the LCS project. (37)

1.

With respect to Claim 4 of the '036 patent, defendant alleges that the LCS program never produced a fully operable communication system. But even if the evidence supports defendant's contention with respect to LCS # 1 and # 2, it does not with respect to LCS # 3. LCS # 3 was removed from the satellite, not because it was inoperable, but rather because there was a question as to whether LCS # 3 could operate long enough in space for the project to be considered feasible. Considered in its entirety, the trial evidence supports the conclusion that LCS # 3 was operable to the extent that if combined with a DSP satellite and launched into space, LCS # 3 would have performed the communication functions called for in Claim 4.

Defendant points, however, to a second and more compelling reason as to why there is no infringement of Claim 4. Claim 4 calls for two spaced stations each having a pulsed laser transmitter and an optical receiver. Plaintiff has not demonstrated that at any single point in time there was an "operable assembly of the whole" of two such stations as required by Deepsouth Packing Co. v. Laitram Corp., 406 U.S. 518, 528 (1972), i.e., at no point in time was there an operable assembly of two positioned spaced stations, each having a pulsed laser transmitter and optical receiver, that could communicate with one another. The LCS units that were attached to satellites but never launched had a pulsed laser and optical receiver. Plaintiff, however, has not demonstrated that prior to or after any connection with a satellite, two LCS units were set up in such a way so as to create a system for communicating with one another. Indeed, plaintiff did not establish that at any particular point in time two LCS units were sufficiently tested, operable, and available to produce a communication system called for in the claim. (38) The LCS units that were integrated with a satellite were each tested with a "test set," but plaintiff did not show that this "test set" had a pulsed laser transmitter and an optical receiver as required in Claim 4.

2.

Unlike Claim 4 of the '036 patent, Claim 13 of the '518 patent does not call for the combination of two stations with a pulsed laser transmitter and an optical receiver but instead is limited to a single "station." The DSP satellite with LCS # 3 attached certainly would qualify as such a station.

As in prior cases, defendant disputes the presence of the required means for acquisition and tracking. But the LCS units contained a quadrant detector, which is equivalent to the disclosed conical scan detector, with processing equipment to integrate the signal and motors in the gimbal assembly to adjust the transmitting optics. Because the LCS units' acquisition and tracking components involve the same or equivalent structures as disclosed in the patent specification "for steering [the] exiting light-beam" and "for causing [the] incoming light-beam to produce . . . tracking-signals," Claim 13 of the '518 patent covers the LCS units.

3.

Claim 15 of the '518 patent calls for a "satellite vehicle." Defendant apparently contends that an LCS unit attached to a satellite that is never launched does not satisfy this element because to qualify as a satellite vehicle, the satellite must actually be in orbit. But as noted above, the dictionary definition of "satellite" is "[a] manmade object designed to orbit a celestial body," Webster's II New Riverside University Dictionary at 1038 (1984) (emphasis added), and there is no requirement that the object actually be in orbit. The DSP satellite to which LCS # 3 was attached was "designed" for orbit and in fact later was launched into orbit. Moreover, plaintiff apparently intended the terms "satellite" and "orbiting satellite" to have different meanings because in drafting the patent claims, plaintiff chose

sometimes to use the term "satellite" and other times to use the term "orbiting satellite." (See, e.g., Claim 2 of the '036 patent.) If the court were to interpret the two terms as synonymous, the court would be ignoring the term "orbiting." In interpreting the scope of claims, court's should endeavor to give meaning to each claim term. Tandon Corp. v. United States Int'l Trade Comm'n, 831 F.2d 1017, 1023 (Fed. Cir. 1987).

Defendant also contests the presence of "a radio receiver for receiving and demodulating a radio signal transmitted to said satellite from a first remote station to obtain the message content of said radio signal." Defendant admits that the LCS units contain a radio receiver, but denies the presence of, or actual communication with, a remote station. But this claim element does not require the actual presence of a remote station or the act of communicating with a remote station. This element calls only for a radio receiver on board the satellite that is capable of receiving and demodulating a radio signal transmitted to the satellite from a remote point. The LCS units' radio receiver apparently had such capability. Accordingly, Claim 15 of the '518 patent covers the LCS units.

The only argument defendant raises with respect to Claim 14 of the '518 patent that is not discussed and rejected above is that the satellite was not "operable" high above the earth as is required by the claim. But the trial evidence indicates that at least the DSP satellite to which LCS # 3 was attached could have been launched into space at the time the operable LCS unit was on board and this is all that Claim 14 in pertinent part requires. Indeed, satellites with other LCS units on board were launched into space at a later point in time. Claim 14 of the '982 patent therefore covers the LCS units.

