

# United States Court of Appeals for the Federal Circuit

03-1574, -1614

CENTRICUT, LLC (New Hampshire),

Plaintiff/Counterclaim Defendant-  
Appellant,

and

CENTRICUT, LLC (Delaware),

Counterclaim Defendant-Appellant,

v.

THE ESAB GROUP, INC.,

Defendant/Counterclaimant-  
Cross Appellant.

Edward A. Haffer, Sheehan Phinney Bass & Green, PA, of Manchester, New Hampshire, argued for plaintiffs/counterclaim defendants-appellants. With him on the brief were Michael J. Bujold and Neal E. Friedman, Davis & Bujold, P.L.L.C., of Manchester, New Hampshire.

Blas P. Arroyo, Alston & Bird, LLP, of Charlotte, North Carolina, argued for defendant/counterclaimant-cross appellant. With him on the brief was Richard M. McDermott.

Appealed from: U.S. District Court for the District of New Hampshire

Judge Steven J. McAuliffe

# United States Court of Appeals for the Federal Circuit

03-1574, -1614

CENTRICUT, LLC (New Hampshire),

Plaintiff/Counterclaim Defendant-  
Appellant,

and

CENTRICUT, LLC (Delaware),

Counterclaim Defendant-Appellant,

v.

THE ESAB GROUP, INC.,

Defendant/Counterclaimant-  
Cross Appellant.

---

DECIDED: December 6, 2004

---

Before MICHEL, CLEVINGER, and DYK, Circuit Judges.

DYK, Circuit Judge.

Centricut, LLC (New Hampshire) and Centricut, LLC (Delaware) (collectively “Centricut”) appeal the judgment of the United States District Court for the District of New Hampshire, finding that Centricut infringed U.S. Patent No. 5,023,425 (the “’425 patent”) and assessing damages in favor of The Esab Group, Inc. (“Esab”), the assignee of the ’425 patent. Esab cross appeals the damages award. We hold that Esab did not meet its burden in proving infringement, reverse the judgment of infringement, and dismiss the cross appeal as moot.

## BACKGROUND

The central issue in this case is whether the absence of relevant expert testimony resulted in a failure of proof.

### I

Esab and Centricut are competitors in the plasma arc cutting torch market. Both companies manufacture and sell electrodes used in plasma arc torches. The electrodes must be replaced periodically. Centricut manufactures replacement electrodes. Esab is the assignee of the '425 patent, which claims an electrode for plasma arc torches and a method of fabricating the electrode. Centricut filed for a declaratory judgment that its product did not infringe the '425 patent. Centricut also sought a declaration that the '425 patent was invalid and unenforceable. Esab counterclaimed, alleging that Centricut had infringed, inter alia, claims 1 and 8 of the '425 patent.

### II

Plasma arc torches use an electric arc to superheat a stream of gas to temperatures of around 30,000 degrees Kelvin. This heated, ionized gas, or plasma, is used to cut metal. Different gasses are used to cut metals of different types and thicknesses. Oxygen gas is particularly suitable for cutting carbon steel up to one and one-half inches thick. However, cutting with oxygen is difficult because its use leads to frequent electrode failures and short electrode life.

Most prior art plasma arc torch electrodes consist of two parts: an emissive insert and a holder. The electric arc (that heats the gas) knits off of the emissive insert and runs between the electrode and the metal being cut. The emissive insert is commonly made of a metal such as hafnium, zirconium, or tungsten, or an alloy of these metals.

The emissive insert is embedded in the holder. The holder is commonly made of a high thermal conductivity metal such as copper or an alloy of copper, and apparently cools the emissive insert with means such as circulating water.

