United States Court of Appeals for the Federal Circuit

99-1533, -1534

WILLIAM A. BUDDE,

Plaintiff-Appellant,

v.

HARLEY-DAVIDSON, INC. and HARLEY-DAVIDSON MOTOR COMPANY,

Defendants-Cross Appellants.

Robert M. Skolnik, of West Long Branch, New Jersey, argued for plaintiff-appellant.

Michael E. Husmann, Michael Best & Friedrich LLP, of Milwaukee, Wisconsin, argued for defendants-cross appellants. With him on the brief was J. Donald Best.

Appealed from: U.S. District Court for the Northern District of California

Judge Jeremy Fogel

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HARLEY-DAVIDSON, INC. and HARLEY-DAVIDSON MOTOR COMPANY,

Defendants-Cross-Appellants.

DECIDED: May 24, 2001

Before BRYSON, LINN, and DYK, Circuit Judges.

LINN, Circuit Judge.

William A. Budde appeals the district court's judgment of non-infringement. Budde v. Harley-Davidson, Inc., C-98-20447-JF (EAI) (N.D. Cal. June 30, 1999). This judgment was entered at Budde's request, following the district court's claim construction order, which Budde now challenges. Budde v. Harley-Davidson, Inc., C-98-20447-JF (EAI) (N.D. Cal. Jan. 29, 1999) ("Order Construing Claims"). We hold that the district court erred in concluding that the claim limitation "electronic sensing means for determining when the ignition system of the engine delivers an electronic pulse to fire each spark plug" requires sensing the electronic pulse that fires the spark plugs and that the specification contained no structure corresponding to the function of the "electronic sensing means." We also address the conditional cross-appeal of Harley-Davidson, Inc. and Harley-Davidson Motor Co. (collectively "Harley-

Davidson"), and hold that the district court did not err in its construction of the claim limitation "status sensing means." We vacate the judgment of non-infringement and remand the case for further proceedings consistent with this opinion.

BACKGROUND

I.

A. Overview

U.S. Patent No. 4,955,348 (the "'348 patent") covers fuel injection conversion systems for reciprocating engines generally and V-twin motorcycle engines in particular. The invention is described as being particularly well-suited for use with V-twin engines customarily used on Harley-Davidson motorcycles. '348 patent, col. 1, ll. 7-11.

Such engines have an ignition system, a fuel delivery system, and two cylinders. Each cylinder includes a cylinder head, a piston, and a spark plug. The '348 patent discloses that Harley-Davidson motorcycle engines typically use one of three types of ignition systems: (1) a breaker ignition system; (2) an electronic ignition system; or (3) a magneto ignition system. Id. at col. 4, ll. 66-67. In each type of ignition system, a device or sensor is used to sense crankshaft or camshaft position. This sensor generates a series of low voltage timing pulses at shaft positions corresponding to the top of the power stroke position of each of the two cylinders. These low voltage pulses feed an ignition coil that, in turn, supplies high voltage pulses to the spark plugs. The patented system is compatible with all of these ignition systems to provide a fuel injection conversion system that will retrofit any Harley-Davidson V-twin motorcycle engine. Id. at col. 2, ll. 49-52.

Fuel injection has long been recognized as an efficient way to provide a fuel-air mixture to reciprocating engines. Fuel injection has also been known to be difficult to implement,

because it requires a sophisticated sensing system to properly time the delivery of a fuel charge to each successive cylinder in the firing sequence. Budde asserts that at the time he and his co-inventor, Floyd Knapp, filed the patent application that issued as the '348 patent, there were substantial compatibility problems in fitting a fuel injection system – either in the initial manufacturing process or in an after-market modification – onto an engine that was originally designed for carburetion. A critical compatibility problem was deriving timing information. Id. at col. 3, ll. 33-36.

Timing information is crucial to proper operation of a fuel injection system, because it assures that the injection system feeds fuel only to the cylinder that is to be fired. Most fuel injection systems acquire timing information from the engine's spark distributor. However, in a carbureted Harley-Davidson V-twin engine, the firing system does not use a spark distributor. In a Harley-Davidson engine, when one cylinder is on the power stroke, the other is on the exhaust stroke, and both spark plugs may be fired simultaneously with no adverse consequences. This eliminates the need for a distributor or any like electromechanical device for "steering" spark pulses. Id. at col. 3, ll. 33-39. Thus, to convert a simultaneously firing V-twin engine to fuel injection requires adding some device or arrangement to ascertain which of the two cylinders needs a fuel charge from the injectors at any particular time in the cycle.