F. CASE 33

Case 33 involves the Air Force's Atlantic Laser Ground Station (ALGS) which is an optical transceiver designed to test and calibrate orbiting satellites equipped with LCS units such as those described in Case 32. The ALGS contains a laser transmitter, optical receivers, and optics for directing the outgoing laser beam. Plaintiff bases his claim on a test performed using the ALGS and a Delta 183 satellite. Plaintiff contends that the ALGS transmitted a laser to the Delta 183 satellite which had an LCS unit on board, and the LCS unit tracked the laser and sent a return beam. Plaintiff asserts that this test was covered by Claims 4 and 17 of the '036 patent, Claim 4 of the '518 patent, and Claim 4 of the '982 patent.

As in many prior cases, defendant alleges that one or more elements of the claims in issue is not present in the accused device because the device does not contain the required means for acquisition and tracking. Although the record is not without some ambiguity, the court ultimately concludes that plaintiff has established that the alleged infringing device contains the structures that perform the claimed functions and, with respect to the method claims, actually performed such functions.

As explained in the discussion in Case 32, the LCS units therein contained all of the structures disclosed in the specification for accomplishing the required acquisition and tracking functions. The ambiguity here is whether the LCS unit on board the Delta 183 satellite actually contained all of the crucial LCS parts for acquisition and tracking. One government document described the contents of that LCS unit and the accomplishments as follows:

DEMONSTRATED FIRST LASERLINK WITH ORBITING VEHICLE

* * * * *

Direct Satellite To Earth Link

Recent Algs Demonstration Validated Optical Link Through Atmosphere

-- MDESC Ladar Experiment Flown On Delta 183

-- Delta 183 Tracked 20 PPS Beacon From ALGS

LCS Hardware Operated In Space On Delta 183

-- Gimbal, Gimbal Drive Electronics And Initialization Software

-- Avalanche Photo Diodes (APDs)

-- Power Regulator

LCS Hardware Also Utilized In ALGS

-- Receiver APD's And Some Optical Elements

-- Communications Electronics Design

-- Flight-Type Lasers And Beam-Steering Mirror Drivers Planned For ALGS Upgrade

This document does not specify that the "Avalanche Photo Diodes" were employed as part of a quadrant detector and does not otherwise specify the interrelationship among the hardware. But the document does state that tracking was accomplished and a communication link was established. In view of the other evidence that shows that at a later point in time the LCS units achieved such tracking using the required conical scan embodiment, the court concludes that it is more likely than not that the Delta 183 satellite achieved tracking in the same way. Plaintiff has made a prima facie showing that the ALGS-Delta 183 test involved the use of acquisition and tracking means that infringe the applicable claim elements. Defendant had an opportunity to rebut that prima facie case by presenting evidence demonstrating that the LCS unit on board the Delta 183 satellite lacked the structures necessary to support infringement. Defendant has not presented such evidence. Therefore, Claims 4 and 17 of the '036 patent and Claim 4 of both the '518 and '982 patents cover the ALGS-Delta 183 test device.

G. CASE 34

Case 34 involves the Air Force Systems Command's purchase and testing of two Laser Communication Test Systems (LCTS) built by Hughes Aircraft. The LCTS project was initiated in part to compare the acquisition and tracking results from the HAVE LACE equipment (Case 30), which used quadrant detectors, with the alternative type of angle tracking detectors used in the LCTS. During testing, one LCTS was located in a building and the other on a moving vehicle on the ground. The tests were successfully completed and the LCTS was operable. Plaintiff contends that these tests were covered by Claims 4, 5, and 17 of the '036 patent and Claims 4 and 13 of the '518 patent.

Plaintiff has not established infringement of Claim 5 of the '036 patent and Claim 4 of the '518 patent because both of these claims call for a satellite and neither the building nor the moving vehicle on the ground to which the two LCTS units were attached constitute satellites. Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent on the other hand do not require the presence of a satellite. Claim

4 calls only for "spaced stations" and Claim 13 calls only for a "station," and an LCTS unit located on a building or a moving vehicle would qualify as such. As explained in the discussion in Case 9, Claim 17 calls only for a device that if attached to a satellite would result in the described communication link. A LCTS unit would so qualify.

With respect to Claim 4 of the '036 patent and Claim 13 of the '518 patent, the only other objection defendant makes in its noninfringement chart is that a test bed is not an operable communication system. But the LCTS units were capable of communicating and the presence of each claim element is sufficient to bring the alleged infringing device within the literal scope of these claims. With respect to Claim 17 of the '036 patent, defendant contends that there was no ground station present. But the alleged LCTS units were stations that were on the ground and therefore would qualify as ground stations. More fundamentally, however, Claim 17 does not require the presence of a ground station but rather only a means to carry out the function of "utilizing the received energy transmission at the satellite to orient a narrow beam laser energy transmission from the satellite to the ground station." The LCTS units carried out this function. Hence, Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent cover the LCTS units.

