United States Court of Appeals,
Federal Circuit.

ARRHYTHMIA RESEARCH TECHNOLOGY, INC., Plaintiff-Appellant,
v.

CORAZONIX CORPORATION, Defendant-Appellee.

No. 91-1091

March 12, 1992

Rehearing Denied May 5, 1992

Holder of patent directed to analysis of electrocardiographic signals in order to determine certain characteristics of heart function brought infringement suit. The United States District Court for the Northern District of Texas, A. Joe Fish, and John B. Tolle, JJ., declared patent invalid for failure to claim statutory subject matter, and plaintiff appealed. The Court of Appeals, Pauline Newman, Circuit Judge, held that process and apparatus claims satisfied criteria for statutory subject matter.
Reversed and remanded.
Rader, Circuit Judge, filed concurring opinion.

West Headnotes

[1] KeyCite this headnote

291 Patents
291I Subjects of Patents
291k4 Arts
291k6 k. Principles or Laws of Nature. Most Cited Cases

291 Patents KeyCite this headnote
291II Patentability
291II(A) Invention; Obviousness
291k16.2 k. Ideas and Abstract Principles. Most Cited Cases

291 Patents KeyCite this headnote
291II Patentability
291II(A) Invention; Obviousness
291k16.3 k. Natural or Scientific Phenomena or Principles. Most Cited Cases

Laws of nature, physical phenomena, and abstract ideas are not patentable. 35 U.S.C.A. § 101.

[2] KeyCite this headnote

291 Patents
291I Subjects of Patents
291k4 Arts
291k6 k. Principles or Laws of Nature. Most Cited Cases

291 Patents KeyCite this headnote
291I Subjects of Patents
291k4 Arts
291k7 k. Process or Methods in General. Most Cited Cases

291 Patents KeyCite this headnote
291II Patentability
291II(A) Invention; Obviousness
291k16.2 k. Ideas and Abstract Principles. Most Cited Cases

291 Patents KeyCite this headnote
291II Patentability
291II(A) Invention; Obviousness
291k16.3 k. Natural or Scientific Phenomena or Principles. Most Cited Cases

Claims directed solely to an abstract mathematical formula or equation, including the mathematical expression of scientific truth or law of nature, whether directly or indirectly stated, are nonstatutory; whereas claims to a specific process or apparatus that is implemented in accordance with a mathematical algorithm will generally satisfy patent statute. 35 U.S.C.A. § 101.

[3] KeyCite this headnote

291 Patents
291I Subjects of Patents
291k4 Arts
291k7.14 k. Particular Processes or Methods as Constituting Invention. Most Cited Cases

Under test for statutory subject matter when invention is described in terms of mathematical procedures, it is first determined whether mathematical algorithm is recited directly or indirectly in the claim; if so, it is next determined whether claimed invention as a whole is no more than the algorithm itself; this is, whether the claim is directed to a mathematical algorithm that is not applied to or limited by physical elements or process steps; such claims are nonstatutory; however, when mathematical algorithm is applied in one or more steps of an otherwise statutory process claim, or one or more elements of an otherwise statutory apparatus claim, requirements of patent statute are met. 35 U.S.C.A. § 101.

[4] KeyCite this headnote

291 Patents
291I Subjects of Patents
291k4 Arts
291k7.14 k. Particular Processes or Methods as Constituting Invention. Most Cited Cases

Use of mathematical formulae or relationships to describe electronic structure and operation of an apparatus does not make it nonstatutory; when mathematical formulae are the standard way of expressing certain functions or apparatus, it is appropriate that mathematical terms be used. 35 U.S.C.A. § 101.

[5] KeyCite this headnote

291 Patents
291I Subjects of Patents
291k4 Arts
291k7.14 k. Particular Processes or Methods as Constituting Invention. Most Cited Cases

Process and apparatus claims for invention directed to analysis of electrocardiographic signals in order to determine certain characteristics of heart function satisfied criteria for statutory subject matter. 35 U.S.C.A. § 101.

KeyCite this headnote

291 Patents
291XIII Decisions on the Validity, Construction, and Infringement of Particular Patents
291k328 Patents Enumerated
291k328(2) k. Original Utility. Most Cited Cases

4,422,459. Declared valid.

***1054** John F. Flannery, Fitch, Even, Tabin & Flannery, Chicago, Ill., argued for plaintiff-appellant. With him on the brief was Robert J. Fox.

Robert W. Turner, Jones, Day, Reavis & Pogue, Dallas, Tex., argued for defendant-appellee. With him on the brief was John E. Vick, Jr., Hubbard, Thurman, Tucker & Harris, Dallas, Tex.

Before NEWMAN, LOURIE and RADER, Circuit Judges.

PAULINE NEWMAN, Circuit Judge.
Arrhythmia Research Technology, Inc. appeals the grant of summary judgment by the

United States District Court for the Northern District of Texas [FN1] declaring United States Patent No. 4,422,459 to Michael B. Simson (the '459 or Simson patent) invalid for failure to claim statutory subject matter under 35 U.S.C. § 101. The court did not decide the question of infringement.

> FN1. *Arrhythmia Research Technology, Inc. v. Corazonix Corp.*, No. CA 3-88-1745-AJ (N.D.Tex. October 3, 1990), *reconsid. denied* (November 8, 1990) (Order); *appeal authorized* (November 9, 1990) (Order).

We conclude that the claimed subject matter is statutory in terms of section 101. The judgment of invalidity on this ground is reversed.

The Simson Invention

The invention claimed in the '459 patent is directed to the analysis of electrocardiographic signals in order to determine certain characteristics of the heart function. In the hours immediately after a heart attack (myocardial infarction) the victim is particularly vulnerable to an acute type of heart arrhythmia known as ventricular tachycardia. Ventricular tachycardia leads quickly to ventricular fibrillation, in which the heart ceases effectively to pump blood through the body. Arrhythmia Research states that 15-25% of heart attack victims are at high risk for ventricular tachycardia. It can be treated or prevented with certain drugs, but these drugs have undesirable and sometimes dangerous side effects. Dr. Simson, a cardiologist, sought a solution to the problem of determining which heart attack victims are at high risk for ventricular tachycardia, so that these persons can be carefully monitored and appropriately treated.