To add a distributor, a cam and switch, or any other type of electromechanical device for the purpose of generating the needed timing information for a fuel injection conversion system requires making undesirable and impractical mechanical modifications to the engine. Id. at col. 3, ll. 44-50. The invention described in the '348 patent overcomes this problem by deriving the needed timing information electronically rather than by adding an electromechanical device.

The invention is based on the recognition that while both spark plugs in a Harley-Davidson V-twin engine fire simultaneously, the time between successive spark plug firings is not identical. Instead, the time separation alternates between 4/9 and 5/9 in each complete timing cycle to accommodate the asymmetrical relationship between the cylinders in the V-twin arrangement. By detecting the low voltage timing pulses produced in the engine's existing ignition system, and by measuring the time between successive low voltage timing pulses, the system of the '348 patent determines electronically (i.e., using a control unit) when each

respective cylinder is ready for a fuel charge without having to add a distributor, a cam and switch, or any other sort of electromechanical device to the engine. Id. at col. 2, ll. 21-34. This not only eliminates having to make mechanical alterations to the engine, but also enables the patented conversion system to be installed on any simultaneously firing V-twin engine regardless of which of the three different types of ignition systems the engine uses.

As stated above, in each type of ignition system addressed by the present invention, a device or sensor is used to sense camshaft position and emits a low voltage spark plug firing pulse (timing pulse) in response thereto. The invention described in the '348 patent feeds the low voltage timing pulses generated by the ignition system's existing device or sensor to a control unit. The control unit then measures the time between successive low voltage timing pulses. Since the time between the firing of cylinder 1 and then cylinder 2 is different from the time between the firing of cylinder 2 and then cylinder 1, the control unit is able to determine from the stream of low voltage timing pulses which cylinder needs to be charged with fuel. The output of the control unit thus provides the needed timing signals for the fuel injectors without any mechanical modification of the engine. Cf. '348 patent, col. 3, ll. 44-47.

B. Detailed Discussion

The '348 patent describes the breaker, electronic, and magneto ignition systems in detail in lines 5 through 56 of column 5. The patent describes how, in each of these ignition systems, low voltage timing pulses are provided by various sensing devices. For breaker and electronic ignition systems, the sensing devices include mechanical points, solid-state devices, or Hall effect devices. Mechanical points are typically driven by a camshaft, which in turn is driven by the engine's crankshaft. As the camshaft rotates, it forces the points apart. When the points are separated, the ignition coil temporarily loses its ground (i.e., the points

temporarily "break" the low voltage current being fed to the ignition coil) and generates a high voltage pulse that fires the spark plugs. Thus, spark plug firing is caused by, and therefore can be determined by, the low voltage interrupt generated by the points as the camshaft rotates. This low voltage interrupt is input to the control unit of the present invention.

A Hall effect device tracks camshaft position using a metallic timing cup having a pair of windows cut into the cup's sides. See '348 patent, at col. 5, ll. 37-39. The metallic timing cup is typically attached to a camshaft, id., which is driven by the engine's crankshaft assembly. The position of the windows on the metallic timing cup corresponds to the position of the pistons within the two cylinders, respectively. See id. at col. 5, ll. 39-41. That is, each window corresponds to a plug firing and causes a magnetic field that creates a low voltage pulse that is sent to the ignition coil, id., to cause the ignition coil to send a high voltage pulse to fire the spark plugs. Thus, spark plug firing is caused by, and therefore can be determined by, a Hall effect device's tracking of windows on a metallic timing cup. The low voltage pulse created by the Hall effect device is input to the control unit of the present invention. Id. at col. 5, ll. 43-45.

Magneto ignition systems are described as using a rotating magnet to generate a constantly changing flux in the core winding of a magneto coil. In the same manner as in the breaker or electronic systems, interruption of the control coil current in the magneto system causes high voltage signals to be generated to fire the spark plugs. Thus, spark plug firing is caused by, and therefore can be determined by, the low voltage interrupt caused by the changing flux. This low voltage interrupt is input to the control unit of the present invention.

The patented system describes the output of the electronic ignition system sensor (e.g., mechanical points, solid-state devices, Hall effect devices) as directly feeding the control unit.

Id. at col. 5, ll. 43-45. If the ignition system uses mechanical points or a Hall effect device, the output of these sensors is described as being used to feed the control unit. Id. at col 5, ll. 45-48. Similarly, the interruption of the control coil current in the magneto system is described as being used to feed the control unit. Id. at col. 5, ll. 50-51. Thus, the '348 patent describes the electronic sensors which are present in the three conventionally used V-twin motorcycle engine ignition systems and the manner in which those sensors determine when, in the engine timing cycle, the ignition system of the engine delivers a low voltage pulse to fire the spark plugs.