The electrode of the '425 patent renders the plasma arc cutting of carbon steel by use of oxygen gas more economical as compared to prior art electrodes. The '425 patent discloses a three-part electrode that comprises an emissive insert, a holder, and a sleeve positioned between the emissive insert and the holder. The emissive insert and holder of the '425 patent's electrode are composed of the same materials as prior art electrodes. '425 patent, col. 3, ll. 4-46. The '425 patent states that prior art electrodes operating in an oxidizing environment, such as oxygen or air, fail when the copper holder oxidizes and begins to support the arc in preference to the emissive insert. Id. at col. 1, ll. 33-43. This occurs because oxidized copper has a lower "work function" than non-oxidized copper. Id.

What is different about the '425 patent is the sleeve. The sleeve is made of a material, such as silver, with a high "work function" relative to the emissive insert. Id. at cols. 1-2. The addition of the sleeve keeps the arc on the emissive insert even as the copper holder becomes oxidized and thus increases the electrode's useful life. Id. at col. 2, ll. 23-28. Therefore, according to the '425 patent, the improved performance of the electrode is a result of the relative "work functions" of the emissive insert, the holder, and the sleeve.

Claim 1 of the '425 patent is stated in terms of "work function" and reads:

1. An electrode adapted for supporting an arc in a plasma arc torch and comprising  
a metallic holder having a front end, and a cavity in said front end,  
and

an insert assembly mounted in said cavity and comprising an emissive insert composed of a metallic material having a relatively low work function, and a sleeve surrounding said emissive insert so as to separate said emissive insert from contact with said holder, said sleeve having a radial thickness of at least 0.1 inches at said front-end and being composed of a metallic material having a work function which is greater than that of the material of said emissive insert, and said sleeve being composed of a metal which is selected from the group consisting of silver, gold, platinum, rhodium, iridium, palladium, nickel, and alloys wherein at least 50% of the composition of the alloy consists of one or more of said metals and

whereby said sleeve acts to resist movement of the arc attachment point from said insert to said holder.

Id. at col. 7, ll. 26-47 (emphases added).<sup>1</sup>

By agreement of the parties, the district court construed the term “work function” as ‘the potential step, measured in electron volts, which permits thermionic emission

---

<sup>1</sup> Claim 8 provides:

8. An electrode adapted for supporting an arc in a plasma arc torch and comprising

a metallic tubular holder defining a longitudinal axis and having a front end and a rear end, and a transverse end wall closing said front end, said transverse end wall having a substantially planar outer front face which is perpendicular to said longitudinal axis, and a cavity formed in said front face and which extends rearwardly along said longitudinal axis, and

an insert assembly mounted in said cavity and comprising

(a) a generally cylindrical emissive insert disposed coaxially along said longitudinal axis and having an outer end face lying in the plane of said front face of said holder, said emissive insert being composed of a metallic material having a relatively low work function so as to be adapted to readily emit electrons upon an electric potential being applied thereto, and

(b) a sleeve positioned in said cavity coaxially about said emissive insert, said sleeve having a radial thickness of at least about 0.1 inches at said front end and being composed of a metallic material having a work function which is greater than that of the material of said holder and greater than that of the material of said emissive insert, said metallic sleeve being selected from the group consisting of silver, gold, platinum, rhodium, iridium, palladium, nickel, and alloys wherein at least 50% of the composition of the alloy consists of one or more of said metals, and

whereby said sleeve acts to resist movement of the arc attachment point from said insert to said holder.

<sup>1</sup>425 patent, col. 8, ll. 27-61 (emphases added).

from the surface of a metal at a given temperature.” Centricut, LLC v. Esab Group, Inc., No. 99-CV-39, slip op. at 9 (D.N.H. Feb. 7, 2002). “Work function is an energy. It’s the energy that’s required to remove an electron from inside the material to outside the material.” (J.A. at 645.) By definition it is easier to move an electron from a low work-function surface than a high work-function surface.

Centricut’s accused electrode is similar to Esab’s patented electrode. It comprises an emissive insert composed of hafnium or hafnium alloy, a holder composed of copper or copper alloy, and a ring or washer (which Esab viewed as satisfying the “sleeve” requirement) composed of silver or silver alloy positioned between the emissive insert and the holder.<sup>2</sup> Like Esab’s electrode, the Centricut electrode exhibits significantly reduced electrode failure and a longer useful life than prior art electrodes when used with oxygen gas.