Heart activity is monitored by means of an electrocardiograph device, whereby electrodes attached to the patient's body detect the heart's electrical signals in accordance with the various phases of heart activity. The signals can be displayed in wave form on a monitor and/or recorded on a chart. It was known that in patients subject to ventricular tachycardia certain anomalous waves having very low amplitude and high frequency, known as "late potentials," appear toward the end of the QRS [FN2] segment of the electrocardiographic signal, that is, late in the ventricular contraction cycle. Dr. Simson's method of detecting and measuring these late potentials in the QRS complex, and associated apparatus, are the subject of the '459 patent.

> FN2. According to Arrhythmia Research, the QRS complex lasts about one tenth of a second and arises from the depolarization of the ventricles prior to contraction.

***1055** The '459 patent specification describes these procedures. Certain of the heart attack patient's electrocardiographic signals, those obtained from electrodes designated as X, Y, and Z leads, are converted from analog to digital values, and a composite digital representation of the QRS segment is obtained by selecting and averaging a large number of the patient's QRS waveforms. The anterior portion of the composite QRS waveform is

first isolated, and then processed by a digital high pass filter in reverse time order; that is, backwards. This step of reverse time order filtering is described as the critical feature of the Simson invention, in that it enables detection of the late potentials by eliminating certain perturbations that obscure these signals. The root mean square of the reverse time filtered output is then calculated, as described in the specification, to determine the average magnitude of the anterior portion of the QRS complex. Comparison of the output, which is measured in microvolts, with a predetermined level of high frequency energy, indicates whether the patient is subject to ventricular tachycardia. That is, if the root mean square magnitude is less than the predetermined level, then low amplitude, high frequency late potentials have been shown to be present, indicating a higher risk of ventricular tachycardia. If the root mean square value is greater than the predetermined level, high risk for ventricular tachycardia is not indicated.

Certain steps of the invention are described as conducted with the aid of a digital computer, and the patent specification sets forth the mathematical formulae that are used to configure (program) the computer. The specification states that dedicated, specific purpose equipment or hard wired logic circuitry can also be used.

The district court held that the method and apparatus claims of the Simson patent are directed to a mathematical algorithm, and thus do not define statutory subject matter. Claim 1 is the broadest method claim:

1. A method for analyzing electrocardiograph signals to determine the presence or absence of a predetermined level of high frequency energy in the late QRS signal, comprising the steps of:

converting a series of QRS signals to time segments, each segment having a digital value equivalent to the analog value of said signals at said time;

applying a portion of said time segments in reverse time order to high pass filter means; determining an arithmetic value of the amplitude of the output of said filter; and

comparing said value with said predetermined level.
Claim 7 is a representative apparatus claim:

7. Apparatus for analyzing electrocardiograph signals to determine the level of high frequency energy in the late QRS signal comprising:

means for converting X, Y, and Z lead electrocardiographic input signals to digital valued time segments;

means for examining said X, Y, and Z digital valued time segments and selecting therefrom the QRS waveform portions thereof;

means for signal averaging a multiplicity of said selected QRS waveforms for each of

said X, Y, and Z inputs and providing composite, digital X, Y, and Z QRS waveforms; high pass filter means;

means for applying to said filter means, in reverse time order, the anterior portion of each said digital X, Y, and Z waveform; and

means for comparing the output of said filter means with a predetermined level to obtain an indication of the presence of a high frequency, low level, energy component in the filter output of said anterior portions.

The Patent and Trademark Office had granted the patent without questioning that its claims were directed to statutory subject matter under § 101.

35 U.S.C. § 101

Whether a claim is directed to statutory subject matter is a question of law. Although ***1056** determination of this question may require findings of underlying facts specific to the particular subject matter and its mode of claiming, in this case there were no disputed facts material to the issue. Thus we give plenary review to the question, with appropriate recognition of the burdens on the challenger of a duly issued United States patent. *See* 35 U.S.C. § 282 (duly issued patent is presumed valid); *Interconnect Planning Corp. v. Feil,* 774 F.2d 1132, 1139, 227 USPQ 543, 548, (Fed.Cir.1985) (statutory presumption of validity is based in part on recognition of the expertise of patent examiners).
[1] A new and useful process or apparatus is patentable subject matter, as defined in 35 U.S.C. § 101:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

The Supreme Court has observed that Congress intended section 101 to include "anything under the sun that is made by man." *Diamond v. Chakrabarty,* 447 U.S. 303, 309, 100 S.Ct. 2204, 2208, 65 L.Ed.2d 144, 206 USPQ 193, 197 (1980), *quoting* S.Rep. No. 1979, 82d Cong., 2d Sess., 5 (1952); H.R.Rep. No. 1923, 82d Cong., 2d Sess., 6 (1952). There are, however, qualifications to the apparent sweep of this statement. Excluded from patentability is subject matter in the categories of "laws of nature, physical phenomena, and abstract ideas". *Diamond v. Diehr,* 450 U.S. 175, 185, 101 S.Ct. 1048, 1056, 67 L.Ed.2d 155, 209 USPQ 1, 7 (1981). A mathematical formula may describe a law of nature, a scientific truth, or an abstract idea. As courts have recognized, mathematics may also be used to describe steps of a statutory method or elements of a statutory apparatus. The exceptions to patentable subject matter derive from a lengthy jurisprudence, but their meaning was probed anew with the advent of computer-related inventions.
In *Gottschalk v. Benson,* 409 U.S. 63, 72, 93 S.Ct. 253, 257, 34 L.Ed.2d 273, 175 USPQ 673, 676 (1972) the Court held that a patent claim that "wholly pre-empts" a mathematical formula used in a general purpose digital computer is directed solely to a mathematical algorithm, [FN3] and therefore does not define statutory subject matter under section 101. The Court described the mathematical process claimed in *Benson* as

"so abstract and sweeping as to cover both known and unknown uses of the BCD [binary coded decimal] to pure binary conversion", 409 U.S. at 68, 93 S.Ct. at 255, 175 USPQ at 675, citing *O'Reilly v. Morse*, 56 U.S. (15 How.) 62, 113, 14 L.Ed. 601 (1852) for its holding that the patentee may not claim more than he has actually invented.