The written description of the '348 patent goes on to describe how the control unit analyzes the low voltage timing pulses generated by the electronic sensing devices to determine which cylinder should be charged with fuel. It does this by measuring the time span between successive pulses. The relationship of spark plug firing between cylinders is fixed for any given type of internal combustion engine based on its structural configuration. In a V-twin engine, the period between spark plug firing between the first cylinder (cylinder 1) and the second cylinder (cylinder 2) is asymmetrical due to the V-shape formed by (or the angle between) the cylinders. Id. at col. 5, l. 57-col. 6, l. 3. In a Harley-Davidson V-twin engine utilizing a Hall effect device, the windows on the camshaft's metallic timing cup reflect this asymmetry. That is, the distance, in one direction, between the window representing cylinder 1 and the window representing cylinder 2 is 4/9 of the circumference of the timing cup in a typical Harley-Davidson engine. The distance, moving in the same direction, between the window representing cylinder 2 and the window representing cylinder 1 is 5/9 of the circumference of the timing cup.

By measuring the asymmetrical firing of the spark plugs, the conversion system of the '348 patent electronically determines which cylinder should be injected with fuel. An engine

timer in the control unit measures the time duration between spark plug firings, i.e., the time between electronic signals received from the electronic ignition system sensor. The control unit stores the times for comparison to determine the longer and shorter periods. By comparing the differences, the desired sequence of cylinder charging is determined by the control unit. The varying distance between the cup windows can be translated into the time lapse between the spark plug firing from cylinder 1 to cylinder 2, which is different than the time lapse between the spark plug firing from cylinder 2 to cylinder 1. For example, when the control unit detects a 4/9 spacing (or time gap) between the windows, cylinder 1 is to be injected with fuel. Conversely, when the Hall effect device detects a 5/9 spacing (or time gap) between the windows, cylinder 2 is to be injected with fuel. Id. at col. 6, ll. 4-10.

The '348 patent's fuel injection system uses a number of other sensors to detect various system parameters and supply further input signals to the control unit. See id. at col. 2, ll. 4-19. The control unit integrates (or processes) the input signals, and transmits output signals to the fuel injectors causing each fuel injector to charge its associated cylinder with fuel at the proper time.1 See id. at col. 3, l. 65 – col. 4, l. 3.

II.

Budde filed a complaint for patent infringement against Harley-Davidson on June 11, 1997 in the Northern District of California. The district court held a Markman hearing on January 14, 1999 to construe the claims of the '348 patent, and issued its Order Construing Claims on January 29, 1999. Seven claim limitations were disputed by the parties. Because all seven of the then-disputed limitations appeared in claim 1 of the '348 patent, the district

1 Budde's brief informs us that the "proper time" is when the piston of the fuel injector's associated cylinder is returning from an exhaust stroke.

court's Order Construing Claims addressed only claim 1, which recites (with the disputed terms underlined):

> 1. A fuel injection conversion system for V-twin motorcycle engines having two cylinders, an ignition system, and a fuel source, comprising
>
> an intake manifold providing separate ducts for delivering a fuel and air mixture separately to each cylinder,
>
> a pair of fuel injectors mounted in a fuel injector and throttle body secured to said intake manifold,
>
> a fuel distributor for delivering an individual pressurized fuel flow to each of said injectors,
>
> a fuel pump for delivering a pressurized fuel flow from the fuel source to the fuel distributor,
>
> a fuel flow pressure regulator for controlling the pressure of the fuel flow delivered by the distributor to said injectors,
>
> an electronic sensing means for determining when the ignition system of the engine delivers an electronic pulse to fire each spark plug of the cylinders and producing an electronic signal in response thereto,
>
> a throttle potentiometer for sensing the position of the throttle and producing an electronic signal in response thereto,
>
> a status sensing means for measuring a combination of air intake and engine temperature, and vacuum in the intake manifold and producing electronic signals therefrom, and
>
> a control unit which discriminates which spark plug of the engine is firing a fuel-air mixture charged cylinder of the engine from the asymmetrical spark plug firing order related electronic signal from said electronic sensing means, said control unit electronically integrating the electronic signals from the throttle potentiometer, the electronic sensing means, and the status sensing means to generate electronic signals which control the fuel injectors and operate them at the proper time and for the calculated duration to deliver the proper amount of fuel to said cylinders for the engine operating conditions by timed injection.