H. CASE 36A

Case 36A involves one of four separate projects, labeled Cases 36A-D, undertaken by ThermoTrex Corporation between 1990 and 1995. This project was part of a program known as Brilliant Pebbles, ultimately discontinued, which was directed at the development of a vast fleet of satellites to form a world-wide complex laser communications network to detect and attack hostile missile launches. This project involved the development, testing, and delivery of two operable prototype laser transceivers. The United States apparently never used these transreceivers on an orbiting satellite. Plaintiff contends that the production and testing of these transceivers was covered by Claim 4 of the '036 patent and Claim 13 of the '518 patent.

In its noninfringement chart, defendant again focuses on acquisition and tracking. Unlike the prior alleged infringing devices which used quadrant detectors, the device in this case employed a detector array. As noted above, the patent specification discloses the use of a detector array, but defendant contends that the accused device did not utilize a detector array for acquisition and tracking as described in the patent specification. The patent specification describes the detector array as follows:

In order to complete the communication link between the satellite and submarine, it is necessary for a transmission from the submarine to be received to aid the satellite in its tracking of the submarine. For this purpose a wide angle optical system is provided for a two-dimensional array of detectors to provide a continuous surveillance system of the surface of the earth corresponding to the area scan encompassed between the limits of the optical scanning device. The detector array is indicated only schematically and will in general be a fine resolution array of photoconductors which are capable of responding to a laser light beam with the optical system imaging the projected area of the earth on the array which will permit the required degree of angular resolution by the array. Since narrow beam laser transmission is one of the features of the invention relied upon to achieve security, it will be necessary to provide an accurate angular resolution by means of the array and for this reason the array may be constructed of a very large number of extremely small photo responsive elemental areas. Such an array will also have an appreciable overall size in order that the energization of one of the elemental areas by a laser beam passing through the optical system may be interpreted as an angular location for the origin of that beam from the earth with the desired degree of accuracy.

Col. 6, lns. 6-32.

The ThermoTrex "Lasercom Risk Reduction" final report refers to the use of detector arrays. The detector array described therein is a 14-by-14, two dimensional array of photosensitive elements. As such, that detector array would seem to fall squarely within the description of the detector array called for in the specification. Hence, Claim 4 of the '036 patent and Claim 13 of the '518 patent cover this device.

I. CASE 36B

Case 36B involves a demonstration test bed developed by ThermoTrex to simulate a system of laser crosslinks. The test bed contained three operable laser transceivers spaced apart from one another. The laser transceivers contained a CCD camera, a form of which is the modern video camera, for acquisition and tracking. The CCD camera contains an array of photodiodes that are photoresponsive and are able to detect the incoming laser beam and resolve the position of point of origin of the beam. Plaintiff alleges that Claims 4 and 17 of the '036 patent and Claims 4 and 13 of the '518 patent cover this device.

For the reasons explained above, the absence of a satellite is fatal to plaintiff's allegations with respect to Claim 4 of the '518 patent. As to the remaining three claims, defendant's noninfringement chart again focuses on acquisition and tracking. Defendant argues that the CCD camera was a significant scientific breakthrough that was not invented until approximately 20 years after plaintiff filed his first patent application and hence could not correspond to the structures described in the specification. But the only reason for noninfringement provided in defendant's noninfringement chart is that the alleged infringing device has "[n]o 'detector array' for acquisition & tracking as described in the patent specification." The specification description quoted above simply calls for an array of detectors which "may be constructed of a very large number of extremely small photo responsive elemental areas." As Dr. Culver explained, the photodiodes in the CCD camera are an array of detectors that are photoresponsive and therefore fit squarely within the description of the detector array in the specification. Hence, Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent cover the test bed device.

J. CASE 36C

Case 36C involves an upgraded transceiver developed by ThermoTrex which is substantially similar to the transceivers previously described. The transceiver contained a CCD camera for acquisition and tracking and was tested by firing a laser toward a retroreflector on a nearby mountain. The retroreflector reflected the incoming laser beam and bounced back a return signal which the transceiver in turn received and tracked. Plaintiff alleges that Claim 13 of the '518 patent covers this device.