> FN3. A mathematical algorithm was defined in *Benson* as a procedure or formula for solving a particular mathematical problem. 409 U.S. at 65, 93 S.Ct. at 254, 175 USPQ at 674. As discussed in *In re Iwahashi*, 888 F.2d 1370, 1374, 12 USPQ2d 1908, 1911 (Fed.Cir.1989), however, any step-by-step process, whether mechanical, electrical, biological or chemical, involves an "algorithm" in the broader sense of the term.

In *Parker v. Flook*, 437 U.S. 584, 591, 98 S.Ct. 2522, 2526, 57 L.Ed.2d 451, 198 USPQ 193, 198 (1978) the Court explained that the criterion for patentability of a claim that requires the use of mathematical procedures is not simply whether the claim "wholly pre-empts" a mathematical algorithm, but whether the claim is directed to a new and useful process, independent of whether the mathematical algorithm required for its performance is novel. Applying these criteria the Court held nonstatutory a method claim for computer-calculating "alarm limits" for use in a catalytic conversion process, on the basis that "once that algorithm is assumed to be within the prior art, the application, considered as a whole, contains no patentable invention." *Flook*, 437 U.S. at 594, 98 S.Ct. at 2527, 198 USPQ at 199.

In accordance with *Flook*, the claims were analyzed to determine whether the process itself was new and useful, assuming the mathematical algorithm was "well known". *Id.* at 592, 98 S.Ct. at 2527, 198 USPQ at 198. As the jurisprudence developed, ***1057** inventions that were implemented by the mathematically-directed performance of computers were viewed in the context of the practical application to which the computer-generated data were put. The Court of Customs and Patent Appeals observed in *In re Bradley*, 600 F.2d 807, 811-112, 202 USPQ 480, 485 (CCPA 1979), *aff'd by an equally divided court, sub nom.* *Diamond v. Bradley*, 450 U.S. 381, 101 S.Ct. 1495, 67 L.Ed.2d 311 (1981):

It is of course true that a modern digital computer manipulates data, usually in binary form, by performing mathematical operations, such as addition, subtraction, multiplication, division, or bit shifting, on the data. But this is only *how* the computer does what it does. Of importance is the significance of the data and their manipulation in the real world, i.e., *what* the computer is doing. [Emphases in original]
Thus computers came to be generally recognized as devices capable of performing or implementing process steps, or serving as components of an apparatus, without negating patentability of the process or the apparatus. In *Diamond v. Diehr* the Court explained that non-statutory status under section 101 derives from the "abstract", rather than the "sweeping", nature of a claim that contains a mathematical algorithm. The Court stated: "While a scientific truth, or the mathematical expression of it, is not a patentable invention, a novel and useful structure created with the aid of knowledge of scientific truth may be."

Diehr, 450 U.S. at 188, 101 S.Ct. at 1057, 209 USPQ at 8-9, quoting *Mackay Radio & Telegraph Co. v. Radio Corp. of America*, 306 U.S. 86, 94, 59 S.Ct. 427, 431, 83 L.Ed. 506, 40 USPQ 199, 202 (1939). The mathematical algorithm in *Diehr* was the known Arrhenius equation, and the Court held that when the algorithm was incorporated in a useful process, the subject matter was statutory. The Court confirmed the rule that process steps or apparatus functions that entail computer-performed calculations, whether the calculations are described in mathematical symbols or in words, do not of themselves render a claim nonstatutory. *Diehr*, 450 U.S. at 187, 101 S.Ct. at 1057, 209 USPQ at 8. The Court clarified its earlier holdings, [FN4] stating that "[i]t is inappropriate to dissect the claims into old and new elements and then to ignore the presence of the old elements in the [section 101] analysis." *Id.* at 188, 101 S.Ct. at 1058, 209 USPQ at 9.

> FN4. Although commentators have differed in their interpretations of *Benson*, *Flook*, and *Diehr*, it appears to be generally agreed that these
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> decisions represent evolving views of the Court, and that the reasoning in *Diehr* not only elaborated on, but in part superseded, that of *Benson* and *Flook*. *See, e.g.*, R.L. Gable & J.B. Leaheey, *The Strength of Patent Protection for Computer Products*, 17 Rutgers Computer & Tech.L.J. 87 (1991); D. Chisum, *The Patentability of Algorithms*, 47 U.Pitt.L.Rev. 959 (1986).

[2] The Court thus placed the patentability of computer-aided inventions in the mainstream of the law. The ensuing mode of analysis of such inventions was summarized in *In re Meyer*, 688 F.2d 789, 795, 215 USPQ 193, 198 (CCPA 1982):
In considering a claim for compliance with 35 USC 101, it must be determined whether a scientific principle, law of nature, idea, or mental process, which may be represented by a mathematical algorithm, is included in the subject matter of the claim. If it is, it must then be determined whether such principle, law, idea, or mental process is applied in an invention of a type set forth in 35 USC 101.

The law crystallized about the principle that claims directed solely to an abstract mathematical formula or equation, including the mathematical expression of scientific truth or a law of nature, whether directly or indirectly stated, are nonstatutory under section 101; whereas claims to a specific process or apparatus that is implemented in accordance with a mathematical algorithm will generally satisfy section 101.

In applying this principle to an invention whose process steps or apparatus elements are described at least in part in terms of mathematical procedures, the mathematical procedures are considered in the context of the claimed invention as a whole. ***1058** *Diehr*, 450 U.S. at 188, 101 S.Ct. at 1057, 209 USPQ at 9. Determination of statutory subject matter has been conveniently conducted in two stages, following a protocol initiated by the Court of Customs and Patent Appeals in *In re Freeman*, 573 F.2d 1237, 197 USPQ 464 (CCPA 1978); modified after the Court's *Flook* decision by *In re Walter*, 618 F.2d 758, 205 USPQ 397 (CCPA 1980); and again after the Court's *Diehr* decision by *In re Abele*, 684 F.2d 902, 214 USPQ 682 (CCPA 1982).

[3] This analysis has been designated the *Freeman-Walter-Abele* test for statutory subject matter. It is first determined whether a mathematical algorithm is recited directly or indirectly in the claim. If so, it is next determined whether the claimed invention as a whole is no more than the algorithm itself; that is, whether the claim is directed to a mathematical algorithm that is not applied to or limited by physical elements or process steps. Such claims are nonstatutory. However, when the mathematical algorithm is applied in one or more steps of an otherwise statutory process claim, or one or more elements of an otherwise statutory apparatus claim, the requirements of section 101 are met. The court explained in *Abele*, 684 F.2d at 907, 214 USPQ at 686:

[P]atentable subject matter [is not limited] to claims in which structural relationships or process steps are defined, limited or refined by the application of the algorithm. Rather, *Walter* should be read as requiring no more than that the algorithm be "applied in any manner to physical elements or process steps," provided that its application is circumscribed by more than a field of use limitation or non-essential post-solution activity.