Id. at col. 12, ll. 26-64.

As part of its claim construction, the district court interpreted the claim limitation "electronic sensing means for determining when the ignition system of the engine delivers an electronic pulse to fire each spark plug" and found that the '348 patent specification failed to disclose structure corresponding to the claimed function as construed by the court. Budde concluded that he could not prove infringement based on the court's claim construction and motioned the district court to enter final judgment in favor of Harley-Davidson to facilitate an early appeal. The district court granted Budde's motion and entered a judgment of non-infringement. We have jurisdiction over Budde's appeal from the district court's judgment pursuant to 28 U.S.C. § 1295(a)(1) (1994).

DISCUSSION

I. Standard of Review

A finding of non-infringement requires a two-step analytical approach. First, the claims of the patent must be construed to determine their scope. Carroll Touch, Inc. v. Electro Mech. Sys., Inc., 15 F.3d 1573, 1576, 27 USPQ2d 1836, 1839 (Fed. Cir. 1993). Second, a determination must be made as to whether the properly construed claims read on the accused device. Id. In this case, Budde has conceded the second part of the infringement analysis, leaving only the propriety of the district court's claim construction in issue. Claim construction is a matter of law that we review de novo. Id.

II. Analysis

The parties do not dispute the district court's construction of the following claim limitations: (1) conversion system; (2) fuel and air mixture; (3) pair of fuel injectors mounted in a fuel injector and throttle body; (4) individual pressurized fuel flow; and (5) control unit.

Budde challenges the district court's construction of the "electronic sensing means"

claim limitation. In its conditional cross-appeal, Harley-Davidson challenges the district court's construction of the "status sensing means" claim limitation. Harley-Davidson asserts that the district court erred in concluding that the specification of the '348 patent discloses structure corresponding to the "status sensing means limitation." Our analysis focuses on the construction of these two disputed claim limitations.

The parties agree that the two disputed claim limitations are written in means-plus-function form, and we agree. In construing means-plus-function claim limitations, a court must first define the particular function claimed. Thereafter, the court must identify "the corresponding structure, material, or acts described in the specification." It is not until the structure corresponding to the claimed function in a means-plus-function limitation is identified and considered that the scope of coverage of the limitation can be measured. 35 U.S.C. § 112, para. 6; Sage Prods., Inc v. Devon Indus., Inc., 126 F.3d 1420, 1428, 44 USPQ2d 1103, 1110 (Fed. Cir. 1997); In re Donaldson Co., 16 F.3d 1189, 1195, 29 USPQ2d 1845, 1850 (Fed. Cir. 1994) ("if one employs means-plus-function language in a claim, one must set forth in the specification an adequate disclosure showing what is meant by the language" (emphasis added)).

Whether or not the specification adequately sets forth structure corresponding to the claimed function necessitates consideration of that disclosure from the viewpoint of one skilled in the art. See 35 U.S.C. § 112, para. 1; N. Am. Vaccine, Inc. v. Am. Cyanamid Co., 7 F.3d 1571, 1579, 28 USPQ2d 1333, 1339 (Fed. Cir. 1993); cf. In re Ghiron, 442 F.2d 985, 991, 169 USPQ 723, 727 (CCPA 1971) (stating that "if such a selection would be 'well within the skill of persons skilled in the art', such functional-type block diagrams may be acceptable and, in fact, preferable if they serve in conjunction with the rest of the specification to enable a

person skilled in the art to make such a selection and practice the claimed invention with only a reasonable degree of routine experimentation"). Moreover, failure to disclose adequate structure corresponding to the recited function in accordance with 35 U.S.C. § 112, paragraph 1, results in the claim being of indefinite scope, and thus invalid, under 35 U.S.C. § 112, paragraph 2. In re Dossel, 115 F.3d 942, 945, 42 USPQ2d 1881, 1884 (Fed. Cir. 1997).