### III

The district court held a bench trial to determine (1) whether Centricut’s accused device infringed claims 1 and 8 of the ’425 patent; (2) whether the ’425 patent was invalid due to anticipation or obviousness; and (3) what, if any, damages should be awarded if the ’425 patent was in fact valid and infringed. There was no dispute

---

<sup>2</sup> The ’425 patent includes several limitations, in addition to work function, that Centricut argues its accused device does not meet. First, Centricut contends that the “sleeve” limitation is not met because the accused device has a ring or washer surrounding only the front portion of the emissive insert, while the sleeve of the patent surrounds substantially all of the emissive insert. Second, Centricut contends that the “cavity” limitation is not met because the hole into which the emissive insert and sleeve of the accused device are mounted is a through-hole (i.e., it does not have a back end) while the patent calls for a blind cavity. The district court held in favor of Esab on both of these claim construction issues. On appeal, Centricut urges that the district court’s construction of these claim limitations was also erroneous. In view of our disposition, we do not reach these issues, and accordingly do not discuss them further.

concerning the district court's claim construction of the work-function limitation. The question was whether the accused device satisfied the limitation. Both parties called witnesses to testify on infringement and with respect to work function, although Centricut was the only party to introduce expert testimony. Neither party introduced any evidence of tests conducted to directly measure the work function of the materials used in the accused device. Indeed, neither party introduced evidence of tests or other evidence concerning the exact materials used in the accused device. The only test evidence that Esab introduced concerning the accused device concerned the useful life. In that test, Esab used prior art electrodes and the accused device for long periods of time, usually until the point of failure. The tests showed that the accused device had an average useful life over four times longer than prior art electrodes.

Centricut's expert, physics professor Dr. Marten denBoer, testified that it was not possible to determine the relative work functions of the sleeve and the emissive insert of the accused device without direct testing because many factors affect the work function of a surface. In support of this testimony he submitted tables from various reference texts reporting the work functions of samples of various pure elements, but concluded that these tables established nothing about the relative work function of the sleeve and emissive insert of the accused device. This is because work function is not an intrinsic property of a metal, but is rather a property of specific surfaces under specific conditions. The tables were therefore not representative of the torch under actual operating conditions.

In contrast, Esab argued that the tables showed the Centricut electrode infringed because the work-function values recorded in the tables for hafnium were lower than

almost all of those recorded for silver. Esab argued alternatively that the useful life testing was a surrogate for relative work function and that, because Centricut's accused electrode displayed a significantly longer useful life than prior art electrodes, it must be because the sleeve had a higher work function than the emissive insert. Finally, Esab argued that the relative work functions of hafnium and silver could be inferred from hafnium's use in emissive inserts and silver's nonuse in emissive inserts. As discussed in greater detail below, Esab introduced no expert testimony in support of any of these three alternative theories.

Claims 1 and 8 of the '425 patent differ in that claim 1 requires the sleeve to have a work function higher than that of the emissive insert, whereas claim 8 requires the sleeve to have a work function higher than that of both the emissive insert and the holder. The district court concluded that Centricut had infringed claim 1, and indicated that the work-function limitation of claim 1 had been satisfied.

The district court noted Esab's argument that the long useful life of the accused electrode must be due to the relative work functions of the sleeve and emissive insert. Centricut, LLC v. Esab Group, Inc., No. 99-CV-39, slip op. at 6 (D.N.H. July 9, 2003). However, although the district court mentioned the useful life theory, it did not adopt it. Instead, the district court held that the work-function limitation of claim 1 was met by the accused device by relying upon the tables<sup>3</sup> originally submitted by Centricut's expert, stating:

---

<sup>3</sup> The work-function tables reported work-function values for numerous elements. Many of the tables before the court provided data on multiple samples of the same element using multiple methods for measuring work function. For example, one table reports sixteen work-function values for silver ranging from 3.08-4.81eV. (J.A. at 1361.) The same table reported a single value of 3.53eV for hafnium. (Id. at 1362.) On