Defendant again disputes the presence of a detector array. But, as previously discussed, the CCD camera contains an array of photodiodes that fall within the scope of the claim. Defendant also argues that the recitation in Claim 13 of a "means for receiving a single incoming light-beam from said target station, said single incoming light-beam adapted to have only communication-data modulated thereon" requires a target station that has the capability of actually transmitting a laser beam. Because a retroreflector only reflects the laser and does not actually transmit an independent beam, defendant contends that this claim element is not met. The defect in this argument, however, is that this claim element does not require the presence of any target station but rather simply requires a structure that is capable of receiving an incoming beam that is adapted to have only communication data. Because this is not a method claim, the use of an actual incoming beam is not required. Defendant does not dispute that the transceiver has all of the required structures for

performing this function and hence, the element is present in the alleged infringing device. Therefore, Claim 13 of the '518 patent covers the updated transceiver.

K. CASE 36D

Case 36D involves two other transceivers developed by ThermoTrex that were tested at some point between 1992 and 1994 at the NASA/JPL Table Mountain facility in Wrightwood, California. These transceivers, which used a CCD camera, were placed on two separate mountains and communicated with and tracked one another. Plaintiff contends that Claims 4 and 17 of the '036 patent and Claims 4, 13, and 15 of the '518 patent cover these devices.

Claims 4 and 15 of the '518 patent, which require the presence of a satellite, are not infringed because the transceivers were not attached to satellites. As to the other claims, which do not require the presence of a satellite, the transceivers on the two separate mountains fulfill the limitations calling for a "station" and "spaced stations." In addition, as explained above in the other ThermoTrex cases, defendant is incorrect when it contends in its noninfringement chart that there is "[n]o 'detector array' for acquisition and tracking." The CCD camera used in these transceivers, like the other CCD cameras, contained the required array of photoresponsive and photoconductive elements. Hence, Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent cover these transceivers.

L. CASE 37

Case 37 involves a test bed developed by Ball Aerospace which consists of a primary terminal and two remote terminals, one stationary and the other moveable. The two remote terminals each contains a laser communication transmitter and receiver. This test bed was successfully tested. Plaintiff asserts that Claims 4 and 17 of the '036 patent and Claims 4 and 13 of the '518 patent cover this device.

Claim 4 of the '518 patent, which requires the presence of a satellite, is not infringed because the test bed did not contain a satellite. As to Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent, defendant again disputes that the alleged infringing device had the requisite means for acquisition and tracking. But the test bed used a quadrant detector in conjunction with electrical circuitry for the integration of error signals and a motor for properly aligning the transmitter and receiver optics. The quadrant detector and its accompanying optics, integration unit, and servomotor fall within the scope of the claims in issue for the same reasons articulated in the discussions in the other cases. Hence, Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent cover this device.

M. CASE 41

Case 41 involves a communications link subsystem (COMMLINK) project developed by Martin Marietta Aerospace. Plaintiff alleges that the COMMLINK project involved three deployed satellites, each containing two COMMLINK transceivers to allow for laser communication between the satellites. Plaintiff contends that this project infringed Claim 4 of the '036 patent, [(39)] Claims 4, 7, 8, 13, 14, and 15 of the '518 patent, and Claims 7, 8, and 14 of the '982 patent. Because the COMMLINK project is classified, defendant, in an effort to limit discovery, stipulated for purposes of this case only to the presence of all of the claimed elements except for those related to acquisition and tracking. But the COMMLINK transceivers contained a quadrant APD detector, the equivalent of a conical scan, which sent electrical signals to an acquisition and tracking module that integrated a signal to direct the receiver and transmitter. Therefore, the transceivers contained the required structures for acquisition and tracking and hence, all of the asserted claims cover this device.

Conclusion

For the reasons set forth above, the court concludes that although certain of the claims in issue cover certain of the accused devices, each of these claims is invalid and, hence, plaintiff is not entitled to any compensation under Section 1498(a). Accordingly, the Clerk of the Court is directed to dismiss plaintiff's complaint. No costs.

IT IS SO ORDERED.

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ROGER B. ANDEWELT

Judge

1. Although Section 1498(a) uses the term "cover" rather than "infringe," the inquiry into whether a patent claim covers a device under Section 1498(a), in pertinent part, is identical to the issue of whether a device infringes a patent under 35 U.S.C. §§ 271 and 281. Lemelson v. United States, 752 F.2d 1538, 1548 (Fed. Cir. 1985). Because much of the pertinent case law under Section 1498(a) uses the term "infringe," for simplicity purposes the court will treat the terms "infringe" and "cover" as synonymous.