For a court to hold that a claim containing a means-plus-function limitation lacks a disclosure of structure in the patent specification that performs the claimed function, necessarily means that the court finds the claim in question indefinite, and thus invalid. Because the claims of a patent are afforded a statutory presumption of validity, overcoming the presumption of validity requires that any facts supporting a holding of invalidity must be proved by clear and convincing evidence. Ultra-Tex Surfaces, Inc. v. Hill Bros. Chem. Co., 204 F.3d 1360, 1367, 53 USPQ2d 1892, 1898 (Fed. Cir. 2000); Panduit Corp. v. Dennison Mfg. Co., 810 F.2d 1561, 1570, 1 USPQ2d 1593, 1595 (Fed. Cir. 1987) (stating that the presumption mandated by § 282 is applicable to all of the many bases for challenging a patent's validity). Thus, a challenge to a claim containing a means-plus-function limitation as lacking structural support requires a finding, by clear and convincing evidence, that the specification lacks disclosure of structure sufficient to be understood by one skilled in the art as being adequate to perform the recited function.

Electronic Sensing Means

Claim 1 of the '348 patent recites "an electronic sensing means for determining when the ignition system of the engine delivers an electronic pulse to fire each spark plug of the cylinders and producing an electronic signal in response thereto." The district court parsed the claimed function as: "(1) determining when the ignition system of the engine delivers an

electronic pulse to fire each spark plug of the cylinders; and (2) producing an electronic signal in response thereto." Order Construing Claims, slip op. at 9. Neither party disputes the district court's characterization of the claimed function, and we see no reason to disagree. The district court then held that the '348 patent "fails to disclose any structure corresponding to the claimed function of the electronic sensing means." Order Construing Claims, slip op. at 11.

Budde disputes the district court's analysis, asserting that the process by which the district court consulted the specification to define the structure corresponding to the claimed function was improper. Specifically, Budde asserts that the district court erred in impermissibly narrowing the term "determining" in the claimed function to require electronic "sensing." Although Budde's description of the district court's error is perhaps oversimplified, the district court in fact narrowed its own interpretation of the defined function, based on its incorrect reading of statements contained in the summary and objects of the invention. Based upon those portions of the patent disclosure, the district court erroneously stated that the structure corresponding to the claimed function could not be structure that sensed the position of the camshaft. We discuss the district court's error in more detail below.

As a quid pro quo for the convenience of employing § 112, paragraph 6, Budde has a duty to clearly link or associate structure to the claimed function. Kemco Sales, Inc. v. Control Papers Co., 208 F.3d 1352, 1360, 54 USPQ2d 1308, 1313 (Fed. Cir. 2000) (citing B. Braun Med., Inc. v. Abbott Labs., 124 F.3d 1419, 1424, 43 USPQ2d 1896, 1900 (Fed. Cir. 1997)). Budde asserted to the district court that Figure 3 and the following passage of the specification defined the structure capable of performing the claimed function:

> In the present invention, sensors are utilized to obtain a timing signal from the ignition system which is inputted to the control unit of the fuel injection system for utilization in controlling the operation of the fuel injectors. The

> Electronic ignition systems use sensors that may be optical (usually infrared), or magnetic (usually Hall effect devices). These sensors detect the windows cut in the sides of a metallic "cup" that is attached to the end of the cam shaft. Each window corresponds to a plug firing and the angle between the windows corresponds to the angle between the cylinders. The position of the lobes of a Breaker ignition system have a corresponding relationship. The output of the Electronic ignition system sensor is used directly by the control unit of the present invention.

Col. 5, ll. 31-45.

The district court held that neither the text nor the figure cited by Budde discloses structure capable of determining when the ignition system of the engine delivers an electronic pulse to fire the spark plugs. The district court found that the text cited by Budde merely identifies two types of sensors utilized by ignition systems in Harley-Davidson carbureted engines that detect windows in a cup on the camshaft, and that "the electronic sensing means called for by the claim may not be a structure that senses the position of the camshaft." Order Construing Claims, slip op. at 10-11.

The district court based this assertion on the following statements in the summary and objects of the '348 patent:

> "The present invention is designed to acquire the required timing information for providing the fuel injectors with their instructions by picking up an electronic pulse off the ignition system."

'348 patent, col. 2, ll. 21-24 (emphasis added).

> "An electronic sensing means is provided for determining when the ignition system of the engine delivers an electronic pulse to fire the spark plugs of the cylinders . . . ."

'348 patent, col. 1, l. 68 – col. 2, l. 3 (emphasis added).

> "It is another object of the invention to provide a fuel injection conversion system for Harley-Davidson motorcycle engines which is able to time the fuel injection sequence from analysis of the spark pulses . . . ."

’348 patent, col. 2, ll. 41-44 (emphasis added).