Centricut established that physical circumstances could be manipulated in such a way that some silver could indeed have a work function lower than that of some hafnium [sic]. At the same time, however, it is clear from the scientific references excerpted in Esab's Exhibit 25 [the tables] that silver commonly has a higher work function than hafnium [sic]. Nothing in the record suggests that Centricut made its silver sleeves from one of the relatively few low-work-function forms of silver. It is more likely than not that the accused electrodes' sleeves were made from common forms of silver having a higher work function than hafnium [sic].

Id. at 8 (footnote omitted). Thus, the district court found that Centricut's insert was made of hafnium and its sleeve was made of silver, and, because the tables commonly disclosed higher work-function values for silver than hafnium, Centricut's electrode probably infringed. The district court defended its use of the work-function tables by concluding that although the tables "might not establish to a physical certainty that the silver used by Centricut has a higher work function than the hafnium [sic] in its inserts, those standard references are sufficiently persuasive to support that finding by a preponderance of the evidence." Id. at 8 n.4.

In contrast, the district court held that Centricut did not infringe claim 8 because "the readily available work-function tables disclose too great an overlap in relative work-function values for silver and copper to give rise to a reliable inference one way or the other." Id. at 10. The district court refused to find infringement under the doctrine of equivalents, holding that "Esab's admittedly imprecise description of the physics of plasma arc torch operation is fatal to its claim of infringement under the doctrine of equivalents." Id. at 11. The district court further held that claim 1 of the '425 patent was not invalid due to anticipation or obviousness. Based upon its finding of infringement of

---

this table, one of the work-function values reported for silver was less than the work-function value reported for hafnium.

claim 1 of the '425 patent, the district court ordered Centricut to pay \$2,182,972.24 in damages plus prejudgment interest, and enjoined Centricut from infringing claim 1 of the '425 patent. Centricut appeals.<sup>4</sup> Esab cross appeals the damages award. We have jurisdiction pursuant to 28 U.S.C. § 1295(a)(1).

## DISCUSSION

This case presents the question whether Esab satisfied the burden of proof on infringement in the absence of expert testimony comparing the claims as construed with the accused device. We hold that Esab failed to carry its burden.

### I

The district court's determination of infringement is a question of fact that we review for clear error. Apex Inc. v. Raritan Computer, Inc., 325 F.3d 1364, 1371 (Fed. Cir. 2003). "A finding is 'clearly erroneous' when although there is evidence to support it, the reviewing court on the entire evidence is left with the definite and firm conviction that a mistake has been committed." United States v. United States Gypsum Co., 333 U.S. 364, 395 (1948).

### II

The patentee has the burden of proving infringement by a preponderance of the evidence. Seal-Flex, Inc. v. Athletic Track and Ct. Constr., 172 F.3d 836, 842 (Fed. Cir. 1999). Centricut argues that Esab did not satisfy its burden of proof on infringement because it did not show that the accused device satisfied the work-function limitation. Esab argues that it did, for three reasons. None of these theories was supported by expert testimony.

---

<sup>4</sup> The district court's holding that the '425 patent was not invalid has not been appealed.

First, Esab urges (a little half-heartedly) that the district court's reasoning was correct. As noted above, the district court found the work-function tables showed that the accused device met the work-function limitation by a preponderance of the evidence, even though the only expert testimony directly contradicted this conclusion.