2. In Markman v. Westview Instruments, Inc., 517 U.S. 370 (1996), the Supreme Court held that with the possible exception of a 35 U.S.C. § 112 equivalence determination, the construction of a patent term is an issue reserved for the courts. Subsequent to Markman, many courts, in an effort to simplify the case ultimately presented to the jury, have opted to hold a pretrial "Markman hearing" in which to resolve disputed interpretations of claim terms. Although the instant action involved a bench trial, both the parties and the court agreed that such a hearing would narrow the issues and allow for a more efficient trial.

3. The testimony of both parties' experts supports the conclusion that the quadrant detectors described during the Markman hearing and at trial are structural equivalents of the conical scans disclosed in the specification.

4. Defendant also cites a series of cases that address prosecution history estoppel, which is applied to preclude a patentee from resorting to the doctrine of equivalents to expand the right to exclude to include "equivalents" of what is literally claimed. Wilson Sporting Goods Co. v. David Geoffrey & Assoc., 904 F.2d 677, 684 (Fed. Cir.), cert. denied, 498 U.S. 992 (1990). But the issue herein involves the literal scope of the claims in issue and for literal scope, "the doctrine [of prosecution history estoppel] is irrelevant." Fromson v. Advance Offset Plate, Inc., 720 F.2d 1565, 1571 (Fed. Cir. 1983).

5. Defendant focuses on the phrase in the specification that "the system can be readily modified to permit a transponding mode between the lasers in the satellite and the ground station" and suggests that this modification carries on to the transmission of error signals between the satellite and the ground station. But the only modification specified is "to permit a transponding mode between the lasers." As clarified earlier in the specification, a "transponding mode" is a mode of operation whereby the laser from the satellite fires contemporaneously with the received laser from the ground station. No error signals are transmitted.

6. The court's interpretation of "transponding" is not inconsistent with dictionary definitions. Neither party was able to supply a dictionary definition of "transpond" or "transponding" but the noun "transponder" is defined as "[a] radio or radar receiver-transmitter activated for transmission by reception of a predetermined signal," Webster's II New Riverside University Dictionary 1228 (1984),

and as "[a] transmitter-receiver capable of accepting the challenge of an interrogator and automatically transmitting an appropriate reply," McGraw-Hill Dictionary of Scientific and Technical Terms 1959 (4th ed. 1989). Although the McGraw-Hill definition implies that a "transponder" automatically replies to the station that originates the signal, the Webster's II definition describes a system that transmits a signal automatically upon reception of a predetermined signal, but no particular destination is specified. Hence, even assuming plaintiff intended to use "transponding" consistent with the dictionary definition of the noun "transponder," plaintiff may only have been describing an operation whereby an error signal is transmitted internally upon the reception of a laser and not necessarily an operation whereby the error signal is transmitted to the ground station and then back to the satellite.

7. Brief additional comment is warranted with respect to Claim 4 of the '036 patent. Like amended Claim 22, Claim 4 uses the word "solely" in describing the directivity of the incoming signal. In prosecuting the '036 patent application, plaintiff amended an element in Claim 4 which read "means for reporting the angular location of one station to the other station by means of a laser beam transmission" to read "means for reporting the angular location of one station to the other station solely by means of the directivity of a laser beam transmission from said one station to said other station" (the underlined segments represent added text). The prosecution history of the '036 patent shows that plaintiff made this amendment to clarify that the angle of arrival of the incoming beam to the satellite was not

Footnote Continued

7/ (Footnote Continued)

determined by using signals from the ground station but rather was based on the "mere directivity of the [laser] transmission." The prosecution history of the '518 patent indicates that plaintiff amended Claim 22 to avoid different prior art in which the amplitude of the received signals was used in determining the angle between stations. Hence, when plaintiff sought to address amplitude in amended Claim 22, he chose a different phrase ("solely by resolving the angle of arrival of the [received] laser beam") than he did when not addressing amplitude in Claim 4 ("solely by means of the directivity of a laser beam transmission"). Given plaintiff's decision to use different phrases, the court cannot conclude that plaintiff intended the language in Claim 4, like that in amended Claim 22, to exclude a structure such as a conical scan or quadrant detector that uses the amplitude of received signals to determine the angle between stations.

8. Defendant presented a Department of Commerce publication in U.S. Government Research Reports, Vol. 31, No. 11 (June 5, 1962), which lists Philco III as an unclassified report available to the public. The publication states that the reports listed therein are available from the Office of Technical Services at the Department of Commerce or may be ordered through Department of Commerce Field Offices. This publication is sufficient to create a prima facie showing, unrebutted by plaintiff, that Philco III was accessible to the public as of June 5, 1962.