The district court found that these statements require the electronic sensing means to pick-up or sense high voltage pulses fed to the spark plugs from the ignition coil, rather than sensing camshaft position. Finding no structure for sensing the high voltage pulses fed to the spark plugs, the district court concluded that the ’348 patent specification failed to disclose structure corresponding to the claimed function of the electronic sensing means. We note, however, that the “electronic sensing means” claim limitation merely recites the functions of “determining when” pulses are delivered to fire the spark plugs and “producing an electronic signal in response thereto,” not the function of sensing the high voltage pulses sent from the ignition coil to the spark plugs. Contrary to the view of the district court, ‘determining’ when pulses are delivered to fire the spark plugs does not require direct detection of those pulses. Such a determination can be done indirectly, by detecting a low-voltage electronic signal from a sensor that determines, from the position of the cam shaft, when high-voltage pulses are to be delivered to the spark plugs. That interpretation of the manner in which the electronic sensing means determines when the ignition system delivers an electronic pulse to fire each spark plug is consistent with the statements in the summary and objects of the invention. These sections of the specification contrast the conventional system for obtaining timing information “from the electronic distributor,” ’348 patent, col. 2, ll. 25-26, with the system employed by the invention, i.e., obtaining timing information “from an analysis of the spark plug firing pulses,” ’348 patent, col. 2, ll. 33-34. In context, it appears that the “spark plug firing pulses” that are analyzed, and the “electronic pulse” that is “pick[ed] up . . . off the ignition system,” ’348 patent, col. 2, ll. 23-24, refer to the low-voltage signal from the electronic sensor, not the high-voltage pulse that is sent to fire the spark plugs.

The district court, and Harley-Davidson on appeal, rely heavily on a passage from the objects of the invention, which describes one of the objects as being to provide a fuel injection conversion system that is "able to time the fuel injection sequence from analysis of the spark pulses rather than from a mechanical electronic reading of the electro-mechanical or electronic-mechanical ignition timing unit which fires the spark plugs." '348 patent, col. 2, ll. 41-47. While the district court found that the "electro-mechanical ignition timing unit" referred to is a Hall effect device (or other device for sensing camshaft position), we think the better interpretation is that the reference to the "electronic-mechanical ignition timing unit" refers to the conventional method of acquiring timing information, which the specification identifies as "acquir[ing] the timing information from the electronic distributor." '348 patent, col. 2, ll. 25-26. The problem solved by this invention is determining which plug is being fired (in order to determine the proper fuel injection sequence) in the absence of a distributor. Thus, one skilled in the art would understand that the patent is referring to determining the proper injection sequence using a control unit that analyzes: (1) when the ignition system delivers a low voltage pulse to cause spark plug firing; and (2) the timing between delivery of the low voltage pulses. The control unit can perform this analysis based on the low voltage pulse received from a Hall effect device (or other optical or magnetic sensor), a solid-state sensor, or a standard mechanical point setup. Use of the control unit negates the need for a distributor to determine the proper injection sequence.

In supporting the district court's opinion, Harley-Davidson's attempts to prove a lack of corresponding structure focus on the disclosure set forth in the summary and objects of the invention and, in particular, statements that the claimed function includes an "analysis of the spark plug firing pulses." Harley-Davidson invites us to conclude therefrom that the claimed

function of "determining when the ignition system . . . delivers an electronic pulse to fire each spark plug" requires that the electronic sensing means analyze the firing pulses. To this end, Harley-Davidson points out that although their expert testified that a Hall effect device can determine a window within which spark plug firing occurs, he further testified that the Hall effect device could not determine the exact time of ignition coil activation. Harley-Davidson asserts that because the Hall effect device cannot determine the exact time of ignition coil activation, it does not analyze the spark plug firing pulses, and therefore it cannot perform the claimed function of determining when the ignition system delivers an electronic pulse to fire each spark plug. We are not persuaded by Harley-Davidson's argument, which fails to recognize that, as we have discussed, the summary and objects of the invention can fairly be read to refer to an electronic sensing means that determines the firing sequence of the spark plugs by detecting a low-voltage electronic signal from a sensor within the ignition system. Moreover, whatever force Harley-Davidson's argument might have viewing the summary and objects of the invention sections of the specification in isolation, it cannot be squared with the specific passage that describes in detail the electronic sensing means, see '348 patent, col. 5, ll. 31-56.