As summarized by the PTO in *Ex Parte Logan*, 20 USPQ2d 1465, 1468 (PTO Bd.Pat.App. and Interf.1991), the emphasis is "on *what* the claimed method steps do rather than *how* the steps are performed". (Emphases in original)

Although the *Freeman-Walter-Abele* analysis is not the only test for statutory subject matter, *Meyer*, 688 F.2d at 796, 215 USPQ at 198, and this court has stated that failure to meet that test may not always defeat the claim, *In re Grams*, 888 F.2d 835, 839, 12 USPQ2d 1824, 1827 (Fed.Cir.1989), this analytic procedure is conveniently applied to the Simson invention.

Analysis

Arrhythmia Research states that the district court erred in law, and that the combination of physical, mechanical, and electrical steps that are described and claimed in the '459 patent constitutes statutory subject matter. Arrhythmia Research stresses that the claims are directed to a process and apparatus for detecting and analyzing a specific heart activity signal, and do not preempt the mathematical algorithms used in any of the procedures. Arrhythmia Research states that the patentability of such claims is now well established by law, precedent, and practice.

Corazonix states that the claims define no more than a mathematical algorithm that calculates a number. Corazonix states that in Simson's process and apparatus claims mathematical algorithms are merely presented and solved, and that Simson's designation of a field of use and post-solution activity are not essential to the claims and thus do not cure this defect. Thus, Corazonix states that the claims are not directed to statutory subject matter, and that the district court's judgment was correct.

A. The Process Claims

Although mathematical calculations are involved in carrying out the claimed process, Arrhythmia Research argues that the claims are directed to a method of detection of a certain heart condition by a novel method of analyzing a portion of the electrocardiographically measured heart cycle. This is accomplished by procedures conducted by means of electronic equipment programmed to perform mathematical computation.

Applying the *Freeman-Walter-Abele* protocol, we accept for the purposes of this analysis the proposition that a mathematical ***1059** algorithm is included in the subject matter of the process claims in that some claimed steps are described in the specification by mathematical formulae. *See* *In re Johnson*, 589 F.2d 1070, 1078, 200 USPQ 199, 208 (CCPA 1979) ("Reference to the specification must be made to determine whether [claimed] terms indirectly recite mathematical calculations, formulae, or equations.") We thus proceed to the second stage of the analysis, to determine whether the claimed process is otherwise statutory; that is, we determine what the claimed steps do, independent of how they are implemented.

Simson's process is claimed as a "method for analyzing electrocardiograph signals to determine the presence or absence of a predetermined level of high-frequency energy in the late QRS signal". This claim limitation is not ignored in determining whether the subject matter as a whole is statutory, for all of the claim steps are in implementation of this method. The electrocardiograph signals are first transformed from analog form, in which they are obtained, to the corresponding digital signal. These input signals are not abstractions; they are related to the patient's heart function. The anterior portion of the QRS signal is then processed, as the next step, by the procedure known as reverse time order filtration. The digital filter design selected by Dr. Simson for this purpose, known as the Butterworth filter, is one of several known procedures for frequency filtering of digital waveforms. The filtered signal is further analyzed to determine its average magnitude, as described in the specification, by the root mean square technique. Comparison of the resulting output to a predetermined level determines whether late potentials reside in the anterior portion of the QRS segment, thus indicating whether the patient is at high risk for ventricular tachycardia. The resultant output is not an abstract number, but is a signal related to the patient's heart activity.

These claimed steps of "converting", "applying", "determining", and "comparing" are physical process steps that transform one physical, electrical signal into another. The view that "there is nothing necessarily physical about 'signals' " is incorrect. *In re Taner*, 681 F.2d 787, 790, 214 USPQ 678, 681 (CCPA 1982) (holding statutory claims to a method of seismic exploration including the mathematically described steps of "summing" and "simulating from"). The *Freeman-Walter-Abele* standard is met, for the steps of Simson's claimed method comprise an otherwise statutory process whose mathematical procedures are applied to physical process steps.

It was undisputed that the individual mathematical procedures that describe these steps are all known in the abstract. The method claims do not wholly preempt these procedures, but limit their application to the defined process steps. In answering the question "What

did the applicant invent?", *Grams*, 888 F.2d at 839, 12 USPQ2d at 1827, the Simson method is properly viewed as a method of analyzing electrocardiograph signals in order to determine a specified heart activity. Like the court in *Abele*, which was "faced simply with an improved CAT-scan process", 684 F.2d at 909, 214 USPQ at 688, the Simson invention is properly viewed as an electrocardiograph analysis process. The claims do not encompass subject matter transcending what Dr. Simson invented, as in *O'Reilly v. Morse*, 56 U.S. (15 How.) at 113 (claims covered any use of electric current to transmit characters at a distance); or in *Benson*, 409 U.S. at 68, 93 S.Ct. at 255, 175 USPQ at 675 (use of claimed process could "vary from the operation of a train to verification of driver's licenses to researching the law books for precedents"); or in *Grams*, 888 F.2d at 840, 12 USPQ2d at 1828 (invention had application to "any complex system, whether it be electrical, mechanical, chemical or biological, or combinations thereof.")

The Simson claims are analogous to those upheld in *Diehr*, wherein the Court remarked that the applicants "do not seek to patent a mathematical formula.... they seek only to foreclose from others the use of that equation in conjunction with all of the other steps in their claimed process". ***1060** 450 U.S. at 187, 101 S.Ct. at 1057, 209 USPQ at 8. Simson's claimed method is similarly limited. The process claims comprise statutory subject matter.

B. The Apparatus Claims

The Simson apparatus for analyzing electrocardiographic signals is claimed in the style of 35 U.S.C. § 112, paragraph 6, whereby functionally described claim elements are "construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof". Thus the statutory nature *vel non* of Simson's apparatus claims is determined with reference to the description in the '459 patent specification. *In re Iwahashi*, 888 F.2d 1370, 1375, 12 USPQ2d 1908, 1911-12 (Fed.Cir.1989).