9. During trial, a dispute arose over whether at the time of the witnessing of the concept document plaintiff had conceived of the idea mentioned in the patent specification of placing optical reception and transmission elements on a surface periscope. Defendant argues that, absent such knowledge, one of ordinary skill in the art could not have used the concept document to construct a satellite-submarine communication system without undue experimentation. But the individual who witnessed the concept document testified at trial that after he pointed out to plaintiff problems involved in the reception of signals by submarines, plaintiff indicated that he could make the system work through appendages attached to the periscope. These appendages appear on the concept drawing. In any event, as defendant's expert acknowledged, it would be a simple deduction for one of ordinary skill in the art to conclude that the optical transmission and reception elements could be placed on the periscope.

10. In his pretrial filing, plaintiff argued that the Electro-Optical Report was actually a different report than the report referenced in the March 20, 1962, Department of Commerce publication. Plaintiff apparently abandoned this argument after trial. In any event, such an argument is not convincing in that the March 20, 1962, publication lists the same title and report number as the cover of the Electro-Optical Report.

11. Relying on DX-50, defendant also contends that the patent claims are invalid because the Air Force had prior knowledge of plaintiff's invention. But defendant has failed to prove that either DX-50 or the information contained therein was sufficiently available to the public to constitute prior art.

12. The abstract of the Electro-Optical Report indicates that this optical communication system offers "increased security" due to the "narrow attainable beam[s]."

13. The patent specification explains: "This tracking [of the satellite by the submarine] may be on the basis of the pre-computed satellite orbit as a function of time and the present position of the submarine or it may be with the aid of angular position information transmitted from the satellite and received by the submarine in [the submarine's] receiver." Col. 9, lns. 55-59.

14. Plaintiff's patent specification suggests using this same type of method when the submarine (i.e., the transmitting station) tracks the satellite (i.e., the receiving station). See supra note 13.

15. Some claims specifically call for lasers while others do not and call, for example, for a "light beam" or a "narrow beam energy transmission." But these latter claims use means-plus-function language (e.g., Claim 13 of the '518 patent calls for a "means for producing an exiting light-beam") which invokes the claim interpretation requirements of 35 U.S.C. § 112 described above. Because the only means for producing a narrow beam transmission described in the specification is a laser transmitter, under Section 112 the claims must be interpreted as so limited.

16. Both experts agree that in May 1962, at the time of plaintiff's concept document, one of ordinary skill in the art would have understood the references in the Luck Article to "coherent light" and "optical masers" as involving lasers.

17. In determining whether a reference alleged to anticipate a patent claim is enabling, the court may consider extrinsic evidence. See Beckman Instruments, Inc. v. LKB Produkter AB, 892 F.2d 1547, 1551 (Fed. Cir. 1989).

18. For example, plaintiff gives few details as to which type of modulator or optics to employ and does not describe a conical scan or explain how one operates.

19. Plaintiff cites the following statement in the discussion of tracking in the Electro-Optical Report as evidence that the report envisions tracking through the exchange of positional information: "[The] time required for a signal to pass from transmitter to receiver is not important since the receiver is not concerned about the actual location of the transmitter, only its apparent location." But as explained in the Jacobs Article, so long as the angular coverage of the receiver antenna is sufficiently wide, the time from transmission

Footnote Continued

19/ (Footnote Continued)

to reception of the signal would not affect tracking. To support his interpretation that if the transmission time is not important then tracking necessarily must not be accomplished based upon the directivity of the incoming beam, plaintiff relies upon testimony of his expert. But plaintiff mischaracterizes Dr. Culver's testimony in this regard. Dr. Culver merely testified that if one of the stations suddenly changed directions during the tracking process, then the station that changed position may in some way have to alert the other station of the change. Plaintiff fails even to consider such a situation in his patent specification and instead assumes that the submarine always knows the satellite's position. Moreover, both plaintiff and his expert testified that when a station employs conical scan techniques for tracking, there is no need for the "track computer" on the station to take into account any change in the other station's position. In this regard, the Electro-Optical Report teaches the use of conical scans and plaintiff has not pointed to any statement in that report or in his specification that suggests that the Electro-Optical Report's conical scans do not function in precisely the same way as those disclosed in plaintiff's specification, i.e., that the conical scan unit on the receiving station tracks the transmitting station based exclusively upon the inherent properties of the incoming beam, without the need for any positional information impressed on that beam.

20. The Electro-Optical Report provides more detail on this point than plaintiff's patent specification, which makes no mention of mounting the transmitting and receiving units on the same axis. Plaintiff argued extensively at trial that, in the context of the patent as a whole, the reference in column 11 of the specification to conical scan techniques would disclose to one of ordinary skill in the art that the transmitter on the satellite would always point in the direction of the receiver on the satellite. Thereby, when the conical scan unit on the satellite had resolved the position of the ground station, the transmitter on the satellite would be able to fire in the same direction. For these same reasons, even if the Electro-Optical Report had not mentioned mounting the transmitting and receiving antennas on the same axis, it would have taught one of ordinary skill in the art how to direct the return transmission.