The specification must be read as a whole to determine the structure capable of performing the claimed function. See 35 U.S.C. § 112, para. 6 (1994) (requiring that a means-plus-function claim limitation "be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof" (emphasis added)); see also Serrano v. Telular Corp., 111 F.3d 1578, 1583, 42 USPQ2d 1538, 1542 (Fed. Cir. 1997) (holding that the proper construction of a claim limitation under § 112, paragraph 6 looks to the "[d]isclosed structure [that] is described in a patent specification, including any alternative

structures identified"). In construing terms used in patent claims, it is necessary to consider the specification as a whole, and to read all portions of the written description, if possible, in a manner that renders the patent internally consistent. In addition, it is important to construe claim language through the "viewing glass" of a person skilled in the art. Interactive Gift Express, Inc. v. Compuserve Inc., 231 F.3d 859, 866, 56 USPQ2d 1647, 1653 (Fed. Cir. 2000).

As discussed previously, the problem solved by the Budde invention is how to determine which cylinder needs a charge of fuel in an engine that has no distributor and fires both plugs simultaneously. This problem is preferably solved without making impractical and undesired mechanical modifications to the engine. This is achieved by deriving the needed timing information electronically, rather than mechanically, by analyzing the asymmetrical pulse train generated by the engine's existing ignition system. Analysis of the pulse train determines when each cylinder is ready for a fuel charge. As described in the '348 patent specification, the control unit of the patented system receives as an input the low voltage timing pulses picked up from the existing ignition system. These pulses trigger the simultaneous firing of the spark plugs and, by their asymmetry, impart information that the control unit uses to determine electronically, rather than mechanically, which of the two cylinders is on the power stroke and is thus ready for a fuel charge.

The summary and objects of the invention are followed by a description of the preferred embodiment, and must be read, if possible, in a manner consistent with the rest of the written description. The rest of the written description clearly states that "there are three types of motorcycle ignition systems: Breaker, Electronic, and Magneto. Any one of these types may be in use on a Harley engine, and the solution to providing a conversion system requires the

adaptability to determine fuel injector timing from any one of them." '348 patent, col. 4, l. 66–col. 5, l. 3 (emphasis added). At column 5, lines 35-51, a number of alternative sensors are disclosed that determine when the ignition system delivers a low voltage electronic pulse to fire the spark plugs. The alternative sensors include: (1) an optical sensor; (2) a magnetic sensor (e.g., a Hall effect device); (3) a standard mechanical point setup; and (4) a solid-state sensor. As we discussed in the background portion of this opinion, the detailed description discloses not only each of these sensors, but how the signals from those sensors are fed as an input to the control unit which, in turn, analyzes the low voltage timing pulses to determine electronically when each cylinder needs a fuel charge. These four sensor types are listed under the heading of "Electronic Sensing" in the description of the preferred embodiment, thus directly linking the disclosed structure to the "electronic sensing means" limitation in the claims. Each of these sensors is structure corresponding to the claimed function of the electronic sensing means. They each determine when the engine's ignition system delivers a timing pulse to fire the spark plugs and produce electrical signals in response thereto.

Harley-Davidson also relies on a portion of co-inventor Knapp's deposition testimony to show that co-inventor Knapp could not find structure in the specification of the '348 patent corresponding to the electronic sensing means. However, the portion of the testimony that Harley-Davidson cites is not sufficient to render negligible the written description of the four embodiments of the electronic sensing means discussed above.

In addition, we note that the district court's Order Construing Claims discussed neither the level of skill in the art, nor the requirement that a lack of corresponding structure be proven by clear and convincing evidence. In fact, the district court never addressed the validity of claim 1. It merely concluded, in its Order Construing Claims, that there was no structure

corresponding to the claimed function of the "electronic sensing means." Despite the fact that the district court entered its judgment of non-infringement without addressing the issue of validity, its decision necessarily renders claim 1 invalid. Thus, the district court should have applied the "clear and convincing" evidentiary standard in assessing Harley-Davidson's assertion that the specification of the '348 patent fails to disclose structure corresponding to the "electronic sensing means." The district court's failure to apply the correct "clear and convincing" standard to Harley-Davidson's evidentiary submission on this issue is another reason why we hold that the district court's construction of the "electronic sensing means" limitation was erroneous. So holding requires us to consider Harley-Davidson's conditional cross appeal.

Status Sensing Means

Claim 1 of the '348 patent includes "a status sensing means for measuring a combination of air intake and engine temperature, and vacuum in the intake manifold and producing electronic signals therefrom."