The apparatus claims require a means for converting the electrocardiograph signals from the analog form in which they are generated into digital form. This means is described in the specification as a specific electronic device, a conventional analog-to-digital converter. A minicomputer, configured as described in the specification, is the means of calculating composite digital time segments of the QRS waveform. The product is stored, as stated in the specification, in the form of electrical signals. The high pass filter means is described in the specification as the minicomputer configured to perform the function of reverse time order filtration of the anterior portion of the QRS waveform. The specification and drawings show a disc memory unit to store the composite QRS signals, and associated connecting leads to the computer's processing unit. The comparing means is the processing unit configured to perform the specified function of root mean square averaging of the anterior portion of the QRS complex, and comparison of the resulting output with a predetermined level to provide an indication of the presence of late potentials in the electrocardiograph signal.

The Simson apparatus claims thus define "a combination of interrelated means" for performing specified functions. *Iwahashi*, 888 F.2d at 1375, 12 USPQ2d at 1911. The

computer-performed operations transform a particular input signal to a different output signal, in accordance with the internal structure of the computer as configured by electronic instructions. "The claimed invention ... converts one physical thing into another physical thing just as any other electrical circuitry would do". *In re Sherwood*, 613 F.2d 809, 819, 204 USPQ 537, 546 (CCPA 1980), *cert. denied*, 450 U.S. 994, 101 S.Ct. 1694, 68 L.Ed.2d 193 (1981) (holding statutory claims to an apparatus for analyzing seismic signals including mathematically described means for "sonogramming", "dividing", and "plotting").

[4] The use of mathematical formulae or relationships to describe the electronic structure and operation of an apparatus does not make it nonstatutory. *Iwahashi*, 888 F.2d at 1375, 12 USPQ2d at 1911. When mathematical formulae are the standard way of expressing certain functions or apparatus, it is appropriate that mathematical terms be used. *See W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1556, 220 USPQ 303, 315 (Fed.Cir.1983), *cert. denied*, 469 U.S. 851, 105 S.Ct. 172, 83 L.Ed.2d 107 (1984) (patents are directed to those of skill in the art). *See also In re Bernhart*, 417 F.2d 1395, 1399, 163 USPQ 611, 616 (CCPA 1969) ("all machines function according to the laws of physics which can be mathematically set forth if known.") That Simson's claimed functions could not have been performed effectively without the speed and capability of electronic devices and components does not determine whether the claims are statutory. Corazonix argues that the final output of the claimed apparatus (and process) is simply a number, and that *Benson* and *Flook* support the position that when the end product is a number, the claim is nonstatutory and can not be saved by claim limitations of the use to which this number is put. However, the number obtained is not a mathematical abstraction; it is a measure in microvolts of a specified heart activity, an indicator of the risk of ventricular tachycardia. That the product is numerical is not a criterion of whether the claim is directed to statutory subject matter. *See* ***1061** *Meyer*, 688 F.2d at 796 n. 4, 215 USPQ at 198 n. 4 (explaining that so-called "negative rules" of patentability "were not intended to be separate tests for determining whether a claim positively recites statutory subject matter.")

[5] The Simson apparatus claims satisfy the criteria for statutory subject matter. They are directed to a specific apparatus of practical utility and specified application, and meet the requirements of 35 U.S.C. § 101.

Conclusion

The judgment of invalidity on the ground that the claimed method and apparatus do not define statutory subject matter is reversed. The cause is remanded for resolution of remaining issues.

Taxable costs in favor of Arrhythmia Research.

REVERSED AND REMANDED.

RADER, Circuit Judge, concurring.

Nearly twenty years ago, in *Gottschalk v. Benson*, 409 U.S. 63, 93 S.Ct. 253, 34 L.Ed.2d 273 (1972), the Supreme Court dealt with a computer process for conversion of binary coded decimals into pure binary numbers. *Benson* held this mathematical algorithm ineligible for patent protection. 409 U.S. at 65, 71-72, 93 S.Ct. at 254, 257. Because computer programs rely heavily on mathematical algorithms, commentators saw dire implications in the Supreme Court's opinion for patent protection of computer software. For instance, one treatise, citing *Benson*, stated:

[A] recent Supreme Court decision seemingly eliminated patent protection for computer software.

Donald S. Chisum, *Patents* § 1.01 (1991); *see also id.* at § 1.03[6].

The court upholds the '459 patent by applying a permutation of the *Benson* algorithm rule. In reaching this result, the court adds another cord to the twisted knot of precedent encircling and confining the *Benson* rule. While fully concurring in the court's result and commending its ability to trace legal strands through the tangle of post-*Benson* caselaw, I read later Supreme Court opinions to have cut the Gordian knot. The Supreme Court cut the knot by strictly limiting *Benson.*

Relying on the language of the patent statute, the Supreme Court in *Diamond v. Diehr*, 450 U.S. 175, 101 S.Ct. 1048, 67 L.Ed.2d 155 (1981), turned away from the *Benson* algorithm rule. Thus, I too conclude that the '459 patent claims patentable subject matter--not on the basis of a two-step post-*Benson* test, but on the basis of the patentable subject matter standards in title 35. Rather than perpetuate a nonstatutory standard, I would find that the subject matter of the '459 patent satisfies the statutory standards of the Patent Act.

I.

The questions presented by this case are whether the '459 patent claims a process and apparatus within the meaning of 35 U.S.C. § 101 (1988). Section 101 states:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

According to this language, "any" invention or discovery within the four broad categories of "process, machine, manufacture, or composition of matter" is eligible for patent protection. "Any" is an expansive modifier which broadens the sweep of the categories. *See Diamond v. Chakrabarty*, 447 U.S. 303, 308-09, 100 S.Ct. 2204, 2207, 65 L.Ed.2d 144 (1980). The language of section 101 conveys no implication that the Act extends patent protection to some subcategories of machines or processes and not to others. The limits on patentable subject matter within section 101 focus not on subcategories of machines or processes, but on characteristics, such as newness and usefulness. Section 101 also specifies that, in addition to newness and usefulness, an invention or discovery must satisfy other "conditions and requirements." These other "conditions and requirements" encompass***1062*** characteristics like nonobviousness under 35 U.S.C. §

103 (1988), or requirements like those in 35 U.S.C. § 112 (1988). In other words, the language of the Patent Act does not suggest that the words "machine" or "process" carry limitations outside their ordinary meaning. *See Diehr*, 450 U.S. at 182, 101 S.Ct. at 1054 ("Unless otherwise defined, 'words will be interpreted as taking their ordinary, contemporary, common meaning.' "). Rather the Act, by its terms, extends patent protection to "any" machine or process which satisfies the other conditions of patentability.