21. The Electro-Optical Report states that "[f]reedom of atmospheric attenuation and the possibility of the development of coherent generators will, after 80 years of stagnation, allow the realization of the full potential of optical communications." After noting the security benefits that could result if lasers are used in communications, the Hulberger Article concludes that "SPACE COMMUNICATIONS are expected by many researchers to be an area of early practical applications of lasers." The Luck Article explains that the invention of lasers provided the basis for "a whole new technology" for communication.

22. For example, both the JPL Report and the Luck Article address the difficulties relating to acquisition of the laser at the receiving station. Because of its narrow beamwidth, the laser must be directed at the receiving station with some level of precision in order for the beam to be detected. Both references suggest the use of a multiplicity of detectors so as to allow for a greater field of view at the receiver. But, as the Luck Article suggests, if the relative position of the receiving station is accurately known in advance, mosaic detectors are not necessary for establishing contact. The Electro-Optical Report suggests using such a priori knowledge to direct the beam toward the receiving station. Moreover, as evidenced by plaintiff's expert's testimony and the Holahan Article, one of ordinary skill in the art would recognize that extremely narrow beamwidths are not necessary, and that beams can be widened if there is a problem detecting the beams.

23. The Holahan Article states:

The essentials of any coherent-light information system therefore are a generator, a modulator, a detector, and the focusing, collecting and filtering optics. An advanced system in addition might use an optical preamplifier and possibly superheterodyne components such as a local oscillator, a mixer, and a wide-band . . . amplifier.

(Emphasis added.) The Dulberger and Luck Articles mention the use of laser amplification and/or superheterodyne components but also indicate that these methods are options to direct detection. Similarly, Philco III and the JPL Report merely propose a system utilizing such techniques and do not suggest that these techniques are required. In any event, these references are prior art for all that they teach, Beckman, 892 F.2d at 1551, and when viewed as a group along with the expert testimony, it is clear that one of ordinary skill in the art at the time would have known that laser amplifiers and superheterodyne detectors were simply possible alternatives to direct detection.

24. Claim 1 calls for " a means for communicating with said vehicle from a remote point via said satellite and said narrow beam communication link." The specification describes a radio relay as a means for carrying out this function.

25. During trial, defendant offered as prior art an article by Philip J. Klass in the December 19, 1960, edition of Aviation Week and Space Technology. The article expressly discloses use of a radio relay in a laser communication system. (The phrase "optical maser" used in the article is another name for a laser.) Defendant, however, failed, consistent with this court's orders, to make a timely disclosure of its intent to rely upon this document as prior art. Based upon defendant's failure to comply with pretrial orders and the potential prejudice that would have resulted to plaintiff, the court did not admit this document into evidence as prior art.

26. Plaintiff presented no evidence indicating that anyone either in the military or private sector copied his patented invention.

27. The absence of secondary considerations favoring nonobviousness did not factor into the court's conclusion that the claims are obvious. "[T]he absence of objective evidence does not preclude a holding of nonobviousness because such evidence is not a requirement for patentability. As stated in Medtronic, Inc. v. Intermedics, Inc., [799 F.2d 734, 739 (Fed. Cir. 1986),] the absence of objective evidence 'is a neutral factor.'" Custom Accessories, Inc. v. Jeffrey-Allan Ind., Inc., 807 F.2d 955, 960 (Fed. Cir. 1986) (footnotes omitted).

28. At trial, plaintiff also alleged that Claim 4 of the '518 patent covered the work performed under the LCT project, but plaintiff apparently has abandoned this contention. In his post-trial reply brief, plaintiff asserts that Case 9 infringes only Claims 4 and 17 of the '036 patent and Claim 13 of the '518 patent. Moreover, in his arguments with respect to Case 9, plaintiff contends that each of the claims that cover the alleged infringing device therein is a "product claim--not a method claim," and Claim 4 of the '518 patent is a method claim.

In any event, Claim 4 of the '518 patent does not cover the structures involved in the LCT project. A method claim is directly infringed only if the patented method is actually performed. Joy Techs. Inc. v. Flakt, Inc., 6 F.3d 770, 775 (Fed. Cir. 1993). The fact that a particular apparatus is capable of performing the process is not sufficient. Claim 4 of the '518 patent calls for establishing a communication link upon a relay satellite and utilizing a laser at the satellite. As explained above, no satellite was used in the LCT project. In addition, although one breadboard illuminated a second breadboard with a laser, and the second breadboard utilized information to determine the directivity of the incoming beam, the second breadboard never sent a responsive laser back to the first breadboard. Claim 4 of the '518 patent requires such a return transmission.