The district court correctly identified the claimed function as: "(1) measur[ing] a combination of air intake and engine temperature; (2) measur[ing] vacuum in the intake manifold; [and] (3) produc[ing] electronic signals from those measurements." Order Construing Claims, slip op. at 12. The parties do not dispute that the specification of the '348 patent discloses a thermistor as the structure capable of performing the first and third functions. However, the parties dispute whether the patent sufficiently discloses structure capable of performing the second function, i.e., measuring vacuum in the intake manifold. The district court held that the corresponding structure was identified in the written description of

the patent as a "commercially available" vacuum sensor that produces an analog signal. Harley-Davidson asserts that this generic reference in the specification of the '348 patent does not adequately disclose structure for measuring vacuum in the intake manifold.

The specification states, at column 6, lines 38-40, "vacuum sensors are commercially available units which produce analog signals for the control unit." In addition, Figure 3 of the '348 patent is a block diagram of the fuel injection controller that includes a box labeled "VACUUM SENSOR."

In its claim construction analysis and corresponding determination of definiteness of the means-plus-function claims under 35 U.S.C. § 112, paragraph 2, the district court held that "the box labeled VACUUM SENSOR and the passage describing 'commercially available units' meet the definiteness requirement of § 112, ¶ 2." Order Construing Claims, slip op. at 14. The district court explained,

> Vacuum sensors were well known in the art of motorcycle engine manufacturing at the time the patent issued. The phrase "commercially available units" particularly and distinctly pointed out to those skilled in the art the vacuum sensors [that] the '348 patent claimed. Accordingly, the structure which corresponds to the [second function] is a vacuum sensor which produces an analog signal and which was commercially available at the time the patent was issued.

Id.

Harley-Davidson asserts that Budde's use of "commercially available units" unfairly allows him to incorporate by reference every commercially available vacuum sensor, which is not allowable under our holding in Atmel Corporation v. Information Storage Devices, Inc., 198 F.3d 1374, 1381, 53 USPQ2d 1225, 1229 (Fed. Cir. 1999). We are not persuaded by this argument because the facts of the present case are distinguishable from Atmel.

In Atmel, the means-plus-function claim limitation was "high voltage generating means

disposed on said semiconductor. . . ." 198 F.3d at 1376, 53 USPQ2d at 1226. The specification stated, "the present invention may include high-voltage generator circuit 34. Known Circuit techniques are used to implement high-voltage circuit 34. See On-Chip High Voltage Generation in NMOS Integrated Circuits Using an Improved Voltage Multiplier Technique, IEEE Journal of Solid State Circuits, Volume SC-11, No. 3, June 1976." Id. In addition, the figures of the patent depicted the high voltage generator circuit 34 a s a black box. Id. at 1377, 53 USPQ2d at 1226. This court held that the patentee could not incorporate the disclosure of the cited article by reference to fulfill the definiteness requirement of § 112, paragraph 2. Id. at 1382, 53 USPQ2d at 1230. In other words, the content of the article could not be used to discern sufficient structure in the specification that corresponded to the claimed function.

In the present case, the issue is not whether subject matter absent from the specification can be incorporated by reference to satisfy the requirement that corresponding structure be adequately described in the specification. The issue is whether the characterization, in the patent specification, of the vacuum sensor as a "commercially available unit" would be understood by one skilled in the art as structure capable of performing the function recited in the claim limitation. The record reflects, as found by the district court, that vacuum sensors were well known in the art. See In re Dossel, 115 F.3d at 946-47, 42 USPQ2d at 1885 ("Clearly, a unit which receives digital data, performs complex mathematical computations and outputs the results to a display must be implemented by or on a general or special purpose computer (although it is not clear why the written description does not simply state 'computer' or some equivalent phrase.)").

Harley-Davidson points to its expert's testimony at the Markman hearing that the expert "didn't see any description in the patent of the vacuum sensor other than that [the invention] has one and it's in the diagram." Relying on Atmel, Harley-Davidson argues that testimony from those skilled in the art is instructive as to whether the specification discloses structure corresponding to the claimed function. Atmel, 198 F.3d at 1379, 53 USPQ2d at 1228. However, Harley-Davidson's expert misses the mark in not shedding any light on the significance to, or understanding of, one skilled in the art of the described "commercially available" vacuum sensor. He also admitted that he was "not very well versed in pressure sensors." This is hardly the type of testimony that amounts to clear and convincing evidence that one skilled in the art would not understand the scope of claim 1 when read in light of the specification. In view of the foregoing, we conclude that the district court did not err in holding that the '348 patent sufficiently discloses structure capable of measuring vacuum in the intake manifold.

CONCLUSION

Because the judgment of non-infringement was entered based on an erroneous claim construction of "electronic sensing means," we vacate the judgment of non-infringement and remand for further proceedings consistent herewith.

VACATED AND REMANDED