II.

In *Benson*, the Supreme Court encountered the question of whether a method for converting binary-coded decimals, which was useful in programming digital computers, was a patentable "process" under section 101. 409 U.S. at 64, 93 S.Ct. at 254. The Court, by reading a limitation not found in the statute into the term "process," determined the method of conversion did not satisfy section 101.

In *Parker v. Flook*, 437 U.S. 584, 98 S.Ct. 2522, 57 L.Ed.2d 451 (1978), the Court followed *Benson.* Flook claimed a method for updating alarm limits during catalytic conversion of hydrocarbons. The Court found Flook's method involving mathematical calculations--though applied to a post-solution use-- unpatentable. *Flook*, 437 U.S. at 590, 98 S.Ct. at 2525. *Flook* clearly limited the *Benson* rule to mathematical formulae and mathematical algorithms. *Id.* 437 U.S. at 585, 587, 589, 590, 591, 592, 594, 595, 98 S.Ct. at 2523, 2524, 2525, 2525, 2526, 2526, 2527, 2528. By mixing the terms "formula" and "algorithm," 437 U.S. at 585-86, 98 S.Ct. at 2523, however, *Flook* further confused the meaning of "mathematical algorithm." As used by *Benson*, that term meant "a procedure for solving a given type of mathematical problem." 409 U.S. at 65, 93 S.Ct. at 254. Thus, an "algorithm" required both a mathematical problem and a solution procedure. A "formula" does not present or solve a mathematical problem, but merely expresses a relationship in mathematical terms. A "formula," even under *Benson*'s definition, is not an algorithm.

In the wake of *Benson*, the Court of Customs and Patent Appeals struggled to implement the algorithm rule. [FN1] Much of the difficulty sprang from the obscurity of the terms invoked to preclude patentability--terms like "law of nature," "natural phenomena," "formulae," or "algorithm." [FN2] ***1063** *Benson*, 409 U.S. at 65, 67, 93 S.Ct. at 254, 255; *Flook*, 437 U.S. at 593, 98 S.Ct. at 2527. In the context of a product's subject matter patentability, Justice Frankfurter discussed this analytical difficulty:

> FN1. *See, e.g.*, *In re Christensen*, 478 F.2d 1392, 1396, 178 USPQ 35 (CCPA 1973) (Rich, J., concurring) ("The Supreme Court in *Benson* appears to have held that claims drafted in such terms are not patentable-- for what reason remaining a mystery."), *overruled in part by* *In re Taner*, 681 F.2d 787, 214 USPQ 678 (1982); *In re Johnston*, 502 F.2d 765, 773, 183 USPQ 172, 179 (CCPA 1974) (Rich, J., dissenting) ("I am probably as much--if not more--confused by the wording of the *Benson* opinion as many others."); *rev'd*, *Dann v. Johnston*, 425 U.S. 219, 96 S.Ct. 1393, 47 L.Ed.2d 692 (1976); *In re Chatfield*, 545 F.2d 152, 157, 191 USPQ 730, 735 (CCPA 1976) (Nonstatutory claims are "drawn to mathematical problem-solving algorithms or to purely mental steps."), *cert. denied*,

Dann v. Noll, 434 U.S. 875, 98 S.Ct. 226, 54 L.Ed.2d 155 (1977).

FN2. The Court in *Diamond v. Diehr*, 450 U.S. 175, 101 S.Ct. 1048, 67 L.Ed.2d 155 (1981), expressly recognized that the term algorithm "is subject to a variety of definitions." 450 U.S. at 186 n. 9, 101 S.Ct. at 1056 n. 9. Even *Benson*'s definition for "algorithm" creates legal problems. For instance, the Benson-Tabbot algorithm worked with numbers, but "solved" a "mathematical problem" only in a very loose sense. Rather the Benson-Tabbot algorithm translated symbols from one numerical system to another. *Cf.* *In re Toma*, 575 F.2d 872, 197 USPQ 852 (CCPA 1978) (Using a digital computer to translate technical languages was not an algorithm.); *In re Freeman*, 573 F.2d 1237, 197 USPQ 464 (CCPA 1978) (Using computer to transcribe alphanumeric characters was not an algorithm.).

Moreover some problems, even if expressed in mathematical terms, are not mathematical problems. Mathematics, like a language, is a form of expression. The operation of a machine, the generation of electricity, the reaction of two chemicals, a baseball batter's swing, a satellite's orbit--all are within the descriptive power of mathematics. The Court of Customs and Patent Appeals recognized this axiomatic point:

However, some mathematical algorithms ... represent ideas or mental processes and are simply logical vehicles for communicating possible solutions to complex problems.

In re Meyer, 688 F.2d 789, 794, 215 USPQ 193, 197 (CCPA 1982). No wonder the *Benson* rule is confusing when electrical, chemical, or mechanical processes escape scrutiny when expressed in written language, but become suspect when expressed in the mathematical language. In *In re Grams*, 888 F.2d 835, 12 USPQ2d 1824 (Fed.Cir.1989), for instance, a medical diagnostic process was considered an unpatentable "mathematical algorithm" even though it did not present, or propose a solution to, a mathematical problem at all.

It only confuses the issue, however, to introduce such terms as "the work of nature" and the "laws of nature." For these are vague and malleable terms infected with too much ambiguity and equivocation. Everything that happens may be deemed "the work of nature," and any patentable composite exemplifies in its properties "the laws of nature." Arguments drawn from such terms for ascertaining patentability could fairly be employed to challenge almost every patent.

Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 134-35, 68 S.Ct. 440, 443, 92 L.Ed. 588 (1948) (Frankfurter, J., concurring). When attempting to enforce a legal standard embodied in broad, vague, nonstatutory terms, the courts have floundered. At length, in In re Freeman, 573 F.2d 1237, 197 USPQ 464 (CCPA 1978) as modified by In re Walter, 618 F.2d 758, 205 USPQ 397 (CCPA 1980), the Court of Customs and

Patent Appeals settled on a two-step test to detect unpatentable algorithms under the Benson rule:

First, the claim is analyzed to determine whether a mathematical algorithm is directly or indirectly recited. Next, if a mathematical algorithm is found, the claim as a whole is further analyzed to determine whether the algorithm is "applied in any manner to physical elements or process steps," and, if it is, it "passes muster under § 101." In re Pardo, 684 F.2d 912, 915, 214 USPQ 673, 675-76 (CCPA 1982) (citing In re Abele, 684 F.2d 902, 214 USPQ 682 (CCPA 1982)). Walter adopted Flook's implicit limitation of the Benson rule to "mathematical algorithms." 618 F.2d at 764-65 n. 4. Like Flook, however, Walter confused "mathematical algorithms" with calculations, formulas, and mathematical procedures generally. Id.

Although downstream from Benson, this Freeman-Walter fork hid some of the same unnavigable cross-currents. In the first place, the term "mathematical algorithm" remained vague. Without a statutory anchor, this term was buffeted by every judicial wind until its course was indiscernible. The obscurity of the term "mathematical algorithm" is evident in two cases. In Pardo, 684 F.2d 912, the court narrowly limited "mathematical algorithm" to the execution of formulas with given data. In the same year, the court in In re Meyer, 688 F.2d 789, 215 USPQ 193 (CCPA 1982), sweepingly interpreted the same term to include any mental process that can be represented by a mathematical algorithm.

The second part of the test had similar uncertainties. The test did not suggest how many physical steps a claim must take to escape the fatal "mathematical algorithm" category. In Abele, 684 F.2d 902, the court upheld claims applying "a mathematical formula within the context of a process which encompasses significantly more than the algorithm alone." Id. at 909. Thus, the court apparently made compliance with the two-part test a function of the "significance" of additions to the algorithm--hardly a predictable standard. The Court of Customs and Patent Appeals later clarified that the two-part algorithm is not the exclusive test for detecting unpatentable subject matter. Meyer, 688 F.2d at 796. Indeed, the court abandoned the two-step test in In re Taner, 681 F.2d 787, 214 USPQ 678 (CCPA 1982).

With the advent of the Court of Appeals for the Federal Circuit, this court continued to grapple with the inherent vagueness of the two-part test for unpatentable algorithms. See In re Grams, 888 F.2d 835, 12 USPQ2d 1824 (Fed.Cir.1989); In re Iwahashi, 888 F.2d 1370, 12 USPQ2d 1980 (Fed.Cir.1989). At one point, this court clarified ****1064*** *that failure to satisfy the second prong of the two-part test "does not necessarily doom the claim." Grams, 888 F.2d at 839. Instead this court recommended asking the broader question of "What did applicants invent?" in the context of the claim and its supporting disclosure. Id. At another point in the same opinion, this court put the central question in terms of whether "the claim in essence covers only the algorithm." Id. at 837. Recognizing the obscurity of "algorithm," this court in Iwahashi attempted to "take the mystery out of the term":*

[W]e point out once again that every step-by-step process, be it electronic or chemical or mechanical, involves an algorithm in the broad sense of the term. Since § 101 expressly includes processes as a category of inventions which may be patented and § 100(b) further defines the word "process" as meaning "process, art or method, and includes a new use of a known process, machine, manufacture, composition of matter, or material," it follows that it is no ground for holding a claim is directed to nonstatutory subject matter to say it includes or is directed to an algorithm. This is why the proscription against patenting has been limited to mathematical algorithms....

888 F.2d at 1374 (emphasis in original). Because the Iwahashi claims as a whole described a machine or a manufacture (which fit within section 101 without regard to the meaning of "process"), this court in Iwahashi did not have occasion to resolve conflicts over the legal bounds of "mathematical algorithm."

In sum, the two-part test was cast in the crucible of confusion created by Benson. If the Benson algorithm rule was the last and binding word on the meaning of "process" under section 101, this court would be obligated to follow--regardless of any imprecision or ambiguity. The Supreme Court, however, has already shown another reading of the Patent Act.

III.

In Diehr, the Supreme Court adopted a very useful algorithm for determining patentable subject matter, namely, following the Patent Act itself. Diehr upheld claims to a process for curing synthetic rubber which included use of a mathematical computer process. After setting forth the procedural history of the case, the Supreme Court stated:
In cases of statutory construction, we begin with the language of the statute. Diehr, 450 U.S. at 182, 101 S.Ct. at 1054. Perhaps with an eye to the attempts to apply the Benson rule, the Court then noted:

[I]n dealing with the patent laws, we have more than once cautioned that "courts 'should not read into the patent laws limitations and conditions which the legislature has not expressed.' "

Id. (citations omitted). Indeed Congress has never stated that section 101's term "process" excludes certain types of algorithms. Therefore, as Diehr commands, this court should refrain from employing judicially-created tests to limit section 101.

With that introduction, the Court proceeded to interpret the word "process" from section 101. In doing so, the Court briefly examined the history of patent laws back to 1793. See also Chakrabarty, 447 U.S. at 308-09, 100 S.Ct. at 2207. The Court summed up the legislative intent of the patent laws with this broad admonition:

[T]he Committee Reports accompanying the 1952 Act ... inform us that Congress intended statutory subject matter to "include anything under the sun that is made by

man." S.Rep. No. 1979, 82d Cong., 2d Sess., 5 (1952); H.R.Rep. No. 1923, 82d Cong., 2d Sess., 6 (1952).

Diehr, 450 U.S. at 182, 101 S.Ct. at 1054. This passage underscores the fallacy of creating artificial limits for the words of the 1952 Act.

Courts should give "process" its literal and predictable meaning, without conjecturing about the policy implications of that literal reading. Cf. Chakrabarty, 447 U.S. at 316-18, 100 S.Ct. at 2211-12. If Congress wishes to remove some processes from patent protection, it can enact such an exclusion. Again, in the absence of legislated ****1065*** *limits on the meaning of the Act, courts should not presume to construct limits. The Supreme Court directed this court to follow the Act.*

With that preface, the Supreme Court in Diehr specifically limited Benson. In the first place, the Court acknowledged the narrow definition of "mathematical algorithm" set forth by Benson. 450 U.S. at 186 n. 9, 101 S.Ct. at 1056 n. 9. Moreover, the Court expressly stated:

Our previous decisions regarding the patentability of "algorithms" are necessarily limited to the more narrow definition employed by the Court....

