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Paper No. 57
Entered: June 21, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAL ELECTRIC CO.,
Petitioner,

v.

UNIVERSITY OF VIRGINIA PATENT FOUNDATION,
Patent Owner.

Case IPR2016-00357
Patent RE44,644 E

Before KARL D. EASTHOM, TREVOR M. JEFFERSON, and J. JOHN LEE, *Administrative Patent Judges*.

LEE, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

INTRODUCTION

On December 16, 2015, General Electric Co. ("GE") filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 75, 76, 78–82, 84–92, 94–102, 107–109, 111, 113–115, 118, 128–130, 132–136, 138–140, 157, 158, 169–178, 180–184, 186–194, 196–204, 209–211, 213, 215–17, 220, 230–232, 234–238, 240, 241, and 254–260 ("the challenged claims") of U.S. Patent No. RE44,644 E (Ex. 1001, "the '644 Patent"). Patent Owner University of Virginia Patent Foundation ("UVAPF") timely filed a Preliminary Response. Paper 7.

An *inter partes* review of all challenged claims was instituted on June 22, 2016. Paper 13 ("Inst. Dec."). After institution, UVAPF filed a Patent Owner Response (Paper 21, "PO Resp."), and GE filed a Petitioner Reply (Paper 27, "Pet. Reply" (redacted public version); Paper 25 (filed under seal)).[1] UVAPF further filed a Motion for Observations on Cross-Examination (Paper 34), and GE filed a Response to UVAPF's Observations (Paper 41). The parties also filed additional motions that remain pending, which are addressed below. An oral hearing was held on March 2, 2016. Paper 56 ("Tr.").[2]

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. As

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[1] This Decision cites to the public versions of all cited documents unless otherwise specified.

[2] A combined hearing was held for this case as well as related *inter partes* reviews IPR2016-00358 and IPR2016-00359. Although the parties at times referred to specific claims at issue in only one of these cases, many of the substantive issues also are present in all three cases and, as such, the parties' statements at the hearing are applied to each of the cases as appropriate. Additionally, the parties raised objections to demonstrative exhibits presented at the oral hearing. Upon review, all such objections are denied.

explained below, GE has shown by a preponderance of the evidence that the challenged claims of the ’644 Patent are unpatentable.

A. Related Proceedings

GE identifies the following matters as related to its Petition: (1) *University of Virginia Patent Foundation v. General Electric Co.*, No. 3:14-cv-00051-nkm (W.D. Va.); (2) two other petitions requesting *inter partes* review of other claims of the ’644 Patent (IPR2016-00358 and IPR2016-00359); and (3) a petition requesting *inter partes* review of certain claims of U.S. Patent No. RE45,725 E, a related patent (IPR2017-00109). Pet. 1–2; Paper 46, 1. In addition to the above, UVAPF further identifies U.S. Patent Application No. 14/708,875 as related to the ’644 Patent. Paper 8, 1.

B. The ’644 Patent

The ’644 Patent is a reissue of U.S. Patent No. 7,164,268 (“the ’268 Patent”). Ex. 1001, at [64]. The ’268 Patent was issued on January 16, 2007, from a PCT application filed on December 21, 2001. *Id.* The ’268 Patent—and, thus, the ’644 Patent—claims priority to U.S. Provisional Application No. 60/257,182 (“the ’182 Application”), which was filed on December 21, 2000. *Id.* at [60]. Dr. John P. Mugler III and Dr. James R. Brookeman are the named inventors of the ’644 Patent. *Id.* at [75].

According to the specification, the ’644 Patent relates to nuclear magnetic resonance imaging (“MRI”) technology. Ex. 1001, 1:34–38. In particular, the ’644 Patent relates to spin-echo MRI, which provides “a wide range of useful image contrast properties that highlight pathological changes and are resistant to image artifacts from a variety of sources such as radio-frequency or static-field inhomogeneities.” *Id.* at 1:44–49.

In spin-echo MRI, one or more spin-echo magnetic resonance ("MR") signals are generated after an initial "excitation radio-frequency (RF) pulse." *See id.* at 1:50–2:36. Data about the imaged subject in k-space may be collected periodically in conjunction with a series of spin echoes (i.e., a spin-echo train), and gradient magnetic fields are used for spatial encoding, to produce an image of the subject. *See id*. The spin echoes are generated using RF "refocusing" pulses, which are characterized by, among other things, a "flip angle." *See id.* at 2:46–48. Conventional spin-echo techniques at the time of the invention—including, for example, "fast spin-echo" or "turbo spin-echo" techniques—used high flip angle refocusing RF pulses, which limited the usable duration of the echo trains and, thus, the amount and/or quality of data obtained. *See id.* at 2:46–3:6.

Unlike most conventional spin-echo techniques, which used constant flip angles, the '644 Patent describes the use of variable flip angles for the refocusing RF pulses. *Id.* at 3:48–55. According to the '644 Patent, variable flip angle pulse sequences according to the claimed invention can extend the duration of usable spin-echo trains, which in turn can improve spatial resolution and/or reduce the time needed to acquire images. *Id.* at 3:55–60. Further, the variable flip angle sequences of the '644 Patent use flip angles that, typically, are less than the 180° flip angles common in conventional spin-echo techniques, permitting less power to be applied to human subjects and, thus, enhancing patient safety. *Id.* at 5:35–47.

C. Challenged Claims

GE challenges claims 75, 76, 78–82, 84–92, 94–102, 107–109, 111, 113–115, 118, 128–130, 132–136, 138–140, 157, 158, 169–178, 180–184, 186–194, 196–204, 209–211, 213, 215–17, 220, 230–232, 234–238, 240,

241, and 254–260 of the ’644 Patent. Pet. 3–4, 23–59. Claims 75, 140, 157, 158, 176, and 177 are independent claims, and all other challenged claims depend, directly or indirectly, from those independent claims. Independent claim 75 is illustrative:

> 75. A method for generating a spin-echo pulse sequence for operating a magnetic resonance imaging apparatus for imaging an object, said method comprising:
>
> providing a data-acquisition step based on a spin-echo-train pulse sequence, said data-acquisition step comprises:
>
> > providing an excitation radio-frequency pulse having a flip angle and phase angle;
> >
> > providing at least two refocusing radio-frequency pulses, each having a flip angle and phase angle,
> >
> > > wherein, to permit during said data-acquisition step at least one of lengthening usable echo-train duration, reducing power deposition and incorporating desired image contrast into the signal evolutions, at least one of said angles is selected to vary among pulses to yield a signal evolution for the associated train of spin echoes for at least one first substance of interest in said object, with corresponding T1 and T2 relaxation times and spin density of interest, and to yield a signal evolution for the associated train of spin echoes for at least one second substance of interest in said object, with corresponding T1 and T2 relaxation times and spin density of interest,
> > >
> > > wherein said signal evolutions result in T2-weighted contrast in the corresponding image(s) that is substantially the same as T2-weighted contrast that would be provided by imaging said object by using a turbo-spin-echo or fast-spin-echo spin-echo-train pulse sequence that has constant flip angles, with values of 180 degrees, for the refocusing radio-frequency pulses, and

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