29. In its post-trial brief, defendant contests the presence of another element in Claim 4--a "means for reporting the angular location of one station to the other station solely by means of the directivity of a laser beam." But defendant conceded in its noninfringement chart used at trial that it was not contesting

the presence of this element. At this point, the court will not permit defendant to change the position it took during trial because plaintiff would be prejudiced in that plaintiff could have prepared and presented expert testimony on this issue.

30. In Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 117 S. Ct. 1040, 1045 (1997), the Supreme Court refused to set forth any particular test for equivalence and instead allowed the Federal Circuit some latitude in its word choice.

31. Claims 2, 9, 10, 11, 12 and 13 of the '982 patent contain an additional limitation that the relay station receive a message from one station and then transmit that identical message to the second station. The trial evidence does not suggest that such a message was sent to the airplane and in turn sent to the submarine.

32. In these other modes, the receiver and transmitter are either manually pointed, point continuously at one relative point, or perform a preset scanning pattern. The automatic tracking mode, on the other hand, utilizes the incoming beam to direct the receiver and transmitter toward the transmitting station so as to enable the transmission of a return beam.

33. Plaintiff questioned Munn about one of the scanning modes in which the receiver and transmitter perform a preset scanning pattern covering a finite area in an attempt to "acquire," or in other words detect, the incoming beam. Acquisition, however, is distinct from tracking which is also necessary to utilize the incoming signal to orient a return beam. During Munn's deposition, plaintiff asked whether the scanning process was performed so as to acquire a signal. Plaintiff then asked, "Did that occur?" When opposing counsel asked "did what occur," plaintiff slightly changed his question by specifying "acquiring a signal to track" (emphasis added). As plaintiff points out, Munn replied, "I think we tried it one time and I believe it occurred." But plaintiff's questioning went on as follows:

Q: You previously referred to the scanning mode mentioned there if used with the receiver resulted in tracking I believe.

A: No. It could result in detection signal --

Q: Acquisition after scanning detection; is that correct?

* * * * *

A: If there is another signal present, you can move from detection to tracking.

34. Defendant contends that this requirement, along with the other limitations in the method claims, should be limited to include only those acts recited in the specification in accordance with 35 U.S.C. § 112(6). Because this particular element, i.e., that the received laser be "utilized" to orient a return beam, is written in functional terms and no concrete, identifiable act is recited, it may well be that Section 112 (6) requires this element to be "construed to cover the corresponding . . . acts described in the specification and equivalents thereof." The court, however, need not reach this issue because even if the element is not limited to the acts described in the specification and equivalents thereof, the TALC device did not perform these required acts.

35. All of the pertinent claims of the '982 patent call for a "relay station high above the surface of the earth." Defendant contends that the airplane used in the TALC project, which was flying at approximately 10,000 feet, was not "high above the surface of the earth." This argument, however, is not

compelling. "[H]igh above the surface of the earth" is a relative term and compared to a satellite in orbit, an airplane at 10,000 feet certainly can be argued to be low to the ground. But viewed from a ground station, an airplane flying at 10,000 feet would be viewed as "high above the surface of the earth." Nothing in the specification suggests to the contrary. Indeed, the specification describes an embodiment alternative to an orbiting satellite by stating that "in a given tactical situation a relay station of a temporary nature may be launched for relaying messages during a limited interval of time while the tactical situation is in existence." Col. 2, lns. 6-9. It is reasonable to interpret this embodiment as referring to a temporary relay station located at 10,000 feet above the surface of the earth.

36. Defendant makes two other arguments consistent with its noninfringement chart. Defendant contends that the laser transmitted by the submarine was not a "narrow beam energy transmission" as is required, for example, by Claim 4 of the '982 patent. A laser transmission from a submarine beneath the water surface would cause the beam to diverge somewhat, and thus, defendant contends, the beam could not be classified as "narrow." But "narrow" is a relative term and compared to other types of energy signals employed in 1962, such as radar or radio signals, even with divergence the laser beam could be classified as "narrow."

37. During trial, plaintiff withdrew Claim 1 of the '036 patent from infringement consideration.

38. Plaintiff did not demonstrate that LCS # 2 and # 3 were tested and "operable" at the same time. In this regard, apparently some of the components of LCS # 2 were scavenged for use in LCS # 3 after both units had been removed from their respective satellites.

39. At trial, plaintiff asserted that the COMMLINK project also infringed Claim 1 of the '036 patent, but in his post-trial brief indicated that he was no longer pursuing that claim.