Id. Thus, after Diehr, only a mathematical procedure for solution of a specified mathematical problem is suspect subject matter.

The Supreme Court in Diehr also limited Benson to a further narrow proposition. That narrow proposition supports reliance on the statutory language of the 1952 Act, rather than a nonstatutory algorithm rule.

Citing Benson, the Court in Diehr stated:

This Court has undoubtedly recognized limits to § 101 and every discovery is not embraced within the statutory terms. Excluded from such patent protection are laws of nature, natural phenomena, and abstract ideas.

Our recent holdings in Gottschalk v. Benson, supra, and Parker v. Flook, supra, both of which are computer-related, stand for no more than these long-established principles. 450 U.S. at 185, 101 S.Ct. at 1056. In Taner, 681 F.2d at 791, this court's predecessor said:

[I]n Diehr, the Supreme Court made clear that Benson stands for no more than the long-established principle that laws of nature, natural phenomena, and abstract ideas are excluded from patent protection and that "a claim drawn to subject matter otherwise statutory does not become nonstatutory because it uses a mathematical formula, computer program, or digital computer." [Citations omitted.]

Thus, Diehr limited Benson and its progeny to three classes of unpatentable subject

matter--laws of nature, natural phenomena, and abstract ideas. Indeed, in Chakrabarty, the Court also cited Benson for the proposition that these three categories are unpatentable. 447 U.S. at 309, 100 S.Ct. at 2207; see also Flook, 437 U.S. at 593, 98 S.Ct. at 2527.

Because the Supreme Court cited Benson in Diehr, 450 U.S. at 185-86, 101 S.Ct. at 1056, this court has doubted whether Diehr limited the algorithm rule. Grams, 888 F.2d at 838. However, In re Taner, clearly interprets Diehr as strictly limiting Benson. 681 F.2d at 789, 791. More importantly, the Supreme Court instructed this court to apply the language of the 1952 Act without reading unexpressed limitations into the statute. Diehr, 450 U.S. at 182, 101 S.Ct. at 1054. Finally, to the extent that the Benson rule applies to mathematical algorithms in the wake of Diehr, the Supreme Court defined "mathematical algorithm" very narrowly.

By strictly limiting Benson, the Supreme Court signalled a change in the focus for patentability from the algorithm rule to the statutory standards of the Patent Act. The Supreme Court confined Benson to a narrow proposition which certainly does not preclude patentability of the '459 patent's heart attack risk detection process.

The '459 Patent

The '459 patent discloses an apparatus and a method for analyzing electrocardiograph signals to detect heart attack risks. The apparatus is a machine and is covered by the Iwahashi rule. The method converts an analog signal to a digital signal which passes, in reverse time order, through the mathematical equivalent of a filter. The filtered signal's amplitude is then measured and compared with a predetermined value.

*The '459 invention manipulates electrocardiogram readings to render a useful result. While many steps in the '459 process involve the mathematical manipulation of data, the claims do not describe a law of nature or a natural phenomenon. Furthermore, the claims do not disclose mere abstract***1066** ideas, but a practical and potentially life-saving process. Regardless of whether performed by a computer, these steps comprise a "process" within the meaning of section 101.*

The district court granted summary judgment in favor of Corazonix because "the claims of the '459 patent are drawn to a nonstatutory mathematical algorithm and, as such, are unpatentable pursuant to the provisions of 35 U.S.C. § 101." This erroneous conclusion illustrates the confusion caused by Benson and its progeny.

This conclusion is erroneous for several reasons. First, even if mathematical algorithms are barred from patentability, [FN3] the '459 patent as a whole does not present a mathematical algorithm. The '459 patent is a method for detecting the risk of a heart attack, not the presentation and proposed solution of a mathematical problem. In Diehr, the Supreme Court viewed the claims as "an industrial process for molding of rubber

products," not a mathematical algorithm. 450 U.S. at 192-93, 101 S.Ct. at 1060. The '459 patent's claims as a whole disclose a patentable process.

> FN3. The Court in *Diehr* stated: "we concluded that such an algorithm, or mathematical formula, is *like a law of nature,* which cannot be the subject of a patent." 450 U.S. at 186, 101 S.Ct. at 1056 (emphasis added). In fact, a mathematical algorithm does not appear in nature at all, but only in human numerical processes.
>
> A law of nature is indeed not patentable, but for reasons unrelated to the meaning of "process." A law of nature, even if a process, is not "new" within the meaning of § 101. Moreover, in *Sarker,* this court's predecessor gave another reason a law of nature cannot satisfy section 101. *In re Sarker,* 588 F.2d 1330, 1333, 200 USPQ 132, 137 (CCPA 1978). In sum, the Patent Act excludes laws of nature from patent protection even without a strained explanation excluding laws of nature from the meaning of "process." It is difficult to determine how or why mathematical algorithms are "like" laws of nature.

Second, the '459 patent does not claim a natural law, abstract idea, or natural phenomenon. Diehr limited the Benson rule to these three categories, none of which encompass the '459 patent.

Finally, and most important, Diehr refocused the patentability inquiry on the terms of the Patent Act rather than on non-statutory, vague classifications. Under the terms of the Act, a "process" deserves patent protection if it satisfies the Act's requirements. The '459 patent claims a "process" within the broad meaning of section 101. Therefore, this court must reverse and remand.

CONCLUSION

When determining whether claims disclosing computer art or any other art describe patentable subject matter, this court must follow the terms of the statute. The Supreme Court has focused this court's inquiry on the statute, not on special rules for computer art or mathematical art or any other art.

The claims of the '459 patent define an apparatus and a process. Both are patentable subject matter within the language of section 101. To me, the Supreme Court's most recent message is clear: when all else fails (and the algorithm rule clearly has), consult the statute. On this basis, I, too, would reverse and remand.

C.A.Fed. (Tex.),1992.
Arrhythmia Research Technology, Inc. v. Corazonix Corp.
958 F.2d 1053, 60 USLW 2603, 22 U.S.P.Q.2d 1033
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