Centricut called as its witness Dr. Marten denBoer, a physics professor who was qualified as an expert witness on the issue of work function. He filed an expert report to which a number of work-function tables from various scientific reference books were appended. The tables reported the measured work functions of samples of various pure metals, including silver and hafnium. In the report, Dr. denBoer attempted to rank the work functions of copper, hafnium, and silver. He concluded that "tabulated values of . . . work function are . . . of limited value in attempting to rank work functions of specific materials" because many factors affect the work function of a surface. (J.A. at 1335.) Dr. denBoer's subsequent testimony and affidavits supported his conclusion in the report that reference to work-function tables is an unreliable way to rank the work functions of specific materials. In particular, he testified that work function is a property of specific surfaces, not of specific elements as represented in the tables. He also testified that the tables were prepared under much different conditions than a torch in operation and that these differences in conditions greatly impact the work function measurement. He concluded that the tables were not probative as to the relative work functions in the actual accused device.

Esab barely mentions the work-function tables in its brief. Esab points to no expert testimony or contrary testimony supporting the use of the tables.

### III

Alternatively Esab urges that it satisfied its burden of proof on the work-function issue by showing that the accused device had a longer useful life than devices without the sleeve and that the extended useful life was attributable to work function. Esab's sole testimony attempting to show that useful life is a surrogate for work function was the testimony of the inventor, Wayne Severance. His testimony can be read to support Esab's theory. Severance provided an explanation for why useful life is probative of work function. He testified that the failure of an electrode usually occurs when the arc moves off of the hafnium insert and onto the copper holder. When this occurs, the holder rapidly deteriorates and the electrode is destroyed. He theorized that the arc moves because the copper holder oxidizes to the point where its work function is lower than that of the hafnium insert. He further theorized that the silver sleeve resists the movement of the arc from the insert to the holder because the sleeve has a higher work function, and, therefore, the arc is less likely to knit off of the sleeve. When asked about other properties that might explain the longer useful life, Severance testified that work function was the only explanation.

However, Centricut presented extensive expert testimony by Dr. denBoer that longer useful life could be attributed to a number of different factors, including temperature, the geometry of the electrode, the thermal and electrical conductivity of the sleeve, or the sleeve's resistance to oxidation, and that it was not reasonable to conclude that longer useful life was attributable to work function. Dr. denBoer, Centricut's work-function expert, stated unequivocally that, while he did not know why

the sleeve affects useful life, the useful life tests conducted by Esab told him “absolutely nothing about work function.” (J.A. at 679.)

As with the first theory, there was no supporting expert testimony. Severance, the inventor, was not qualified as an expert witness on any matter under Rule 702 of the Federal Rules of Evidence. More to the point, he admitted that he was not an expert on the issue of work function. He admitted that he had not studied the subject at college, and had no graduate degree. He also did not claim to have acquired an expert’s knowledge of work function during the course of his employment. In short, he offered no foundation for offering reliable testimony on work function.

#### IV

Esab offers a final theory as to why the accused device reads on claim 1 of the '425 patent. Esab asserts that testimony regarding the general properties of hafnium and silver, and their use within the plasma arc torch field, was sufficient to prove that the work-function limitation was satisfied. Esab argues that it is generally known that hafnium is highly emissive and that its use in emissive inserts proves this, while silver is a poor emitter, and that its nonuse in emissive inserts proves this. Esab theorizes that emissivity and work function are the same.

Again the district court made no finding supporting such a theory, and again the theory was not supported by expert testimony. There was no expert testimony that emissivity and work function are the same. The only expert witness to address the issue, Dr. denBoer, testified that although they are related, work function and emissivity are not the same. None of the witnesses upon which Esab relies for the contrary view had an expert knowledge of work function. Charles Landry identified himself as

Centricut's director of engineering and technical support, but affirmatively disclaimed expert knowledge of work function. Daniel O'Hara was Centricut's plasma arc cutting torch expert, but he too admitted to having "a limited understanding of work function." (J.A. at 278.) Richard Couch, CEO of Centricut's parent company Hypertherm, testified that, although he was skilled in the art of plasma arc torches, he was familiar with work function only "in a very general sort of way." (J.A. at 908.) Patrick Byrne, the former president, CEO, and chairman of the board of Centricut, testified that someone explained work function to him during his first day at Centricut, but that he never discussed work function again in the three years he was there, nor did he have any sort of scientific training. Severance, a senior staff engineer at Esab and the inventor of the '425 patent, cannot be considered an expert on work function for the reasons already discussed. In summary, all of the witnesses upon which Esab relies to support this argument lacked expert knowledge of work function.

Thus, each of Esab's three theories suffers from the same deficiency: none is supported by expert testimony. The first theory, adopted by the district court, rests on the district court's own interpretation of the evidence. The latter two theories rest on the testimony of witnesses who were admittedly not experts on work function.

V

In many patent cases expert testimony will not be necessary because the technology will be "easily understandable without the need for expert explanatory testimony." Union Carbide Corp. v. Am. Can Co., 724 F.2d 1567, 1573 (Fed. Cir. 1984); see also Bernhardt, L.L.C. v. Collezione Europa USA, Inc., 386 F.2d 1371, 1384 (Fed. Cir. 2004). But there is no claim that this is such a case. Indeed, in this case the

technology involved was complex. The district court concluded that “the field of technology from which [the invention] sprang is so poorly understood that it qualifies as a ‘black art.’” Centricut, LLC v. Esab Group, Inc., No. 99-CV-39, slip op. at 20 n.6 (D.N.H. July 9, 2003).

In other areas of the law courts have held that relevant expert testimony regarding matters beyond the comprehension of laypersons is sometimes essential.<sup>5</sup> Expert testimony may be similarly important in patent cases involving complex technology such as this one. Where the field or art is complex, we have repeatedly approved the use of expert testimony to establish infringement. See, e.g., Ultradent Prods., Inc. v. Life-Like Cosmetics, Inc., 127 F.3d 1065, 1070 (Fed. Cir. 1997). We have also noted that “typically” expert testimony will be necessary in cases involving complex technology. Schumer v. Lab. Computer Sys., Inc., 308 F.3d 1304, 1315 (Fed. Cir. 2002).

We do not state a per se rule that expert testimony is required to prove infringement when the art is complex. Suffice it to say that in a case involving complex

---

<sup>5</sup> See, e.g., Wills v. Amerada Hess Corp., 379 F.3d 32, 36-37, 41 (2d Cir. 2004) (estate of a deceased seaman suing under the Jones Act claimed that long-term exposure to toxic chemicals caused the decedent’s death; held “that: . . . expert testimony on the issue of causation is necessary in Jones Act cases where a lay juror could not be expected to intuit the causal relationship between the acts in question and the injury”); Allison v. McGhan Med. Corp., 184 F.3d 1300, 1320 (11th Cir. 1999), (“expert testimony was essential to prove causation” in products liability case); Mitchell v. United States, 141 F.3d 8, 13 (1st Cir. 1998) (“Under Massachusetts tort law . . . a plaintiff in a medical malpractice action may carry his or her burden of proof on the issues of negligence and causation only with the assistance of expert testimony.”) (citations omitted); Whelan Assocs. Inc. v. Jaslow Dental Labs., Inc., 797 F.2d 1222, 1232-33 (3d Cir. 1986) (“expert testimony is essential to even the most fundamental understanding of” computer programs that were the subject of the copyright infringement case); Carroll v. Beto, 421 F.2d 1065, 1068 (5th Cir. 1970) (lay testimony not sufficient to establish competence to stand trial; “expert testimony [is] essential” to the determination of accused’s competence to stand trial).

technology, where the accused infringer offers expert testimony negating infringement, the patentee cannot satisfy its burden of proof by relying only on testimony from those who are admittedly not expert in the field. That is what happened here, and the patentee thus failed to satisfy its burden of proof. This case stands as an apt example of what may befall a patent law plaintiff who presents complex subject matter without inputs from experts qualified on the relevant points in issue when the accused infringer has negated infringement with its own expert.

Esab does not argue that a remand is necessary or appropriate to determine infringement under the doctrine of equivalents. Esab's cross appeal of the district court's damages award is dismissed as moot.

#### CONCLUSION

The decision of the district court is

REVERSED.

#### COSTS

No costs.